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October 1, 2014

Via Electronic Filing

Ms. Barcy McNeal
Administration/Docketing
Public Utilities Commission of Ohio
180 East Broad Street, 11th Floor
Columbus, OH 43215-3793

Re: NTE Ohio, LLC, OPSB Case No. 14-534-EL-BGN

Dear Ms. McNeal:

NTE Ohio, LLC submits for the public record a copy of the attached Phase II Archaeological Survey for the Middletown Energy Center project.

Please do not hesitate to contact me if you have any questions.

Sincerely,

Sally W. Bloomfield

Sally W. Bloomfield

Attachment

cc: Christina Burri (w/Attachment)

TETRA TECH

September 30, 2014

David M. Snyder, Ph.D., RPA
Archaeology Reviews Manager
Resource Protection and Review
Ohio Historic Preservation Office
800 E. 17th Avenue
Columbus, OH 43211-2474

Subject: Phase II Archaeological Investigation of Site 33BU1071
Middletown Energy Center, City of Middletown, Butler County, Ohio

Dear Dave:

Enclosed please find an original quality hardcopy of the Phase II Archaeological Investigation report completed on behalf of NTE Ohio, LLC by Tetra Tech, Inc.

Based upon the results of the Phase I survey, Tetra Tech had recommended Phase II testing to evaluate the potential site significance of an 8-acre low rise (33BU1071) within the larger agricultural field proposed as the location of the Middletown Energy Center. In accordance with the approved survey protocol, Phase II investigations incorporated an initial geophysical survey. Guided by that geophysical data, Tetra tech excavated 62 shovel test and 29 square meters of measured test units. Artifact recovery was low from plowzone (surface layer) soils, and exceedingly low from all below-plowzone contexts. The low density of the finds can be interpreted as reflecting occasional, short-term occupations of the site through the Archaic period.

Based upon an analysis of materials recovered during the Phase II survey, Tetra Tech finds that the investigated area exhibits (1) no temporal stratigraphy; (2) poor organic preservation in soils; (3) no statistically significant patterning of clustered artifacts; and (4) low artifact density. On the basis of these findings, Tetra Tech concludes that Site 33BU1071 does not contain sufficient integrity and research significance to be considered eligible for listing on the National Register of Historic Places. Tetra Tech, therefore, recommends no further archaeological investigations at the site, and requests concurrence that construction of the Middletown Energy Center will have no adverse effects on significant cultural resources.

If you have any questions or require additional information, please do not hesitate to contact me (978.203.5352 or *lynn.gresock@tetratech.com*). Thank you in advance for your assistance.

Sincerely,

Tetra Tech, Inc.

Lynn Gresock

Lynn Gresock
Environmental Consultant

Phase II Archaeological Investigation of Site 33BU1071

for

Middletown Energy Center

City of Middletown, Butler County, Ohio

Prepared for:

NTE Ohio, LLC

Middletown Energy Center
an NTE Energy Project

Prepared by:

TETRA TECH

1000 The American Road
Morris Plains, New Jersey 07950

September 2014

EXECUTIVE SUMMARY

Tetra Tech, Inc. (Tetra Tech) conducted a Phase II archaeological investigation of Site 33BU1071 (the Site) in the City of Middletown, Butler County, Ohio, for NTE Ohio, LLC (NTE). The investigation was undertaken to support NTE's permit application to the Ohio Power Siting Board (OPSB) for the Middletown Energy Center, a proposed electric generating facility (the Project). Tetra Tech conducted a Phase I survey of the Project in May 2014, and identified a prehistoric archaeological site on a low rise within an agricultural field of the AK Steel parcel. Tetra Tech concluded that the archaeological remains were potentially eligible for listing on the National Register of Historic Places (NRHP), and recommended Phase II testing to evaluate site significance. In correspondence dated June 30, 2014, the Ohio Historic Preservation Office (OHPO) concurred with Tetra Tech's recommendation.

Phase II investigations incorporated an initial geophysical survey of the Site to identify and map potential cultural features by means of magnetic gradient data collection coupled with soil coring. The geophysical survey, undertaken by Ohio Valley Archaeology, Inc. (OVAI) identified 21 subsurface anomalies, classified anomalies by type, and ranked these according to strength of signal data and presence of organic soils. OVAI identified seven anomalies as highly ranked and recommended these for further archaeological investigation. Tetra Tech excavated shovel tests to refine site boundary definitions, and undertook test unit excavations at the seven high-ranked anomalies. Three anomalies were concluded to represent deep plow-scars from historic and/or modern agricultural activities; two anomalies were concluded to be the product of tree-throws; one anomaly was concluded to be a false-positive signal; and one anomaly (No. 15) was concluded to be a shallow cooking or heating pit (Feature 2). A Late Prehistoric arrow point, circa AD 1000-1600, was recovered from intermixed topsoil above Feature 2, and may be an indicator of feature age.

Excavators exposed a shallow cooking or heating pit that had not previously been identified as an anomaly by the geophysical survey. Designated as Feature 1, the pit contained wood charcoal that returned a conventional radiocarbon age of 2800±30 BP [before the present], with a 2-sigma calibrated date of 1015 to 895 BC, placing it at the end of the Maple Creek phase of the Late Archaic period.

The 2014 Phase I survey and Phase II investigation recovered a total of 295 prehistoric stone artifacts from the 8-acre archaeological site, including 210 chipped-stone specimens and 85 fire-cracked rocks. Overall artifact density is low, equaling 1 artifact per 110 square meters. Artifact distribution is broadly clustered within an eastern locus and western locus that are associated with the higher elevations of the rise and their adjacent sideslopes. Accounting for only the delineated loci, artifact density equals approximately 1 item per 45 square meters.

Temporally diagnostic stone tools recovered from the Site include Thebes and Decatur points (Early Archaic period, circa 8000-6000 BC); a Stanly Stemmed point (Middle Archaic period, circa 6000-5000 BC); Brewerton and McWhinney Heavy Stemmed points (Late Archaic period, circa 4000-1000 BC); an

Adena point base (Early Woodland period, circa 800-300 BC); and a Madison triangle point (Late Prehistoric period, circa AD 1000-1600). The Site exhibits no stratigraphic separation between temporally diagnostic finds.

Features 1 and 2 soils were sampled for paleobotanical and paleofaunal analysis. Feature 1 contained a minute quantity of carbonized hickory shell (0.02 grams); neither feature yielded any carbonized seeds or faunal materials. It is concluded that organic preservation within Site soils is poor.

The site setting consists of a low, sandy rise that extends approximately 250 meters in length. Phase I pedestrian reconnaissance and Phase II shovel testing delineated site boundaries and identified two broad clusters of stone artifacts occurring on the eastern and western high points of the rise and on their adjacent sideslopes. Contingency tests (chi-square) were conducted between paired artifact classes to determine whether observed artifact distributions within the two clusters were the product of patterned cultural activities. The chi-square values indicate that statistically significant associations are not present between major artifact classes within the two artifact clusters, and that they represent random distributions.

In summary, the Site exhibits (1) *no temporal stratigraphy*; (2) *poor organic preservation in soils*; (3) *no statistically significant patterning of clustered artifacts*; and, (4) *low artifact density*. On the basis of these findings, Tetra Tech concludes that Site 33BU1071 does not contain sufficient integrity and research significance to be considered eligible for listing on the NRHP. Tetra Tech, therefore, recommends no further archaeological investigations at the Site, and requests concurrence that construction of the Middletown Energy Center will have no adverse effects on significant cultural resources.

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1.0 INTRODUCTION

Tetra Tech, Inc. (Tetra Tech) conducted a Phase II archaeological investigation of Site 33BU1071 (the Site) at the NTE Ohio, LLC (NTE) Middletown Energy Center, a proposed 510 to 525 megawatt (MW) combined cycle gas turbine electric generating facility (the Project) in the City of Middletown, Butler County, Ohio (Figure 1). The investigation was undertaken to support the Project's permit application to the Ohio Power Siting Board (OPSB) pursuant to its rules regarding the development of electric generation facilities (Ohio Administrative Code 4906-13). The Project may require a Nationwide Permit for wetlands from the United States Army Corps of Engineers.

Tetra Tech identified Site 33BU1071 during a Phase I archaeological survey of the Project conducted in May 2014. That Phase I survey, employing pedestrian reconnaissance and shovel testing, recovered a broad scatter of prehistoric chert (flint) tools and chipping debris located on a low sandy rise within an agricultural field (Photographs 1 and 2). Among the recovered tools were diagnostic projectile points attributable to the Early Archaic period (circa 8000 – 6000 BC), Late Archaic period (circa 3500 – 800 BC), and Late Prehistoric (circa AD 1000 – 1600). In addition, Tetra Tech's analysis revealed that the site artifact assemblage contained a range of stone tool types and a variety of chert raw materials that were distributed in two broad clusters on the rise. On the basis of these factors (chronology, tool types, chert types, and artifact clustering) Tetra Tech concluded that Site 33BU1071 was potentially eligible for listing on the National Register of Historic Places (NRHP) (Tetra Tech 2014). Tetra Tech recommended that Phase II archaeological investigation be undertaken to evaluate the site's potential to be NRHP-eligible.

Tetra Tech submitted a Phase I survey report along with a draft Work Plan for Phase II archaeological investigations to the Ohio Historic Preservation Office (OHPO) for comment. OHPO's comment is presented in Appendix A. After consultation with OHPO, Tetra Tech implemented its Work Plan during Phase II testing in August 2014. This report presents the research design, results, and recommendations of the Phase II investigation undertaken in compliance with OHPO's *Archaeology Guidelines* (1994), and in accordance with the *Secretary of the Interior's Standards and Guidelines for Archeological Documentation* (48 FR 44734-37). The report and its findings will meet the requirements for cultural resource protection and scientific standards of current research as defined in OHPO's guidelines and in 36 CFR Part 800 and the *Advisory Council on Historic Preservation Handbook*.

The objectives of a Phase II investigation are to evaluate the context, integrity, and potential significance of a site by the NRHP Evaluation Criteria, and to determine whether these qualities exist to the degree that the site is eligible for listing on the NRHP (NPS 1997). A determination of eligibility requires that any adverse effects by an undertaking that are likely to diminish these qualities must be mitigated through avoidance or the retrieval of data sufficient to preserve its essential significance.

Section 2 of this report describes the Project's environmental setting and cultural contexts. Section 3 presents the Phase II research design, field methodology, and artifact analysis methodology. Section 4 provides the results of the Phase II investigation. Section 5 contains Tetra Tech's conclusions and cultural resource management recommendations.

Lynn Gresock serves as Tetra Tech project manager for the Project. Sydne Marshall, Ph.D., RPA, serves as Tetra Tech cultural resources manager. Robert Jacoby, M.A., serves as Tetra Tech field and lab director; in this capacity, he conducted the background research, developed the research design, supervised the fieldwork, and authored this report. The field team consisted of Mr. Jacoby, Andrew Ericson, Nicole Jacobson, and Jason Kindinger.

2.0 ENVIRONMENTAL SETTING AND PREVIOUS INVESTIGATIONS

2.1 Physiography and Geology

The proposed Project lies within the Southern Ohio Loamy Till Plain physiographic province, a region of low to moderate relief dissected by steep-valleyed streams (Brockman 1998). Bedrock underlying this region consists of interbedded shales and limestones of Upper Ordovician age (ODNR 1991). The Project Area lies entirely within the glaciated portion of Ohio, with at least three Pleistocene glacial advances represented by surficial geology. The pre-Illinoian, dating more than 300,000 years before the present (BP), is the least well known of the three advances and shows limited evidence as ground moraine in the middle Ohio River valley, south of the Project. The Illinoian glacial advance dates from 300,000 to 130,000 BP and is broadly expressed as ground moraine in a sinuous band from southwestern to northeastern Ohio. There is some evidence of the Illinoian episode in southern Butler County in the form of dissected ground moraines. The final glacial advance during the Pleistocene, the Wisconsinan, covered two-thirds of the surface of Ohio in the period from 24,000 to 14,000 BP, and is responsible for sediment deposits above bedrock that range from near-surface to more than 200 feet in depth (Bartels et al. 2014, ODNR 1991).

Another spatial framework for organizing environmental settings is the eco-region, which is defined as an area of similar climate within which ecological communities recur in predictable patterns (Bailey 2005:S14). Conceived at a somewhat finer-grained resolution than the physiographic province, the Loamy, High Lime Till Plains subsection of the Eastern Corn Belt Plains contains fertile soils that supported beech, oak, and sugar maple forests, and elm-ash swamp forests prior to Euro-American settlement (Woods et al. 1998).

The principal drainage in the Project vicinity is the Great Miami River, which drains Indian Lake in Logan County, Ohio, and flows southwesterly to its confluence with the Ohio River west of Cincinnati, Ohio. At its closest approach, the Great Miami River lies approximately 3.7 miles west of the Project. To the east, the Little Miami River roughly parallels the course of the Great Miami River, coming within about 8.7 miles of the Project. The Project parcels are surrounded to the south by Millers Creek, to the west by Shaker Creek and to the north by Dicks Creek, low gradient streams that flow into one another and drain westward into the Great Miami River.

The climate of southwest Ohio is characterized as continental temperate. The 30-year (1981-2010) mean temperature in Hamilton, Ohio is 30 to 75 degrees Fahrenheit (°F), with a mean maximum of 86°F in July and a mean minimum of 21°F in January. The 30-year (1971-2000) mean precipitation in Middletown is 40 inches, with February registering 2.3 inches and May 4.4 inches (NOAA 2014).

2.2 Flora and Fauna

Following retreat of glacial ice, herbaceous plants colonized the glacial landscape, with alders and water birch expanding along drainages. By 12,000 BP, warmer-adapted trees began expanding into the lower Erie-Ontario Lowlands, including white pines, northern hardwoods (birch, alder, beech and hemlock), and oaks. Climate became warmer during the subsequent Boreal period (10,200 to 8000 BP) corresponding with increases of pine, oak, birch, hemlock, and ash across uplands and lowlands. Climatic warming culminated in a period of maximum heat and dryness during the Atlantic climatic period (8000 to 5000 BP), corresponding with increases of oaks and other hardwoods, with hemlocks dominating in moister areas. Late Holocene climates became wetter and cooler during the Sub-Boreal climatic period (5000 to 2500 BP), then warmer during the Sub-Atlantic climatic period (2500 to 500 BP) to a cold period during the Little Ice Age (500 to100 BP). The Little Ice Age marked a significant cold period discernible by the expansion of spruce, northern hardwoods, spruce, and hemlock on uplands of the Appalachian Plateau (Davis 1983).

The present distribution of plants in the site vicinity bears little resemblance to the natural environment first encountered by Euro-American traders and settlers. At the time of earliest Euro-American settlement, nearly all of Butler County was forested with beech and maple communities on better-drained uplands, and elm and ash communities on poorly drained soils. A nineteenth century account of common tree species in Butler County included hackberry, sweet buckeye, box-alder, sycamore, honey locust, black walnut, and shell-bark hickory in the bottomland, and white oak, white ash, black locust, red-bud, elm, and dogwood in upland settings (Western 1882:56-57 and 124-125). The narrative continues that by 1890, 80 percent of the forests had been cut. In the late twentieth century, only around ten percent of the county supported woodland, generally small and isolated stands in poorly drained soils considered unsuitable for cultivation (Lerch et al. 1980:3).

Faunal remains recovered at Sheriden Cave (33WY252), a Paleo-Indian-period site located about 100 miles northeast of the Site, indicate the presence of a wide range of taxa, including caribou, black bear, white-tailed deer, beaver, woodchuck, small mammals, amphibians, and lizards (Redmond and Tankersley 2005:512-513). Many of the same species were present in the Late Woodland archaeological deposits at Chesser Cave, located about 110 miles east of the Site (Prufer 1967a:45). Economically significant mammals mentioned in early written descriptions of the area include bear, deer, wolf, raccoon, fox, opossum, squirrel, and wild turkey, among others (Western 1882). Most large mammals have been extirpated from the vicinity as a result of land clearance and the elimination of habitat.

The Project tract has been used for agricultural purposes since at least the middle of the nineteenth century, and possibly as early as the 1830s. In recent years the field has grown soybeans and corn.

2.3 Soils

Local soils are classified within the Fincastle-Patton-Xenia association, found on nearly level and gently sloping terrain, and derived from loess, glacial till, and glacio-lacustrine silt (Lerch et. al. 1980). The major soil unit at the Site consists of Princeton sandy loam, 2 to 8 percent slopes. This unit is a well-drained soil that occurs on slight rises and knolls within alluvial terraces and relict lakebeds. Its parent material is described as sandy and/or loamy aeolian (wind deposited) material, and the rise on which the Site is situated can be characterized as a dune-like knoll. Soils to the north, east, and southeast of the knoll are classified as Patton silty clay loam. This poorly drained soil was derived from lakebed deposits. Soils along the western margin of the knoll are Ross loam, an alluvium deposited by flooding of Shaker Creek. After heavy rains on August 21 and 22, temporary ponding was observed in low-lying parts of the field containing Patton silty clay loam and Ross loam units. Aerial photos clearly distinguish between the well-drained Princeton and poorly-drained Patton and Ross units, reflecting their disparate composition and drainage patterns.

Shovel test and test unit excavations exposed an Ap-horizon (organic topsoil) of dark yellowish brown sandy loam that ranged in thickness from approximately 20 centimeters to 38 centimeters. Gravel inclusions were generally absent from soils in the western portion of the Site. Small quantities of rounded and subangular gravels were noted in the Ap-horizon in the eastern portion of the Site. The underlying B2t-horizon (subsoil) consisted principally of strong brown to dark yellowish brown sandy clay loam, with increased clay content to the southwest. A layer of massive, blocky, olive brown, C-horizon (parent material) clay was exposed in Test Units 2 and 3, trending surfaceward toward the southwest. Geotechnical soil borings were undertaken on behalf of NTE to evaluate soils for Project construction suitability. Boring No. 07, located near site grid N930/ E1240, identified a clay layer underlying the topsoil to a depth of approximately 3 meters beneath ground surface. This layer is interpreted as late-Pleistocene to early-Holocene lakebed deposits. The total thickness of these lacustrine deposits underlying the Project vicinity is estimated to be between 4 to 6 meters (TTL 2014:8).

2.4 Previous Investigations

Schneider et al. (2007) conducted a Phase I archaeological survey for the Rockies Express pipeline project and identified two small artifact clusters within the AK Steel tract, designated as Sites 33BU1071 and 33BU1072. Site 33BU1071 contained four chert flakes, and Site 33BU1072 contained four chert flakes, two igneous celts, and one grit-tempered Early Woodland pottery sherd. Celts are chisel-like stone tools and are generally assigned in Ohio to the Early Woodland Adena culture (circa 450 BC to AD 100) or Middle Woodland Hopewell culture (circa 200 BC to AD 400) (Converse 1973). Celts are interpreted as heavy duty wood working tools which began to replace grooved stone axes in toolkits at the beginning of the Early Woodland period (Applegate 2008:343, Converse 1973). Schneider et al. concluded that neither site was NRHP-eligible, and recommended no further archaeological investigations.

In May 2014, Tetra Tech conducted a Phase I archaeological survey for the Project, employing a combination of pedestrian reconnaissance and shovel testing within the 35-acre agricultural field of the AK Steel parcel. This field had recently been plowed and rain washed, and ground visibility was generally in excess of 90 percent. The pedestrian reconnaissance identified 51 chert chipped-stone artifacts on the elevated surface of the sandy rise and its slopes. This assemblage included whole and fragmentary bifacial tools and chipping debris, or debitage, manufactured from a variety of local and non-local chert sources. The artifacts recovered on the surface were distributed in two broad clusters, to east and west, separated by a drainage swale that yielded only a few items. The field team excavated ten shovel tests to assess the vertical distribution of artifacts within the soil layers and to gain information on site stratigraphy. Seven of the ten shovel tests yielded stone artifacts, all from the plowzone (topsoil) layer. In all, the Phase I survey recovered 64 chert artifacts from the rise and its immediate margins. Among the diagnostic bifaces was an Early Archaic Thebes point (circa 8000-6000 BC), a possible Early Archaic Decatur, or “fractured-base” point (circa 7000-6000 BC), a Middle Woodland Hopewell point (circa 200 BC-AD 400), and a Fort Ancient serrated point (circa AD 1000-1450).

OHPO site forms indicated that the mapped locations of 33BU1071 and 33BU1072 fell within the broad confines of the artifact clustering identified during the May 2014 survey. After consulting with OHPO’s archaeology survey and data manager, Tetra Tech consolidated Sites 33BU1071 and 33BU1072 together with the new finds as Site 33BU1071. The Ohio Archaeological Inventory site forms were updated to reflect this revised site enumeration.

3.0 PHASE II ARCHAEOLOGICAL RESEARCH DESIGN AND METHODOLOGY

The purpose of a Phase II archaeological investigation is to determine whether a site is eligible for listing on the NRHP and the State Registry of Archaeological Landmarks. Eligibility to the NRHP is based upon the qualities of significance and integrity inherent in a historic property, whether it be a district, site, building, structure, or object: "If the property being evaluated does represent an important aspect of an area's history or prehistory *and* possesses the requisite quality of integrity, then it qualifies for the National Register" (NPS 1997:7). A historic property must meet one or more of the following criteria for evaluation of significance to be considered NRHP-eligible:

- Criterion A – Associated with events that have made a significant contribution to the broad patterns of our history;
- Criterion B – Associated with the lives of persons significant in our past;
- Criterion C – Embodying the distinctive characteristics of a style, period, or method of construction, or that represent the work of a master, or that possess high artistic values;
- Criterion D – Contains the potential to yield information important in prehistory or history.

Prehistoric archaeological sites are almost always evaluated under Criterion D. An archaeological property, prehistoric or historic, is eligible for listing in the state registry of archaeological landmarks if it:

- Possesses integrity of location, context, or materials; and
- Has yielded, or may be likely to yield, information important in furthering the understanding of prehistory or history.

3.1 Phase II Research Design

OHPO (1994:33) has established six Phase II research objectives for the evaluation of site significance. These objectives are:

- Boundary definition of sites;
- Identification of features;
- Artifact distribution;
- Dating;
- Identification of stratified deposits; and
- Botanical/ faunal information potential.

The Phase II research design was crafted to address all six of these objectives. The Site boundary delineated in the Phase I survey was expected to be refined through excavation of a gridded array of shovel tests. While ground visibility was excellent during the May 2014 pedestrian reconnaissance, an expanded shovel testing program was intended to answer basic questions related to the horizontal and vertical distribution of artifacts across the site. Shovel testing was implemented as a useful means of recovering temporally diagnostic artifacts from which periods of site occupations could be inferred. Direct dating of feature or anomaly contexts would be performed through radiocarbon assay of carbonized organic materials. The undertaking of a geophysical (magnetometry) survey, as suggested by OHPO in its initial review of the field protocol, was anticipated to yield relevant data for the identification and excavation of cultural features. Paleobotanical and paleofaunal potential was addressed through the collection of soil samples from all excavated features and anomalies. Deep stratified deposits were not anticipated to be identified at the site because alluvial processes deriving from Shaker Creek do not appear to have been sufficiently energetic to overtop the site rise. The Phase I retrieval of projectile points attributable to different periods from exposed surface contexts suggested the occurrence of only limited sedimentation on the site since the early Holocene. However, wind-blown sediments may have contributed to the burial of former occupational surfaces resulting in the vertical separation of temporal units. The presence of features, stratified deposits, or botanical/faunal material is not always necessary or sufficient to evaluate a site for NRHP eligibility. At a minimum, however, OHPO identifies that site boundary definition, artifact distribution, and site dating are essential for a determination of significance.

Geophysical surveys have been utilized with increased occurrence in recent years in Ohio and elsewhere as important adjuncts to the standard Phase II archaeological testing program (e.g., Burks 2007). Tetra Tech chose magnetic gradient and magnetic susceptibility surveys as geophysical techniques to complement shovel testing for identifying potential features.

No historic period artifacts were recovered during the Phase I survey. Historic county atlas and USGS quadrangles do not depict any buildings or structures within the site boundary. The nearest map-documented structure is the Christian Holly residence (Everts 1875), which appears to have been located approximately 300 meters (1,000 feet) northwest of Site 33BU1071, and 250 meters (820 feet) outside of the Project boundary. It is presently non-extant. Based upon these findings, it was considered unlikely that a historic period archaeological resource would be identified during Phase II testing.

3.2 Field Methodology

In accordance with OHPO guidelines, shovel tests were arrayed at intervals of 15 meters in parallel, staggered transects across portions of the site to evaluate site boundary and stratigraphy, collect diagnostic artifacts, and to identify subsoil staining that may indicate the presence of intact cultural features. Shovel tests measured 50 x 50 centimeters, and were excavated to a depth sufficient to demonstrate that subsoil strata were sterile of cultural deposits.

The results of the geophysical survey and shovel tests were used as a guide for the placement of test units, to investigate identified magnetic anomalies and areas of high artifact concentrations. Excavated test units measured 2x2-meters to be of sufficient size to “capture” subsoil anomalies in plan view. Test units were excavated by 1x1-meter quadrants, designated as southwest, northwest, northeast, and southeast. Plowzone soils were excavated to the interface of the B-horizon, at which point the entire unit was trowelled to reveal any staining or disturbance that could be associated with the mapped magnetic anomaly. Anomalies and features identified in plan view were mapped, photographed, and bisected. Bisected anomalies/features were excavated to reveal a complete long-axis profile, which was sketched and photographed. Soil samples for flotation were collected from the bisected portion of each anomaly/feature.

All excavated soil (shovel tests, test units, and anomaly/features) was screened through 0.25-inch mesh sieves to facilitate systematic artifact recovery. All recovered artifacts were retained for cleaning, identification, and inventory. Results of each shovel test and test unit, including its stratigraphy or soil horizons, were recorded using standard terminology such as United States Department of Agriculture (USDA) soil texture categories and Munsell color codes. All excavated soil was backfilled upon completion of the excavation.

3.3 Laboratory Methods and Analyses

Artifacts recovered from the Phase I survey were brought to Tetra Tech's lab for cleaning, analysis, and cataloguing. This three-step procedure led from in-field artifact collection to the compilation of an artifact database and the preparation of artifacts for long-term curation. A complete artifact inventory is presented in Appendix B.

Tetra Tech staff employed a sortable spreadsheet to compile an artifact inventory for data manipulation and storage. Attribute fields recorded locational data, functional classes, material types, counts, and other descriptive traits when appropriate.

The analysis of prehistoric lithic artifacts was grounded in an approach linking attributes of form and function to particular stages in stone tool reduction and use strategies (Andrefsky 1998, 2001; Callahan 1979; Clark 1986; and Crabtree 1972). Emphasis was also placed on the identification of projectile points within the context of regionally recognized cultural horizons. The texts of Prufer and McKenzie (1967), Converse (2007), and DeRegnaucourt (1991) on Ohio archaeology were particularly important in this regard.

All lithic artifacts were classified into major type, including debitage, biface, uniface, and fire-cracked rock. Analysis then proceeded to categorize artifacts by sub-type yielding a typology that combines tool-making debris with a continuum of end-products representing manufacturing failures, single-use tools, and rejuvenated tools, as well as thermally altered specimens. Formal lithic categories include:

- *Debitage*. All types of chipped-stone refuse, or debris, that bear no obvious traces of having been utilized or intentionally modified. Debitage forms reflect a continuum from initial reduction of a cobble or block to final preparation and rejuvenation of a tool. Decortication flakes (DF) are the first series of debitage detached during lithic reduction and typically exhibit 50 percent or more cortex covering their outer, or dorsal, surface. Early reduction flakes (ERF) are early-stage debris that display limited evidence of prior reduction and contain less than 50 percent dorsal cortex. Biface reduction flakes (BRF) are generated during the middle and late stages of biface production and maintenance, and generally have no dorsal cortex. Flake fragments (FF) are sections of flakes that are too fragmentary to be assigned to a particular flake type. Block shatter (BS) are angular or blocky fragments resulting from uncontrolled fracturing along inclusions or internal cleavage, usually produced during early reduction of cores and bifaces.

- *Cores*. Stone cobbles or blocks that have been used as a nucleus for the production of tools or prepared flakes. Various core types can be described that reflect differing techniques for tool, flake, or blade production.

- *Bifaces*. A flake or core that has had multiple flakes removed from the dorsal and ventral surfaces to reveal 'two faces,' (thus, bi-face). Bilateral symmetry and lenticular cross-sections are common attributes. Included are early-, middle-, and late-stage bifaces reflecting the degree of reduction and removal of cortex, as well as all hafted and unhafted bifaces that functioned as a tool. Projectile points/knives are finished bifaces that functioned as projectiles or knives hafted onto spears, arrows, or handles. Choppers are sizable bifaces that may have been employed in tasks requiring heavy-duty cutting, chopping, or severing. Drills are slender bifaces that could have been used as a perforator or awl to work leather, wood, or bone.

- *Unifaces*. Can be a formal tool or an informal expedient tool used for tasks requiring a plane or scraper. Formalized tools are fashioned from a flake or block by uniformly retouching its edges to create a specific working angle and a standardized shape. Informal expedient unifaces are unmodified flakes or minimally shaped flakes.

- *Cobble Tools*. Stream and glacial cobbles were used as, hammers, anvils, grinding stones, or a combination of purposes.

- *Groundstone Tools*. Formal stone tools and ornaments that were manufactured by pecking, grinding, and sometimes flaking soft stone, such as slate, serpentine, and greenstone. Typical artifact types are grooved axes, celts, smoking pipes, and pendants.

- *Fire-Cracked Rock*. Cobbles and/or blocks that were used in heating and cooking activities. These typically exhibit angular fractures and may be thermally discolored red or black.

All chipped-stone artifacts were analyzed for the amount of remnant cortex, or patinated rind, on their surfaces. A number of studies (e.g., Andrefsky 1994; Johnson 1989; Seddon 1992) have demonstrated relationships between cortex and such variables as stages of reduction, distance from lithic sources, and the size of raw material nodules. The degree of remnant cortex on an artifact was cataloged as Cortex Rank. An item with no remnant cortex was classified as Cortex Rank 0; those with <25 percent remnant cortex were classified as Cortex Rank 1; 25-50 percent remnant cortex was classified as Cortex Rank 2; and >50 percent remnant cortex as Cortex rank 3 (see Appendix B).

Two types of cortex were identified: cobble and block. Block cortex refers to chunks, or blocks of stone that were quarried from an outcropping. Typically, the cortex surface on these pieces is somewhat roughened and flat, reflecting internal cleavages within the rock matrix. Items exhibiting block cortex were classified as Cortex Type 1. Cobble cortex refers to a piece of rock that has been stream or glacial-rolled, producing a rounded to sub-rounded cobble or gravel with a smoothed and weathered outer surface. Items exhibiting cobble cortex were classified as Cortex Type 2. Artifacts without cortex were classed as Cortex Type 0. The characterization of artifacts by their lithic raw material was a key element in the analysis. Toward this goal, DeRegnaucourt (1991), Foradas (1994), and Converse (2007) proved to be valuable references due to the variety of chert types recovered at Site 33BU1071.

4.0 PHASE II RESULTS

4.1 Geophysical Survey

Ohio Valley Archaeology, Inc. (OVAI) conducted a geophysical survey of the site for Tetra Tech. OVAI's methodology, results, and conclusions are presented in Appendix C. OVAI collected two types of magnetic datasets, magnetic gradient, and magnetic susceptibility, representing different magnetic properties of site materials. Sediments (soils and rocks) that have been subjected to temperatures in excess of approximately 500-700° Celsius (e.g., from campfires, forest fires) will undergo realignment of their magnetic polarity depending on the duration of heat exposure and the presence of magnetic minerals (Burks 2007). Contrasts (gradients) between magnetically realigned sediments and nearby non-heated sediments, measured in nanoteslas (nT), can be detected by instruments such as a gradiometer. The magnetic gradient survey identified and recorded locations of elevated nT values, and generated site maps from the recorded data delineating areas of high and low magnetization.

Magnetic susceptibility is a measure of a material's (e.g., sediment, rocks) ferromagnetic potential in response to an applied magnetic field. Organic-rich topsoils intrinsically exhibit more intense magnetic force than subsoils which contain higher clay (organic-poor) content (Burks 2007:3). Ground disturbing activities that might result in the displacement of topsoil and subsoil into reverse stratigraphic order, such as animal burrows, tree-throws, and prehistoric pits, should in principle be detectable by magnetic susceptibility survey. The magnetic susceptibility of surface soils can be somewhat enhanced through the addition of organic waste (e.g., food, charcoal, feces) generated in prolonged or cyclic occupation by people.

The instrument used to record magnetic gradient data was a Geoscan Research FM 256 fluxgate gradiometer, which also indiscriminately detects susceptibility values. OVAI conducted the magnetic gradient survey prior to the start of excavations, and returned during the last week of the Phase II to perform a magnetic susceptibility survey over selected portions of the site. After post-processing the gradient data to minimize noise and stitch together transect files, OVAI cored mapped anomalies of interest at their centerpoint and at radial positions between 1 to 2 meters from the center. Coring allowed an immediate assessment of anomaly soils and provided a rough estimate of the size of each anomaly. A 1-inch diameter split-spoon core was initially employed but due to the excessive dryness and compaction of site soils, it was replaced by a 1-inch power augur. OVAI identified 21 magnetic anomalies, ranking them according to their peak amplitude signal and by the results of coring. Based on these parameters, seven anomalies (Nos. 5, 6, 7, 8, 15, 16, and 17) were interpreted as "highly likely" cultural features, and recommended for Phase II excavation. Table 2 in Appendix C presents information on the identified anomalies.

The magnetic gradient survey identified several linear anomalies that were interpreted as relict drainageway features and historic fence lines and were not assigned anomaly designations. The nature and orientation of the historic fence lines was confirmed by reference to historic aerial photographs (1938 and 1964) archived by the Butler County (Ohio) Soil and Water Conservation District (see Appendix C: Figure 1). The relict drainageway features are interpreted as the product of high-energy flood events from Shaker Creek or streamflow from early Holocene impoundments.

Anomaly 3 was mapped and identified by magnetic gradient survey as a "rock, small possible pit" based on the magnetic signal and coring. The location of the anomaly corresponds with the location of Phase I Shovel Test 40. This correspondence was confirmed by GPS navigation to the shovel test location. It is concluded that Anomaly 3 is the backfilled shovel test.

4.2 Shovel Testing

Sixty-nine shovel tests were placed in staggered transects at 15-meter intervals across the site to (1) delineate horizontal boundaries of artifact recovery; (2) obtain information regarding site stratigraphy; and, (3) recover temporally diagnostic artifacts (Figure 2). In all, 50 pieces of chert debitage and 1 piece of window glass were recovered from 29 positive shovel tests. All artifacts were recovered from plowzone contexts. The site boundary delineated from shovel testing essentially corresponds with that identified in the Phase I pedestrian reconnaissance, and confirm the presence of two primary artifact clusters, or loci. The eastern locus and western locus occupy the higher elevations and immediate side slopes of the site rise, and are separated by a drainage swale from which few artifacts were recovered.

4.3 Test Units

Eight 2x2-meter test units were placed to investigate the seven highest ranked magnetic anomalies and areas of high artifact density from shovel test results. Test Units 1, 2, 3, 4, and 8 were located in the western locus, and Test Units 5, 6, and 7 were located in the eastern locus (Figure 2).

4.3.1 Test Unit 1

Anomaly 5 was identified as a "possible pit" from data retrieved during the magnetic gradient survey. It was investigated by the excavation of Test Unit 1 (N947.1 E1082.2) (Figure 2). The Ap-horizon was characterized as dark yellowish brown sandy loam with rare quantities of angular gravel and yielded 24 prehistoric artifacts, consisting of 15 debitage, 8 fire-cracked rocks, and 1 biface (Appendix B). The biface is classified as a McWhinney Heavy Stemmed projectile point, which was the principal point type of the Central Ohio Valley Archaic phase of the Late Archaic period, circa 3400-2500 BC, and continuing into the Maple Creek phase of the Late Archaic period, circa 2500-800 BC (Justice 1987:138-139; Vickery 2008:9). The debitage chiefly consists of late-stage thinning flakes.

At the interface between the plowzone and subsoil, excavators noted the presence of parallel plow-scars across the western portion of the test unit (Figure 3; Photograph 3). After the plow-scars were excavated, no soil staining or anomalies were visible on the trowelled and water-sprayed subsoil surface. Two 10-centimeter levels were excavated into the sandy clay loam B2t-horizon. No artifacts were recovered from subsoil contexts.

Anomaly 5 is concluded to be deep plow-scars exposed at the Ap-/B2t-interface.

4.3.2 Test Unit 2

Anomaly 6 was interpreted as a "rock, possible pit" from magnetic gradient data and was investigated via Test Unit 2 (N935.7 E1092) (Figure 2). The test unit yielded only one flake and four small cracked rocks in the Ap-horizon. Well-defined plow-scars were noted at the Ap-/B2t-interface and overlap with the mapped location of the Anomaly 6 centerpoint (Figure 4 and Photograph 4). No artifacts were recovered in the subsoil. The B2t-horizon thins conspicuously to the south and overlies a thick layer of C-horizon blocky clay. The clay is interpreted as lakebed sediments deposited during the late-Pleistocene or early-Holocene epoch, and in the vicinity of the site exhibit an overall thickness of around 3 meters (TTL 2014:8). In plan view the demarcation between the sandy clay loam B2t-horizon and the surfaceward-trending clay C-horizon is very distinct (Photograph 5), although at 40 centimeters below ground surface it is possibly too deep to have triggered a magnetic susceptibility response.

Two large root casts were noted in the east profile (Figure 4). Both have distinctive 7.5YR-colored 'halos,' or rims, around their outer edges. The northern root cast lies entirely within the B2t-horizon, while the southern root cast extends into the C-horizon clay. These casts are offset from the mapped anomaly centerpoint by about 1 meter, and are probably too small to be responsible for the magnetic signal that identified Anomaly 6.

Anomaly 6 is concluded to be deep plow-scars noted at the Ap/B2t-interface.

A soil stain was noted in the northeast quadrant of Test Unit 2 and was treated as a separate anomaly. It yielded one flake and one FCR in its first excavated level, and 2 flakes in the second excavated level. This anomaly extended into the northern wall of the test unit and was "chased" by Test Unit 8. A description of this anomaly/feature and its interpretation is presented below in Section 4.3.8.

4.3.3 Test Unit 3

Anomaly 7 registered the highest peak amplitude during the magnetic gradient survey, with the exception of a large, modern pit of buried fence posts and wire (Anomaly No. 23) (Appendix C). OVAI interpreted the signal/core results of Anomaly 7 as highly likely of an "earth oven, possible rock" signature. It was investigated with Test Unit 3 (N932.5 E1102.8) (Figure 2).

Excavation of the plowzone yielded 45 artifacts, comprising 25 debitage, 13 fire-cracked rocks, 1 core, and 6 historics (Appendix B). Exposure of the Ap/B2t-interface revealed a diffuse light-colored stain extending across the northwestern quadrant and a portion of the northeastern quadrant in the shape of an irregular oval (Figure 5; Photograph 6). In planview, Anomaly 7 measured around 125x80 centimeters, and exhibited well-developed root casts with distinctive light yellowish brown halos. Extending off its northwest edge was an amorphous dark yellowish brown zone. Surrounding the anomaly, the dark yellowish brown, sandy clay loam B2t-subsoil displayed moderate amounts of manganese staining with increased clay content in the matrix trending from northeast to southwest. Four artifacts were recovered in the 10-centimeter level excavated into subsoil outside of the anomaly. These finds include a late-stage biface with cobble cortex, 2 fire-cracked rocks, and 1 chert flake.

Excavators bisected Anomaly 7 along its long axis, opening a 150x50-centimeter trench running southwest to northeast. Three small fire-cracked rocks and three thinning flakes were recovered from the top 10-centimeter excavation level of the anomaly, and one thinning flake and one fire-cracked rock were found in the second excavated level (32-42 centimeters below ground surface). No artifacts were recovered beneath level 2 to the base of the anomaly. Soil samples were collected from levels 3 and 4 and were submitted for flotation processing and analysis (Appendix E). Plant macro-remains included carbonized wood charcoal fragments (N=8, weight=0.09 grams), carbonized hickory shell (N=3, weight=0.02 grams), and uncarbonized seeds. Analysis of the charcoal identified pine, red oak, non-specifiable deciduous taxa, and unidentifiable fragments. The uncarbonized seeds included goosefoot/knotweed, carpetweed, purselane, and grass, and are interpreted as modern intrusions through bioturbation access.

Anomaly 7 extended 30-40 centimeters into the B2t-horizon (sandy clay loam), and another 30 centimeters into the C-horizon, composed of very compact, blocky clay (see Section 2.3). In all, the anomaly fill was 78 centimeters thick, and consisted of four interior strata of well-developed, compact sandy loam and sandy clay loam (Figure 5; Photographs 7 and 8). Root casts with yellowish brown halos were present in the upper 25 centimeters of the anomaly fill. In profile, the southwestern wall of the anomaly was nearly vertical; the northeastern wall exhibited slight undulations with an overall slope of approximately 60 degrees. The anomaly base was flat to slightly concave. At the nadir of the anomaly was a vertically-oriented zone of brown sandy loam (Zone 6 in Figure 5). Overlying this soil was a compact, strong brown sandy clay loam with many gray mottles that occupied most of the bottom-third of the anomaly and exhibited an elliptical upper surface (Zone 5). The central portion of the anomaly was characterized by an irregularly-shaped lens of yellowish brown sandy clay loam with many gray and dark yellowish brown mottles (Zone 4). The upper strata (Zones 1 and 2) are the light-colored soils visible in the opening plan view of the anomaly. To the northwest, Zone 3 suggests an animal burrow or other disturbance.

The basic morphology of the excavated anomaly has some similarities with a category of large Late Prehistoric period features referred to as storage, or silo pits (McKenzie 1967:66-67; Pollack 2008:647).

Silo pits were deep, steep-walled, flat-bottomed pits that were utilized to over-winter surplus foodstuffs, such as maize, nuts, and root crops. Most recorded pits of this type excavated in Ohio contained dark, organic-rich soil that intruded into the surrounding lighter-colored subsoils, and which typically yielded some paleobotanical or paleofaunal remains in addition to lithic and/or ceramic evidence. This feature type contrasts with a similar category of large pit features, Archaic-period cooking facilities, or earth ovens. Abundantly found at Ohio River valley sites and across southern Ohio, these oval-shaped roasting pits tended to be more shallow and less vertical than the silo pits, and usually contained mixed contents of fire-cracked rocks, charcoal, thermally reddened soils, and some form of organic and non-organic artifactual remains (Purtill 2008:49-52, 2009:584-586). In terms of the underground storage of foodstuffs, non-porous clayey subsoils would have been preferred to porous sandy soils because of their greater capacity to inhibit water flow. The blocky C-horizon clay through which the anomaly extends might have been an ideal environment for food storage. Although highly resistant to the sharpened steel shovels of the site excavators, the clay might not have been an insurmountable barrier to stone hoe-wielding Native Americans willing to expend considerable time and effort in digging a deep storage pit.

Anomaly 7's internal structure and contents, however, suggest an alternative interpretation of its genesis, one that corresponds well with that of a large tree-throw dating from some point in the Archaic period. An estimate of the age of Anomaly 7 fill stems from a pedologic analysis of root cast zonation and soil development. On examination, the root cast cores are finer grained than the root cast rims (the "halos"), with the cores tending to be grayish in color and the rims an oxidized strong brown to yellowish brown. The differential development of root cast cores and rims is a result of gradual physical and chemical processes, including the movement of water and dissolved ions through the soil, the progressive accumulation of iron in rims through alternating oxidation/reduction regimes, and the gleying of cores due to the decreased permeability of the rims. The age of the zonation exhibited by the root casts within Anomaly 7 fill is estimated to be on the order of several thousand years based on the model of fossil root cast genesis developed by Mossa and Schumacher (1993) (Figure 6). In their model, root rims exhibit oxidation coloring and manganese staining approximately 10,000 years after initial tree growth. The root casts in Anomaly 7 exhibit oxidation but no manganese staining, suggesting an intermediate age for the anomaly fill. In contrast, manganese staining is present in the lower portion of the B2t-horizon, indicating a longer period of soil development. The margins of the anomaly are ill-defined in plan and profile, exhibiting a "fusion" or blending between re-deposited fill and subsoil, an indicator of long-term soil development along the zone of contact between them.

Zone 6 is interpreted as a remnant central taproot. Mature red oaks, for instance, are supported by a taproot that can reach one meter or more in length and several centimeters in diameter in friable soil (Lyford 1980:10-11). Rocks or heavy clay soils, however, will divert roots laterally unless they can find a structural weakness or prior disturbance to exploit. The taproot noted at the base of Anomaly 7 is unlikely to have penetrated the blocky clay on its own unless the C-horizon had been loosened by a tree-throw of some previous generation of trees, or by the presence of an excavated and abandoned pit. Yet meter-plus-deep storage pits are virtually unknown from the Archaic period in the region. The Greenlee Tract sites in southern Adams County, Ohio, contained several Middle and Late Archaic pit features with an average depth of approximately 30 centimeters and a single pit in the range between 40-60 centimeters deep (Purtill 2012:124-128). Not until Middle Woodland contexts at Greenlee (circa 100 BC-AD 300) did silo pits approach meter depths. In the American Bottom of Illinois, "deep" Archaic period pits were considered to be from 30-60 centimeters in depth (Yerkes 1987:63).

If a large tree had become established within an abandoned pit, its growth, presence, and eventual collapse would have re-worked and re-mixed the contents, eliminating evidence of primary deposition and generating new strata. Anomaly 7 is concluded to represent a sequence of cultural and non-cultural processes terminating as a likely tree-throw.

4.3.4 Test Unit 4

Anomaly 8 was interpreted as a "possible pit" by the geophysical survey, and was investigated by Test Unit 4 (N927 E1103.5) (Figure 2). The dark yellowish brown, sandy loam Ap-horizon yielded one decortication flake exhibiting possible unifacial retouch. An amorphous dark yellowish brown stain was discerned at the Ap/B2t-interface. It was characterized by an irregular oval shape (Stratum 1) and a transitional outer ring of sandy clay loam with abundant light yellowish gray mottles and manganese staining (Stratum 2) (Figure 7; Photograph 9). Anomaly 8 measures approximately 120x100 centimeters in plan view.

The anomaly was bisected along its east-west long axis by the excavation of a 165x50-centimeter trench (Figure 7; Photograph 10). No artifacts were recovered in the anomaly fill or the adjoining subsoil layer. Neither soil reddening nor charcoal was noted during the excavation of the anomaly. In profile, Stratum 1 and Stratum 2 resolve into a thin upper lens (Stratum 1) and an underlying matrix with a highly irregular base (Stratum 2). Flotation samples yielded 0.02 grams of carbonized wood charcoal consisting of hickory and unspecified deciduous wood. No carbonized nuts or seeds were recovered (Appendix E). Non-carbonized seeds included goosefoot/knotweed, sheepsorrel, and panic/foxtail grass. All the non-carbonized seeds are concluded to be modern intrusions via bioturbation transport.

Anomaly 8 is concluded to be non-cultural, a tree-throw of a shallow-rooted species, such as red maple, willow, or ash.

4.3.5 Test Unit 5

Anomaly 15 was interpreted as a "possible pit" following the magnetic gradient survey (Appendix X), and was investigated by Test Unit 5 (N934.4 E1196) (Figure 2). The excavators recovered 1 debitage, 1 probable triangle point, and 14 small fire-cracked rocks from the sandy loam plowzone soils. The plowzone fire-cracked rock weighed 533 grams with a mean weight of 27 grams per element.

A brown sandy loam stain was distinguished at the Ap/B2t-interface in the southwest quadrant and small portions of the southeast and northwest quadrants (Figure 8; Photograph 11). The anomaly boundaries were not sharply defined, as the anomaly and surrounding subsoil differed only slightly in color and texture. Excavators bisected the anomaly along its east-west axis, opening a 130x50-centimeter trench (Photograph 12). Recovered artifacts consisted of 20 small fire-cracked rocks, with a total weight of 919 grams and a mean weight of 46 grams per rock. Four of the fire-cracked rocks were mends from a single original cobble, and three other pieces appeared to be from the same nodule based upon their color and texture. No flakes or other knapped-stone artifacts were found within the excavated anomaly soil, or in the surrounding subsoil layer. No charcoal flecking or thermally altered soil was noted.

The flotation analysis (Appendix E) identified two carbonized wood charcoal fragments weighing 0.02 grams of unspecific deciduous species. No carbonized nutshells or seeds were recovered. Non-carbonized seeds included goosefoot/knotweed, carpetweed, and purselane, all concluded to be modern intrusions.

Although charcoal and soil reddening were not observed, evidence of high temperature is present in the form of the fire-cracked rocks recovered in the anomaly fill and overlying plowzone soil. Together, the rocks number 33 elements and weigh 1,418 grams, being the largest cluster of fire-cracked rocks onsite and accounting for 39 percent by count and 46 percent by weight of the site total.

It is concluded that Anomaly 15 is a shallow pit of prehistoric cultural origin, possibly a cooking/heating hearth. The absence of charcoal, thermally-altered soil, botanical remains, and chipped-stone artifacts suggest that this pit feature witnessed limited use. A tentatively identified Late Prehistoric triangle point (Cat# 24.1) was recovered directly above Feature 2 in plowzone soil, and may be an indicator of feature age (see Section 4.5.5 below for a description of the point).

4.3.6 Test Unit 6

Anomaly 16 was identified by magnetic gradient survey and described as a “possible pit” (Appendix C). The anomaly was investigated by Test Unit 6 (Figure 2). The plowzone consisted of dark yellowish brown sandy loam and contained 1 bifacial midsection fragment, 1 micro-blade core, 15 debitage, 11 fire-cracked rocks, and 1 piece of aqua bottle glass with embossed letters. The biface midsection is manufactured of unidentified chert and is too fragmentary to ascribe overall form, size, or flaking technique. It is a late-stage specimen and is lenticular in cross-section. The damage appears to be plow-inflicted judging by advanced patination of intact surface. The small, exhausted core is Upper Mercer chert, and exhibits several parallel flake scars around its distal pole from which long, narrow blades were struck. The debitage consists principally of late-stage bifacial thinning flakes and flake fragments.

A series of parallel plow-scars was revealed at the Ap/B2t-interface (Figure 9; Photograph 13). After excavating the plow-scars and trowelling the strong brown B-horizon surface, excavators did not identify any soil staining or disturbances that might have been associated with a subsurface anomaly or feature.

An excavation level within the subsoil yielded no artifacts, charcoal, or other evidence of cultural activities.

Anomaly 16 is concluded to be the observed plow-scars at the Ap/B2t-interface.

4.3.7 Test Unit 7

Anomaly 17 was classified as an "irregular, possible pit" by magnetic gradient survey (Appendix C), and investigated with Test Unit 7 (Figure 2). The dark yellowish brown, sandy loam Ap-horizon yielded 1 Thebes Early Archaic point, 1 biface base, 1 micro-blade core, 8 debitage, and 1 fire-cracked rock. The Thebes point (circa 8000-6000 BC) is made from a light gray quartzitic chert that weathered to a buff with a few oxidized spots. The point exhibits basal and notch grinding. The blade has beveled edges resulting from repeated sharpening. It was found in two pieces from separate quadrants, apparently the result of agricultural plow damage. The biface base is formed on fine-grained bluish-gray chert. It is well-thinned and is interpreted as an Adena point base, circa 800-300 BC (Justice 1987:192). The core is small, conical-shaped, and exhibits several parallel flake negatives from which micro-blades were detached. The material is an unidentifiable fine-grained chert. The debitage includes early reduction and bifacial thinning flakes. No artifacts were recovered from subsoil contexts.

Exposure of the Ap/B2t-interface revealed no discernable plow-scars. No soil staining or disturbances were noted on the surface of the B2t-horizon, nor at the base of the excavated subsoil level. It is concluded that the magnetic signature of Anomaly 17 is a response to the thin occupational midden that is present across much of the site within the Ap-horizon.

4.3.8 Test Unit 8

During the investigation of Anomaly 6, excavators noted an oval soil stain in the northeast quadrant of Test Unit 2 and treated it as a separate anomaly. It had not been identified by the magnetic gradient survey. In plan view and profile, this soil staining extended to the north of Test Unit 2 (Figure 10; Photograph 5). Test Unit 8 was positioned to expose and investigate the north half of the staining, referred to as Feature 1 (Figure 2).

Three artifacts were recovered from the plowzone above Feature 1 from Test Units 2 and 8; 1 late-stage biface, 1 bifacial reduction flake, and 1 fire-cracked rock (Appendix B). The biface is a midsection fragment of Upper Mercer chert. Artifacts recovered from Feature 1 fill included three fire-cracked rocks and two bifacial reduction flakes.

Feature 1 fill consisted of yellowish brown compact sandy loam with strong brown mottles, and measured approximately 165x125-centimeters (Figure 10; Photograph14). The base of the feature reaches 65 centimeters below ground surface. One small charcoal fragment was collected and returned a conventional radiocarbon age of 2800±30 BP (Beta-389353) (Appendix F). The two-sigma calibrated date is 1015-895 BC, placing it in the late Maple Creek phase of the Late Archaic period. McWhinney Heavy Stemmed points are diagnostic of the Maple Creek phase (Vickery 2008:20). The lone McWhinney point in the site assemblage was recovered in plowzone soil approximately 15 meters northwest of Feature 1 in Test Unit 1. Flotation analysis of Feature 1 fill identified two small carbonized hickory (*carya* spp.) shell fragments, suggesting an autumn occupation. No carbonized seeds, faunal remains or microdebitage were recovered. Non-carbonized seeds from feature fill include goosefoot/knotweed and carpetweed, and are interpreted as modern intrusives.

Feature 1 is concluded to be a small cooking hearth or earth oven dating from circa 1000-900 BC. The low quantity of recovered fire-cracked rock, paleobotanical remains, and charcoal within a homogeneous fill matrix suggest that the pit was scavenged for rocks to be used elsewhere, and that the abandoned pit filled with soil through erosion and wind.

4.4 Artifact Analysis

The 2014 Phase I survey and Phase II testing recovered a total of 311 artifacts from surface and subsurface contexts. The assemblage comprised 295 prehistoric lithic artifacts and 16 historic artifacts. The historic artifacts consist of seven small brick fragments, two pieces of window glass, six glass bottle shards, and one unidentified fragment of plastic. The prehistoric artifacts include 184 debitage, 20 bifaces, 2 drills, 4 cores, and 85 fire-cracked rocks. Table 1 presents the distribution of lithic artifacts by site locus. Lithic raw materials identified in the assemblage included local sources (pebble cherts, Four Mile Creek chert, and slate) and a variety of non-local cherts (e.g., Delaware, Vanport, Upper Mercer, Cedarville-Guelph, and Indiana hornstone). Among the identifiable materials, Delaware, Vanport, and Upper Mercer cherts were the principal varieties. The debitage frequency by raw material is presented in Table 2.

The ratio of chipped stone tools (N=22) to debitage (N=184) is approximately 1:9. This value is relatively high (i.e., a higher percentage of tools) compared with other southern Ohio sites. At the Houpt Site (33BU477), located about 18 kilometers southwest of 33BU1071, the ratio of chipped stone tools to debitage was 1:16 (Duerksen and Doershuck 1998:105); at the Davisson Farm Site in Lawrence County the ratio was 1:13 (Purtill 2008:55); and at the Greenlee Tract Sites in Adams County the recorded ratio between tools and debitage was 1:30 (Purtill 2012:61-62). The high tool to debitage ratio is interpreted as an indicator that late-stage biface reduction and tool maintenance activities were the prevailing lithic industry at Site 33BU1071. Early-stage cobble and block reduction typically produces generous quantities of debitage as both whole flakes and block shatter, whereas late-stage reduction yields fewer total flakes and a higher percentage of flake fragments (Sullivan and Rozen 1985:763). While there is evidence that some decortication and early-reduction activity occurred onsite at 33BU1071, it appears to have been a minor component of chipped-stone taskwork. Table 3 presents information on debitage subtypes recovered at the site. Flake fragments represent the most common debitage subtype in the assemblage, and a majority of these were broken bifacial thinning flakes, a byproduct of late-stage tool making and rejuvenation.

The biface sample includes nine hafted points, three point fragments, four late-stage bifaces or fragments, two drills, one middle-stage biface fragment, one early-stage chopper, and one expediently chipped slate knife. Temporally diagnostic points and point fragments are described below in Section 4.5. None of the complete points, late-stage bifaces, or drills exhibits any remnant cortex. The early-stage chopper (Cat# 76) is a small cobble with just a few flakes removed to form a rudimentary jagged edge. The drills (Cat# 67 and Cat# 70) are manufactured from fine-grained cherts (Photograph 15). The former has a flared base with well-ground base; the latter is a midsection fragment. The slate biface (Cat# 72) is a half-moon shaped knife, or ulu, 69 millimeters long and 9 millimeters thick (Photograph 15). Slate was often ground or polished in Ohio to create pendants and figurines of a wide variety during the Archaic and Woodland periods. Cat# 72 was neither ground nor polished, and instead exhibits expedient flaking along its curved margin to create a working edge.

The four recovered cores (Cat#s 02, 11, 26, and 34.2) represent end-state, or "exhausted" specimens, from which nearly all usable stone has been detached for flake tools. They are thus, on the whole, quite small, weighing between 1.5 grams to 33 grams, with a mean weight of 11.8 grams. Cat# 011, alone, has remnant cobble cortex and is the largest of the group. Cat# 26 and 34.2 are wedge-shaped microblade cores, from which very thin and narrow blades were detached. These microblades, or "bladelets," are believed to have been used as insets in composite wood and stone tools. These diminutive cores are made of fine-grained cherts and were recovered in the eastern locus. The two larger specimens are flake cores from the western locus (Photograph 16).

Whole classes of common Native American artifacts were not recovered in the 2014 Phase I survey or Phase II testing. These "missing" types include, groundstone tools (e.g., metates, axes), cobble tools (e.g., hammerstones, pestles), and pottery. The uniface category is represented by Cat# 6.1, a McWhinney Heavy Stemmed point re-sharpened to a scraper edge. However, no formal scrapers or retouched flakes were identified in the site assemblage.

The historical artifacts are found clustered in the western portion of the Site. No historic period buildings or structures are depicted at the Site on the 1875 county atlas (Everts 1875), the 1906 topographic map (USGS 1906), or on the Butler County aerial photographs dating from 1938 and 1964 and archived at the Butler County (OH) Soil and Water Conservation District. All four sources do show a farm residence and outbuilding complex located approximately 1,250 feet northwest of the Site, associated on the 1875 map with Christian Holly. The collected historic artifacts are concluded to be random field scatter of household refuse from the Holly residence and subsequent tenants.

4.5 Site Chronology

An assessment of site chronology is derived from nine temporally diagnostic artifacts recovered during the Phase I survey and Phase II testing, and from the radiocarbon assay of charcoal collected in Feature 1. All diagnostic artifacts are chipped-stone bifaces or bifacial fragments. The Early Archaic, Middle Archaic, and Late Archaic periods are represented by complete bifaces with firm cultural attributions. An Early Woodland period occupation is suggested by a point base fragment, and the Late Prehistoric period by a probable triangle point fragment.

4.5.1 Early Archaic period (circa 8000-6000 BC)

The Early Archaic period is represented at Site 33BU1071 by two Thebes points (cat# 32.1/ 34.1 and 73) (Photograph 17). Thebes points are characterized by deep notches, basal and notch grinding, and beveled blades. This point type is distributed principally from Missouri to Ohio and Kentucky (Justice 1987). Cat# 32.1/ 34.1 is from excavated plowzone context in the eastern locus and is manufactured from a quartzitic chert. Its two mending pieces form a whole point, measuring 58 millimeters in length, 36 millimeters in width, and 8 millimeters thick. Cat# 73 is a Phase I surface find from non-locus area at the eastern edge of the site, and is bluish-gray Vanport chert. It exhibits distal fracture and considerable plow damage to the base. A partial point (Cat# 122) is classified as a possible Decatur, or fractured-base, point (Converse 2007; Justice 1987) (Photograph 17). This Early Archaic form dates from circa 7500-6000 BC, and is found in the interior southeastern and midwestern United States. This specimen exhibits a thick, biconvex cross-section on Four Mile Creek chert. The distal end of the blade and a small portion of the base are fractured. Weathering of the blade fracture suggests that breakage occurred at the time of use, rather than by modern plowing.

4.5.2 Middle Archaic period (circa 6000-4000 BC)

Middle Archaic period site occupation is inferred by a Stanly Stemmed point. This type exhibits a broad blade and a small basal notch, and is found across a wide zone of the eastern United States including the Ohio Valley. Stanly points are dated circa 6000-5000 BC. Cat# 71 was a surface find from the eastern locus fashioned from light-colored, semi-translucent unidentifiable chert. It is well-thinned, somewhat asymmetric, and exhibits light basal grinding (Photograph 17).

4.5.3 Late Archaic period (circa 4000-800 BC)

The Late Archaic period is represented by two Brewerton side-notched points and one McWhinney Heavy Stemmed point. The Brewertons are both surface finds, with Cat# 68 a reddish-brown non-local chert from the east locus. Despite damage to one corner, its complete dimensions are measurable: 35 millimters in length, 22 millimeters in width, and 7 millimeters thick (Photograph 18). Cat# 93 a fine-grained Delaware chert from the west locus measuring 33 millimeters in length, 26 millimeters in width, and 7 millimeters thick (Photograph 18). Brewerton side-notched points span a broad geographic area from the Great Lakes to Middle Atlantic region and New England, and have been recovered from dated contexts in the Ohio Valley between 4000-1200 BC (Purtill 2008:73-75).

The McWhinney point type temporally overlaps with the Brewerton series, sometimes co-occurring, and is the principal point type of the Central Ohio Valley Archaic phase (circa 2750-1750 BC) and succeeding Maple Creek phase (circa 1750-1000 BC) in southwestern Ohio. The McWhinney specimen (Cat# 06.1) was recovered from plowzone soils in Test Unit 1. The stem is straight to slightly contracting and forms small barbs at the shoulders. The blade is nearly flat on one face and exhibits a prominent step-fracture on the other face. The blade has been resharpened, reducing the tip to a broad, rounded edge. At this final stage in its use-life, the tool was used as a hafted scraper. Biface length is 62 millimeters, width is 26 millimeters, and thickness is 10 millimeters. The biface was manufactured on chalky pinkish-white chert with parallel striations throughout (Photograph 18). Vickery (2008:20) interpreted the McWhinney type as a projectile point, but Cat# 6.1 clearly has been re-sharpened to a blunt distal tip and was probably used as a hafted scraper.

Radiocarbon dating of charcoal from Feature 1 indicates a calibrated age of 1015-895 BC, placing it at the end of the Late Archaic period. Table 4 presents radiocarbon assays from sites in Butler and Warren Counties, Ohio, as context for this feature age. The Houpt Site (33BU477) is located approximately 18 kilometers southwest of the Site and yielded Late Archaic radiocarbon dates that bracket the Feature 1 assay. Other local sites with radiocarbon dates within the Maple Creek phase of the Late Archaic period are 33WA04, 33WA78, and 33WA92.

4.5.4 Early Woodland period (800-300 BC)

An Early Woodland period site visit is inferred by a point base (Cat# 32.2) recovered from plowzone in the eastern locus. This specimen consists entirely of a broken stem with the hint of a shoulder (Photograph 18). The stem is rounded and well-thinned on a bluish-gray, fine-grained chert, possibly Vanport. In form and raw material it resembles a small Adena point, circa 800-300 BC (Justice 1987: 191-192). No pottery was recovered during the 2014 Phase I or Phase II investigations for the Middletown Energy Center Project. Schneider et al. (2007) reported one sherd collected from the Site during the Rockies Express Pipeline survey, and identified it as a grit-tempered Early Woodland ware.

4.5.5 Late Prehistoric period (AD 1000-1600)

One tentatively identified triangle point (Cat# 24.1) indicates a Late Prehistoric site use (see Section 4.3.5). The point, manufactured on oolitic chert, is exceedingly thin and well made, measuring 21 centimeters in length and only 4 centimeters thick (Photograph 18). Fractures along both corners obscure its true outline and a precise measurement of its width, which likely would not exceed about 20 millimeters. Typologically, it fits into the Late Prehistoric period Madison arrow point variety, circa AD

1000-1600. It was recovered in the plowzone overlying Feature 2, and is a possible indicator of feature age. Cat# 24.1 lacks any hint of the serrated edges that characterize most Fort Ancient points, and indeed, does not closely resemble any of the Fort Ancient types described by Railey (1992). Rather, it fits comfortably into the mean metrics of the Madison type as described by Justice (1987:256). A small, untyped biface (Cat# 106) exhibits a few characteristics of Fort Ancient points (e.g., size, serrations), but overall it too does not conform to the Railey typology (Photograph 18). Based on size and form, it may have functioned as an arrow point which would place it into the Late Prehistoric period.

4.6 Site Patterning

Artifacts, viewed as a residue of human activity, can be examined individually to extract evidence of functional use, or can be analyzed in the aggregate to identify patterned cultural behavior. On a macro-scale, pattern analysis examines the structure of a site to reveal processes of internal community organization and the forms these processes manifest in the archaeological record. Organized behavior governed by social rule and traditions may generate recognizable spatial patterns among artifact classes, indicating the presence of discrete activity zones (Binford 1979, 1983), use by different populations (Cowan 1999), or seasonal variation. On the other hand, site formation processes caused by site re-use, erosion, and bioturbation may re-arrange these patterns and disguise the original activities that produced them (O'Connell 1987, Schiffer 1983).

The Phase I surface reconnaissance and the Phase II testing program identified two broad clusters of artifacts that have been termed the eastern locus and western locus (Figure 2). Artifact density within the eastern locus is one artifact per 28.9 square meters, and is one artifact per 43 square meters in the western locus. If these geographic loci were the product of different subsistence activities or different populations, there might be a strong dependent relationship in the distributions of major artifact classes. Calculating chi-square values is a useful statistical test to evaluate whether significant differences exist between observed numbers of artifacts, representing different activities or populations, from expected random values (Thomas 1976:272-278). Contingency tests for FCR/debitage, bifaces/debitage, bifaces/FCR, and early-stage debitage/late-stage debitage were performed to measure the strength and significance of any relationship between artifact classes. The null hypothesis for each test is that the observed value would not exceed the expected chi-square value, indicating a random distribution of the paired artifact classes between loci. Tables 5-8 present the results of these tests. In each case, the calculated chi-square value was not statistically significant and the null hypothesis was accepted at a probability of 99 percent ($p<0.01$).

These results indicate that the two artifact loci do not represent specialized activity zones, or preferred locales by different populations, or other patterned distributions. Rather, they are examples of a repeated logistical camp (Schlanger 1992). This site type involved cyclic visits to a location to acquire and process specific resources available on a seasonal or occasional basis, followed by return to a base camp. In terms of stone tools, these sites normally are provisioned from elsewhere and do not have a high proportion of debris produced by manufacturing. Debitage is dominated by repair rather than primary reduction. Facilities other than certain specialized facilities are either not present or not diverse. It is proposed that the Site was used as a logistical camp when the Shaker Creek floodplain was inundated. The Patton clay loam between the Site and the creek and underlying C-horizon clay may have functioned as a perched water table to sustain ponding, attract game, and support aquatic plants.

Vertically, the site assemblage exhibits virtually no patterning. The co-occurrence on the site surface and within the plowzone of diagnostic projectile points representing a span of 8,000 years reflects the limited depositional processes at work in this environmental setting. It is possible that a thin mantle of aeolian sediments provided some vertical separation between the various site occupations from the Archaic through Late Prehistoric periods, but if present at all these were not of sufficient depth to survive the intermixing of soils by plowing since the mid-nineteenth century. With the exception of a handful of finds in the upper strata of Features 1 and 2, and Anomaly 7, all recovered artifacts derived from plowzone contexts; none were found in the B2t-subsoil. No stratified deposits were identified during the Phase II investigations.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Phase II archaeological investigations were conducted at the Site prior to development of the Middletown Energy Center. The objective of Phase II fieldwork was to collect sufficient information to evaluate archaeological resources for NRHP eligibility. During the 2014 Phase I survey, pedestrian reconnaissance and limited shovel testing revealed the presence of a surface scatter of lithic artifacts across approximately 8 acres of a low, dune-like rise. Overall, artifact density was low (N=63) but clustered within two loci, one on the eastern “summit” and the other on the sideslope of the western “summit.” Diagnostic artifacts included projectile points from the Early Archaic, Middle Woodland, and Late Prehistoric periods. Phase II investigations commenced with a magnetic gradient survey to identify potential cultural features and midden, followed by the excavation of 69 shovel tests and 29 square meters of measured test units. The Phase I survey and Phase II testing recovered a total of 295 prehistoric lithic artifacts, 16 historic artifacts, investigated eight soil anomalies, and identified two probable prehistoric hearths. Additional analyses included paleobotanical examination of soil samples, and a radiocarbon assay of feature charcoal.

The investigations addressed three principal research questions central to evaluating NRHP eligibility.

1. *Does the Site contain evidence of stratified deposits or patterned behavior?*

Excavations revealed a stratigraphic sequence across the site rise of a surface Ap-horizon of sandy loam, overlying a sandy clay loam B2t-horizon, followed by a blocky clay C-horizon. Excavators noted the absence of a buried A-horizon. The Site artifact assemblage was confined to the ground surface and the Ap-horizon, conflating Early Archaic, Late Archaic, and Late Prehistoric occupations into a single stratigraphic layer. Surface finds and shovel testing delineated the site boundary across an 8-acre zone on the summit and side slopes of the topographic rise, and identified two broad loci of clustered artifacts. Contingency testing (chi-square) of paired artifact classes (biface/fire-cracked rock; biface/debitage; fire-cracked rock/debitage; and, early reduction debitage/late reduction debitage) resulted in no statistically significant patterning in their distributions between the eastern locus and western locus. Tetra Tech concludes that a data recovery program would likely yield little additional information regarding Site patterning to data already recovered during the 2014 Phase I survey and Phase II investigation.

2. *Does the Site contain evidence of past activities related to subsistence and technology?*

The Phase II investigation examined the seven highest ranking anomalies identified by the magnetic gradient survey plus one anomaly not identified through magnetometry. One of these, Anomaly 15, is concluded to be a prehistoric cultural feature. The others are interpreted as plow scars (Nos. 5, 6, and 16), tree-throws (Nos. 7 and 8), and a false positive result (No. 17). Anomaly 15/Feature 2 is interpreted as a short-term use hearth/earth oven. Feature fill contained insignificant quantities of charcoal, no carbonized nutshell or seeds, and aside from fire-cracked rock, no artifacts. A Late Prehistoric triangle point (circa

AD 1000-1600) was recovered in plowzone soil overlying Feature 2, and may be an indicator of feature age.

Excavators identified a shallow basin pit (Feature 1) that is interpreted as a small hearth. It had not been previously identified through magnetic gradient survey. A charcoal sample from Feature 1 returned a 2-sigma calibrated date of a conventional radiocarbon age of 2800±30 BP (Beta-389353), with a two-sigma calibrated date of 1015-895 BC, placing it in the late Maple Creek phase of the Late Archaic period. Feature 1 yielded two small fragments of carbonized hickory shell, no carbonized seeds, three fire-cracked rocks and two chert biface reduction flakes. No paleofaunal material was recovered from either of the cultural features, or from the non-cultural anomalies.

Features 1 and 2 and Anomalies 7 and 8 each contained non-carbonized seeds that are interpreted as modern intrusives, transported via plant or animal disturbance. Because organic preservation appears to be poor within sub-plowzone contexts, and because intrusion into feature fill of modern or ancient botanical material cannot be ruled out, Tetra Tech concludes that data recovery would likely yield little additional subsistence information to data already recovered during the Phase II investigation.

Lithic raw material recovered at the Site includes local material (pebble cherts, Four Mile Creek chert), regional material (Cedarville-Guelph chert), and non-local material (Delaware, Vanport, and Upper Mercer cherts). Procurement and transportation strategies of lithic raw material are critical links between settlement systems and technological systems. If raw material is scarce, groups may spend considerable effort obtaining it through movement or trade, or curate available stone by means of specific core, flake or blade industries. The ability to source lithic raw material in a site assemblage can provide context for understanding group territoriality and mobility, inter-group transactions, and technology. The means to address this issue depend on the capacity of a site to discriminate patterns of stone usage by discrete groups within defined temporal periods. The Site does not provide sufficient discrimination of datasets to discern any statistically significant patterns in the distribution of raw material and artifact classes. Tetra Tech concludes that data recovery would likely yield little additional technological information to data already recovered during the Phase II investigation.

3. *Do archaeological resources at the Site reflect larger cultural patterns of prehistoric settlement in the region?*

Within a five mile radius of the Site are 169 recorded prehistoric archaeological sites and 19 sites with historic and prehistoric components. Of these, 47 sites contained datable components or diagnostic artifacts. Two archaeological sites are listed on the NRHP, Armco Park Mound 1 (33WA0059) and Armco Park Mound II (33WA0060). Both of these mounds are characterized as unspecified Woodland period sites and are situated on upper terraces above Shaker Creek. Armco Park Mound I lies approximately 3.5 miles (5.6 kilometers) east-southeast of the Site; Armco Park Mound II is located approximately 3.1 miles (5 kilometers) east-southeast of the Site.

Additionally, two sites have recently undergone data recovery investigations in the region. Situated on a bluff overlooking Dicks Creek near its junction with the Great Miami River, Sites 33BU1110 and 33BU1122 are located 3.1 miles (5 kilometers) and 2.6 miles (4.1 kilometers) west of the Site, respectively. Site BU1110 contained a Kirk phase Early Archaic component, plus evidence of Late Archaic through Late Woodland occupations. Site BU1122 contained Decatur and St. Charles points dating from the Early Archaic, and fire-cracked rock features datable to Early Woodland and Late Woodland timeframes.

Data acquired in the Phase II investigation indicates that Site 33BU1071 was likely utilized as a repeated logistical camp. This finding suggests that site visits were strictly short-term and confined to the procurement and immediate processing of specific resources, perhaps associated with wetland plants and fauna that would have been present along the margins of Shaker Creek. This site type is commonly found in the Middle Ohio Valley and its tributaries, often with evidence of multiple temporal occupations without stratified sequencing. The Site likely functioned within the prevailing Archaic period settlement system that included many other small procurement camps and base camps represented by 33BU1110 and 33BU1122. Evidence for Woodland and Late Prehistoric visits at the Site is negligible, and may reflect either changing environmental conditions or a change of cultural preferences vis-à-vis available resources, or both. Tetra Tech concludes that data recovery would likely yield little additional information relative to regional systematics to data already recovered during the Phase II investigation.

In summary, Phase II investigations at Site 33BU1071 documented a low density scatter of chipped-stone artifacts and fire-cracked rock across an 8-acre rise in the vicinity of Shaker Creek, a low-order tributary of the Great Miami River. Overall, artifact distribution was equivalent to one artifact per 110 square meters of the delineated site; the eastern density registers one artifact per 43 square meters, the western locus one per 28.9 square meters. Excavations identified two small prehistoric period hearths/earth ovens, one radiocarbon dated to the late-Late Archaic period. The feature fill appears to have poor organic preservation, and few paleobotanical materials were recovered form soil samples. Several anomalies mapped and identified through geophysical survey have been investigated and interpreted as plow scars, tree-throws, and a false positive signal.

The Site artifact assemblage is contained almost entirely within surface and plowzone contexts; no artifacts were recovered within subsoil layers. An array of temporally diagnostic bifaces, including Thebes, Decatur, Brewerton, McWhinney, and Madison forms, share the same stratigraphic horizon and do not resolve into patterned distributions. Paired contingency tests between major artifact classes indicate no statistically significant patterns to their distributions within the eastern artifact locus or western artifact locus.

Tetra Tech concludes that Site 33BU1071 does not contain sufficient integrity and research significance under Criterion D to be considered eligible for listing on the NRHP. Tetra Tech, therefore, recommends no further archaeological investigations at the Site, and requests concurrence that construction of the Middletown Energy Center will have no adverse effects on significant cultural resources.

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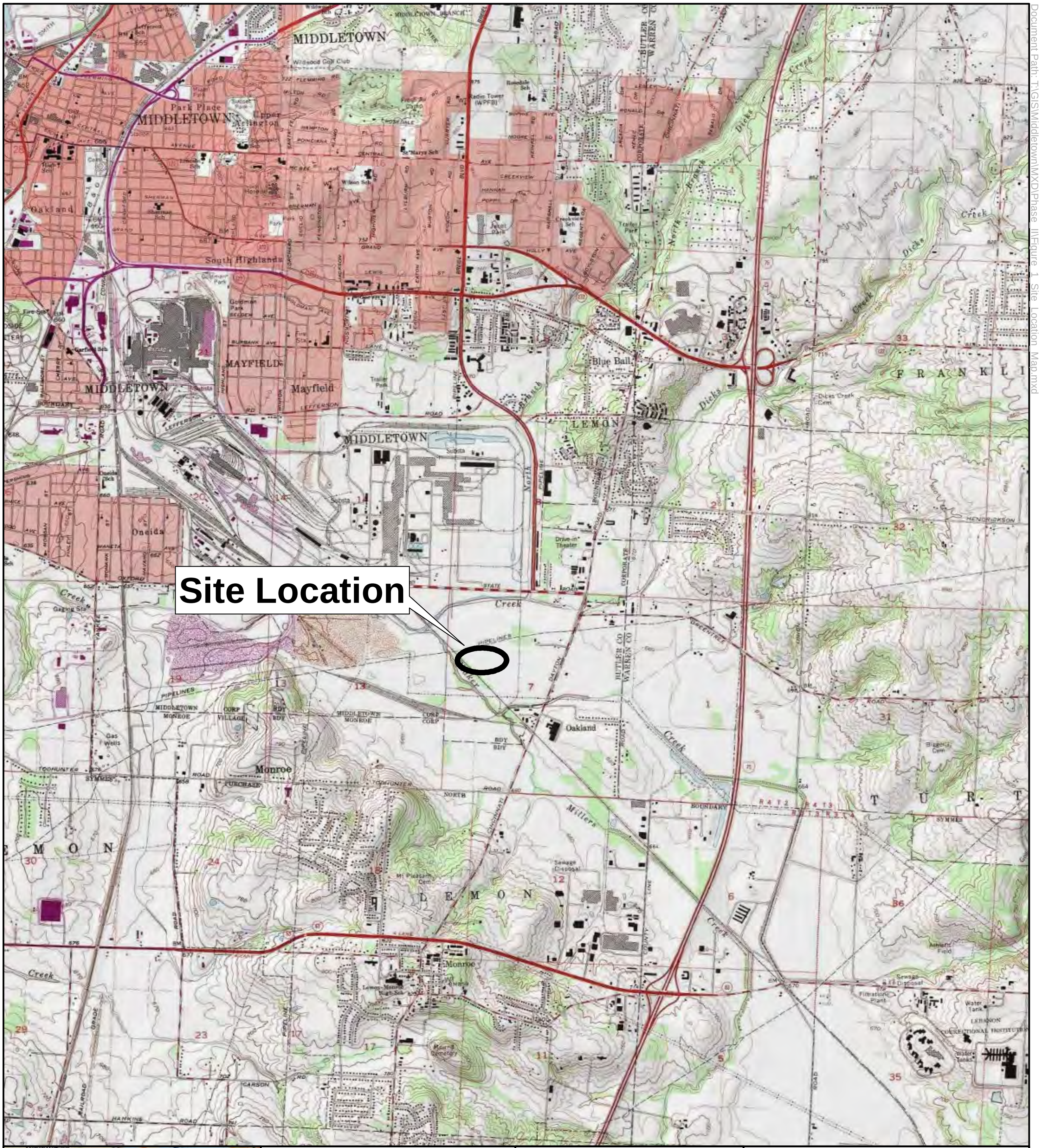
FIGURES



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Site Location

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Middletown Energy Center

Figure 1
Site Location Map

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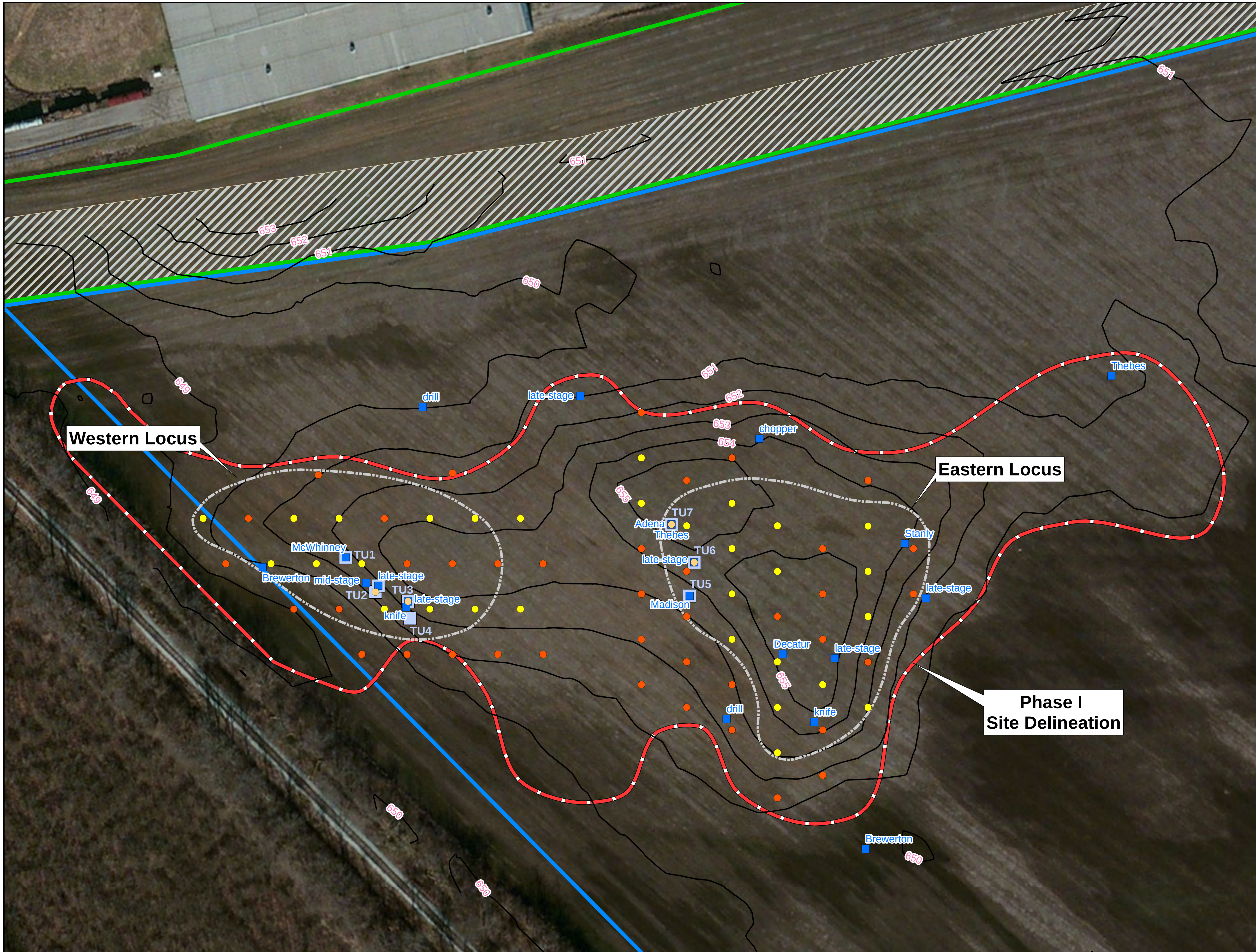

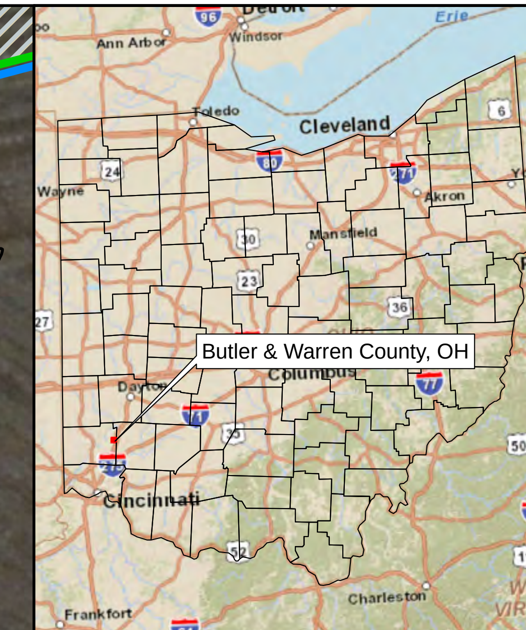

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Legend

- Cores
- Bifaces
- Test Unit
- Negative Shovel Test
- Positive Shovel Test
- Topographic Contours (ft)
- Artifact Locus
- Archeological Site Boundary
- Construction Site
- Facility Site
- Pipeline Easement

0 100 200
Feet

Meters
0 25 50

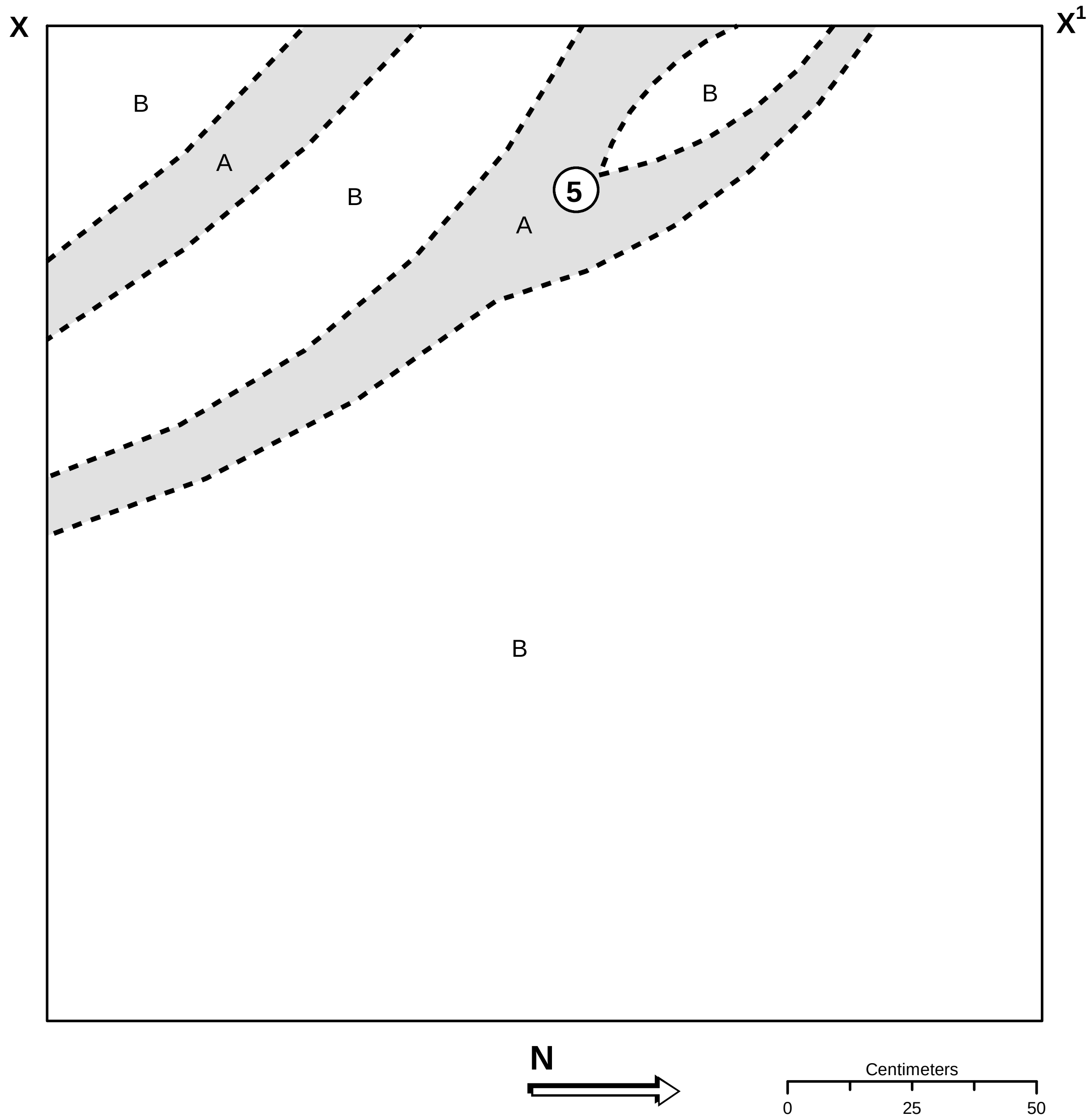
Middletown Energy Center

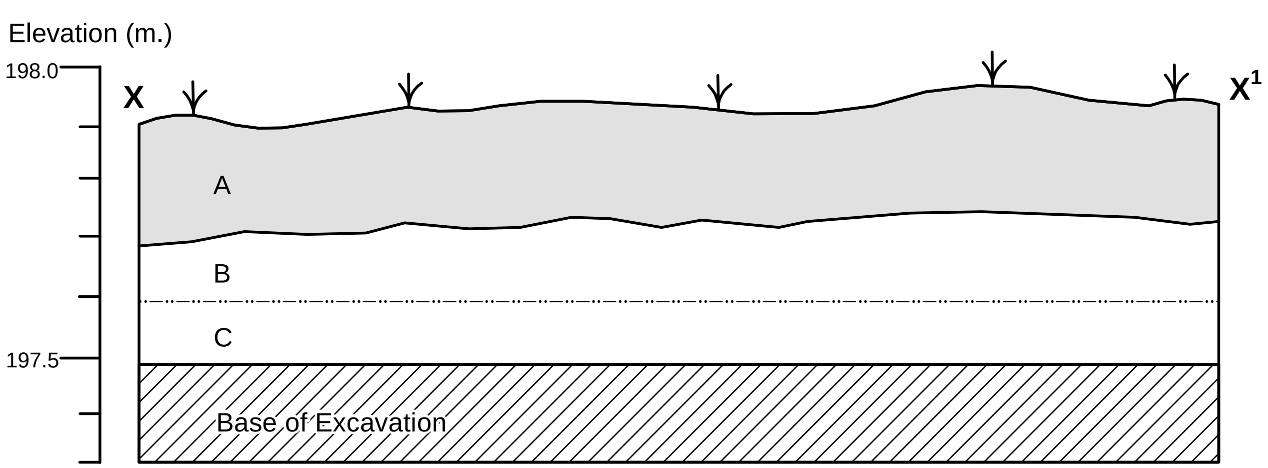
Figure 2

Site 33BU1071 Details

TETRA TECH

Plan View





West Profile

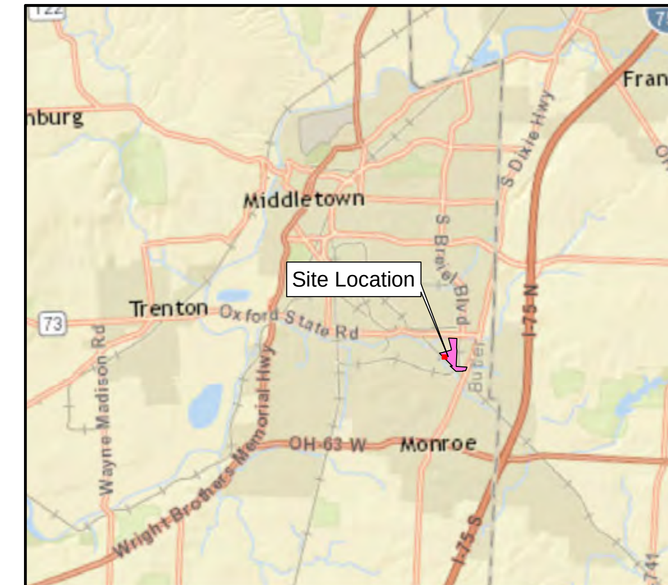
Legend:

A - 10YR 4/4 sandy loan (Ap-horizon).

B - 7.5YR 4/6 sandy clay loam (B2t - horizon).

C - 10YR4/6 sandy clay loam mottled with 10YR 5/2 and 10YR 2/1 manganese staining (B2t - horizon).

(5)- Anomaly centerpoint as mapped by magnetometry survey.



Middletown Energy Center

Figure 3

Test Unit 1 Profile and Anomaly 5 Plan

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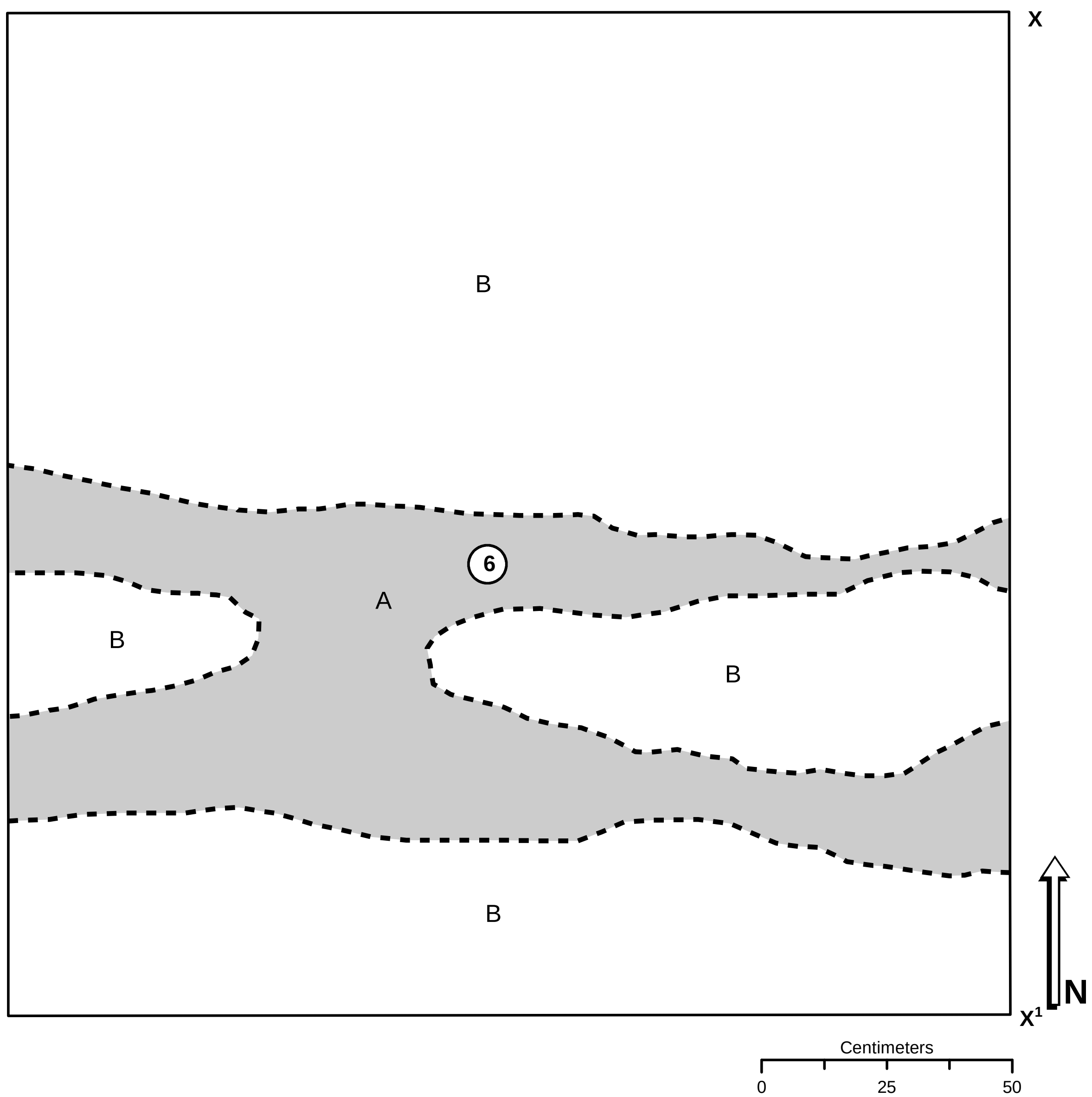
Plan View



Legend:

A - 10YR 4/4 sandy loam (Ap-horizon).

B - 7.5YR 4/4 sandy clay loam with rare 10YR 2/1 manganese staining (B2t - horizon).

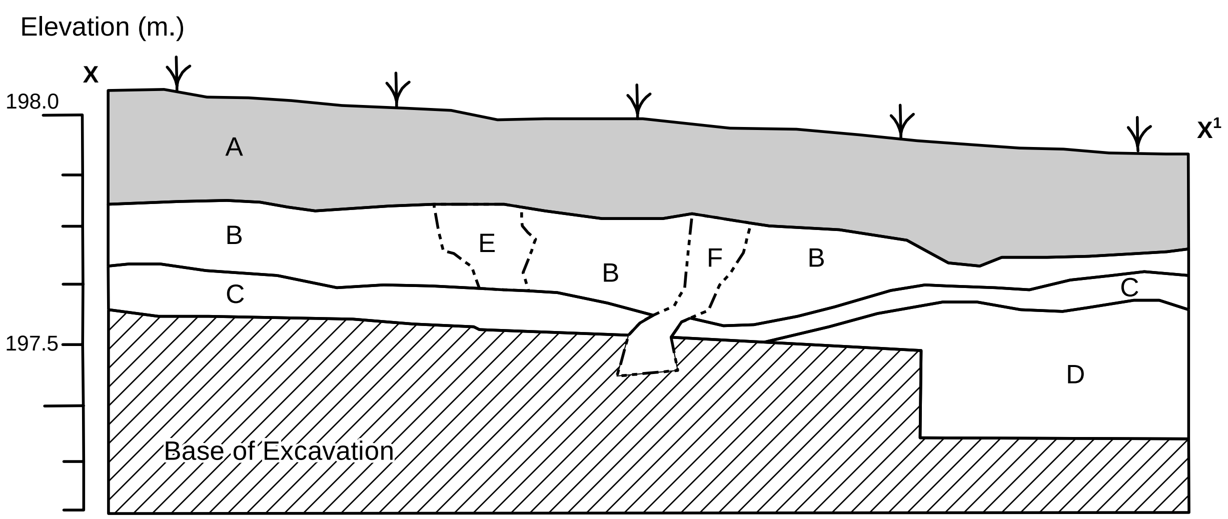
C - 7.5YR 4/3 clay loam with common 10YR 2/1 manganese staining (B2t - horizon).

D - 10YR 5/2 clay, compact (C - horizon).

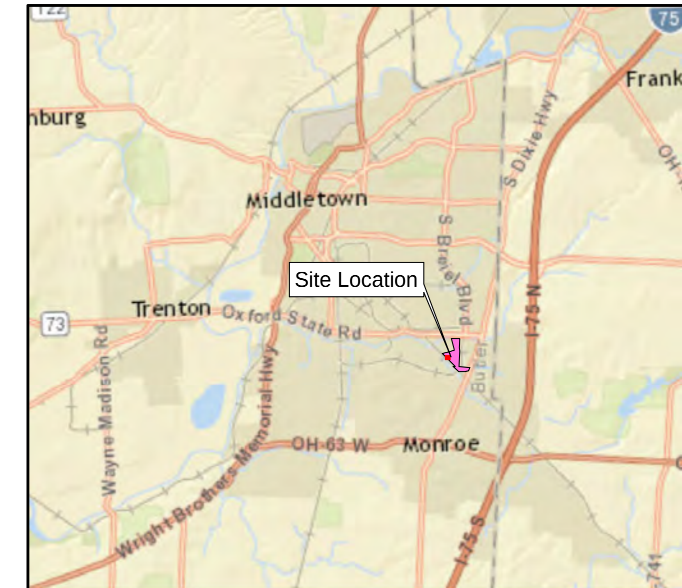
E - 10YR 6/4 sandy loam with 7.5YR 4/4 sandy loam halo (root cast).

F - 10YR 4/2 sandy clay loam with 7.5YR 5/4 sandy clay loam halo (root cast).

(6)- Anomaly centerpoint as mapped by magnetometry survey.



East Profile



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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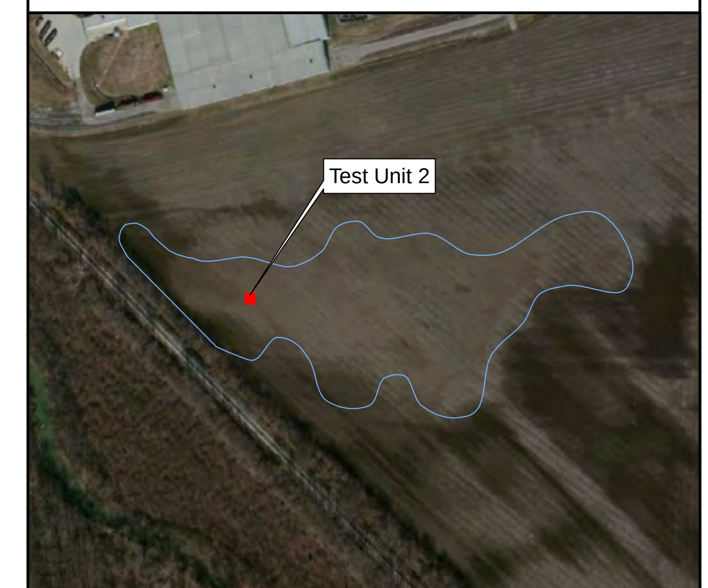

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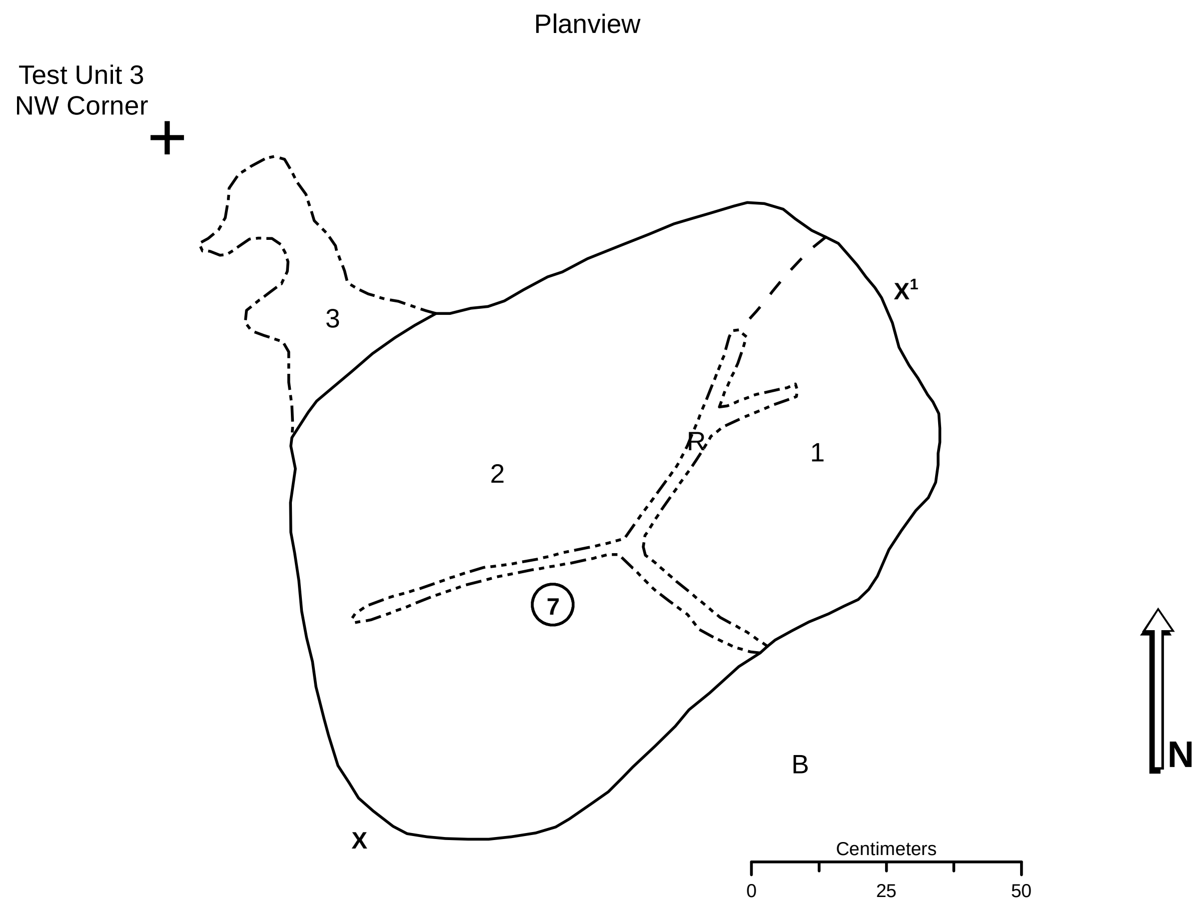
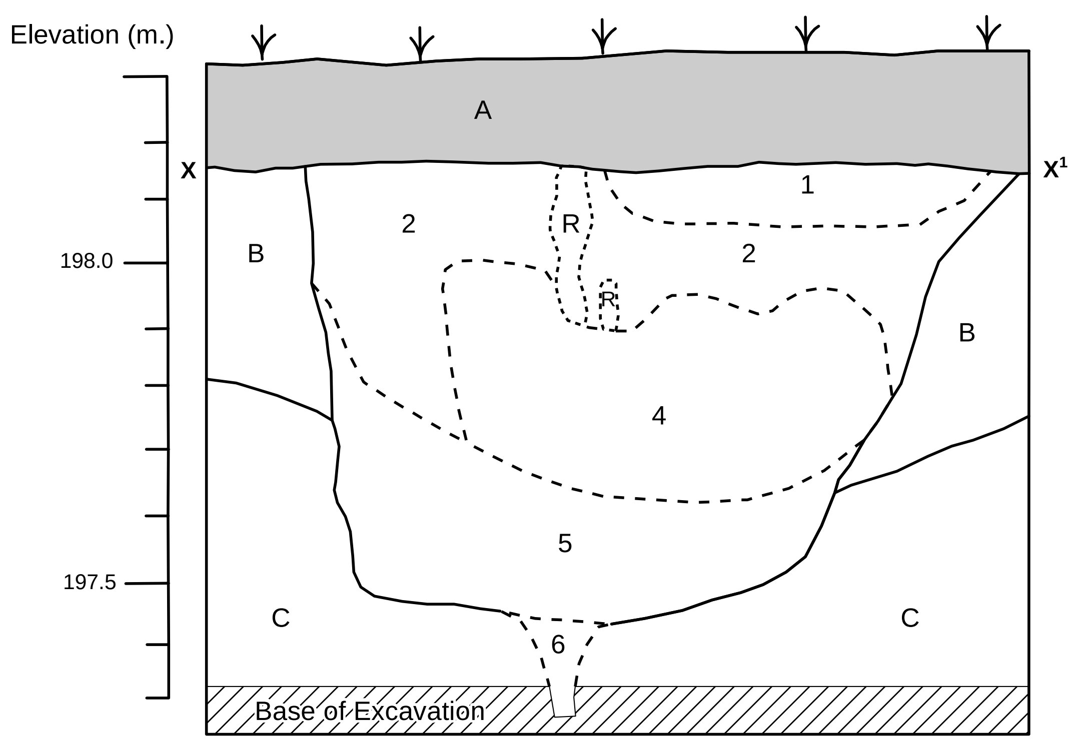
Figure 4

Test Unit 2 Profile and Anomaly 6 Plan

TETRA TECH





Southeast Bisection

Legend:

A - 10YR 4/4 sandy loam (Ap-horizon).

B - 10YR 4/6 sandy clay loam with common manganese staining; increasing clay from northeast to southeast (B2t - horizon).

C - 2.5YR 4/4 very compact blocky clay.

1 - 10YR 6/3 sandy loam mottled w/10YR 5/4 (Anomaly fill).

2 - 10YR 5/4 sandy loam mottled w/10YR 6/2 (Anomaly fill).

3 - 10YR 4/4 sandy loam mottled w/10YR 5/4 (Anomaly fill).

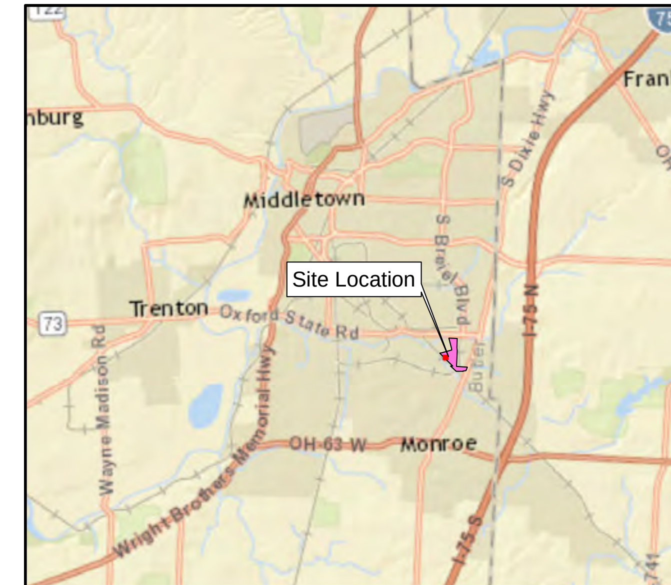
4 - 10YR 5/4 sandy loam heavily mottled w/10YR 5/1 and 10YR 4/6 (Anomaly fill).

5 - 7.5YR 4/6 sandy clay loam mottled w/10YR 5/1 (Anomaly fill).

6 - 10YR 4/3 sandy loam (Anomaly fill - tap root).

R - 10YR 5/3 fine sandy loam w/ 10YR 5/8 halo (root cast)

(7)- Anomaly centerpoint as mapped by magnetometry survey.



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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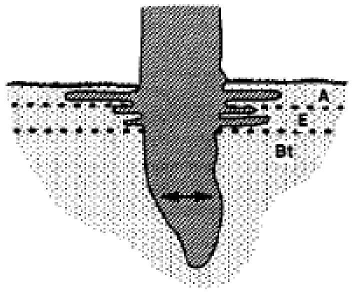
Figure 5

Test Unit 3 Anomaly 7 Plan and Bisection

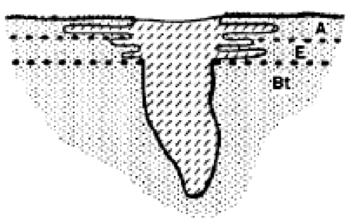
TETRA TECH

PHASE 1
Tree Growth
(~100 years)



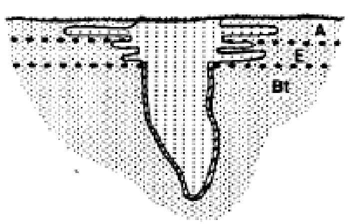
PROCESSES	EFFECTS
Expansion of tree roots	Compaction and compression of surrounding soil; change in bulk density and porosity around periphery
Microbial activity in rhizosphere	Prevention of Fe and Mn precipitation

PHASE 2
Tree death: initial development
Of fossil tap root cast (~100-1,000 years)



PROCESSES	EFFECTS
Tree dies	Cessation of organic matter production
Translocation of fine-grained material from sheetwash and other processes into void left by tap root	Contrasts in physical properties (grain size and bulk density) between core and surrounding soil
Decreased microbial activity in rhizosphere	Precipitation of Fe and Mn compounds near periphery of void
Water fluctuations	Additional Fe and Mn added to system through soil water movement

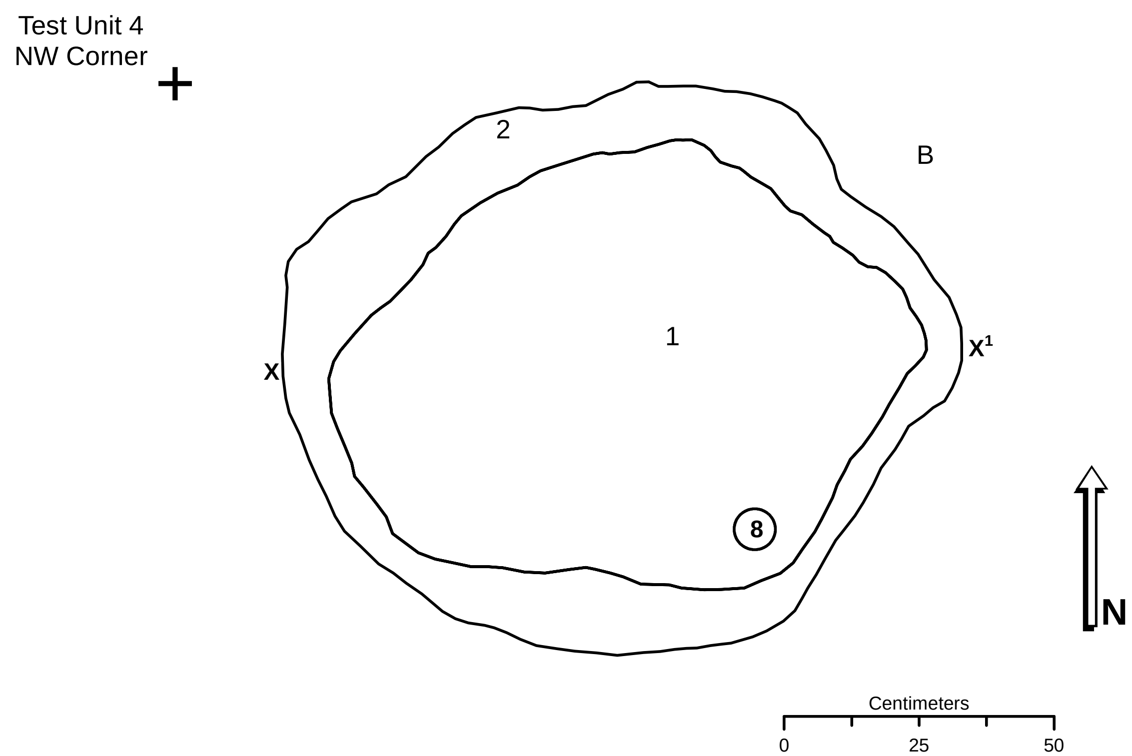
PHASE 3
Secondary development of
fossil tap root cast
(>10,000 years)



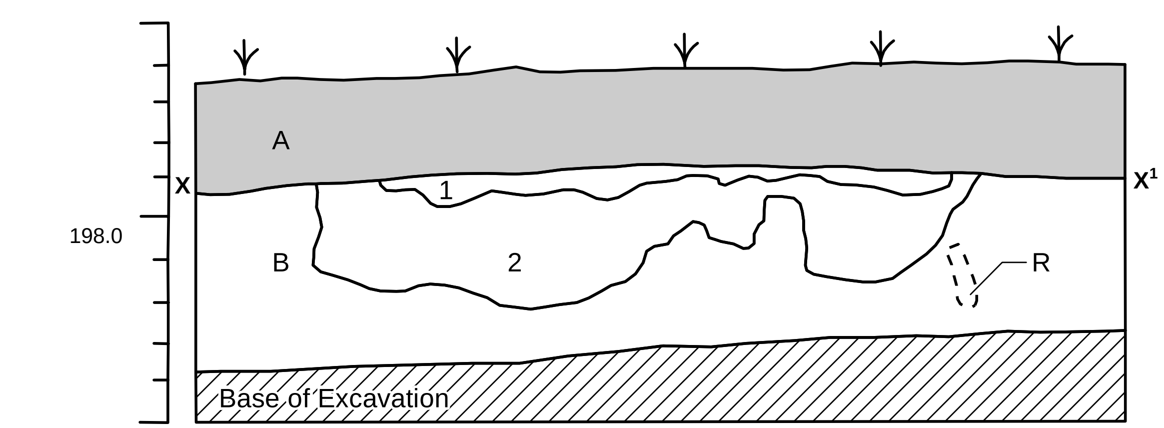
PROCESSES	EFFECTS
Movement of water and dissolved ions through solum	Progressive accumulation of Fe and Mn oxides in rim
Alternating oxidation/reduction conditions in solum	Increased differences in consistence and bulk density due to rim growth and hardening
Core retains water due to increased bulk density and decreased permeability of rim	Color differentiation and restriction of clay mineral changes because of reducing conditions in core

Figure 6. A model of fossil root cast genesis. (Adapted from Mossa and Schumacher 1993).

Plan View



Elevation (m.)



South Bisection

Legend:

A - 10YR 4/3 sandy loam (Ap-horizon).

B - 10YR 4/6 sandy clay loam heavily mottled with 10YR 5/8 and 10YR 6/2 (B2t - horizon).

1 - 10YR 4/4 sandy loam mottled with 10YR 4/6 and 10YR 5/2 (Anomaly fill).

2 - 10YR 4/4 sandy clay loam heavily mottled with 10YR 6/2 and common mangenese staining (Anomaly fill).

R - 10YR 5/4 sandy loam with 10YR 5/8 halo (root cast).

⑧- Anomaly centerpoint as mapped by magnetometry survey.

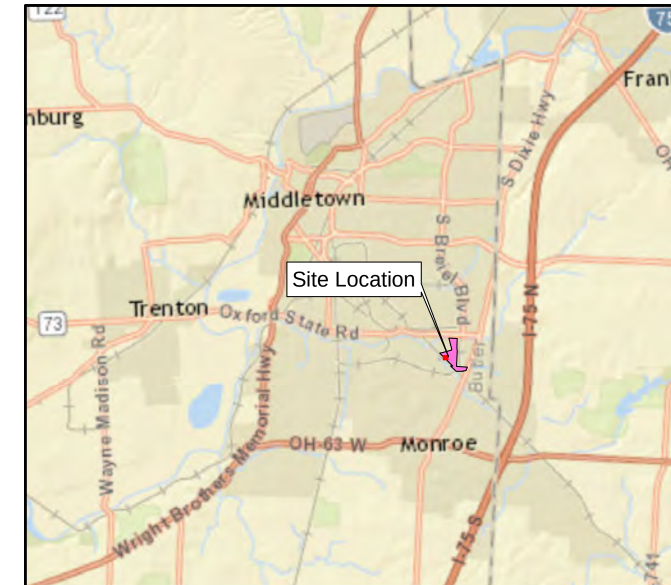


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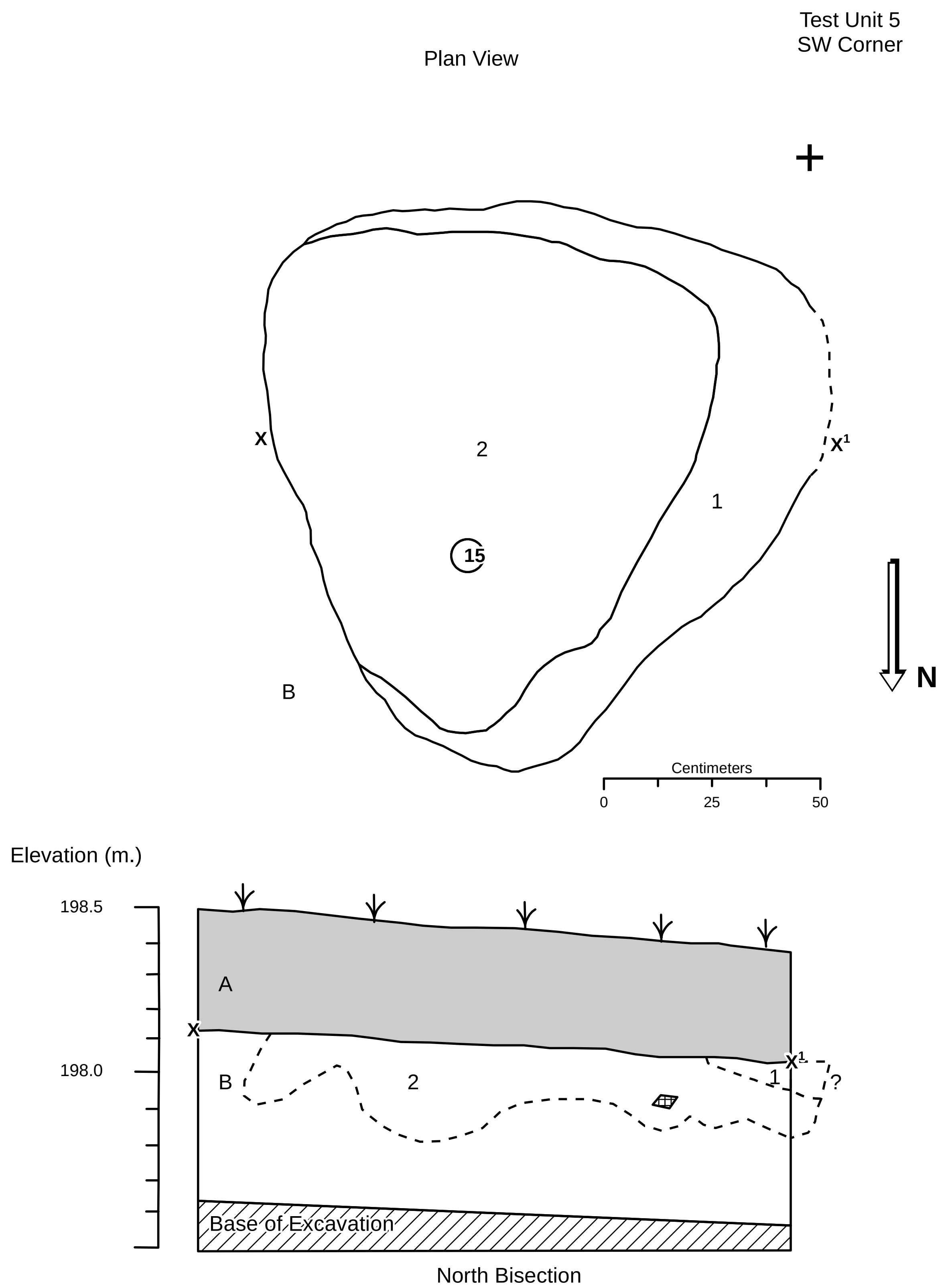
Figure 7

Test Unit 4, Anomaly 8 Plan and Bisection

TETRA TECH



Legend:

A - 10YR 4/4 sandy loam (Ap-horizon).

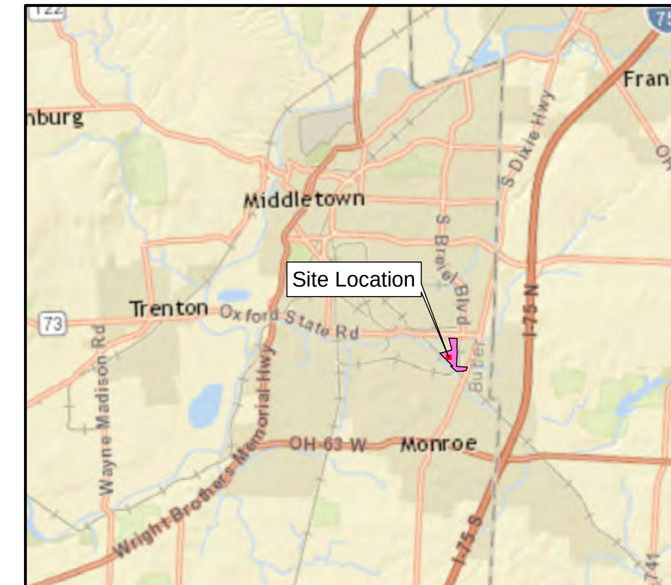
B - 7.5YR 4/3 sandy loam mottled with10YR 5/3 grading to sandy clay loam with depth (B2t - horizon).

1 - 10YR 5/3 sandy loam (Anomaly fill).

2 - 10YR 4/3 sandy loam (Anomaly fill).

- Cracked Rock

15 - Anomaly centerpoint as mapped by magnetometry survey.



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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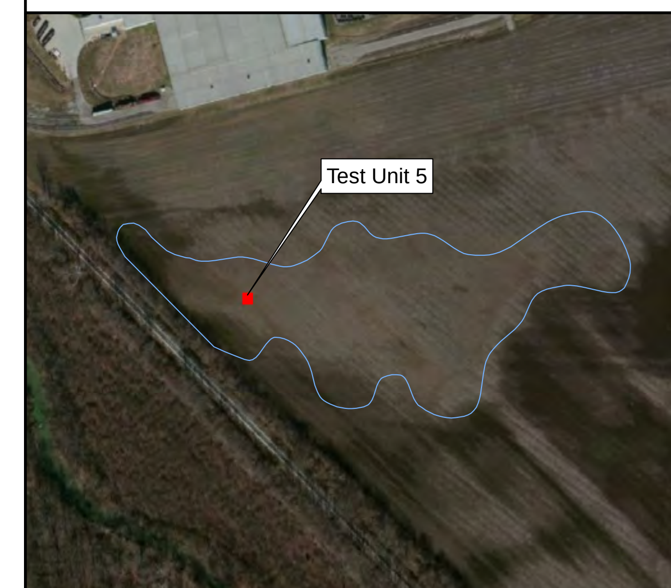

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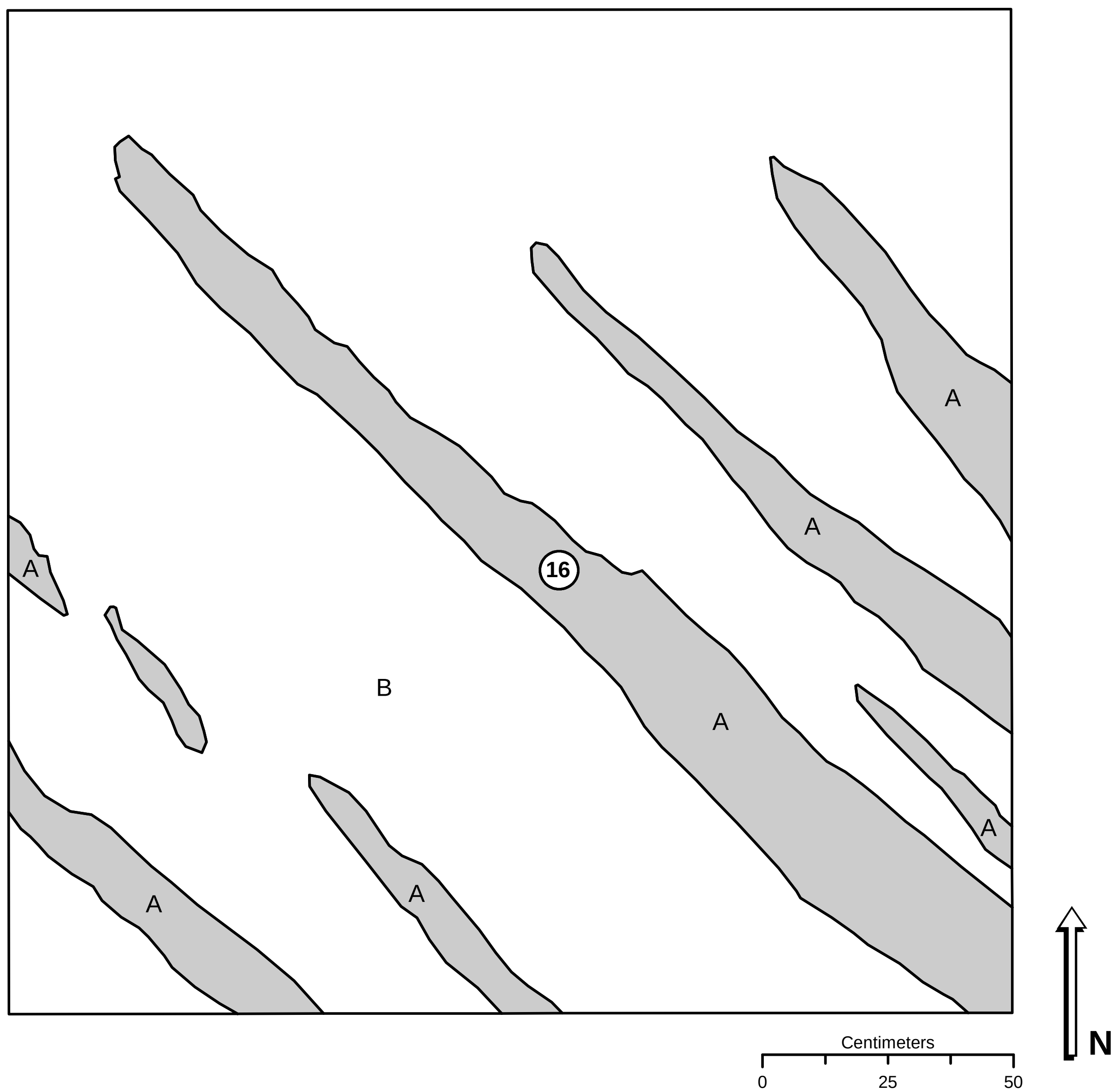
Figure 8

Test Unit 5, Anomaly 15/Feature 2
Plan and Bisection

TETRA TECH

Plan View

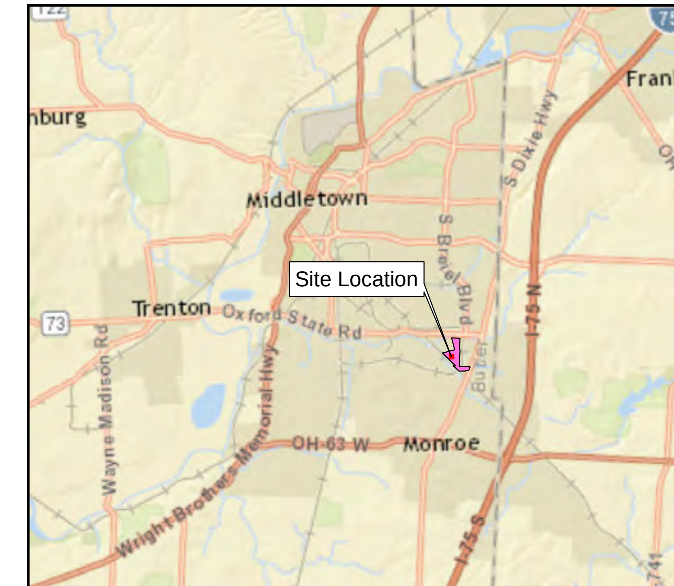


Legend:

A - 10YR 4/4 sandy loam (Ap-horizon).

B - 7.5YR 4/6 sandy clay loam (B2t - horizon).

(16) - Anomaly centerpoint as mapped by magnetometry survey.



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

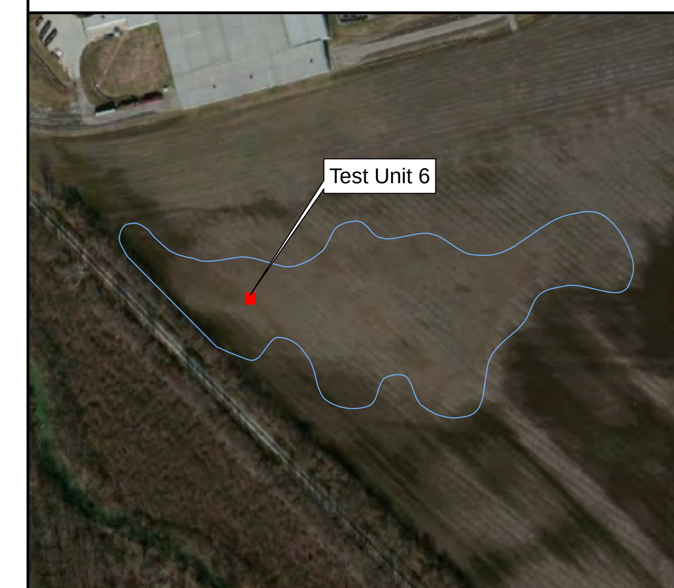


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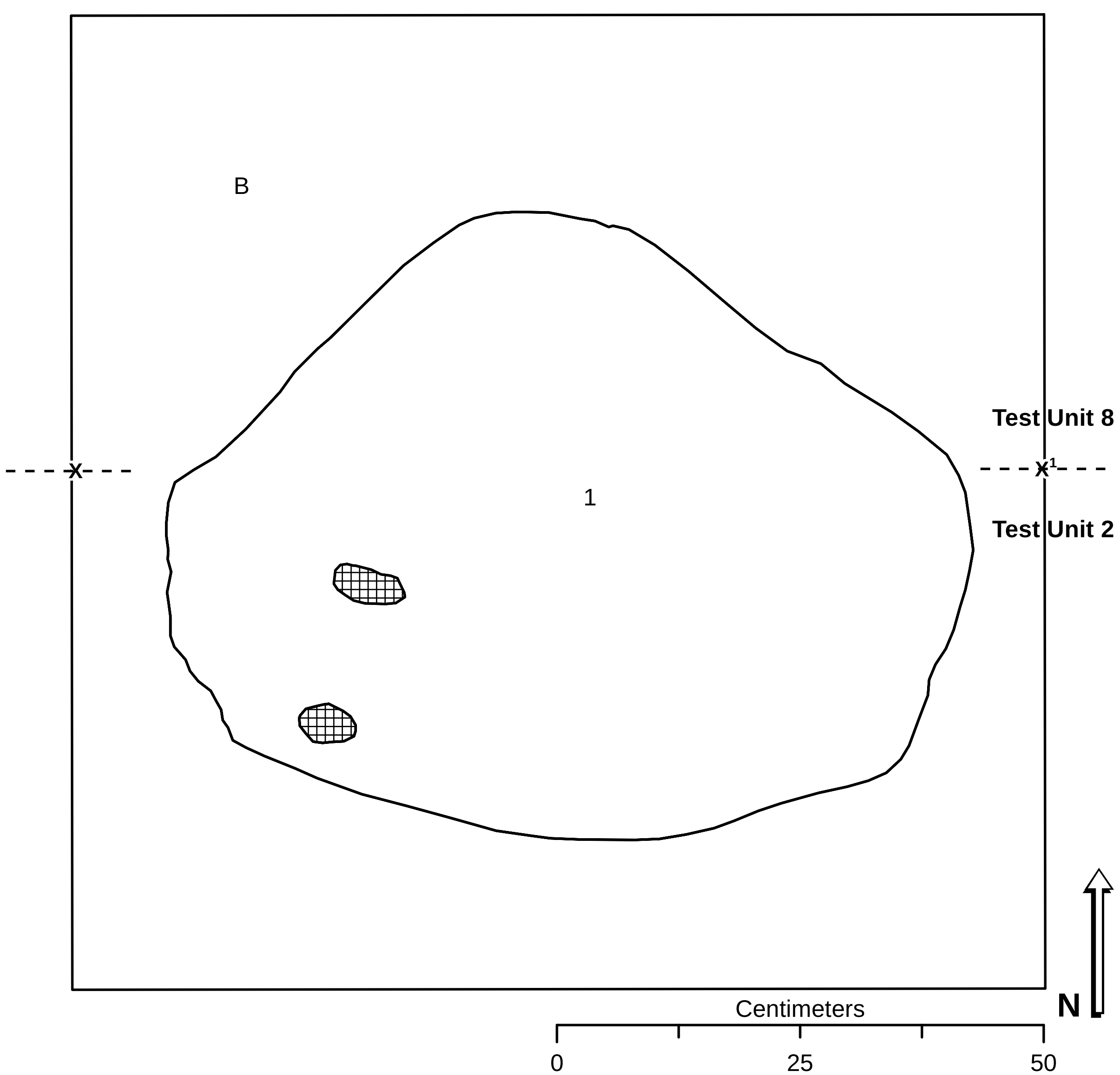
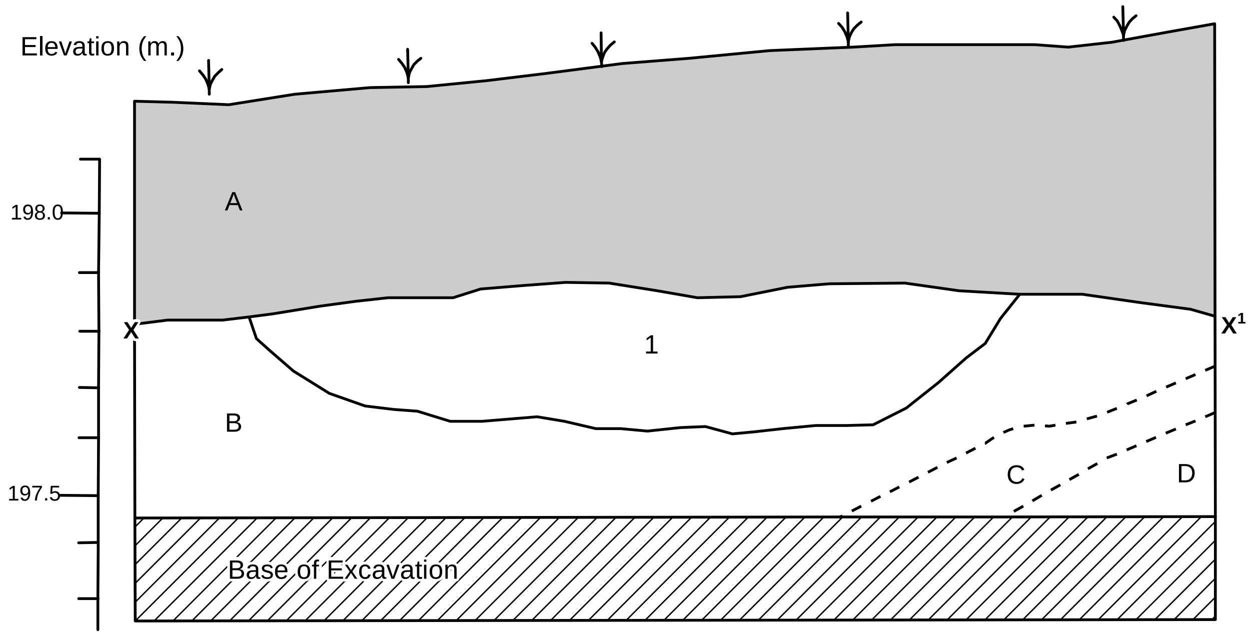
Figure 9

Test Unit 6, Anomaly 16 Plan

TETRA TECH

Plan View





North Profile

Legend:

A - 10YR 4/4 sandy loam (Ap-horizon).

1 - 10YR 5/6 compact sandy loam mottled with 7.5YR 4/4 (Feature 1).

B - 7.5YR 4/4 sandy loam mottled with10YR 5/1 (B2t - horizon).

C - 7.5YR 4/4 sandy loam mottled with10YR 5/1 and common manganese staining (B2t - horizon).

D - 7.5YR 4/3 clay loam with abundant manganese staining (B2t - horizon).

- Cracked Rock

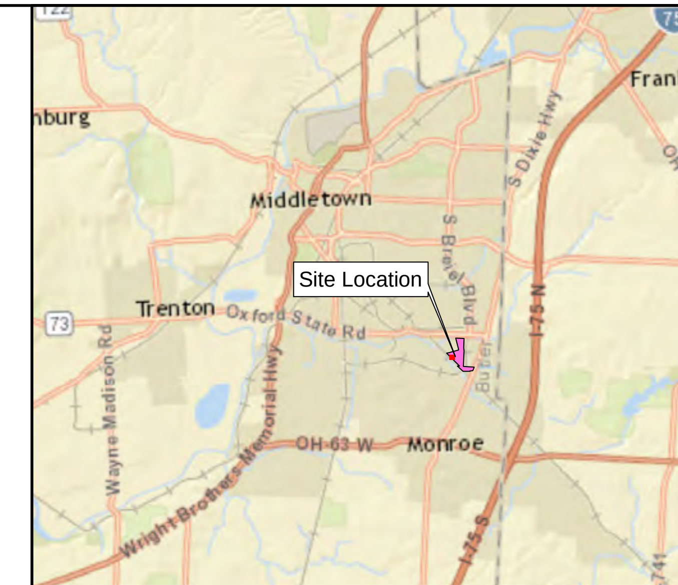


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Figure 10

Test Unit 2 and 8, Feature 1
Plan and Bisection

TETRA TECH

TABLES

TABLE 1. Site 33BU1071 Phase I and Phase II Lithic Artifacts by Locus.

Artifact Type	East Locus	West Locus	Non-Locus	Total
Bifaces	13	5	2	20
Drills	1	-	1	2
Cores	2	2	-	4
Debitage	75	99	10	184
FCR	50	34	1	85
Total	141	140	14	295

TABLE 2. Site 33BU1071 Phase I and Phase II Debitage Raw Material by Locus.

Raw Material	East Locus	West Locus	Non-Locus	Total
Delaware chert	12	14	2	28
Upper Mercer chert	10	5	-	15
Vanport chert	8	6	-	14
Cedarville-Guelph chert	5	7	1	13
Four Mile Creek chert	2	5	1	8
Chalcedony	2	5	-	7
Indiana hornstone	6	-	-	6
unclassified	30	57	6	93
Total	75	99	10	184

TABLE 3. Site 33BU1071 Phase I and Phase II Debitage Types by Locus.

Debitage Type	East Locus	West Locus	Non-Locus	Total
Decortication	7	7	1	15
Early Reduction	13	4	-	17
Biface Reduction	13	20	5	38
Block shatter	9	12	-	21
Flake fragments	32	56	3	91
Other	1	-	1	2
Total	75	99	10	184

TABLE 4. Radiocarbon Assays from Butler and Warren Counties, Ohio.

Site No.	Site Name	Lab Number	Sigma	Calibrated Age
33WA02	South Fort Village	Beta-74555	50	AD 1896, 1902, 1955
33WA02	South Fort Village	Beta-74459	80	AD 1511, 1600, 1616
33BU33	Hine Village	Beta-14223	70	AD 1454
33BU02	Campbell Island	Beta-17995	70	AD 1446
33WA100	Sandy Run	UGA-3120	75	AD 1440
33WA86	Carroll-Oregonia Road	DIC-1042	90	AD 1436
33WA100	Sandy Run	UGA-3121	105	AD 1423
33WA373	Kern Effigy	SI-6267	95	AD 1415
33BU02	Campbell Island	Beta-14222	60	AD 1410
33BU33	Hine Village	Beta-14224	80	AD 1298
33BU33	Hine Village	Beta-14225	60	AD 1298
33WA02	South Fort Village	Beta-74460	60	AD 1286
33WA04	Anderson Village	DIC-776	100	AD 1286
33WA373	Kern Effigy	SI-6268	80	AD 1279
33BU204	Johnson	Beta-17993	50	AD 1275
33WA83	Oglesby-Harris	DIC-1034	80	AD 1195
33WA78	Pipeline	DIC-1036	45	AD 1176
33WA02	South Fort Village	Beta-74461	70	AD 1162
33WA92	Wood-73	DIC-889	95	AD 1022
33WA92	Wood-73	DIC-890	95	AD 1022
33WA92	Wood-73	DIC-890	155	AD 883
33WA92	Wood-73	DIC-890	55	AD 719, 739, 766
33WA112	King Road	DIC-1041	145	AD 676
33BU205	Todd Mound(33Wa205)	UGA-2151	60	AD 540
33WA82	Jonah's Run 1	DIC-887B	105	AD 423
33WA82	Jonah's Run 1	DIC-887A	300	AD 397
33BU205	Todd Mound (33Wa205)	UGA-2148	60	AD 226, 278, 331
33BU205	Todd Mound (33Wa205)	UGA- 2147	60	AD 226
33BU205	Todd Mound (33Wa205)	UGA-2149	60	AD 218
33BU205	Todd Mound (33Wa205)	UGA-2150	60	AD 88, 98, 115
33WA92	Wood-73	DIC-1039	310	AD 12
33WA112	King Road	DIC-1040	270	763, 620, 601 BC
33BU477	Houpt	Beta-71185	60	805 BC
33BU477	Houpt	Beta-71184	100	1259, 1232, 1227 BC
33BU477	Houpt	Beta-71183	90	1516 BC
33WA78	Pipeline	DIC-1035	110	1525 BC
33BU477	Houpt	Beta-71186	70	1597, 1568, 1529 BC
33WA04	Anderson Village	DIC-777	145	1613 BC
33WA92	Wood-73	DIC-1038	90	1742 BC
33WA83	Oglesby-Harris	DIC-1037	50	3028, 2975, 2930 BC
33WA83	Oglesby-Harris	DIC-1037	150	3091, 3055, 3047 BC

sources: Maslowski et al. (1995), Purtill (2209, Morlan (2005).

TABLE 5. Site 33BU1071: Chi-square Test for Differences in the Distributions of Fire-Cracked Rock (FCR) and Debitage at the Eastern Locus and Western Locus.

Site Loci	Major Artifact Types				Row Totals
	FCR-observed	FCR-expected	Debitage-observed	Debitage-expected	
Eastern	50	40.7	75	84.3	125
Western	34	43.3	99	89.7	133
Column Totals	84		174		258 (Grand Total)

Null Hypothesis: the observed does not exceed the expected chi-square value, indicating a random distribution of fire-cracked rock and debitage at the Eastern Locus and Western Locus.

Observed chi-square = 6.12
Expected chi-square = 6.64 (p<0.01, df = 1).

Conclusion: the Null Hypothesis is accepted, fire-cracked rock and debitage are randomly distributed at Eastern Locus and Western Locus.

TABLE 6. Site 33BU1071: Chi-square Test for Differences in the Distributions of Bifaces and Debitage at the Eastern Locus and Western Locus.

Site Loci	Major Artifact Types				Row Totals
	Bifaces-observed	Bifaces-expected	Debitage-observed	Debitage-expected	
Eastern	14	8.76	75	80.24	89
Western	5	10.24	99	93.76	104
Column Totals	19		174		193 (Grand Total)

Null Hypothesis: the observed does not exceed the expected chi-square value, indicating a random distribution of bifaces and debitage at the Eastern Locus and Western Locus.

Observed chi-square = 6.45
Expected chi-square = 6.64 (p<0.01, df = 1).

Conclusion: the Null Hypothesis is accepted, bifaces and debitage are randomly distributed at Eastern Locus and Western Locus.

TABLE 7. Site 33BU1071: Chi-square Test for Differences in the Distributions of Bifaces and Fire-Cracked Rock (FCR) at the Eastern Locus and Western Locus.

Site Loci	Major Artifact Types				Row Totals
	Bifaces-observed	Bifaces-expected	FCR-observed	FCR-expected	
Eastern	14	11.81	50	52.19	64
Western	5	7.19	34	31.81	39
Column Totals	19		84		103 (Grand Total)

Null Hypothesis: the observed does not exceed the expected chi-square value, indicating a random distribution of bifaces and FCR at the Eastern Locus and Western Locus.

Observed chi-square = 1.32
Expected chi-square = 6.64 (p<0.01, df = 1).

Conclusion: the Null Hypothesis is accepted, bifaces and FCR are randomly distributed at Eastern Locus and Western Locus.

TABLE 8. Site 33BU1071: Chi-square Test for Differences in the Distributions of Early-Stage Debitage and Late-Stage Debitage at the Eastern Locus and Western Locus.

Site Loci	Debitage				Row Totals
	Early-Stage-observed	Early-Stage-expected	Late-Stage-observed	Late-Stage-expected	
Eastern	20	15.98	13	17.02	33
Western	11	15.02	20	15.98	31
Column Totals	31		33		64 (Grand Total)

Null Hypothesis: the observed does not exceed the expected chi-square value, indicating a random distribution of early-stage debitage and late-stage debitage at the Eastern Locus and Western Locus.

Observed chi-square = 4.04
Expected chi-square = 6.64 (p<0.01, df = 1).

Conclusion: the Null Hypothesis is accepted, early-stage debitage and late-stage debitage are randomly distributed at Eastern Locus and Western Locus.

PHOTOGRAPHS

Photograph 1. Site 33BU1071. Test Units 6 and 7 are visible. View to west.
Date: August 26, 2014
Photographer: Rob Jacoby

Photograph 2. Site 33BU1071. Test Units 6 and 7 are visible. View to east-southeast.
Date: August 27, 2014
Photographer: Rob Jacoby

Photograph 3. Test Unit 1 showing plow scars at Ap/B-horizon interface (Anomaly 5). View to west.
Date: August 15, 2014
Photographer: Rob Jacoby

Photograph 4. Test Unit 2, showing plow scars at Ap/B-horizon interface (Anomaly 6). View to east.
Date: August 16, 2014
Photographer: Rob Jacoby

Photograph 5. Test Unit 2, Feature 1, Level 1, at left. View to east. Note B2t/C-horizon interface at center.
Date: August 16, 2014
Photographer: Rob Jacoby

Photograph 6. Test Unit 2, B-horizon, Anomaly 7, Level 1. View to west.
Date: August 17, 2014
Photographer: Rob Jacoby

Photograph 7. Test Unit 3, Anomaly 7, Level 3, bisection and plan.
Date: August 20, 2014
Photographer: Rob Jacoby

Photograph 8. Test Unit 3, Anomaly 7, Level 5, bisection and plan. View to northwest.
Date: August 20, 2014
Photographer: Rob Jacoby

Photograph 9. Test Unit 4, B-horizon, Anomaly 8. View to north.
Date: August 23, 2014
Photographer: Rob Jacoby

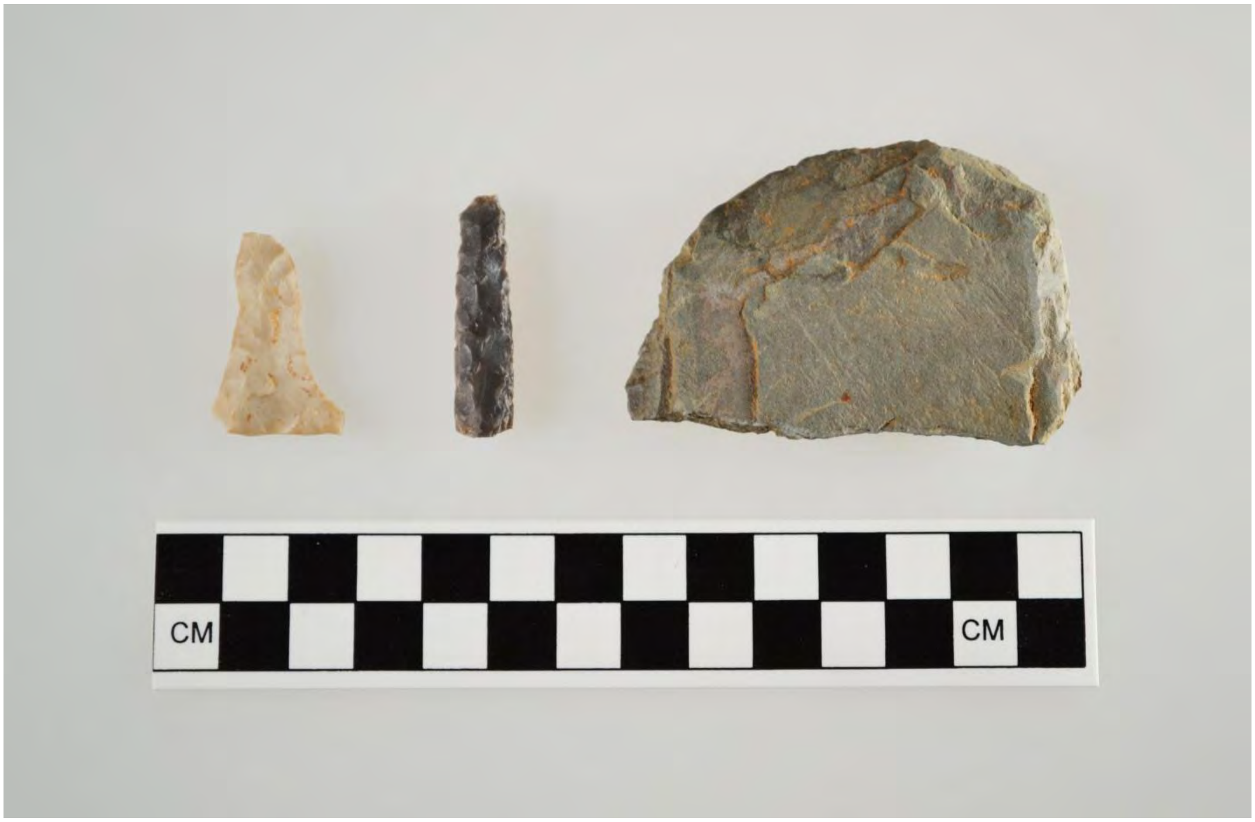
Photograph 10. Test Unit 4, Anomaly 8, Level 3, bisection. View to north.
Date: August 24, 2014
Photographer: Rob Jacoby

Photograph 11. Test Unit 5, B-horizon, Anomaly 15/Feature 2. View to north.
Date: August 24, 2014
Photographer: Rob Jacoby

Photograph 12. Test Unit 5, Anomaly 15/Feature 2, Level 3, bisection and plan. View to south.
Date: August 25, 2014
Photographer: Rob Jacoby

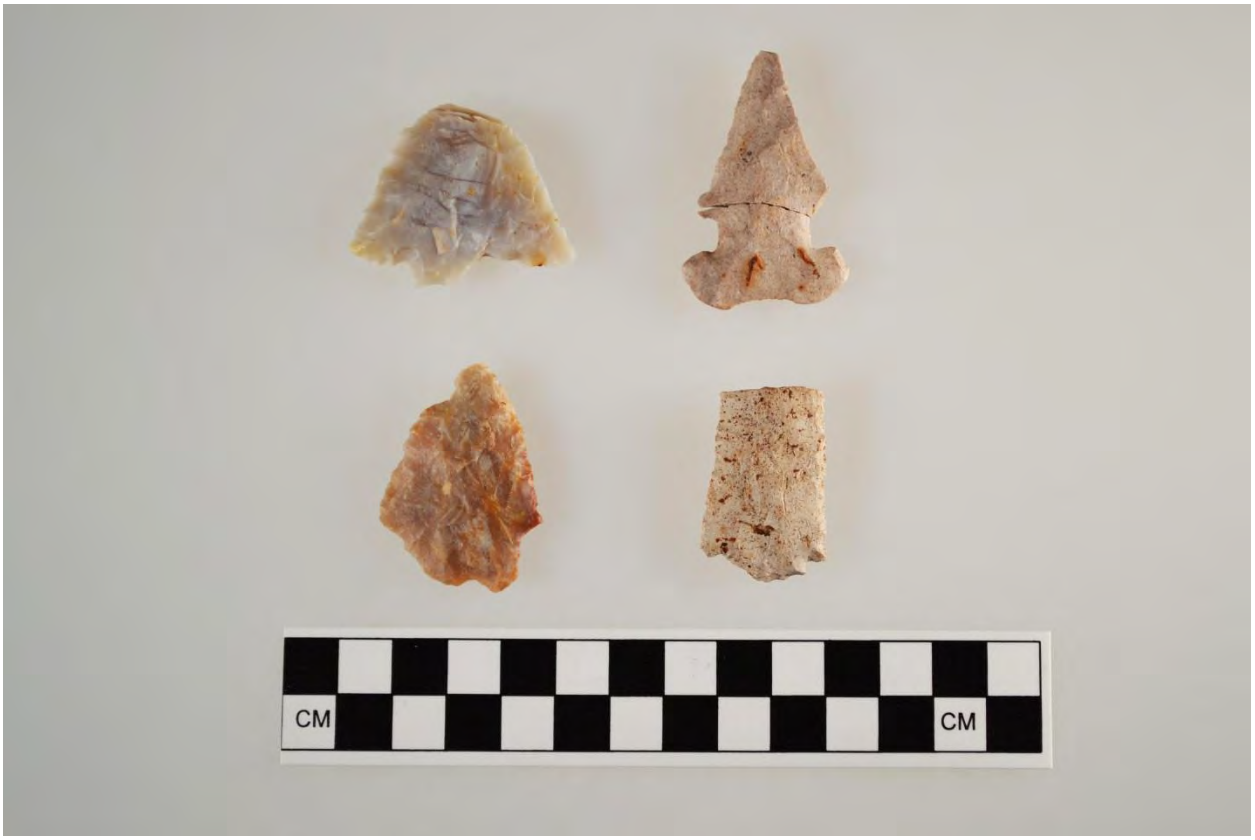
Photographer 13. Test Unit 6, showing plow scars at Ap/B-horizon interface (Anomaly 16). View to north.
Date: August 25, 2014
Photographer: Rob Jacoby

Photograph 14. Test Unit 2, Feature 1, north profile. View to north.
Date: August 17, 2014
Photographer: Rob Jacoby

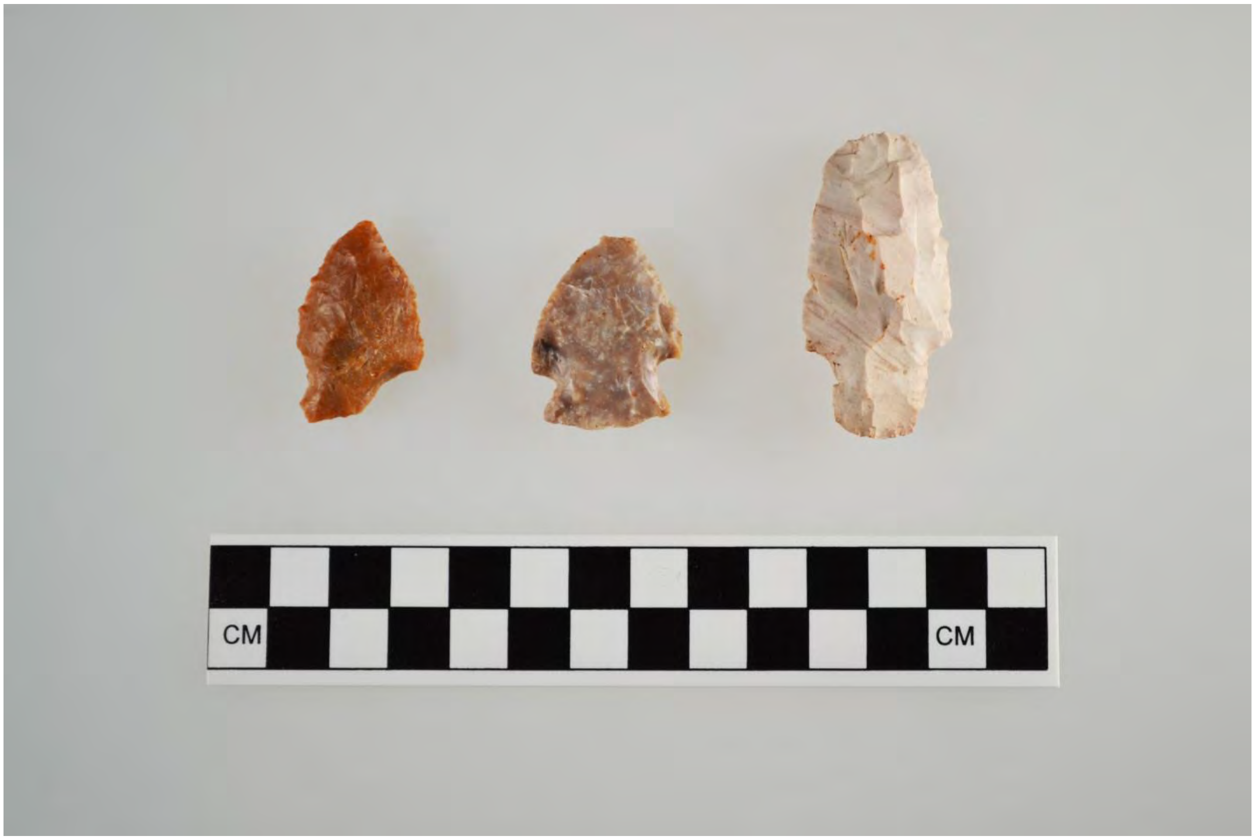


Photograph 15. Chert Drills (Cat# 67 and 70), and Slate Biface (Cat# 72).
Date: September 26, 2014
Photographer: Rob Jacoby

Photograph 16. Chert Cores (l. to r.), flake cores (Cat# 02 and 11); microblade cores (Cat# 26 and 34.2).
Date: September 26, 2014
Photographer: Rob Jacoby



Photograph 17. Early Archaic and Middle Archaic period projectile points. Top row (l. to r.), Thebes (Cat# 73 and 32.1/34.1 [mends]); Bottom row (l. to r.), Stanly Stemmed (Cat# 71), Decatur (Cat# 122).
Date: September 26, 2014
Photographer: Rob Jacoby



Photograph 18. Late Archaic period Projectile Points (l. to r.), Brewerton Side-Notched (Cat# 68 and 93), McWhinney Heavy Stemmed (Cat# 06.1).
Date: September 26, 2014
Photographer: Rob Jacoby

Photograph 19. Woodland and Late Prehistoric Projectile Points (l. to r.), Adena base (Cat# 32.2), Madison triangle (Cat# 24.1), Fort Ancient-like (Cat# 106).
Date: September 26, 2014
Photographer: Rob Jacoby

APPENDIX A

OHIO
HISTORY
CONNECTION

June 30, 2014

Lynn Gresock
Environmental Consultant
Tetra Tech, Inc.
160 Federal Street, 3rd Floor
Boston, MA 02110

Re: Middletown Energy Center
Middletown, Butler County, Ohio

Dear Ms. Gresock,

This is in response to correspondence from your office dated June 5, 2014, regarding the above referenced project. The comments of the Ohio Historic Preservation Office (OHPO) are submitted in accordance with provisions of the National Historic Preservation Act of 1966, as amended (16 U.S.C. 470 [36 CFR 800]) and the Memorandum of Agreement for this undertaking.

The correspondence provides a Phase II archaeological testing work plan for archaeological site 33-BU-1071. For the proposed Phase II investigations we recommend the inclusion of geophysical testing, such as magnetometry. It has been our experience that remote sensing prior to digging shovel tests can help identify areas likely to contain subplowzone features. We agree with the research questions and we agree with your recommendation that archaeological site 33-BU-1071 merits Phase II testing to consider recognition of National Register eligibility. We do not object to the initiation of Phase II testing at this site.

Any questions concerning this matter should be addressed to David Snyder at (614) 298-2000, between the hours of 8 am. to 5 pm. Thank you for your cooperation.

Sincerely,

David Snyder

David Snyder, Ph.D., RPA, Archaeology Reviews Manager
Resource Protection and Review

DMS/ds (OHPO Serial Number 1054279)

APPENDIX B

APPENDIX B
MIDDLETOWN ENERGY CENTER
PHASE II ARTIFACT INVENTORY

Cat #	TU	ST	FS	Quad	Strat/Lev	Anom	Fea	Anom/ Fea Lev	Art Type	Art Sub	Material	Quantity	Cortex Type	Cortex Rank	Comments
1.0	2	-	-	SW	A/1	-	-	-	Lithic	BRF	chert-0	1	0	0	-
1.0	2	-	-	SW	A/1	-	-	-	Lithic	FCR	quartzite	1	-	-	-
2.0	2	-	-	NW	A/1	-	-	-	Lithic	BRF	chert-0	1	1	1	-
2.0	2	-	-	NW	A/1	-	-	-	Lithic	Core	chert-0	1	2	1	thermal alt
2.0	2	-	-	NW	A/1	-	-	-	Lithic	FCR	igneous	1	-	-	-
2.0	2	-	-	NW	A/1	-	-	-	Lithic	FF	chert-1	3	0	0	-
3.0	1	-	-	SW	A/1	-	-	-	Lithic	BS	chert-0	1	0	0	-
3.0	1	-	-	SW	A/1	-	-	-	Lithic	DF	chert-0	1	2	3	-
3.0	1	-	-	SW	A/1	-	-	-	Lithic	FCR	quartzite	2	-	-	-
3.0	1	-	-	SW	A/1	-	-	-	Lithic	FF	chert-2	1	0	0	-
4.0	1	-	-	NW	A/1	-	-	-	Lithic	BRF	chert-3	1	0	0	-
4.0	1	-	-	NW	A/1	-	-	-	Lithic	FCR	quartzite	2	-	-	-
4.0	1	-	-	NW	A/1	-	-	-	Lithic	FF	chert-0	2	0	0	-
5.0	1	-	-	NE	A/1	-	-	-	Historic	architectural	brick	6	-	-	fragments
5.0	1	-	-	NE	A/1	-	-	-	Historic	architectural	pane glass	1	-	-	-
5.0	1	-	-	NE	A/1	-	-	-	Historic	misc	plastic	1	-	-	-
5.0	1	-	-	NE	A/1	-	-	-	Lithic	BRF	chert-0	1	0	0	-
5.0	1	-	-	NE	A/1	-	-	-	Lithic	FCR	sedimentary	1	-	-	-
5.0	1	-	-	NE	A/1	-	-	-	Lithic	FF	chert-0	2	0	0	-
6.0	1	-	-	SE	A/1	-	-	-	Lithic	FCR	quartz	1	-	-	-
6.0	1	-	-	SE	A/1	-	-	-	Lithic	FCR	sedimentary	2	-	-	-
6.0	1	-	-	SE	A/1	-	-	-	Lithic	FF	chert-4	1	0	0	-
6.0	1	-	-	SE	A/1	-	-	-	Lithic	FF	chert-3	1	0	0	-
6.0	1	-	-	SE	A/1	-	-	-	Lithic	FF	chert-0	4	0	0	-
6.1	1	-	-	SE	A/1	-	-	-	Lithic	Biface	chert-0	1	0	0	McWhinney pt
7.0	3	-	-	SW	A/1	-	-	-	Historic	architectural	brick	1	-	-	fragment
7.0	3	-	-	SW	A/1	-	-	-	Historic	container	glass	2	-	-	clear
7.0	3	-	-	SW	A/1	-	-	-	Lithic	BS	chert-0	1	0	0	-
7.0	3	-	-	SW	A/1	-	-	-	Lithic	ER	chert-0	1	3	1	-
7.0	3	-	-	SW	A/1	-	-	-	Lithic	FCR	sedimentary	4	-	-	-
7.0	3	-	-	SW	A/1	-	-	-	Lithic	FF	chert-0	2	0	0	-
7.0	3	-	-	SW	A/1	-	-	-	Lithic	FF	chert-4	1	0	0	-
7.0	3	-	-	SW	A/1	-	-	-	Lithic	FF	chert-5	1	0	0	-
8.0	2	-	-	SE	A/1	-	-	-	Lithic	FCR	igneous	1	-	-	-
8.0	2	-	-	SE	A/1	-	-	-	Lithic	FCR	sedimentary	2	-	-	-
8.0	2	-	-	SE	A/1	-	-	-	Lithic	FF	chert-1	1	0	0	-

APPENDIX B
MIDDLETOWN ENERGY CENTER
PHASE II ARTIFACT INVENTORY

Cat #	TU	ST	FS	Quad	Strat/Lev	Anom	Fea	Anom/ Fea Lev	Art Type	Art Sub	Material	Quantity	Cortex Type	Cortex Rank	Comments
9.0	2	-	-	NE	A/1	-	-	-	Lithic	FCR	sedimentary	1	-	-	-
10.0	3	-	-	NW	A/1	-	-	-	Lithic	BRF	chert-0	1	2	2	-
10.0	3	-	-	NW	A/1	-	-	-	Lithic	BRF	chert-2	1	0	0	-
10.0	3	-	-	NW	A/1	-	-	-	Lithic	FCR	igneous	2	-	-	-
10.0	3	-	-	NW	A/1	-	-	-	Lithic	FCR	metamorphic	1	-	-	-
10.0	3	-	-	NW	A/1	-	-	-	Lithic	FF	chert-5	1	0	0	-
10.0	3	-	-	NW	A/1	-	-	-	Lithic	FF	chert-0	5	0	0	-
11.0	3	-	-	NE	A/1	-	-	-	Lithic	BRF	chert-1	1	0	0	-
11.0	3	-	-	NE	A/1	-	-	-	Lithic	Core	chert-0	1	2	2	-
11.0	3	-	-	NE	A/1	-	-	-	Lithic	FCR	igneous	1	-	-	-
11.0	3	-	-	NE	A/1	-	-	-	Lithic	FCR	sedimentary	4	-	-	-
11.0	3	-	-	NE	A/1	-	-	-	Lithic	FF	chert-1	1	0	0	-
11.0	3	-	-	NE	A/1	-	-	-	Lithic	FF	chert-0	5	0	0	-
12.0	2	-	-	NE	-	-	1	1	Lithic	FCR	sedimentary	1	-	-	-
13.0	2	-	-	NE	B/2	-	-	-	Lithic	BRF	chert-1	1	0	0	-
14.0	3	-	-	SE	A/1	-	-	-	Historic	container	glass	3	-	-	clear
14.0	3	-	-	SE	A/1	-	-	-	Lithic	BS	quartzite	2	0	0	-
14.0	3	-	-	SE	A/1	-	-	-	Lithic	BS	chert-6	1	1	3	-
14.0	3	-	-	SE	A/1	-	-	-	Lithic	FCR	sedimentary	1	-	-	-
14.0	3	-	-	SE	A/1	-	-	-	Lithic	FF	chert-1	1	0	0	-
15.0	3	-	-	NW	B/2	-	-	-	Lithic	Biface	chert-0	1	2	1	late-stage
16.0	3	-	-	NE	B/2	-	-	-	Lithic	FCR	sedimentary	1	-	-	-
16.0	3	-	-	NE	B/2	-	-	-	Lithic	FCR	igneous	1	-	-	-
16.0	3	-	-	NE	B/2	-	-	-	Lithic	FF	chert-0	1	0	0	-
17.0	2	-	-	NE	-	-	1	1	Lithic	BRF	chert-1	1	0	0	-
17.0	2	-	-	NE	-	-	1	1	Lithic	FF	chert-0	2	0	0	-
18.0	3	-	-	-	-	7	-	1	Lithic	FCR	igneous	3	-	-	-
18.0	3	-	-	-	-	7	-	1	Lithic	FF	chert-3	2	0	0	-
18.0	3	-	-	-	-	7	-	1	Lithic	FF	chert-0	1	0	0	-
20.0	3	-	-	-	-	7	-	2	Lithic	BRF	chert-5	1	0	0	-
20.0	3	-	-	-	-	7	-	2	Lithic	FCR	sedimentary	1	-	-	
22.0	5	-	-	NE	A/1	-	-	-	Lithic	FCR	igneous	1	-	-	
23.0	5	-	-	SE	A/1	-	-	-	Lithic	FCR	igneous	2	-	-	
23.0	5	-	-	SE	A/1	-	-	-	Lithic	FCR	sedimentary	4	-	-	
24.1	5	-	-	SW	A/1	-	-	-	Lithic	Biface	chert-0	1	0	0	triangle pt
24.0	5	-	-	SW	A/1	-	-	-	Lithic	DF	chert-0	1	2	3	-

APPENDIX B
MIDDLETOWN ENERGY CENTER
PHASE II ARTIFACT INVENTORY

Cat #	TU	ST	FS	Quad	Strat/Lev	Anom	Fea	Anom/ Fea Lev	Art Type	Art Sub	Material	Quantity	Cortex Type	Cortex Rank	Comments
24.0	5	-	-	SW	A/1	-	-	-	Lithic	FCR	metamorphic	2	-	-	
24.0	5	-	-	SW	A/1	-	-	-	Lithic	FCR	igneous	2	-	-	
24.0	5	-	-	SW	A/1	-	-	-	Lithic	FCR	sedimentary	3	-	-	
26.0	6	-	-	SW	A/1	-	-	-	Lithic	Biface	chert-0	1	0	0	late-stage midsection
26.0	6	-	-	SW	A/1	-	-	-	Lithic	BRF	chert-1	1	0	0	-
26.1	6	-	-	SW	A/1	-	-	-	Lithic	Core	chert-4	1	0	0	micro-blade core
26.0	6	-	-	SW	A/1	-	-	-	Lithic	DF	chert-0	1	2	3	-
26.0	6	-	-	SW	A/1	-	-	-	Lithic	FCR	igneous	2	-	-	
26.0	6	-	-	SW	A/1	-	-	-	Lithic	FCR	sedimentary	2	-	-	
26.0	6	-	-	SW	A/1	-	-	-	Lithic	FF	chert-0	1	0	0	-
27.0	6	-	-	NW	A/1	-	-	-	Lithic	BRF	chert-0	1	0	0	-
27.0	6	-	-	NW	A/1	-	-	-	Lithic	FCR	igneous	1	-	-	
27.0	6	-	-	NW	A/1	-	-	-	Lithic	FCR	sedimentary	2	-	-	
27.0	6	-	-	NW	A/1	-	-	-	Lithic	FF	chert-4	2	0	0	-
27.0	6	-	-	NW	A/1	-	-	-	Lithic	FF	chert-2	1	0	0	-
27.0	6	-	-	NW	A/1	-	-	-	Lithic	FF	chert-3	1	0	0	-
28.0	6	-	-	NE	A/1	-	-	-	Lithic	BS	chert-0	1	0	0	-
28.0	6	-	-	NE	A/1	-	-	-	Lithic	FCR	sedimentary	3	-	-	
28.0	6	-	-	NE	A/1	-	-	-	Lithic	FF	chert-0	3	0	0	-
29.0	5	-	-	-	-	15	-	1	Lithic	FCR	igneous	6	-	-	
29.0	5	-	-	-	-	15	-	1	Lithic	FCR	sedimentary	2	-	-	
30.0	5	-	-	-	-	15	-	2	Lithic	FCR	igneous	3	-	-	
30.0	5	-	-	-	-	15	-	2	Lithic	FCR	sedimentary	9	-	-	
31.0	6	-	-	SE	A/1	-	-	-	Historic	container	glass	1	-	-	aqua; letter embossment
31.0	6	-	-	SE	A/1	-	-	-	Lithic	BRF	chert-1	1	0	0	-
31.0	6	-	-	SE	A/1	-	-	-	Lithic	FCR	igneous	2	-	-	
31.0	6	-	-	SE	A/1	-	-	-	Lithic	FCR	sedimentary	1	-	-	
31.0	6	-	-	SE	A/1	-	-	-	Lithic	FF	chert-2	1	0	0	-
31.0	6	-	-	SE	A/1	-	-	-	Lithic	FF	chert-0	1	0	0	-
32.0	7	-	-	SE	A/1	-	-	-	Lithic	DF	chert-0	1	2	3	-
32.0	7	-	-	SE	A/1	-	-	-	Lithic	DF	chert-0	1	2	1	-

Cat #	TU	ST	FS	Quad	Strat/Lev	Anom	Fea	Anom/ Fea Lev	Art Type	Art Sub	Material	Quantity	Cortex Type	Cortex Rank	Comments
32.1	7	-	-	SE	A/1	-	-	-	Lithic	Biface	chert-0	1	0	0	Thebes pt base, mends with Cat. 34.1
32.2	7	-	-	SE	A/1	-	-	-	Lithic	Biface	chert-7	1	0	0	Adena pt base
33.0	7	-	-	NW	A/1	-	-	-	Lithic	FCR	quartzite	1	-	-	
34.0	7	-	-	SW	A/1	-	-	-	Lithic	BRF	chert-0	1	0	0	-
34.0	7	-	-	SW	A/1	-	-	-	Lithic	FF	chert-7	1	0	0	-
34.0	7	-	-	SW	A/1	-	-	-	Lithic	FF	chert-2	1	0	0	-
34.0	7	-	-	SW	A/1	-	-	-	Lithic	FF	chert-1	1	0	0	-
34.0	7	-	-	SW	A/1	-	-	-	Lithic	FF	chert-0	1	2	2	-
34.1	7	-	-	SW	A/1	-	-	-	Lithic	Biface	chert-0	1	0	0	Thebes pt blade, mends with Cat. 32.1
34.2	7	-	-	SW	A/1	-	-	-	Lithic	Core	chert-0	1	0	0	micro-blade core
35.0	7	-	-	NE	A/1	-	-	-	Lithic	FF	chert-0	1	0	0	-
36.0	8	-	-	-	A/1	-	-	-	Lithic	BRF	chert-1	1	0	0	-
36.1	8	-	-	-	A/1	-	-	-	Lithic	Biface	chert-4	1	0	0	late-stage midsection
37.0	-	12	-	-	A	-	-	-	Lithic	BRF	chert-0	1	0	0	-
38.0	-	13	-	-	A	-	-	-	Lithic	DF	chert-0	1	2	3	-
38.0	-	13	-	-	A	-	-	-	Lithic	FF	chert-5	1	0	0	-
39.0	-	14	-	-	A	-	-	-	Lithic	FF	chert-0	1	0	0	-
40.0	-	18	-	-	A	-	-	-	Lithic	FCR	quartzite	1	-	-	
41.0	-	19	-	-	A	-	-	-	Lithic	FF	chert-1	1	0	0	-
41.0	-	19	-	-	A	-	-	-	Lithic	FF	chert-0	1	2	1	-
42.0	-	21	-	-	A	-	-	-	Lithic	BS	chert-0	1	0	0	-
43.0	-	22	-	-	A	-	-	-	Lithic	DF	chert-0	1	2	3	-
43.0	-	22	-	-	A	-	-	-	Lithic	FF	chert-0	1	0	0	-
44.0	-	25	-	-	A	-	-	-	Lithic	FF	chert-1	2	0	0	-
45.0	-	26	-	-	A	-	-	-	Lithic	BRF	chert-1	1	0	0	-
46.0	-	24	-	-	A	-	-	-	Lithic	FF	chert-4	1	0	0	-
47.0	-	47	-	-	A	-	-	-	Lithic	ERF	chert-7	1	0	0	-
48.0	-	48	-	-	A	-	-	-	Lithic	BS	chert-0	1	2	3	-
49.0	-	32	-	-	A	-	-	-	Lithic	FF	chert-0	1	0	0	-
50.0	-	31	-	-	A	-	-	-	Lithic	ERF	chert-2	1	0	0	-

APPENDIX B
MIDDLETOWN ENERGY CENTER
PHASE II ARTIFACT INVENTORY

Cat #	TU	ST	FS	Quad	Strat/Lev	Anom	Fea	Anom/ Fea Lev	Art Type	Art Sub	Material	Quantity	Cortex Type	Cortex Rank	Comments
50.0	-	31	-	-	A	-	-	-	Lithic	FF	chert-0	1	2	2	-
50.0	-	31	-	-	A	-	-	-	Lithic	OF	chert-2	1	0	0	poss. micro-blade
51.0	-	49	-	-	A	-	-	-	Lithic	FF	chert-3	1	0	0	-
52.0	-	30	-	-	A	-	-	-	Lithic	BRF	quartzite	1	0	0	-
52.0	-	30	-	-	A	-	-	-	Lithic	DF	chert-5	1	2	3	-
52.0	-	30	-	-	A	-	-	-	Lithic	ERF	chert-1	1	2	1	-
53.0	-	28	-	-	A	-	-	-	Lithic	FCR	sedimentary	1	-	-	
53.0	-	28	-	-	A	-	-	-	Lithic	FCR	metamorphic	1	-	-	
54.0	-	27	-	-	A	-	-	-	Lithic	BS	chert-7	1	0	0	-
54.0	-	27	-	-	A	-	-	-	Lithic	BS	chert-0	1	0	0	-
55.0	-	36	-	-	A	-	-	-	Lithic	DF	chert-0	1	2	3	-
55.0	-	36	-	-	A	-	-	-	Lithic	ERF	chert-0	1	2	1	-
55.0	-	36	-	-	A	-	-	-	Lithic	FF	chert-5	1	0	0	-
56.0		39	-	-	A	-	-	-	Lithic	ERF	chert-0	1	2	2	-
57.0	-	41	-	-	A	-	-	-	Lithic	FF	chert-0	1	2	3	-
58.0	-	42	-	-	A	-	-	-	Lithic	FF	chert-0	1	2	3	-
59.0	-	43	-	-	A	-	-	-	Lithic	ERF	chert-0	1	0	0	-
60.0	-	50	-	-	A	-	-	-	Lithic	FF	chert-0	1	0	0	-
61.0	-	51	-	-	A	-	-	-	Lithic	BRF	chert-0	1	0	0	-
61.0	-	51	-	-	A	-	-	-	Lithic	FF	chert-0	1	0	0	-
62.0	-	52	-	-	A	-	-	-	Lithic	BRF	chert-0	1	0	0	-
62.0	-	52	-	-	A	-	-	-	Lithic	FF	chert-2	1	0	0	-
62.0	-	52	-	-	A	-	-	-	Lithic	FF	chert-4	1	0	0	-
62.0	-	52	-	-	A	-	-	-	Lithic	FF	chert-5	1	0	0	-
63.0	-	53	-	-	A	-	-	-	Historic	architectural	pane glass	1	-	-	
63.0	-	53	-	-	A	-	-	-	Lithic	BRF	slate	1	0	0	-
64.0	-	65	-	-	A	-	-	-	Lithic	ERF	chert-1	1	2	1	-
64.0	-	65	-	-	A	-	-	-	Lithic	FF	chert-0	1	0	0	-
65.0	-	67	-	-	A	-	-	-	Lithic	FF	chert-4	1	0	0	-
65.0	-	67	-	-	A	-	-	-	Lithic	FF	chert-5	1	0	0	-
65.0	-	67	-	-	A	-	-	-	Lithic	FF	chert-0	2	0	0	-
66.0	-	72	-	-	A	-	-	-	Lithic	FF	chert-0	1	2	1	-
67.0	-	-	50	-	Surface	-	-	-	Lithic	Drill	chert-1	1	0	0	basal grinding
68.0	-	-	51	-	Surface	-	-	-	Lithic	Biface	chert-0	1	0	0	Brewerton pt
69.0	-	-	52	-	Surface	-	-	-	Lithic	Biface	chert-4	1	0	0	distal

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Cat #	TU	ST	FS	Quad	Strat/Lev	Anom	Fea	Anom/ Fea Lev	Art Type	Art Sub	Material	Quantity	Cortex Type	Cortex Rank	Comments
70.0	-	-	53	-	Surface	-	-	-	Lithic	Drill	chert-7	1	0	0	midsection
71.0	-	-	54	-	Surface	-	-	-	Lithic	Biface	chert-0	1	0	0	Stanly stemmed pt
72.0	-	-	55	-	Surface	-	-	-	Lithic	Biface	slate	1	0	0	ulu
73.0	-	-	1		Surface	-	-	-	Lithic	Biface	chert-2	1	0	0	Thebes pt
74.0	-	-	2		Surface				Lithic	BRF	chert-4	1	0	0	-
75.0	-	-	3	-	Surface	-	-	-	Lithic	ERF	chert-2	1	0	0	-
76.0	-	-	4		Surface	-	-	-	Lithic	Biface	chert-0	1	2	3	small chopper
77.0	-	-	5	-	Surface	-	-	-	Lithic	ERF	chert-0	1	0	0	-
78.0	-	-	6		Surface	-	-	-	Lithic	Biface	chert-0	1	2	1	late-stage
79.0	-	-	7		Surface	-	-	-	Lithic	BPF	chert-8	1	2	1	-
80.0	-	-	8		Surface				Lithic	BRF	chert-5	1	0	0	-
81.0	-	-	9		Surface				Lithic	BRF	chert-0	1	0	0	-
82.0	-	-	10		Surface				Lithic	BRF	chert-2	1	0	0	-
83.0	-	-	11	-	Surface	-	-	-	Lithic	ERF	chert-0	1	2	1	-
84.0	-	-	12		Surface				Lithic	BS	chert-0	1	2	1	-
85.0	-	-	13		Surface				Lithic	BS	chert-0	1	2	1	-
86.0	-	-	14		Surface				Lithic	BRF	chert-1	1	0	0	-
87.0	-	-	15	-	Surface	-	-	-	Lithic	FF	chert-8	2	0	0	-
88.0	-	-	16		Surface				Lithic	BS	chert-0	1	2	3	-
89.0	-	-	17		Surface				Lithic	BRF	chert-5	1	0	0	-
90.0	-	-	18		Surface				Lithic	BRF	chert-0	1	0	0	-
91.0	-	-	19	-	Surface	-	-	-	Lithic	FF	chert-0	1	0	0	-
92.0	-	-	20	-	Surface	-	-	-	Lithic	FF	chert-8	1	0	0	-
93.0	-	-	21		Surface	-	-	-	Lithic	Biface	chert-2	1	0	0	Brewerton pt
94.0	-	-	22	-	Surface	-	-	-	Lithic	ERF	chert-8	1	2	2	-
95.0	-	-	23	-	Surface	-	-	-	Lithic	FF	chert-5	1	0	0	-
96.0	-	-	24		Surface				Lithic	BS	chert-2	1	1	2	-
97.0	-	-	25		Surface	-	-	-	Lithic	Biface	chert-3	1	1	1	mid-stage fragment
98.0	-	-	26		Surface				Lithic	BRF	chert-0	1	0	0	-
99.0	-	-	27		Surface				Lithic	BRF	chert-1	1	0	0	-
100.0	-	-	28		Surface				Lithic	BS	chert-0	1	2	2	-
101.0	-	-	29	-	Surface	-	-	-	Lithic	ERF	chert-4	1	0	0	-
102.0	-	-	30		Surface				Lithic	BRF	chert-4	1	0	0	-
103.0	-	-	31	-	Surface	-	-	-	Lithic	DF	chert-0	1	1	3	-

Cat #	TU	ST	FS	Quad	Strat/Lev	Anom	Fea	Anom/ Fea Lev	Art Type	Art Sub	Material	Quantity	Cortex Type	Cortex Rank	Comments
104.0	-	-	32	-	Surface	-	-	-	Lithic	FF	chert-0	1	0	0	-
105.0	-	-	33		Surface				Lithic	BRF	chert-1	1	0	0	-
106.0	-	-	34	-	Surface	-	-	-	Lithic	Biface	chert-7	1	0	0	late-stage
107.0	-	-	35	-	Surface	-	-	-	Lithic	DF	chert-0	1	2	3	-
108.0	-	-	36	-	Surface	-	-	-	Lithic	FF	chert-5	1	0	0	-
109.0	-	-	37	-	Surface	-	-	-	Lithic	DF	chert-8	1	2	3	-
110.0	-	-	38		Surface	-	-	-	Lithic	Biface	chert-2	1	0	0	late-stage fragment
111.0	-	-	38	-	Surface	-	-	-	Lithic	ERF	chert-1	1	0	0	-
112.0	-	-	38	-	Surface	-	-	-	Lithic	ERF	chert-0	1	1	2	-
113.0	-	-	39		Surface				Lithic	BS	chert-0	1	2	1	-
114.0	-	-	40		Surface				Lithic	BS	chert-4	1	2	1	-
115.0	-	-	41		Surface				Lithic	BS	chert-0	1	1	2	-
116.0	-	-	42		Surface				Lithic	BRF	chert-8	1	0	0	-
117.0	-	-	43		Surface				Lithic	BRF	chert-1	1	0	0	-
118.0	-	-	44		Surface				Lithic	BS	chert-0	1	0	0	-
119.0	-	-	45	-	Surface	-	-	-	Lithic	FF	chert-2	1	0	0	-
120.0	-	-	46	-	Surface	-	-	-	Lithic	FF	chert-0	1	0	0	-
121.0	-	-	47		Surface				Lithic	BRF	chert-1	1	0	0	-
122.0	-	-	48		Surface	-	-	-	Lithic	Biface	chert-8	1	0	0	poss. Decatur or fractured base pt
123.0	-	I-32	-	-	A	-	-	-	Lithic	FF	chert-0	1	0	0	-
124.0	-	I-35	-	-	A	-	-	-	Lithic	ERF	chert-0	1	0	0	-
126.0	-	I-36	-	-	A	-	-	-	Lithic	FF	chert-1	1	0	0	-
127.0	-	I-38	-	-	A	-	-	-	Lithic	DF	chert-0	3	2	3	-
131.0	-	I-40	-	-	A	-	-	-	Lithic	ERF	chert-0	1	0	0	-
133.0	-	I-40	-	-	A	-	-	-	Lithic	FF	chert-0	1	0	0	-
125.0	-	I-35	-	-	A	-	-	-	Lithic	BRF	chert-1	1	0	0	-
128.0	-	I-38	-	-	A	-	-	-	Lithic	BRF	chert-4	1	0	0	-
129.0	-	I-38	-	-	A	-	-	-	Lithic	BS	chert-0	1	0	0	-
130.0	-	I-39	-	-	A	-	-	-	Lithic	BS	chert-8	1	0	0	-
132.0	-	I-40	-	-	A	-	-	-	Lithic	BRF	chert-1	1	0	0	-
133.0	4	-	-	NE	A/1	-	-	-	Lithic	DF	chert-1	1	1	3	-

APPENDIX B, continued

Translation of chert material types:

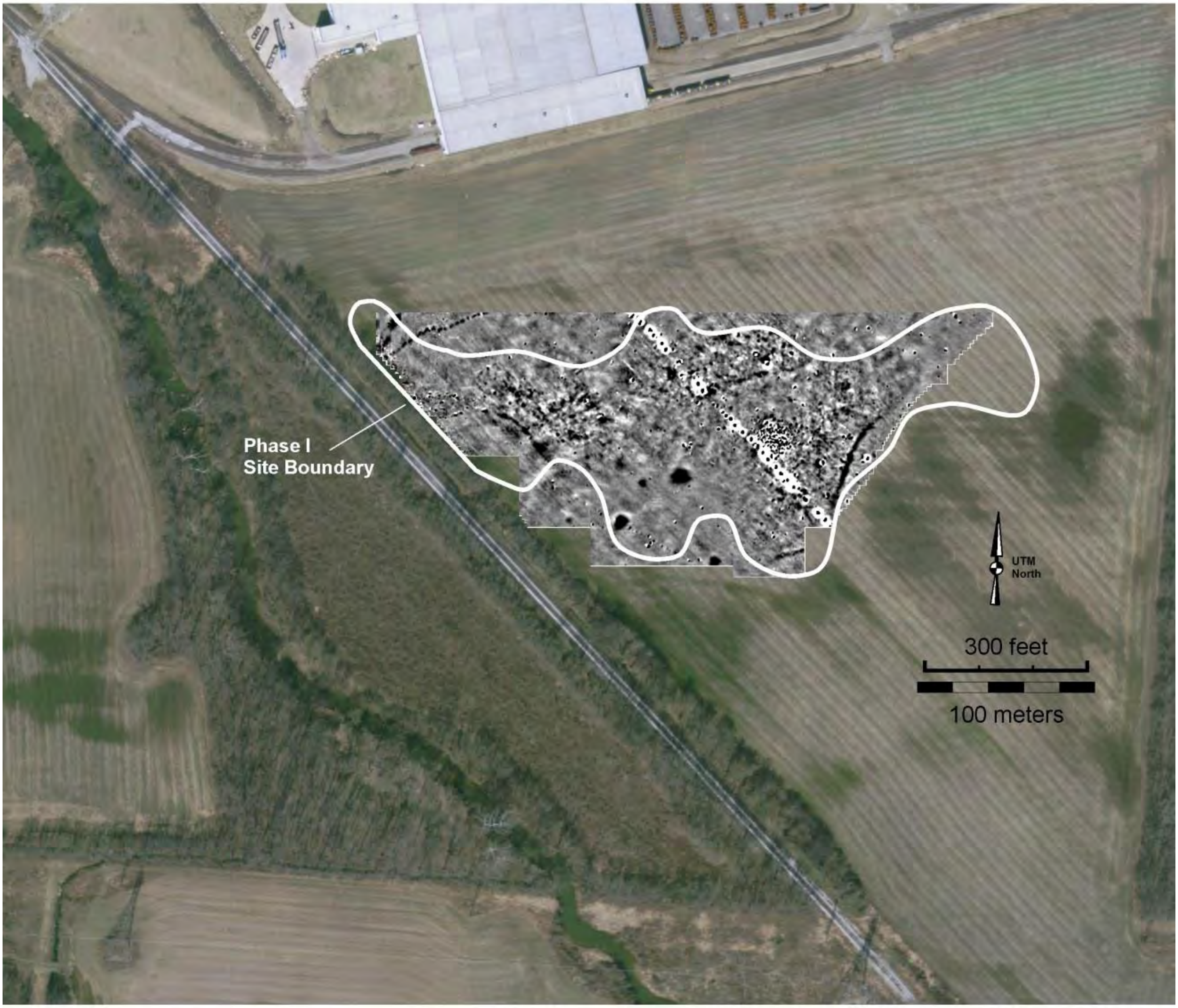
Chert-0	unidentifiable
Chert-1	Delaware chert
Chert-2	Vanport chert
Chert-3	Vanport chalcedony
Chert-4	Upper Mercer chert
Chert-5	Cedarville-guelph chert
Chert-6	jasper
Chert-7	Indiana hornstone
Chert-8	Four Mile Creek chert

APPENDIX C

Geophysical Survey at Site 33BU1071, a Multicomponent Prehistoric Native American Site in Butler County, Ohio

Jarrod Burks, Ph.D.

2014



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OVAI Contract Report 2014-46

OVAI Contract Report #2014-46

Geophysical Survey at Site 33BU1071, a Multicomponent Prehistoric Native American Site in Butler County, Ohio

by

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September 2014

Executive Summary

During the week of August 4-8, 2014, magnetic gradient and magnetic susceptibility surveys were conducted at site 33BU1071 in an effort to locate intact subsurface archaeological features and areas of thermal refuse dumping. These surveys were conducted by Ohio Valley Archaeology, Inc. on behalf of Tetra Tech. Numerous magnetic anomalies of potential archaeological interest were detected, including 21 possible pit-type features, an old fence line and refuse from burning a pile of fencing debris, and other anomalies of geological and unknown origin. Limited ground truthing at some of these anomalies in the form of coring and augering showed that distinct, though subtle soil color and texture differences are associated with some. An anomaly ranking system was used to determine which of the 21 anomalies were the most likely to be archaeological features of interest, in this case, pit-type features. Seven anomalies are recommended for further archaeological testing.

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Introduction

This report presents the results of geophysical survey work conducted at site 33BU1071 during the week of August 4-8, 2014. The project was conducted by Ohio Valley Archaeology, Inc. on behalf of Tetra Tech as part of an undertaking reviewed by the Ohio Power Siting Board. Site 33BU1071 is a multicomponent prehistoric Native American site located on a relict sand dune. The site appears to have two artifact clusters, one to the east and another to the west, that coincide with two topographic prominences. Lithic debris and fire-cracked rock are present in both clusters, suggesting the possible presence of buried thermal features. Just prior to the survey the soybeans growing in the field that contains the site were mowed to facilitate data collection.

Figure 1 shows the location of the survey area and the Phase I delimited site boundary for 33BU1071 on 2006 and 1964 aerial photographs. The magnetic gradient survey was conducted over an area of about 8.38 acres (3.39 ha). Of note, this area has long been an agricultural field and at one point a fence (in 1964 it appears to be a wire fence) crosscut the middle of the site. No obvious sign of the fence is present on the surface today, but upon close inspection during the magnetic survey several steel fence post fragments were observed on the surface.

The survey area is predominantly covered by Princeton sandy loam soils, with the topographically lower areas stretching into Patton silty clay loam. All of the archaeological materials appear to be on the topographically higher, Princeton soils, which are Typic Hapludalf forest soils (with an Ap horizon) that have formed into eolian silt and fine sand (USDA 2011). Based on the shape of the landform at 33BU1071, it would appear that the site is sitting on Princeton soils formed into a relict sand dune. This is an important detail for the magnetic survey because sand-rich soils tend to have fairly low magnetic contrast, making it harder to detect archaeological features.

This report is divided into several sections. First a methods section outlines the geophysical survey devices used during the project and the kinds of data they generate. Interpreting the geophysical data is a critical step in producing useful results; therefore, some time is spent on outlining the data interpretation approach used here. With that as background, the results of the surveys are presented in detail, with a discussion of the kinds of features that might have been detected. A final section provides a summary of the results and conclusions about the survey.

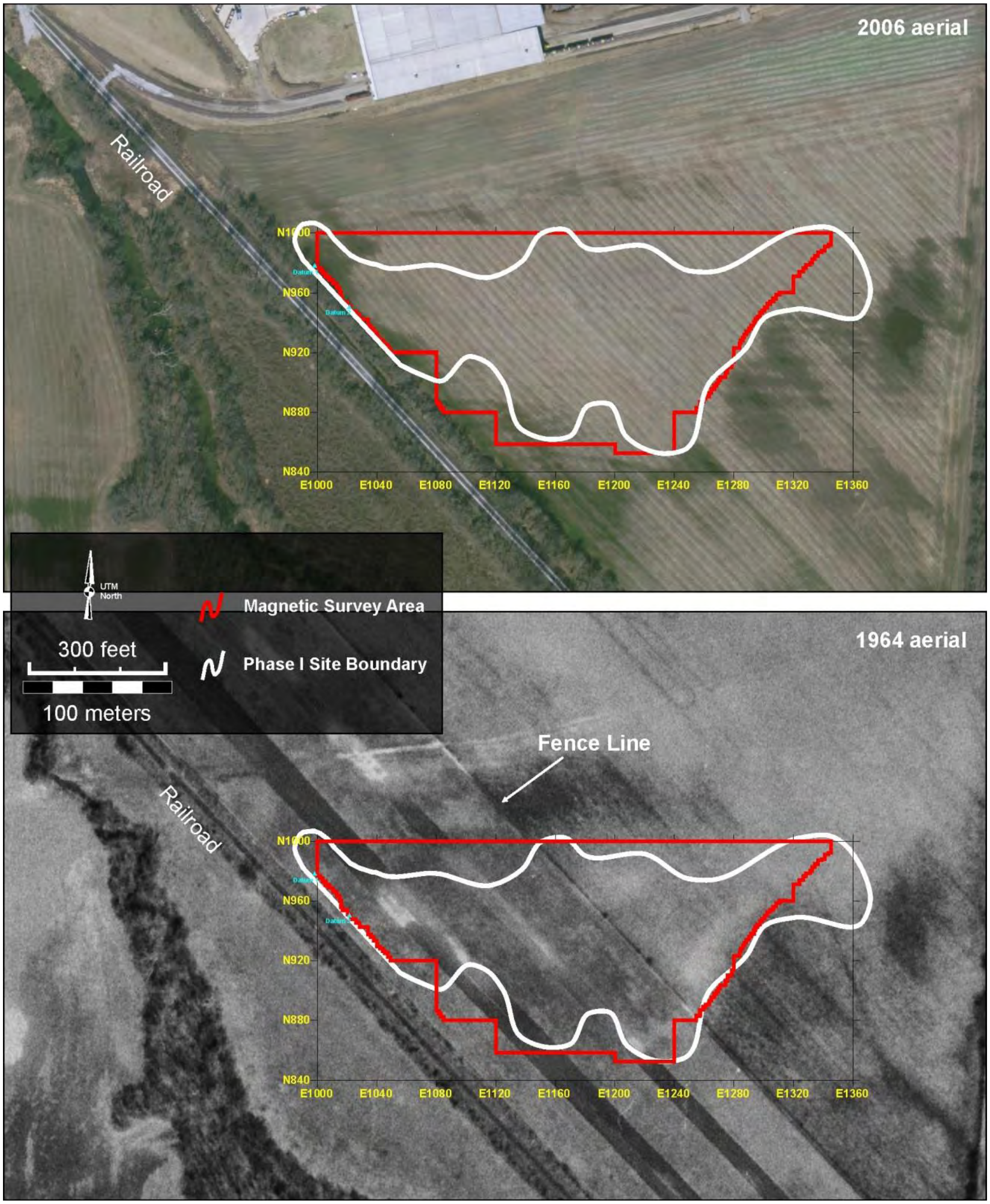

Figure 1. Geophysical survey area location on 2006 and 1964 aerial photographs.

Methods

Geophysical survey instruments have come a long way in the last twenty years in terms of their usefulness for characterizing site structure and locating subsurface features on archaeology sites (e.g., Aspinall *et al*. 2008; Bevan 1998; Clark 2000; Dalan and Banerjee 1998; Gaffney and Gater 2003; Heimmer and DeVore 1995; Lowrie 1997; Weymouth 1986; Witten 2006). Some of the biggest changes are that instruments can now log readings much faster and dataloggers can store vastly larger amounts of data. With some kinds of instruments, this means that multiple sensors can be attached to one datalogger and operated simultaneously, greatly boosting the amount of area that can be surveyed per day.

Two instruments were used to survey site 33BU1071, a magnetometer and a magnetic susceptibility meter (Figure 2). The magnetometer survey, or magnetic gradient survey, was performed with a Foerster Instruments Ferex-DLG 4.032 magnetometer system, set up in a 4-probe array. This instrument consists of four fluxgate gradiometers (i.e., eight total sensors), each with an internal sensor separation of 65 cm. Ten readings were collected per meter along transects spaced 50 cm apart within complete and partial 40x40 meter blocks. For the magnetic susceptibility survey, a Bartington Instruments MS2 meter with a MS2D field sensor was used to collect readings at a roughly ten-meter interval approximated through pacing. A Trimble GeoXT global positioning system (GPS) was used to record the locations of the susceptibility readings.

Figure 2. Geophysical instruments used during the survey work: (left) magnetometer, a Foerster Instruments Ferex-DLG 4.032 4-Probe fluxgate gradiometer array, and (right) the magnetic susceptibility meter, a Bartington MS2 meter with a MS2D field sensor (and a Trimble GeoXT global positioning system for data recording).

Magnetic Gradient Survey

Magnetometers are very sensitive to ferromagnetic materials, that is, materials such as artifacts, rocks, and sediments that contain iron. Iron objects, such as large nails, farm machinery parts, and other structural and mechanical components, have very strong, unmistakable magnetic signatures. In addition to their ability to detect iron objects, magnetometers also can detect changes in the soil related to iron oxides—especially variability in the thickness of topsoil or archaeological midden (the refuse that tends to build up at locations where people live). The relative magnetic quality of the topsoil, in contrast to the clay subsoil, is often expressed in the visibility of plow marks on sites that have been plowed. In those areas where the topsoil is not as magnetic (i.e., has low magnetic susceptibility) plow marks tend to be hard to see in magnetic data. Conversely, topsoil that is magnetically enhanced tends to produce distinctive plow marks, especially when surface/subsurface ridges and furrows are present. Areas with enhanced magnetic susceptibility caused by the presence of archaeological midden can appear in magnetic gradient data as areas of higher background variability.

Most magnetometers react to two kinds of magnetization in archaeological sediments: thermoremanent magnetization and magnetic susceptibility (Aspinall et al. 2008; Clark 2000; Gaffney and Gater 2003). When sediments and rocks are heated above a certain temperature, known as the ferromagnetic Curie temperature (ca. 500-700^{o}C; Lowrie 1997), their magnetic orientation is realigned to the local magnetic field, which produces a permanent *remanent magnetization*. Campfires and trash burning can produce more than enough heat to reach the Curie point. Upon cooling, magnetic iron oxides in the soil around or under the fire, such as magnetite and hematite, recrystalize and are fixed with a common orientation toward magnetic north. Intense heating can make an otherwise magnetically neutral (i.e., random) patch of ground highly magnetic by transforming less magnetic iron oxides (e.g., hematite) into a more magnetic iron oxide (e.g., magnetite and maghemite), and by producing magnetic ash (Linford and Canti 2001). Even sediments that have been disturbed and redeposited, such as by sweeping, raking, plowing, or other kinds of earth moving, can maintain at least some of their permanent magnetization, which is not reset until the sediments are once again heated up to a point above the Curie temperature. Objects and sediments that are permanently magnetic do not require an outside magnetic field to be magnetic, like those materials that are susceptible to magnetic fields.

Soils and ferromagnetic substances that have high *magnetic susceptibility* react when they are in the presence of a magnetic field, which on archaeological sites is the earth's own magnetic field. Certain soil horizons and components of soil, such as organic rich topsoil (A horizon), are generally more susceptible to induced magnetic fields than other soil horizons (Le Borgne 1955, 1960), such as Bt (i.e., subsoil) horizons. If a hole dug a few feet into the ground is backfilled with mixed up sediments, the backfilled hole will likely have a different magnetic susceptibility than the surrounding, intact soils—especially if the hole is entirely filled with topsoil. Furthermore, human occupation of an area is known to enhance a soil's magnetic susceptibility (Dalan and Banerjee 1998; Tite and Mullins 1971). While the mechanisms behind soil susceptibility enhancement are complex and not totally understood, bacteria that use and produce small magnetic particles are known to contribute to the process (Fassbinder et al. 1990), as well as burning and the amount of certain iron oxides present in the soil (Evans and Heller 2003; Graham 1974; von Frese 1984).

Like most magnetometers, the Foerster Ferex fluxgate gradiometers are passive instruments (i.e., they do not create a magnetic field), and they simultaneously detect both kinds of magnetism, remanent magnetism and magnetic susceptibility. They cannot differentiate the two. Each of the Ferex's four gradiometers consists of two fluxgate sensors spaced 65 cm apart, one atop the other. Thus, they measure the localized change in the vertical component of the magnetic field as it exists between the two sensors while the instrument is pushed back and forth across the survey area. The uppermost detector in each gradiometer senses (along one axis) the earth's background magnetic field, which in the Midwest U.S. region measures approximately 50,000-55,000 nanotesla (nT) and can vary in one day as much as a few hundred nanotesla from morning to evening (Breiner 1973). The lower detector senses the earth's background magnetic field (along one axis) *and* changes in it caused by objects or soils on the surface or as much as about two to three feet beneath (or above) the surface. Even deeper features and soils can be detected if they are strongly magnetic. Fired earth in prehistoric hearths and organic-rich soil in buried pits or ditches tend to concentrate the earth's magnetic field in measurable amounts of approximately 2-30 nT, while large iron objects or brick-filled features can measure in the hundreds or thousands of nanoteslas. Sandy soils or deep, highly organic soils can reduce the range of more subtle features to 1.5-5 nT. And this magnetic variability is not always linked to changes in soil color that are readily identifiable during excavation. Once a reading has been taken, the instrument's onboard electronics subtract the reading of the top detectors (earth's varying background magnetism) from the reading of the bottom detectors (earth's varying background magnetism plus local magnetic variability), leaving—in principle—the local magnetic gradient caused by surface and buried phenomena[1]. These numbers are then stored in the instrument until a data dump is performed.

The data were transferred from the Foerster Ferex's datalogger to a laptop computer using Foerster's Ferex Dataline (v. 3.404) software. Small spatial adjustments were made to the data in Dataline to correct for zig-zag error (what Foerster refers to as "slippage" in their Ferex manual) and in some cases a single-track "automatic compensation" was performed to remove stripping from line to line. The data were then exported as xyz files, regridded in Surfer, rotated, and imported into Geoscan Research's Geoplot (ver. 3.00s) software for further data processing and to build the 40 m x 40 m survey blocks into one survey area. Such processing is fairly common and involves applying mathematical algorithms to the data in an effort to reduce background noise and accentuate the potential, buried archaeological phenomena. Three processing algorithms were used in Geoplot to prepare the magnetic gradient datasets for presentation and analysis: zero mean traverse, interpolation, and low pass filter.

After processing, the data were exported from Geoplot and pulled into Surfer 8.0, where a color scale and grid were added. The surfer images were then copied into CorelDRAW for integration with the area site map, interpretation, and final image production. Data processing is necessary to prepare the data for interpretation and visualization; however, excessive processing can also produce false data anomalies. Care was taken to avoid creating false anomalies.

Interpreting Magnetic Gradient Results

There is a certain knack to interpreting magnetic gradient data at archaeology sites; general rules of thumb vary between historic-era and prehistoric sites, and across sites with differing soils. Historic sites are usually covered in objects that are very magnetic and the signatures of these objects can dominate a dataset, obscuring the locations of important architecture. Of course, they can also highlight the locations of buildings since artifacts often occur in higher densities around buildings and within foundations. For example, Figure 3 shows a large cluster of anomalies in the location of a barn that was torn down and burned at the Dillon site in northern Ohio (from Burks 2011). Dark areas are more magnetic while light areas are less magnetic. Relatively even gray tones represent areas with little magnetic variability. The magnetic anomalies in the barn cluster are likely related to iron building hardware and other iron objects left in the barn when it was demolished. The anomalies along the north edge of the survey area (the small circular dark spots), especially to the northeast, are related to the prehistoric occupation of the site.

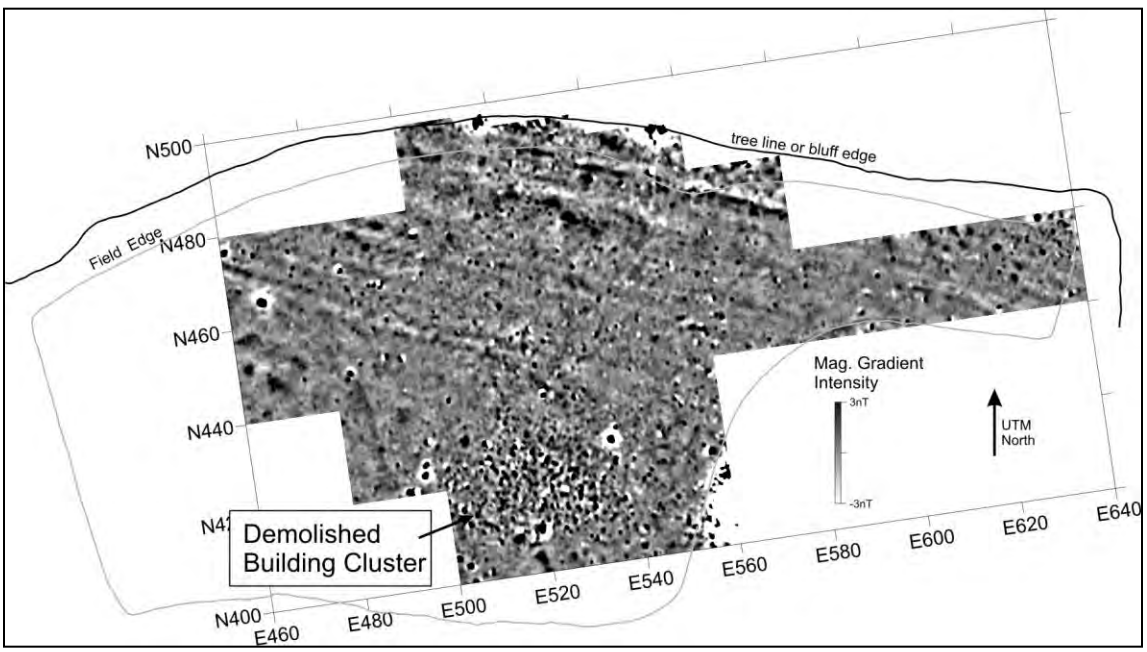

Figure 3. Example of magnetic gradient data from a demolished barn location (Dillon site, from Burks 2011).

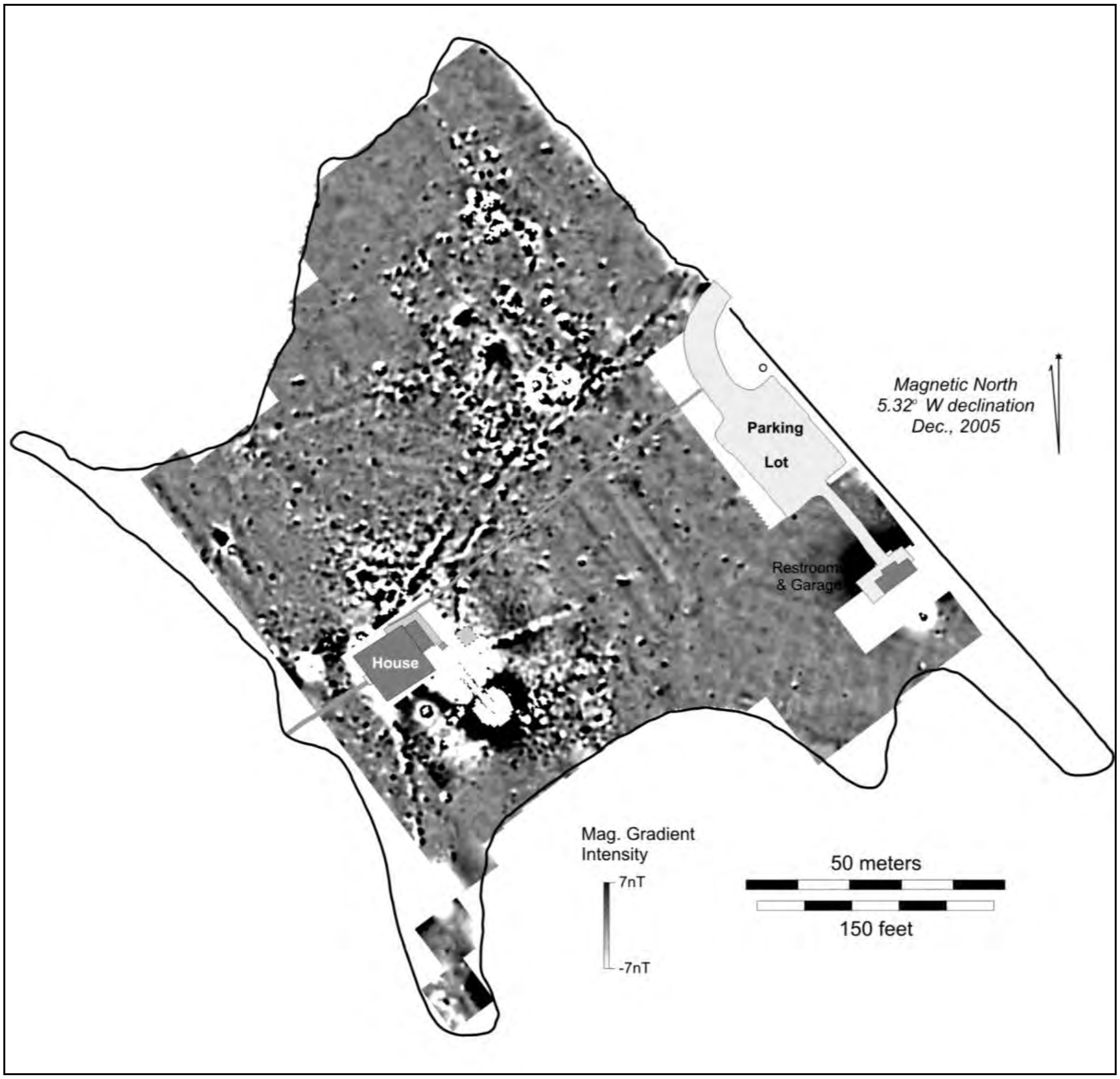

Figure 4. Example of magnetic gradient data around a historic-era house/farmstead (Burks 2006).

In another case, Figure 4 shows the results of a fluxgate magnetometer survey around the John Rankin House, a standing brick structure built in 1828 on the bluff overlooking Ripley, Ohio. Clearly, there are numerous magnetic anomalies around the house, and the dense concentration of anomalies off the northwest corner of the house marks the location of a buried summer kitchen foundation. The clusters of anomalies to the east of the house are related to a trash dump in the bottom of a swale. Farther to the north is a rectangular pattern of anomalies indicating the location of a fence that once surrounded a barn.

Picking out individual features in magnetic data at historic sites is difficult because it can be hard to differentiate the magnetic signature of a well, for example, from that of a large iron object. However, foundations and former building locations are often indicated by tight clusters of small anomalies, which makes it sometimes possible to identify the general location of outbuildings in magnetic data—assuming that these buildings were constructed with nails and other magnetic hardware or were the locus of iron-bearing trash disposal.

At prehistoric Native American sites every small positive anomaly in the data might be an archaeological feature, but generally pit features have a very distinctive magnetic signature that follows a consistent pattern in size, shape, and peak magnetic intensity. Figure 5 is an example of a magnetic gradient survey at a series of Hopewell household sites in Ross County, Ohio. Excavations have shown that the many small circular anomalies are pit features, including earth ovens (which are the magnetically strongest anomalies), storage pits, fire hearths, and at least one burial. The two long linear anomalies arcing through the survey area from southwest to northeast are old stream channel scars that have since been filled in with flood deposits and prehistoric trash (the areas of the stream channels that contained more trash were also more strongly magnetic). Many of the lighter-colored areas along the stream channels and in small areas elsewhere in the data are sand near the surface—sand has very low magnetism and when it is plentiful it displaces the more magnetic topsoil.

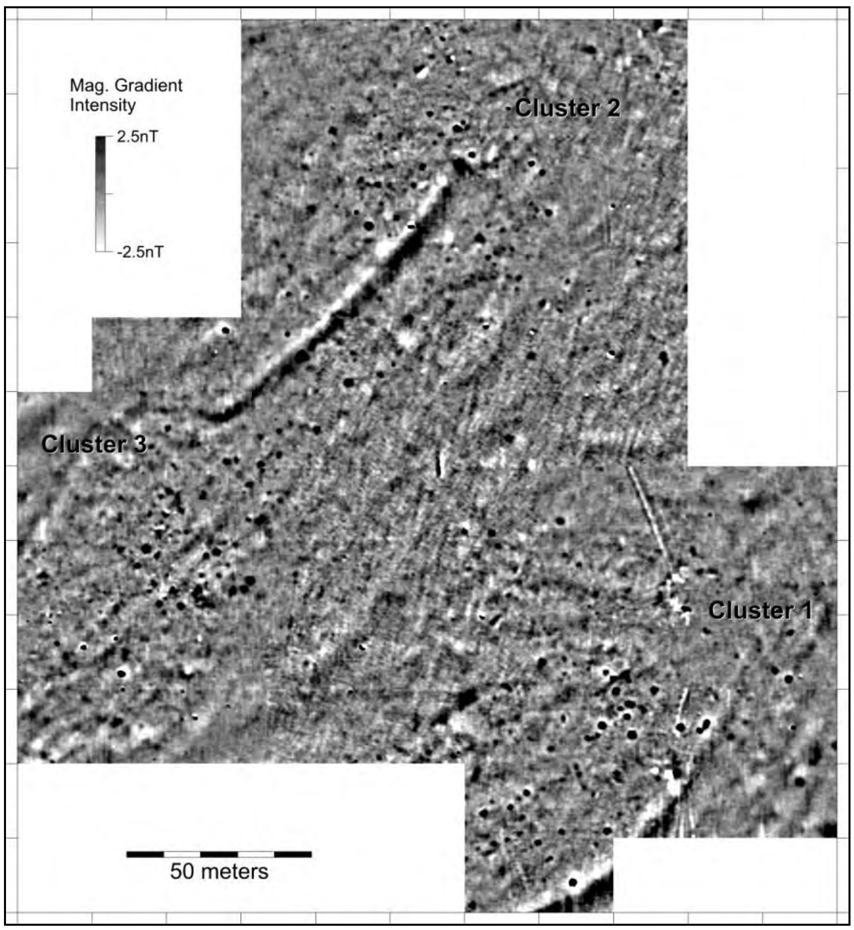

Figure 5. Example of magnetic gradient data from the Brown's Bottom cluster of Hopewell household sites in Ross County, Ohio. Many of the small dark anomalies are cultural features. (See Pacheco et al. 2005, 2009a, 2009b for more on Brown's Bottom.)

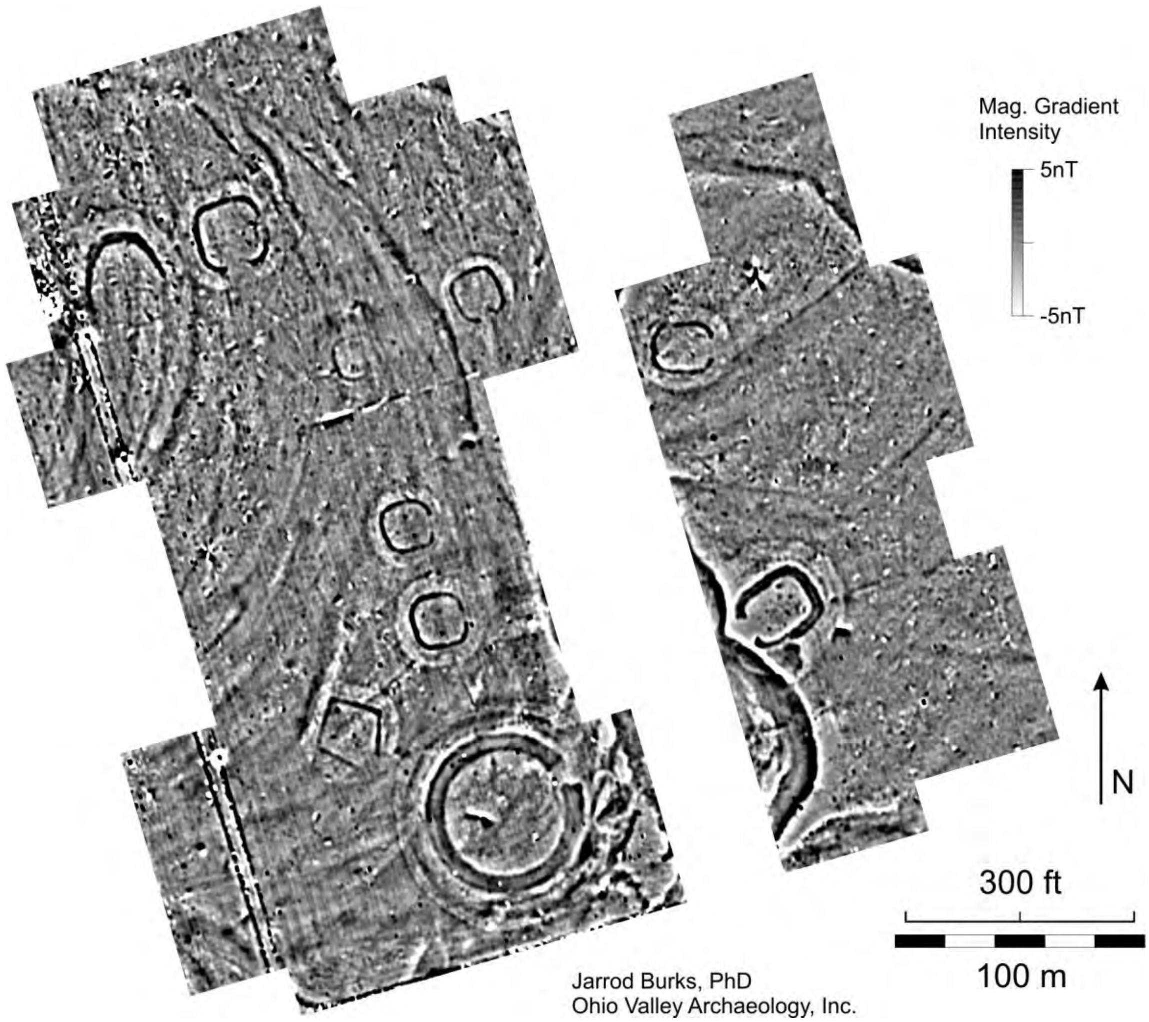

Figure 6. An example of magnetic gradient data from an Ohio earthwork site in Ross County, Ohio (modified from Burks and Cook 2011).

Earthworks, especially ditch-and-embankment enclosures, create some of the most distinctive magnetic data in Ohio. More often than not, the ditches surrounding the enclosure embankments are readily imaged in magnetic data. Figure 6 shows the magnetic data from the Steel Group site, located in Ross County, Ohio. The small enclosures at this site each consist of a ditch surrounded by an embankment. The ditches are readily apparent in the data because of their stronger magnetism (bear in mind that the ditches of all but the largest of these enclosures are completely filled in). The embankments, all of which are plowed flat (except for the large circle), appear as less magnetic strips surrounding the ditches and they tend to have slightly higher readings along their edges. Clearly some basal component of these embankments remains intact even though the embankments are not topographically evident. At other sites, especially in areas of the state where the soils have low magnetic contrast, it is much more difficult to detect the embankments in magnetic data (see e.g., the Holder-Wright Group magnetic data in Burks and Cook 2011).

Of course, there are other things in the ground that can create magnetic anomalies that look much like the magnetic signatures of prehistoric and historic features. Some of this equifinality can be overcome by knowing the peak magnetic amplitude and anomaly type for each anomaly of interest. For this reason, such information for each anomaly of interest, where appropriate, has been tabulated and is presented below in the results section.

In most magnetic gradient data there are five kinds of potentially significant magnetic anomalies that can occur on archaeology sites: Monopolar Positive, Dipolar Simple, Dipolar Complex, Multi-Monopolar Positive, and Monopolar Positive/Dipolar Simple[2]. It can be useful to classify a site's anomalies as this is one way to locate archaeological features of interest. The shape, size, intensity, and polarity (positive or negative) of magnetic anomalies is determined by the characteristics of the anomaly's source (or target), including the target's (object or archaeological feature) shape, material composition, mass, orientation, and depth. An object or feature's anomaly shape can also be affected by the magnetic signatures of nearby objects and features. And of course, anomaly shape and intensity is affected by where on the planet (especially latitude) the survey was conducted, which determines the inclination of the earth's magnetic field: approximately horizontal at the equator and vertical at the poles.

Most targets of interest, such as pit features, hearths, wells, foundations, cellars, and the like, produce fairly consistent kinds of anomalies that are comparable all across the U.S. and at similar latitudes around the globe where soils are formed into alluvium, glacial tills, and even eolian deposits. For example, in vertical gradiometer data prehistoric pit features are almost always weakly magnetic (3–30 nT), positive monopolar anomalies, unless they are filled with highly magnetic rock. As a type of pit feature, historic cisterns, wells, and privies can also appear as somewhat stronger, positive monopolar anomalies. However, historic pits frequently contain large amounts (high mass) of highly magnetic materials, such as bricks and iron objects. If these materials are well represented or are large in size, they can make the historic pit's magnetic signature look like that of a large bar magnet with north and south poles (i.e., dipolar). Given these consistencies between magnetic anomalies and their sources, the five anomaly classes used in this report serve to describe and summarize the magnetic survey results as well as provide an estimate for the kinds of targets found:

<u>Monopolar Positive (MP)</u>- Anomalies in this class are localized, positive peaks in the magnetic gradient signature of the site. They appear as isolated dark gray to black areas in grayscale data displays (Figure 7). Typically, these anomalies are created by localized areas of soil with increased magnetic susceptibility (e.g., pit features, large tree root casts, and somewhat burned surfaces). However, it is not uncommon for weakly magnetic or deeply buried objects with a dipolar magnetic signature (e.g., an iron object or a large magnetic rock) to be detected as positive or negative monopolar anomalies. If one of the poles of a dipolar anomaly is close to the surface (and close to the magnetometer) and the opposite pole is too far away to be detected (because it is too deep underground, for example), then objects that typically produce distinctive dipolar anomalies (iron objects) can be mistaken for those that typically produce monopolar anomalies (pit features). Positive monopolar targets of interest, such as pit features, can produce peak intensities ranging from 1 nT to 200 nT, though only historic period features tend to be greater than

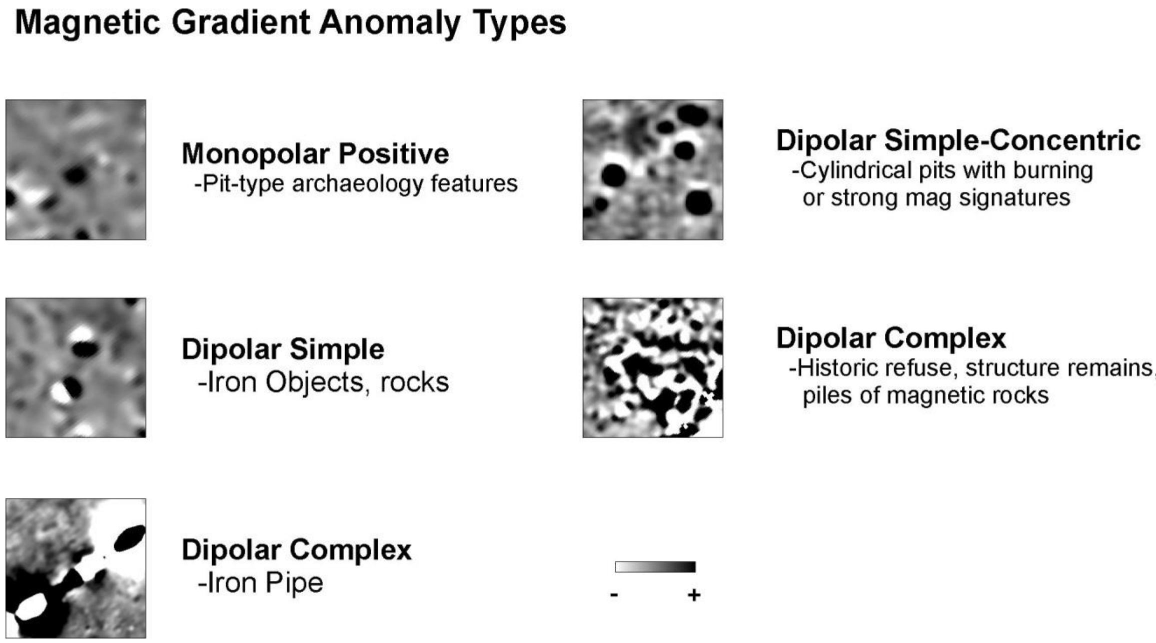

Figure 7. Magnetic gradient anomaly types used to classify the data at 33BU1071.

40 nT in intensity (unless highly magnetic rocks are present). Not all pit features, prehistoric or historic, produce positive monopolar anomalies. In fact, a small percentage of pit features can produce dipolar simple and dipolar complex anomalies, especially when intensely burned, *in situ* sediments and rocks are present within the feature. Thus, prehistoric earth ovens and hearths are sometimes dipolar anomalies. Historic-era pits filled with large iron objects will also likely be dipolar.

Dipolar Simple (DS)- Dipolar anomalies are characterized by negative and positive peaks that are immediately adjacent to one another, making distinctive black and white anomalies in magnetic data (Figure 7). A simple dipolar anomaly has only one positive and one negative peak. These peaks can be similar in size and intensity (e.g., +6/-5 nT) or highly asymmetrical (e.g., +57/-4 nT). Iron objects and magnetic rocks are the most common sources of dipolar anomalies on archaeology sites. In general, the larger (greater mass) the iron object, the more magnetic intensity (i.e., higher highs and lower lows) it will have and the more area its magnetic signature/influence will affect. For example, most square nails, while highly magnetic, are so small that when buried in the plowzone or just below surface they are difficult to detect with a gradiometer during a typical survey, unless there are many nails bunched together or the instrument is held very close to the ground. Conversely, a foot-long piece of half inch diameter iron rebar pounded down into the ground vertically (like a datum) is exceptionally magnetic and can be detected (as a large positive area surrounded by negative, or vice versa) from 2-3 meters away (i.e., making an anomaly 4-6 meters across). The rusted off bottoms of steel fence posts look very similar to this, only larger if they are still buried in the ground vertically. Steel well casings left in the ground are even more magnetic, and they can be detected from over 10 meters away even though the steel pipe is not visible at the surface.

Exceptionally magnetic prehistoric features, such as hearths and intact earth ovens, can also produce dipolar simple anomalies. Frequently, the magnetic signature of these burned prehistoric features appears as an area of strong positive values (up to 35-40 nT) surrounded by a weak negative ring—much like the signature of a bar magnet buried in the ground vertically. These are here referred to as Dipolar Simple-Concentric type anomalies. However, the positive and negative components of the signature also can be side-by-side, which is common for shallow, burned features. With most dipolar simple anomalies in the northern hemisphere (because of the inclination of the earth's magnetic field), the target creating the anomaly is located below, but not directly, the positive area of the anomaly (Bevan 1998).

Dipolar Complex (DC)- Complex dipolar anomalies have multiple negative and positive peaks of varying intensity that are clustered together (Figure 7). They can take on all kinds of shapes and sizes. Typically, this class of anomaly is associated with burned areas or features/disturbed areas filled with magnetically mixed sediments and objects. In-filled historic foundations and cellars, as well as some back-filled trenches and excavation pits, produce dipolar complex anomalies because the mixed fill in these features is more or less magnetic than the surrounding soils and generally contains historic objects that are also magnetic (in fact, the example in Figure 7 is the foundation and remains of a summer kitchen). Areas of soil burned to different depths and/or temperatures can also produce this kind of anomaly (Linford and Canti 2001). Prehistoric structure or mound floors, if intact, sometimes appear as dipolar complex anomalies. Lightning strikes are an important natural source of dipolar complex anomalies. They can generate very strong magnetic fields and high temperatures, changing the remanent magnetization of the materials they strike (Verrier and Rochette 2002). Classic lightning strike anomalies, or LIRMs (Lightning Induced Remanent Magnetism anomalies) have a tentacled (positive and negative) appearance (Jones and Maki 2005; Beard et al. 2009) and they can range in size from a couple meters across to over 30 meters. Excavations at the locations of these anomalies have shown that the lightning strikes produce nothing that would be visible in a typical archaeological excavation (e.g., Maki 2005). Extensive animal burrow systems, such as those of groundhogs, sometimes produce similar anomalies, as well, though not as large or intense as lightning strikes. Dipolar complex anomalies can have weak (+5/-5 nT) or very strong (+1000/-1000 nT, or more) magnetic gradient signatures.

Multi-Monopolar Positive (MMP)- Anomalies in this class are groups of positive monopoles, generally arranged in linear or arcing patterns, that are usually fairly weak (1-4 nT) in intensity. Most gradiometer datasets are full of dozens or hundreds of small, weakly positive anomalies—making it difficult to pick individual features out of the mass of anomalies. However, patterned groups of anomalies (MMPs) stand out from the other small anomalies (Kvamme 2008). Architectural facilities such as prehistoric structures, post circles, or historic fences can produce linear arrangements of small, weakly positive monopolar anomalies. This class of anomaly is rare in gradiometer data, especially in survey data collected along transects separated by more than 50 cm. Exceptionally large postholes (>30 cm in diameter), or those filled with burned sediment, can be more evident in magnetic data. Likewise, the magnetic signatures of two or more closely spaced postholes can combine to make a more obvious, and larger, anomaly.

Monopolar Positive/Dipolar Simple (MP/DS)- In some cases it is difficult to discern whether an anomaly is monopolar positive or just a portion of a dipolar simple anomaly. These anomalies are assigned to the MP/DS class. In essence, this class serves as an "unknown" category like those used in any type of analysis or classification scheme. More often than not, these anomalies likely are iron objects or small magnetic rocks oriented in such a way that their negative pole is almost too far away to be detected.

Every magnetic gradient dataset from an archaeological site contains hundreds or even thousands of magnetic anomalies—some strong, some weak—and only some of these are caused by cultural features. While the magnetic anomaly classes presented above do not cover all variability, they do attempt, at a general level, to begin the process of segregating and categorizing the magnetic signatures of potentially cultural anomalies. Though intended to be descriptive, these five classes *do* commonly correlate with certain kinds of archaeological and natural features found just below the surface and this has been shown at many dozens of archaeology sites in Ohio and beyond.

Magnetic Susceptibility Survey

Nearly all sediments contain minerals that react (magnetically) when a magnetic field is present—some more so than others. This reaction is called magnetic susceptibility and the measure of this property in sediments is known to have many applications in archaeology (e.g., Dalan 2008; Dalan and Banerjee 1998; Le Borgne 1965; Mullins 1974; Tite and Mullins 1971).

In general darker, organic-rich sediments formed near the surface, in A horizons, are more magnetically susceptible (i.e., more magnetic) than the underlying soil horizons (i.e., clay subsoil) (Le Borgne 1955). Unless soils are severely disturbed or eroded, magnetic susceptibility should be greatest near the surface and decrease with depth (Evans and Heller 2003). This natural variability in soil susceptibility is caused in part by natural oxidation and reduction cycles in iron oxide-rich sediments and by bacteria that feed off of organic-rich sediments and produce tiny magnetic particles as a by-product (Fassbinder *et al*. 1990). In well drained soils (i.e., not gleyed) the elevated magnetic susceptibility of topsoils is stable, such that if the soil is buried under alluvial deposits, for example, the buried topsoil will still have elevated magnetic susceptibility (Le Borgne 1955; Graham and Scollar 1976; Mullins 1977). The same is true for buried archaeological sediments with elevated magnetic susceptibility.

This higher soil susceptibility in the A horizon can be greatly (i.e., measurably) enhanced by human occupation (e.g., Tite and Mullins 1971). Thus, mapping the distribution of magnetic susceptibility values across a site can tell us something about site structure. In particular, it can identify areas of increased susceptibility that likely resulted from certain activities, such as intense, repeated burning (Linford and Canti 2001) or the repeated dumping of organic waste or cleanings from fire hearths (see Dalan [2008] and Dalan and Banerjee [1998] for a longer discussion of the use of magnetic susceptibility in the study of site structure). In fact, the longer people live in one place, and the more organic waste builds up and becomes burned, the greater the enhancement of the magnetic susceptibility, to a point (Tite and Mullins 1970)—though this enhancement is dependent on the soil parent material, the porosity of the soil, and the peak temperatures attained by the fires (Fitzpatrick 1985; Maher 1986; Oldfield *et al*. 1981).

In the least, a map of magnetic susceptibility values from soil samples or readings gathered at a regular interval across a site should be useful for mapping the distribution of more intense midden deposits and trash dumps. It might also indicate the locations of certain *kinds* of midden/trash dumps, such as those containing the refuse from cleaning up after thermal activities (e.g., heating and cooking around a ground-surface hearth within or outside of a structure). While it is not known exactly how much midden/refuse (i.e., how thick) is required to noticeably increase the soil susceptibility at an archaeological site, intense occupation/refuse disposal clearly does increase soil susceptibility (Tite and Mullins 1970)—in Ohio this observation is based on susceptibility surveys conducted at a number of settlements, including Hopewell hamlets (Brown's Bottom #1 and Lady's Run in Ross County [e.g., Pacheco et al. 2005, 2009a, 2009b], two Fort Ancient villages (the Wildcat site north of Dayton [Cook and Burks 2011a] and Reinhardt Village south of Columbus [Nolan et al. 2008]), an early Late Woodland village (the Water Plant site in southern Franklin County), and at the multicomponent Heckleman site in northern Ohio (Burks 2008). In most of these examples artifact distribution studies have documented patterns of site structure that corroborate and compliment the susceptibility survey results.

At site 33BU1071, the Bartington MS2 magnetic susceptibility meter, with an attached MS2D field sensor, was used to collect readings (low frequency) at an approximate 10-meter interval. The readings were taken on top of the sparse vegetation (rather than on bare earth), which did introduce some ground-contact variability and thus some variability in the readings. The MS2D field sensor can detect down about 10 cm and thus is measuring the magnetic susceptibility of the upper portion of the plow layer, which only includes near-surface layers of archaeological midden. A Trimble GeoXT GPS (sub-meter accuracy) was used to record the location of each susceptibility measurement. The maps of the susceptibility data were generated in Surfer, and then they were pulled into CorelDraw to be integrated with the site map.

The Survey Grid

The survey grid established for the Phase II work at 33BU1071 was set up to maximize coverage for the magnetic gradient survey. This meant aligning the northern edge of the survey block to the northern edge of the mowed area, which produced a grid that is roughly aligned to the cardinal directions. A Leica TC405 laser transit with an external data collector was used to set up the grid. Two temporary datums (10-inch galvanized nails were set (pounded down flat with the surface) along the western edge of the field containing the site, beyond the edge of plowing. The location of each datum was also measured in with a Trimble GeoXT global positioning system (GPS). The site grid and GPS locations for the two site datums are presented in Table 1. The GPS coordinates are an average of at least 20 GPS positions per datum.

Table 1. Coordinates related to the survey grid datums.

	Grid North	Grid East	UTM North*	UTM East*
Datum 1	978.09	998.42	4372131.42	727393.21
Datum 2	950.21	1021.75	4372104.13	727417.01

* Universal Transverse Mercator coordinates system, Zone 16 north, datum=NAD83 (conus)

Geophysical Survey Results

The magnetic gradient survey at 33BU1071 covered 8.38 acres and all of the topographically higher ground contained within the site boundaries. The results of the survey are presented in Figure 8. The magnetic survey located many distinctive anomalies. Clearly, some of the areas are very magnetically quite while others seem to have a lot of background variability. The variable areas correspond to the topographically higher areas of the site (e.g., N940, E1100), and these also are the areas where clusters of objects were found on the surface. It is in these areas that the anomalies of potential archaeological interest are found.

In Figure 9, all anomalies of potential archaeological interest are shown overlaid on a topographic contour map of the site (the topo data are the 2006 LiDAR data collected by the state of Ohio). In all, there are 26 numbered anomalies of potential interest, as well as several unnumbered anomalies. The unnumbered anomalies include an old fence line and a drainage tile/utility line, as well as some linear anomalies that likely are related to geology/geomorphic features at the edges of the sand dune. The fence line detected in the magnetic data is clearly the same fence line visible in the 1964 aerial photo shown in Figure 1. The large cluster of dipolar anomalies adjacent to the fence line, Anomaly 23, has the look of a possible historic-era building. A shovel probe test near the center of the anomaly cluster found charcoal and burned earth within and just below the plowzone, as well as rusty fence wire. This is likely where the remains of the fence were piled up and burned after it had been dismantled. No further work is recommended at Anomaly 23.

There are 21 possible pit-type features represented in the magnetic gradient data, all of which are monopolar positive anomalies, and four large area positive anomalies (LAPAs). LAPAs are a rare type of magnetic gradient anomaly that has only begun to appear in magnetic data as larger areas have begun to be surveyed. What exactly they are caused by is not yet known. They are often 4-8 meters across and range from 4nT-10nT in magnetic strength. The four detected at site 33BU1071 are located in a lower area of the site, away from the two artifact clusters. This suggests that perhaps they are not associated with the prehistoric occupations of the site.

The 21 possible pit type features are the most likely candidates in the magnetic data for representing intact subsurface archaeological features. Table 2 presents details related to each of the anomalies, including their center point locations, peak magnetic strength, anomaly type, and rank. Rankings were determined based on magnetic strength, shape, size, and edge characteristics, all of which tend to be fairly consistent with most pit-type features. Rank 1 anomalies are the most likely to be pit-type features while Rank 3 are the least likely. Anomalies 1-8 run along the edge of the western topographic feature and cluster fairly tightly with surface artifacts documented during the Phase I work. The remaining pit-type anomalies are scattered across the survey area and while located within the Phase I site boundaries, they are not as closely associated with artifact clusters as Anomalies 1-8.

To help determine which if any of these anomalies might be culture features, an attempt was made to core them with an Oakfield soil corer. However, the ground was so compact (because of the large amounts of sand) that it was nearly impossible to get the corer into the ground. A shovel was used to remove the plowzone at several of the Anomalies, with the intent of then using the coring device to continue on down into the ground, but even this did not help. During this process of using the shovel to remove the plowzone over Anomaly 7, a distinctly lighter colored soil anomaly was encountered beneath the plowzone, suggesting that some kind of distinct soil feature is present with at least one of the anomalies. An attempt was made to examine more of the anomalies using an electric impact drill (run by a generator) with a 1-inch (approximately) bit and while this technique was able to pull up soils from most of the anomaly locations, the differences in soil color and texture are so subtle between the plowzone and the subsoil that it was difficult to observe any significant soil data related to what might be causing the magnetic anomalies. Therefore, the recommendation was made to excavate Anomaly 7 and six other of the highest ranking anomalies spread across both of the artifact clusters.

A magnetic susceptibility survey covering 2.66 acres was completed of the westernmost artifact cluster to determine if the variability in the background magnetic gradient readings were perhaps related to a concentration of midden. This was not part of the original contract but was done as an experiment by Ohio Valley Archaeology, Inc. Figure 10 shows the results of the magnetic susceptibility survey. Areas of higher magnetic susceptibility appear in red, lower susceptibility is blue and violet. Interestingly, the higher susceptibility values are clustered with the possible pit-type magnetic gradient anomalies and the surface artifacts found during the Phase I work are located more to the west. This could be showing that the site contains different kinds of activity areas, only some of which included the deposition of lithic artifacts.

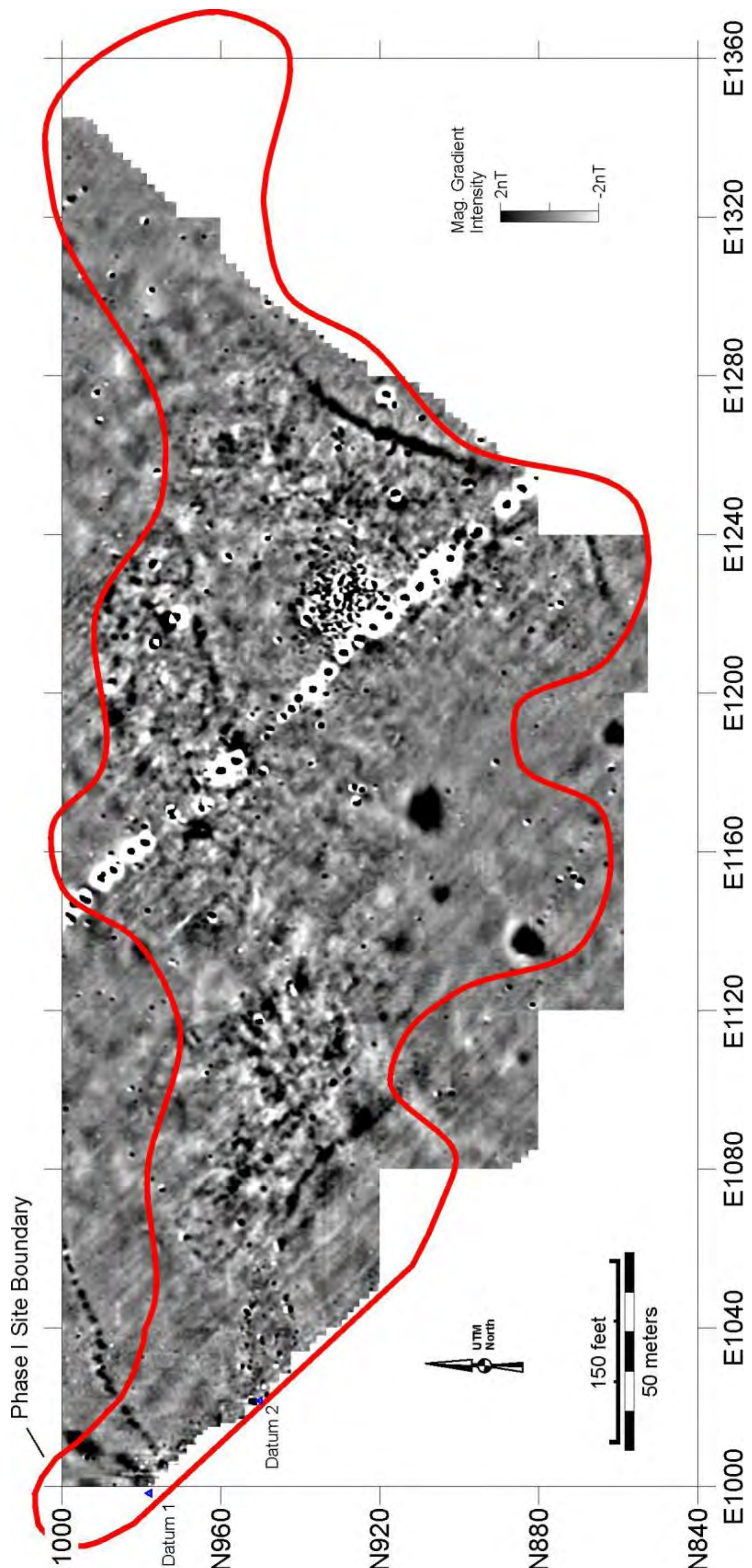

Figure 8. Magnetic gradient survey results from 33BU1071.

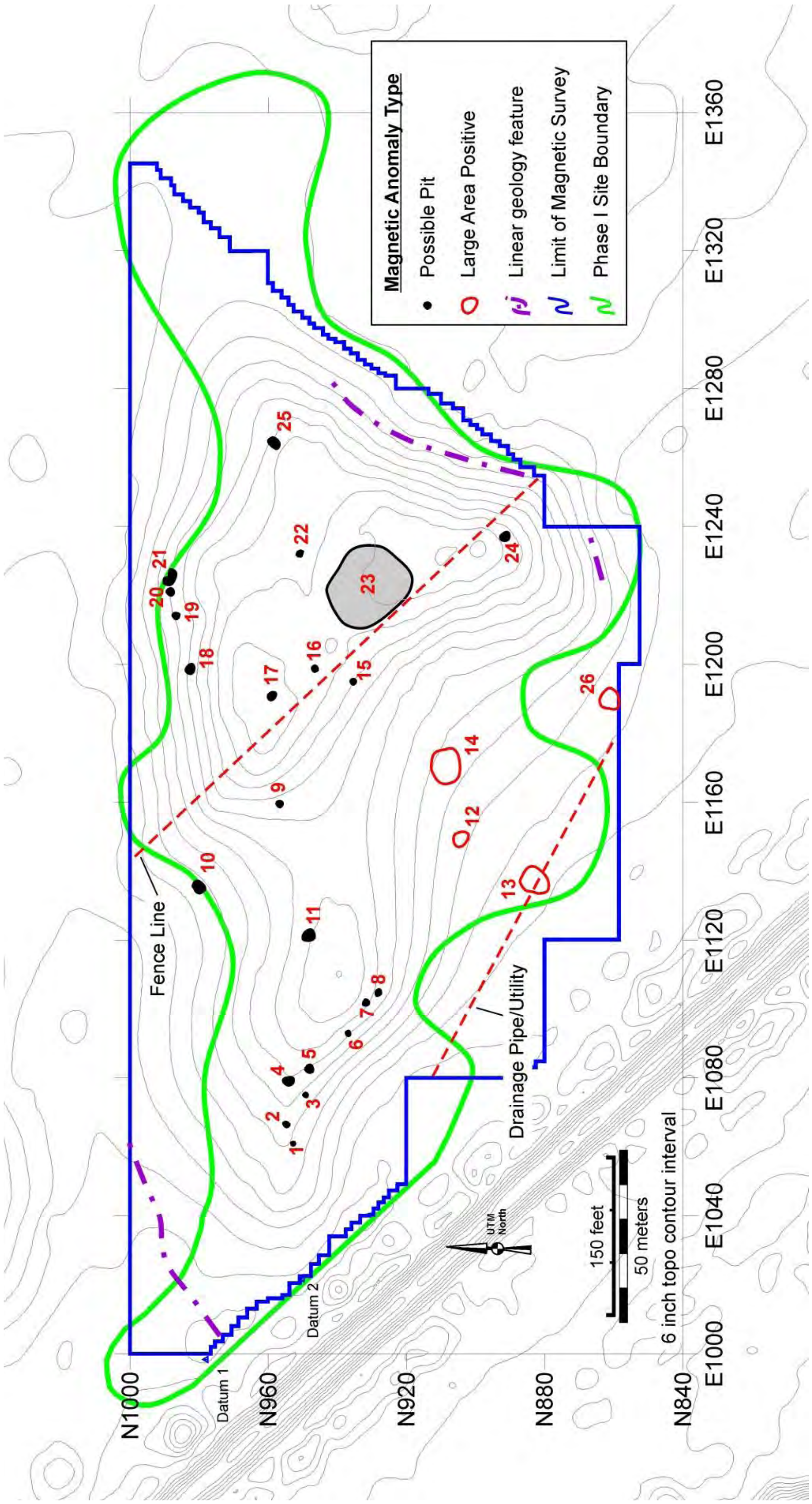

Figure 9. Magnetic anomalies of potential interest on a 2006/7 LiDAR-based topographic model of the

site.

Table 2. Magnetic gradient anomalies of interest (anomalies in red recommended for archaeological excavation).

Anom. #	**North[a]**	**East[a]**	**Peak Amplitude[b]**	**Anomaly Type[c]**	**Rank[d]**	**Comments**
1	952.73	1061.03	5.14	MP	2	Rock, small Possible pit
2	954.68	1066.58	12.82	MP/DS	1	Earth oven, large rock
3	949.05	1075.08	4.66	MP	2	Rock, small Possible pit
4	953.87	1079	6.94	MP	3	Plow zone feature?
5	**948.07**	**1082.76**	**6.34**	**MP**	**2**	**Possible pit**
6	**936.71**	**1092.97**	**10.73**	**MP**	**2**	**Rock, Possible pit**
7	**931.65**	**1101.79**	**14.7**	**MP/DS**	**1**	**Earth oven, possible rock**
8	**928.05**	**1104.73**	**6.14**	**MP**	**1**	**Possible pit**
9	956.73	1159.47	4.41	MP	3	Possible pit
10	979.85	1135.44	7.06	MP/DS?	3	Possible pit/rock
11	948.38	1121.61	5.68	MP	3	Irregular, possible pit/disturbance
12	904.41	1149.41	3.84	LAPA	2	unknown
13	883.74	1139.33	6.76	LAPA	2	Unknown
14	908.38	1170.58	4.89	LAPA	3	Unknown
15	**935.44**	**1195**	**5.38**	**MP**	**1**	**Possible pit**
16	**946.61**	**1198.75**	**4.89**	**MP**	**2**	**Possible pit**
17	**959.04**	**1190.95**	**7.73**	**MP**	**2**	**Irregular, possible pit?**
18	982.64	1198.52	3.99	MP	3	Possible pit, subtle
19	986.83	1214.19	5.14	MP	1-2	Possible pit
20	988.38	1221.02	4.96	MP	1-2	Possible pit
21	988.97	1224.19	6.09	MP	1-2	Possible pit, irregular anomaly
22	950.95	1232.27	3.58	MP	3	Possible pit
23	929.04	1223.67	300+	DC	1	Historic feature-cluster of iron objects
24	891.54	1237.54	4.2	MP	2-3	Possible pit
25	958.3	1264.04	3.12	MP/DS	3	Possible pit
26	860.77	1189.52	5.12	LAPA	3	Unknown

a – coordinates mark the approximate center of the anomaly and are specific to the distinct coordinate system used in each survey area.

b – peak positive value for each anomaly after performing a single track automatic compensation in Ferex Dataline (v.3.404) software. The weakly magnetic anomalies are derived from data that has been through additional filtering steps, making it unsuitable for determining peak intensity values.

c –MP=Monopolar Positive, MP-D=Monopolar Positive-Diffuse, MMP=Multi-Monopolar Positive, DS=Dipolar Simple, DS-B=Dipolar Simple-Bull's-eye, DC=Dipolar Complex.

d – ranking based on likelihood of anomaly being a cultural feature. All anomalies in table might be cultural features, Rank 1 are most likely and Rank 3 are least likely.

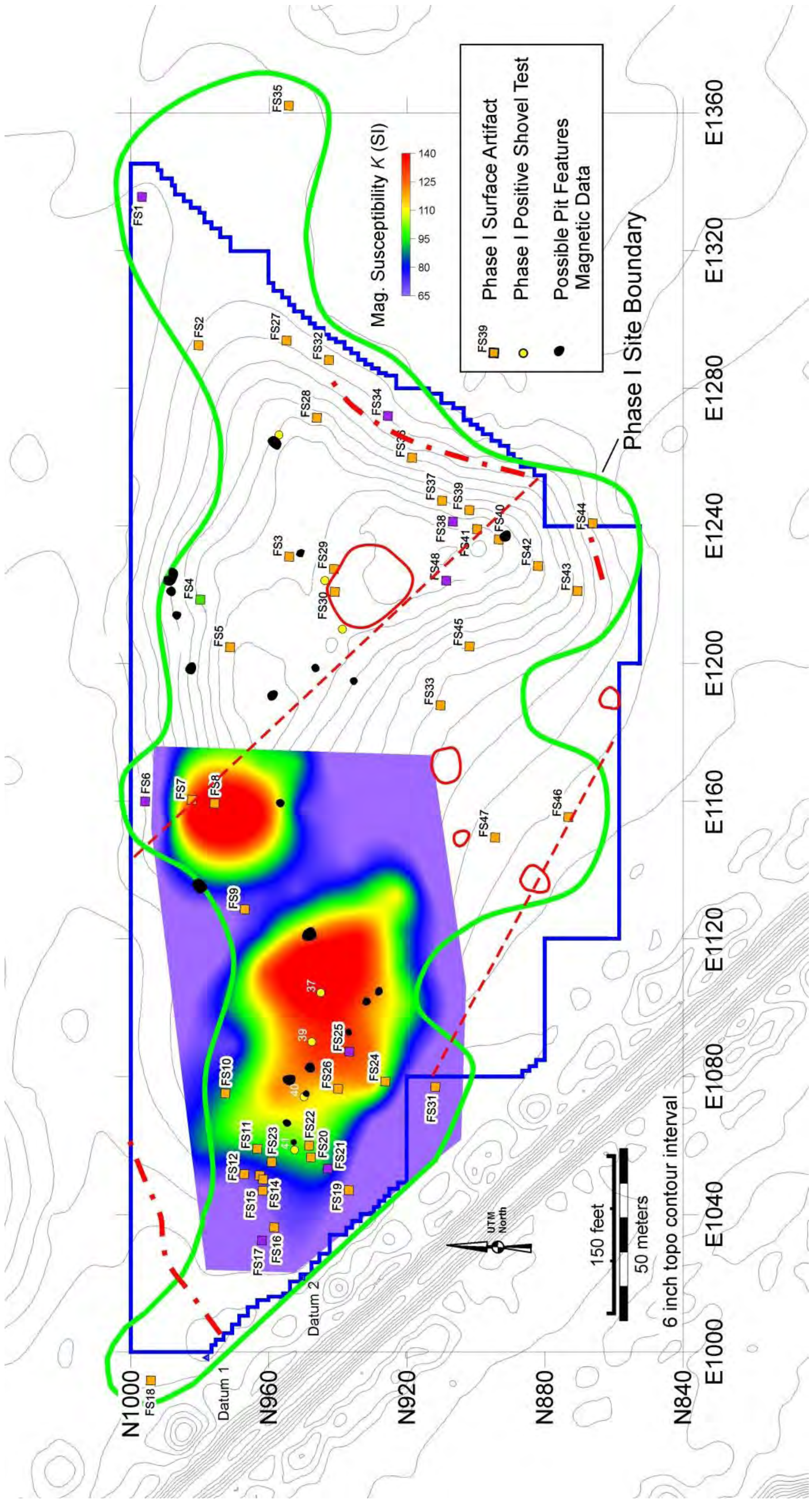

Figure 10. Magnetic susceptibility survey results at the western cluster.

Conclusions and Recommendations

During the week of August 4-8, 2014, magnetic gradient and magnetic susceptibility surveys were conducted at site 33BU1071, a multicomponent prehistoric Native American site on a relict sand dune feature located south of Dick's Creek. The magnetic gradient survey located a range of distinctive magnetic anomalies, including old fence lines and a possible drainage tile, geologic/geomorphic features at the edges of the dune, large area positive anomalies of unknown origin, and 21 possible pit-type features. Some of the pit-type features are located in the same areas where surface artifacts were found. And, a magnetic susceptibility survey of the westernmost artifact cluster showed that high susceptibility readings are associated with the pit-type anomalies in this area of the site.

An attempt was made to core the magnetic gradient anomalies to determine which are most likely to be cultural features and which could be natural features. Unfortunately, the sandy soils have such subtle soil color differences and were so compact that it was not possible to gather much, if any, useful information from the coring (except in one case, where Anomaly 7 was shown through a shovel probe to be associated with lighter colored soils). Instead, the anomalies were ranked according to their peak amplitude, size, shape, and coherence (i.e., crisp edges and solid centers) and the highest ranked anomalies were recommended for excavation. While this approach can result in the excavation of non-archaeological soil features (which can look just like cultural features to the magnetometer), excavating a larger sample of the anomalies helps to ensure that at least some of the excavated anomalies will turn out to be possible cultural features.

The sandy soils at 33BU1071 did produce relatively subtle magnetic survey results, with relatively weak magnetic anomalies. But surprisingly, the magnetometer seems to have picked up on concentrations of site midden, which appeared as what looked to be amorphous positive anomalies in the topographically higher areas of the site. Magnetic susceptibility survey in the western portion of the site helped confirm this, finding areas of high magnetic susceptibility where the magnetometer produced variable background readings. These magneticly variable areas did not directly correspond to the location of the Phase I artifact cluster in this portion of the site, suggesting that the magnetic surveys have detected areas of burning or thermal refuse dumping that are not represented in the surface artifact data.

End Notes

1. Fluxgate gradiometers might be better referred to as difference meters, for they technically do not measure a gradient. Rather, they are detecting the difference in the strength of the magnetic field along one axis and at two points, the spacing between which is usually fixed. Sensor spacing in gradiometers affects the strength of the final recorded reading. For example, the readings from a gradiometer with a 65 cm sensor spacing would be about 1.07 times stronger than those from an instrument with a 50 cm sensor spacing (assuming several important things: the feature is not right at the surface, a magnetic field inclination that is about vertical, and the bottom sensor is at about 30 cm above the surface while the archaeology is about 40 cm beneath the surface) (Bruce Bevan, personal communication, 2013).

2. Truly monopolar magnetic anomalies are theoretically possible but have rarely, if ever, been observed in the "wild" (Merrill 2010). All anomalies are actually dipolar, but in many cases appear monopolar because one of the poles is too far away (i.e., underground) to be detected by the magnetometer. Thus, the terms used in the magnetic anomaly classification refer to the *appearance* of the anomalies in the magnetic data maps, not their true structure.

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APPENDIX D

APPENDIX D
MIDDLETOWN ENERGY CENTER
PHASE II SHOVEL TEST LOG

Shovel Test North Grid	Shovel Test East Grid	Stratum	Depth (cm)	Soil Color	Soil Texture	Inclusions	Prehistoric Count	Historic Count	Comments
915	1087.5	A	0-29	10YR4/3	Sandy clay loam	-	-	-	-
915	1087.5	B	29-42	10YR3/2	Clay loam	-	-	-	-
915	1102.5	A	0-20	10YR3/4	Sandy clay loam	-	-	-	-
915	1102.5	B	20-32	10YR4/3	Sandy clay	-	-	-	-
915	1117.5	A	0-26	10YR4/4	Sandy loam	-	-	-	-
915	1117.5	B	26-39	10YR4/6	Sandy clay	-	-	-	10YR6/3 mottles
915	1132.5	A	0-25	10YR4/4	Sandy loam	-	-	-	-
915	1132.5	B	25-33	10YR4/4	Sandy clay loam	-	-	-	lower plowzone
915	1132.5	C	33-41	10YR4/6	Clay loam	-	-	-	10YR5/8 mottles
915	1147.5	A	0-25	10YR4/3	Sandy loam	rounded gravel	-	-	-
915	1147.5	B	25-35	10YR4/6	Sandy clay loam	-	-	-	10YR5/8 mottles
930	1065	A	0-32	10YR4/3	Sandy clay loam	-	-	-	-
930	1065	B	32-42	10YR3/2	Clay loam	-	-	-	-
930	1080	A	0-39	10YR4/3	Sandy loam	-	-	-	-
930	1080	B	39-46	10YR3/2	Sandy clay loam	-	-	-	-
930	1095	A	0-19	10YR4/3	Sandy clay loam	-	1	1	flake, bottle glass (cat# 063)
930	1095	B	19-30	10YR4/6	Sandy clay	-	-	-	-
930	1110	A	0-30	10YR4/4	Sandy loam	-	4	-	flakes (cat# 062)
930	1110	B	30-45	10YR4/6	Sandy clay loam	-	-	-	-
930	1125	A	0-28	10YR4/4	Sandy loam	angular gravel	2	-	flakes (cat# 061)
930	1125	B	28-38	10YR4/6	Sandy clay loam	-	-	-	-
930	1140	A	0-32	10YR4/4	Sandy loam	rounded gravel	1	-	flake (cat# 060)
930	1140	B	32-43	10YR4/6	Sandy clay loam	-	-	-	-
945	1042.5	A	0-19	10YR4/4	Sandy loam	rounded gravel	-	-	-
945	1042.5	B	19-30	7.5YR4/6	Sandy clay loam	-	-	-	-
945	1057.5	A	0-21	10YR4/4	Sandy loam	-	1	-	flake (cat# 037)
945	1057.5	B	21-32	7.5YR4/6	Sandy clay loam	-	-	-	-
945	1072.5	A	0-25	10YR4/4	Sandy loam	-	2	-	flakes (cat# 038)
945	1072.5	B	25-36	7.5YR4/6	Sandy clay loam	-	-	-	-
945	1087.5	A	0-17	10YR4/4	Sandy loam	rounded gravel	1	-	flake (cat# 039)
945	1087.5	B	17-34	7.5YR4/6	Sandy clay loam	-	-	-	-
945	1102.5	A	0-32	10YR4/4	Sandy loam	rounded gravel	-	-	-
945	1102.5	B	32-44	7.5YR4/6	Sandy clay loam	-	-	-	-
945	1117.5	A	0-31	10YR4/4	Sandy loam	rounded gravel	-	-	-
945	1117.5	B	31-42	7.5YR4/6	Sandy clay loam	-	-	-	-
945	1132.5	A	0-32	10YR4/4	Sandy loam	angular gravel	-	-	-
945	1132.5	B	32-43	7.5YR4/6	Sandy clay loam	-	-	-	-
945	1147.5	A	0-39	10YR4/4	Sandy loam	angular gravel	-	-	-
945	1147.5	B	39-49	7.5YR4/6	Sandy clay loam	-	-	-	-

APPENDIX D
MIDDLETOWN ENERGY CENTER
PHASE II SHOVEL TEST LOG

Shovel Test North Grid	Shovel Test East Grid	Stratum	Depth (cm)	Soil Color	Soil Texture	Inclusions	Prehistoric Count	Historic Count	Comments
960	1035	A	0-14	10YR4/4	Sandy clay loam	-	2	-	flakes (cat# 041)
960	1035	B	14-20	7.5YR4/6	Clay loam	-	-	-	-
960	1050	A	0-22	10YR4/4	Sandy clay loam	-	-	-	-
960	1050	B	22-34	7.5YR4/6	Clay loam	-	-	-	-
960	1065	A	0-19	10YR4/4	Sandy clay loam	-	1	-	flake (cat# 042)
960	1065	B	19-26	7.5YR4/6	Clay loam	-	-	-	-
960	1080	A	0-27	10YR4/4	Sandy loam	-	2	-	flakes (cat# 043)
960	1080	B	27-40	7.5YR4/6	Sandy clay loam	-	-	-	-
960	1095	A	0-22	10YR4/4	Sandy loam	-	-	-	-
960	1095	B	22-32	7.5YR4/6	Sandy clay loam	-	-	-	-
960	1110	A	0-36	10YR4/4	Sandy loam	-	1	-	flake (cat# 046)
960	1110	B	36-50	7.5YR4/6	Sandy clay loam	-	-	-	-
960	1125	A	0-28	10YR4/4	Sandy loam	-	2	-	flakes (cat# 044)
960	1125	B	28-40	7.5YR4/6	Sandy clay loam	-	-	-	-
960	1140	A	0-25	10YR4/4	Sandy loam	-	1	-	flake (cat# 045)
960	1140	B	25-40	7.5YR4/6	Sandy clay loam	-	-	-	-
975	1117.5	A	0-21	10YR4/4	Sandy loam	-	-	-	-
975	1117.5	B	21-31	7.5YR4/6	Sandy clay loam	-	-	-	-
905	1180	A	0-25	10YR4/4	Clay loam	-	-	-	-
905	1180	B	25-34	7.5YR4/6	Clay loam	-	-	-	-
920	1180	A	0-23	10YR4/4	Sandy clay loam	-	-	-	-
920	1180	B	23-34	7.5YR4/6	Sandy clay	-	-	-	-
935	1180	A	0-26	10YR4/4	Sandy loam	-	-	-	-
935	1180	B	26-34	7.5YR4/6	Clay loam	-	-	-	-
950	1180	A	0-36	10YR4/4	Sandy loam	angular gravel	-	-	-
950	1180	B	36-48	7.5YR4/6	Sandy clay loam	-	-	-	-
965	1180	A	0-38	10YR4/4	Sandy loam	angular gravel	4	-	flakes (cat# 065)
965	1180	B	38-49	7.5YR4/6	Clay loam	-	-	-	-
980	1180	A	0-33	10YR4/4	Sandy loam	rounded gravel	1	-	flake (cat# 066)
980	1180	B	33-45	7.5YR4/6	Sandy clay loam	-	-	-	-
995	1180	A	0-31	10YR4/4	Sandy loam	rounded gravel	-	-	-
995	1180	B	31-41	7.5YR4/6	Sandy clay loam	-	-	-	-
897.5	1195	A	0-39	10YR4/4	Sandy loam	-	-	-	-
897.5	1195	B	39-47	7.5YR4/6	Clay loam	-	-	-	-
912.5	1195	A	0-36	10YR4/4	Sandy loam	-	-	-	-
912.5	1195	B	36-46	7.5YR4/6	Sandy clay loam	-	-	-	-
927.5	1195	A	0-29	10YR4/4	Sandy loam	-	-	-	-
927.5	1195	B	29-37	7.5YR4/6	Clay loam	-	-	-	-
942.5	1195	A	0-34	10YR4/4	Sandy loam	angular gravel	-	-	-

APPENDIX D
MIDDLETOWN ENERGY CENTER
PHASE II SHOVEL TEST LOG

Shovel Test		Stratum	Depth (cm)	Soil Color	Soil Texture	Inclusions	Prehistoric Count	Historic Count	Comments
North Grid	East Grid								
942.5	1195	B	34-45	10YR4/6	Sandy clay loam	angular gravel	-	-	-
957.5	1195	A	0-31	10YR4/4	Sandy loam	angular gravel	2	-	flakes (cat# 064)
957.5	1195	B	31-39	7.5YR4/6	Clay loam	-	-	-	-
972.5	1195	A	0-35	10YR4/4	Sandy loam	angular gravel	-	-	-
972.5	1195	B	35-47	7.5YR4/6	Sandy clay loam	-	-	-	-
890	1210	A	0-23	10YR4/3	Sandy clay loam	-	-	-	-
890	1210	B	23-33	10YR4/6	Clay loam	-	-	-	-
905	1210	A	0-24	10YR4/4	Sandy loam	-	-	-	
905	1210	B	24-37	10YR4/6	Sandy clay loam	-	-	-	-
920	1210	A	0-28	10YR4/4	Sandy loam	-	-	-	-
920	1210	B	28-43	10YR4/6	Sandy clay loam	-	-	-	-
935	1210	A	0-40	10YR4/4	Sandy loam	-	1	-	flake (cat# 047)
935	1210	B	40-50	10YR4/6	Sandy clay loam	-	-	-	-
950	1210	A	0-24	10YR4/4	Sandy loam	-	1	-	flake (cat# 048)
950	1210	B	24-34	10YR4/6	Sandy clay loam	-	-	-	-
965	1210	A	0-34	10YR4/4	Sandy loam	-	1	-	flake (cat# 051)
965	1210	B	34-44	10YR4/6	Sandy clay loam	-	-	-	-
980	1210	A	0-29	10YR4/4	Sandy loam	-	-	-	-
980	1210	B	29-40	10YR4/6	Sandy clay loam	-	-	-	-
867.5	1225	A	0-23	10YR4/4	Sandy loam	-	-	-	-
867.5	1225	B	23-33	10YR4/4	Sandy clay loam	-	-	-	-
882.5	1225	A	0-21	10YR4/4	Sandy loam	-	1	-	flake (cat# 049)
882.5	1225	B	21-30	10YR4/6	Sandy clay loam	-	-	-	manganese staining
897.5	1225	A	0-36	10YR4/4	Sandy loam	-	3	-	flakes (cat# 050)
897.5	1225	B	36-43	10YR4/6	Sandy clay loam	-	-	-	10YR5/3 mottles
912.5	1225	A	0-30	10YR4/4	Sandy loam	rounded gravel	4	-	flakes (cat# 052)
912.5	1225	B	30-40	10YR4/6	Sandy clay loam	-	-	-	-
927.5	1225	A	0-28	10YR4/3	Sandy loam	rounded gravel	-	-	-
927.5	1225	B	28-35	10YR4/6	Sandy clay loam	-	-	-	10YR5/3 mottles
942.5	1225	A	0-29	10YR4/4	Sandy loam	-	2	-	FCR (cat# 053)
942.5	1225	B	29-40	10YR4/6	Sandy clay loam	angular gravel	-	-	10YR5/3 mottles
957.5	1225	A	0-42	10YR4/4	Sandy loam	-	2	-	flakes (cat# 054)
957.5	1225	B	42-50	10YR4/6	Sandy clay loam	-	-	-	-
875	1240	A	0-22	10YR4/3	Sandy clay loam	-	-	-	-
875	1240	B	22-34	2.5Y4/4	Clay	-	-	-	-
890	1240	A	0-25	10YR4/4	Sandy loam	angular gravel	-	-	-
890	1240	B	25-35	10YR4/6	Sandy clay loam	-	-	-	-
905	1240	A	0-29	10YR4/4	Sandy loam	angular gravel	3	-	flakes (cat# 055)
905	1240	B	29-40	10YR4/6	Sandy clay loam	-	-	-	-

APPENDIX D
MIDDLETOWN ENERGY CENTER
PHASE II SHOVEL TEST LOG

Shovel Test		Stratum	Depth (cm)	Soil Color	Soil Texture	Inclusions	Prehistoric Count	Historic Count	Comments
North Grid	East Grid								
920	1240	A	0-21	10YR4/4	Sandy loam	angular gravel	-	-	-
920	1240	B	21-31	10YR4/6	Sandy clay loam	-	-	-	-
935	1240	A	0-26	10YR4/4	Sandy loam	angular gravel	-	-	-
935	1240	B	26-36	10YR4/6	Sandy clay loam	-	-	-	-
950	1240	A	0-22	10YR4/3	Sandy loam	-	-	-	-
950	1240	B	22-32	10YR4/6	Sandy clay loam	-	-	-	10YR5/8 mottles
897.5	1255	A	0-32	10YR4/4	Sandy loam	rounded gravel	1	-	flake (cat# 056)
897.5	1255	B	32-42	10YR5/3	Sandy clay loam	-	-	-	10YR4/4 mottles
912.5	1255	A	0-24	10YR4/4	Sandy loam	-	-	-	-
912.5	1255	B	24-33	10YR4/6	Sandy clay loam	-	-	-	10YR4/4 mottles
927.5	1255	A	0-22	10YR4/4	Sandy loam	angular gravel	1	-	flake (cat# 057)
927.5	1255	B	22-32	10YR4/6	Sandy clay loam	-	-	-	-
942.5	1255	A	0-28	10YR4/4	Sandy loam	rounded gravel	1	-	flake (cat# 058)
942.5	1255	B	28-38	10YR4/6	Sandy clay loam	-	-	-	-
957.5	1255	A	0-28	10YR4/4	Sandy loam	angular gravel	1	-	flake (cat# 059)
957.5	1255	B	28-36	10YR4/6	Sandy clay loam	-	-	-	-
972.5	1255	A	0-25	10YR4/4	Sandy loam	angular gravel	-	-	-
972.5	1255	B	25-36	10YR4/6	Sandy clay loam	-	-	-	-
935	1270	A	0-21	10YR4/4	Sandy loam	angular gravel	-	-	-
935	1270	B	21-31	10YR4/6	Sandy clay loam	-	-	-	-
950	1270	A	0-27	10YR4/4	Sandy loam	angular gravel	-	-	-
950	1270	B	27-38	10YR4/6	Sandy clay loam	-	-	-	-

APPENDIX E

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DATE: **September 11, 2014**

TO: **Tetra Tech, Inc.**
Rob Jacoby
1000 The American Road
Morris Plains, NJ 07950

FROM: **Justine McKnight, Archeobotanical Consultant**

RE: **Archeobotanical Remains from the Middletown Energy Center Site (33Bu1071)**

This letter report details the methods and results of the analysis of carbonized archaeological plant macro-remains recovered from four flotation samples collected during Phase II archaeological investigation of the Middletown Energy Center Site (33Bu1071). The site is located within the City of Middletown in Butler County, Ohio. Diagnostic artifacts recovered from the site span the Early Archaic through Fort Ancient cultural periods.

Four soil samples ranging in volume from two to 5.5 liters in volume were submitted for processing and analysis. These were collected from three soil anomalies (Anomaly Numbers 7, 8, 15) and from a shallow basin-shaped feature (Feature 1). Samples were processed using a Flote-Tech flotation system equipped with 0.325 millimeter fine fraction and 1.0 millimeter coarse fraction screens. The Flote-Tech system is a multi-modal flotation system which facilitates the separation and recovery of plant macro-remains from the soil matrix using water agitation and forced air delivery. Processing resulted in two (light and heavy) fractions of material. Floted portions were air dried. All plant remains recovered through flotation were combined and passed through a two millimeter geological sieve, yielding fractions of two different sizes for analysis. Weights and sample descriptions of the resulting greater than or equal to two millimeter and less than two millimeter fractions were recorded. The greater than or equal to two millimeter charcoal specimens were examined under low magnification (10X to 40X) and sorted into general categories of material (i.e. wood, nut). Description, count and weight were taken for each category of the greater than or equal to two millimeter carbonized material. The less than two millimeter size fractions were examined under low magnification and scanned for the remains of carbonized seeds or cultivated plants (none were present).

Botanical identifications were attempted in accordance with standard practice (Pearsall 2000). All identifications were made under low magnification (10X to 40X) with the aid of standard texts (Martin and Barkely 1961; Panshin and deZeeuw 1980) and checked against plant specimens from a modern reference collection representative of the flora of southern Ohio. Each taxon was individually packaged and labeled with archival quality materials. Analysis was consistent with current professional standards for the study of botanical material from archaeological contexts (Pearsall 2000).

Flotation processing of a total of 16.75 liters of cultural sediment yielded a scant 0.18 grams of carbonized plant remains (an average of 0.01075 grams per liter of archaeological soil). The results of the macro-botanical analysis are presented by sample number in the attached table. Recovered plant artifacts include wood charcoal (pine, red oak and hickory species were identified) and carbonized thick-walled hickory nutshell.

In addition to the carbonized plant artifacts, uncarbonized seeds were present within each of the analyzed flotation samples. Six different taxa were identified, and all represent weedy plants common to disturbed ground and agricultural fields. It is the opinion of the analyst that these uncarbonized specimens are modern intrusions to the archaeological record. The presence of insect body parts and eggs and rootlets within the samples suggests that bioturbation of soils could have resulted in the incorporation of seeds from the soil surface into lower soil strata.

This systematic study of flotation-recovered archeobotanical remains from Site 33Bu1071 documents a cultural reliance on a mix of native wood species for fuel, and the harvest of seasonally-predictable hickory nuts as a food source.

References Cited

Martin A. and W. Barkely
1961 *Seed Identification Manual*. University of California Press, Berkeley.

Panshin, Alexis and Carl deZeeuw
1980 *Textbook of Wood Technology*. Volume 1, 4th edition. McGraw Hill, New York.

Pearsall, D.
2000 *Paleoethnobotany: A Handbook of Procedures.* Academic Press, San Diego.

Plant Macro-remains Recovered from Four Flotation Samples
Middletown Energy Center (Site 33Bu1071)

cat no.		18	21	25	19	total
anomaly		7	8	15		
test unit		3	4	5	29	4 samples
Feature					**1**	
stratum		B	B	B	B	
level		2	2	2	2	
volume (liters)		5.5	5.25	2	4	16.75
weight carbonized material (grams)		0.11	0.02	0.02	0.03	0.18
WOOD CHARCOAL (carbonized)	(no of fragments)	8	3	2	2	15
	total weight (grams)	0.09	0.02	0.02	0.01	0.14
Carya spp. (hickory)			1			1
Pinus spp. (pine)		2				2
Quercus spp. (red oak)		1			1	2
deciduous		2	2	2		6
unidentifiable		3			1	4
total identified fragments		8	3	2	2	15
NUTS (carbonized)	(n of specimens)	3	0	0	2	5
	total weight (grams)	0.02	0	0	0.02	0.04
Carya spp. (hickory) shell fragments, thick-walled type		3			2	5
SEEDS (uncarbonized) presence		x	x	x	x	100%
Chenopodium/Amaranthus (goosefoot/knotweed)		x	x	x	x	100%
Mollugo verticillata (carpetweed)		x		x	x	75%
Oxalis stricta (sheepsorrel)			x			25%
Portulacca oleracea (purselane)		x		x		50%
Panicum/Setaria (panic/foxtail grass)			x			25%
POACEAE (grass)		x				25%
possible lithic debitage noted and isolated			x			

APPENDIX F

BETA

Consistent Accuracy . . .
. . . Delivered On-time

Beta Analytic Inc.
4985 SW 74 Court
Miami, Florida 33155 USA
Tel: 305 667 5167
Fax: 305 663 0964
Beta@radiocarbon.com
www.radiocarbon.com

Darden Hood
President

Ronald Hatfield
Christopher Patrick
Deputy Directors

September 18, 2014

Mr. Robert Jacoby
Tetra Tech
1000 The American Road
Morris Plains, NJ 07950
USA

RE: Radiocarbon Dating Result For Sample 013

Dear Mr. Jacoby:

Enclosed is the radiocarbon dating result for one sample recently sent to us. As usual, specifics of the analysis are listed on the report with the result and calibration data is provided where applicable. The Conventional Radiocarbon Age has been corrected for total fractionation effects and where applicable, calibration was performed using 2013 calibration databases (cited on the graph pages).

The web directory containing the table of results and PDF download also contains pictures, a cvs spreadsheet download option and a quality assurance report containing expected vs. measured values for 3-5 working standards analyzed simultaneously with your samples.

The reported result is accredited to ISO-17025 standards and all pretreatments and chemistry were performed here in our laboratories and counted in our own accelerators here in Miami. Since Beta is not a teaching laboratory, only graduates trained to strict protocols of the ISO-17025 program participated in the analysis.

As always Conventional Radiocarbon Ages and sigmas are rounded to the nearest 10 years per the conventions of the 1977 International Radiocarbon Conference. When counting statistics produce sigmas lower than +/- 30 years, a conservative +/- 30 BP is cited for the result.

When interpreting the result, please consider any communications you may have had with us regarding the sample. As always, your inquiries are most welcome. If you have any questions or would like further details of the analysis, please do not hesitate to contact us.

The cost of the analysis was charged to the MASTERCARD card provided. Thank you. As always, if you have any questions or would like to discuss the results, don't hesitate to contact me.

Sincerely,

Darden Hood
Digital signature on file

BETA ANALYTIC INC.
DR. M.A. TAMERS and MR. D.G. HOOD
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305-667-5167 FAX:305-663-0964
beta@radiocarbon.com

REPORT OF RADIOCARBON DATING ANALYSES

Mr. Robert Jacoby — Report Date: 9/18/2014

Tetra Tech — Material Received: 9/4/2014

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 389353	2810 +/- 30 BP	-25.9 o/oo	2800 +/- 30 BP

SAMPLE : 013
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid
2 SIGMA CALIBRATION : Cal BC 1015 to 895 (Cal BP 2965 to 2845)

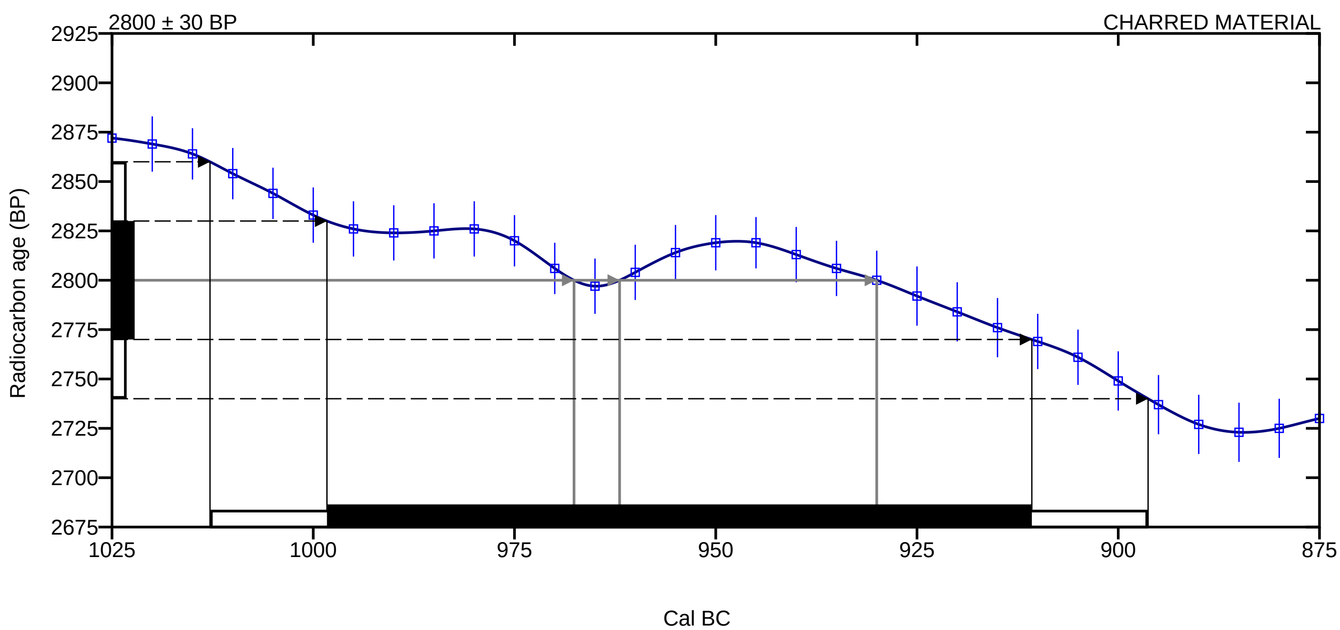
Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12 = -25.9 o/oo : lab. mult = 1)

Laboratory number	**Beta-389353**
Conventional radiocarbon age	**2800 ± 30 BP**
2 Sigma calibrated result 95% probability	**Cal BC 1015 to 895 (Cal BP 2965 to 2845)**
Intercept of radiocarbon age with calibration curve	Cal BC 970 (Cal BP 2920) Cal BC 960 (Cal BP 2910) Cal BC 930 (Cal BP 2880)
1 Sigma calibrated results 68% probability	Cal BC 1000 to 910 (Cal BP 2950 to 2860)



Database used

INTCAL13

References

Mathematics used for calibration scenario

A Simplified Approach to Calibrating C14 Dates, Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2):317-322

References to INTCAL13 database

Reimer PJ et al. IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP. Radiocarbon 55(4):1869–1887.