

ARCHEOLOGICAL SITE EXAMINATION FOR THE
UPTON CHAMBER MASONRY REHABILITATION AND
DRAINAGE IMPROVEMENT PROJECT,
18 ELM STREET (ASSESSOR'S PARCEL 28), TOWN OF UPTON,
WORCESTER COUNTY, MASSACHUSETTS



PREPARED FOR

THE TOWN OF UPTON
UPTON, MASSACHUSETTS

PREPARED BY

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CROTON-ON-HUDSON, NEW YORK

DECEMBER 2012

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Prepared for

The Town of Upton
Upton, MA 01560

Submitted to

The Massachusetts Historical Commission
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ABSTRACT

The site examination consisted of five excavation units (1-x-1 m) for the masonry rehabilitation and drainage improvement project for a stone beehive chamber known as the Upton Chamber (UPT-HA-15, a.k.a. the Pearson Chamber). Since 1893 the Upton Chamber has been the focus of speculative claims about its builders, its age and its function. During 1955 most of the interior of the stone chamber and the area immediately outside the chamber's entrance had been excavated by Harvard University archeologists John Glass and David H. Kelly. The 1955 work uncovered a wooden floor with corroded nails and a small ceramic rim fragment with incised decoration and a "lead slip." From current deed research it was determined that the property was owned in the mid nineteenth century by a tanner, John Hill, whose business was discontinued and the "vats filled up" by 1879. The 2011 site examination was intended to identify whether intact unexcavated cultural strata were present within the area of the masonry rehabilitation and drainage improvements, both inside and outside the chamber's entrance. The archeological testing did not encounter any intact strata within the flooded interior of the chamber's entrance, although lead-glazed redware ceramics typical of the colonial era were recovered in disturbed strata within the chamber's passageway. The area immediately outside of the chamber's entrance also consisted of recent (post-1955) soil and rock accumulation. Two to three meters outside the chamber's entrance, intact strata were identified, but with little cultural material. Two large mammal bone shafts were recovered that had been butchered (chopped and/or hand sawn). Optically Stimulated Luminescence (OSL) dating by USGS of a sediment sample (Upton Sample #5) from behind a boulder in the chamber passageway yielded a minimum age of between 1664 A.D. and 1632 A.D, or (using another method to calculate the equivalent doses) between 1644 and 1592 A.D. To date no conclusive evidence for a pre-colonial origin of the Upton Chamber has been identified. Various theories on the function of the Upton Chamber are discussed, including possible agrarian use as an ice house or root cellar, and possible use as a shelter of refuge for Native Americans or settlers during times of colonial or inter-tribal warfare. In 2011 the Federal Communications Commission (FCC) in Washington, D.C. made a determination that the cultural landscape known as the Pratt Hill - Upton Chamber Historic District is a discontinuous historic district that is eligible for listing on the National Register of Historic Places under Criterion A for its role in the religious and cultural traditions of three tribes - the Narragansett Tribe, the Wampanoag Tribe of Gay Head (Aquinnah), and the Mashpee Wampanoag Tribe. Based upon the limited excavation from the site examination, the Upton Chamber is also recommended as eligible under Criterion D: Information Potential ("has yielded, or may be likely to yield, information important in prehistory or history"), at the local level.

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The Upton Chamber Masonry Rehabilitation and Drainage Improvement Project has been funded by the Town of Upton through the Community Preservation Act. The Upton Historical Commission has been instrumental in this preservation effort following the purchase of the Upton Chamber property by the Town of Upton. The present study has been conducted through the oversight of the Massachusetts Historical Commission in conjunction with the Upton Historical Commission. During the course of the project Barbara Burke, Chair of the Upton Historical Commission, and other commission members made field visits and assisted in the logistics of the project. In particular, Upton Historical Commission member Cathy Taylor deserves full credit for her daily assistance to the project. Cathy was available on numerous occasions to check on the progress of the project and offer assistance. While field work was being conducted by the author and project archeologist T. Arron Kotlensky, field work was aided voluntarily by professional archeologists Alan F. Smith and David Gutbrod. David Gutbrod also generously loaned and operated the water pump during the course of the project. David Mathisen assisted in moving a large boulder that blocked the chamber entrance. Optically Stimulated Luminescence Sampling was proposed and executed by Dr. Frederick W. Martin, and his contributions and observations have been included in this report. A number of town residents offered their recollections of the Upton Chamber in years past. Visitors also included Paul Robinson, former State Archaeologist of Rhode Island, and Doug Harris, Preservationist for Ceremonial Landscapes of the Narragansett Indian Tribal Historic Preservation Office. Last and not least, the citizens of the Town of Upton are to be commended for their support in preserving the Upton Chamber, which came very near to being destroyed through private ownership. The stone chamber has a legacy of mystery and intrigue and a history which has yet to be fully understood. Regardless of who built the chamber and when, the Upton Chamber is an exemplary cultural resource that can be appreciated by generations of town folk to come.

1.0 INTRODUCTION

The Town of Upton contracted John Milner Associates, Inc. (JMA) to conduct an archeological site examination for the Upton Chamber Masonry Rehabilitation and Drainage Improvement Project for the Upton Chamber at 18 Elm Street, assessor's parcel # 28, in the town of Upton, Massachusetts (Figure 1). The property, owned by the Town of Upton, has historically been associated with a stone chamber known as the Upton Chamber (UPT-HA-15, a.k.a. the Pearson Chamber) on the premises. The 18 Elm Street Project involves the rehabilitation of the stone chamber's entrance. During 1955 most of the interior of the stone chamber and the area immediately outside the entrance had been excavated by archeologists John Glass and David H. Kelly. As a result, the masonry rehabilitation and drainage improvement project was not expected to affect any previously undisturbed portions of the chamber's interior, except possibly below the level of any previous excavations. Outside the chamber's entrance intact yard deposits were anticipated. The site examination was intended to identify whether intact unexcavated cultural strata were present within the area of the masonry rehabilitation and drainage improvements, both inside and outside the chamber's entrance.

Dr. David Stewart-Smith, the stone mason contracted to do the masonry rehabilitation and drainage improvements, noted that freezing and thawing along the chamber's walls seems to have created voids in the stonework, especially along left-hand (northeast) wall. Tree roots were also a concern, having expanded toward the wall on the right (southwest). The main entryway lintel had tipped forward and moved out from the mound (Appendix I). The masonry rehabilitation involved repacking the stonework near the entrance from the bottom up using stones on the floor that had come away from the wall originally and could be used to repack the walls. Pockets of slump behind the walls would be excavated using a trowel and then repacked with trap rock and stone. The proposed drainage improvements for the chamber entryway were to allow water to drain off. The floor would be excavated down to its original level and the entrance yard leveled so that water would flow out of the chamber (Appendix I).

The purpose of an archeological site examination is to obtain "a preliminary definition of the size, data contents, and spatial arrangement of artifacts and features for the purposes of assessing a site's integrity, research potential, and significance, in order to make an opinion of the potential eligibility of the site for inclusion in the National Register" (950 CMR 70.04:17). The archeological investigation for the Upton Chamber Masonry Rehabilitation and Drainage Improvement Project was specifically focused within the proposed work area for the masonry rehabilitation. Since the Upton Chamber (UPT-HA-15) is a known archeological site, this work is classified as a site examination. The goal of the archeological site examination as conducted was to identify whether any potentially significant archeological deposits were present within the area of the masonry rehabilitation and drainage improvements. To the extent possible within this limited area of field investigation a preliminary definition of the size, data contents, and spatial arrangement of artifacts and features and an assessment of the site's integrity, research potential, and significance have been made in order to make an opinion of the potential eligibility of the site for inclusion in the National Register. This work was conducted under Permit # 3276 issued by the State Archeologist on September 8, 2011 and conducted in compliance with Massachusetts General Laws Chapter 9, Sections 26-27c (950 CMR 70-71).

During the course of the site examination field investigation at the Upton Chamber, the Federal Communications Commission (FCC) in Washington, D.C. made a determination that the cultural landscape known as the Pratt Hill - Upton Chamber Historic District is a discontinuous historic district that is eligible for listing on the National Register of Historic Places under Criterion A for

its role in the religious and cultural traditions of three tribes - the Narragansett Tribe, the Wampanoag Tribe of Gay Head (Aquinnah), and the Mashpee Wampanoag Tribe (FCC Communication October 20, 2011, see Appendix II). While the Upton Chamber is currently part of a cultural landscape that is important to the religious and cultural practices of the three tribes, the origin, history and function of the Upton Chamber has been an ongoing controversy for over 100 years.

2.0 SITE EXAMINATION RESEARCH DESIGN

2.1 STATEMENT OF PURPOSE

The Town of Upton contracted JMA to conduct an archeological site examination for the Upton Chamber Masonry Rehabilitation and Drainage Improvement Project at 18 Elm Street, assessor's parcel # 28, in the town of Upton, Massachusetts (Figure 1). The property, owned by the Town of Upton, has historically been associated with a stone chamber known as the Upton Chamber (UPT-HA-15, a.k.a. the Pearson Chamber) on the premises. The purpose of the site examination is to identify whether any potentially significant archeological deposits are present within the area of the masonry rehabilitation and drainage improvements for the Upton Chamber. The archeological evaluation of the work area of the Upton Chamber Masonry Rehabilitation and Drainage Improvement Project is warranted to test for undisturbed archeological deposits that may aid in determining the age, function and significance of the Upton Chamber.

2.2 DOCUMENTARY RESEARCH

Documentary research for the present investigation included review of pre-Contact and historical archeological site files and cultural resource management (CRM) reports, historic maps and the town survey report for the town of Upton, Worcester County Massachusetts on file at the MHC. This information has been used to assess the pre-Contact and historic potential of the project area and to further develop the pre-Contact and historic context. Additional research has focused on deeds at the Worcester County Registry of Deeds in the city of Worcester and on published and unpublished sources relating to the Upton Chamber and previous investigations there. Additional documents and historic maps have been supplied from the Upton Historical Commission.

The Upton Chamber is located at 18 Elm Street, assessor's parcel # 28, in the town of Upton, Massachusetts (Figures 2 and 3). Preliminary deed research was conducted online and at the Worcester County Registry of Deeds by Eric Metzger in the city of Worcester. Time did not permit a complete examination of all the deeds pertaining to the 18 Elm Street property. The deed research reported here in Section 4.4 traces the property back from the present town ownership to the mid 1800s. This research represents a starting point for additional deed research.

2.3 SITE EXAMINATION FIELD METHODS AND STRATEGIES

The purpose of an archeological site examination is to obtain "a preliminary definition of the size, data contents, and spatial arrangement of artifacts and features for the purposes of assessing a site's integrity, research potential, and significance, in order to make an opinion of the potential eligibility of the site for inclusion in the National Register" (950 CMR 70.04:17). The archeological investigation for the Upton Chamber Masonry Rehabilitation and Drainage Improvement Project was specifically focused within the proposed work area for the masonry rehabilitation. Since the Upton Chamber (UPT-HA-15) is a known archeological site, this work is classified as a site examination. The goal of the site examination was to identify any potentially significant archeological deposits present within the area of the masonry rehabilitation and drainage improvements. To the extent possible with this limited field investigation a preliminary definition of the size, data contents, and spatial arrangement of artifacts and features was made and an assessment of the site's integrity, research potential, and significance in order to make an opinion of the potential eligibility of the site for inclusion in the National Register.

The plan of the 1955 archeological excavations at the Upton Chamber indicates that all of the entrance and the passageway, and half of the beehive chamber had been excavated, leaving a portion of the beehive chamber unexcavated. In addition, an excavation unit measuring approximately 4-x-4 ft (1.2-x-1.2 m) was excavated outside the entrance to the stone chamber and a trench was excavated 18 ft (5.5 m) west of the chamber entrance that encountered cobbles. The Upton Chamber Masonry Rehabilitation and Drainage Improvement Project was proposed within an area that has already been largely archeologically excavated. Despite this, it was not clear if the 1955 investigation excavated down into sterile natural substratum or if any remnants of an historic wood floor were left in-situ inside the chamber's passageway.

Four 1-x-1 m excavation units (EUs) were proposed, with two EUs inside the chamber entrance and two EUs outside the entrance, to form a continuous 4-x-1 m excavation. A fifth 1-x-1 m excavation unit was proposed outside the chamber to allow for an extension of the drainage area. Based on the present scope of the masonry rehabilitation, the masonry work was not expected to extend more than 2-m inside of the chamber and no external excavation of the chamber's stonework was proposed by the stone mason. Excavation outside of the chamber for drainage was proposed to remove a hump of soil that hindered the drainage of water from the chamber.

All excavated soil was passed through one-quarter inch hardware cloth to ensure uniform recovery of artifacts.

Recovered artifacts and cultural materials were placed in bags marked with standard provenience information and returned to JMA's Littleton, Massachusetts laboratory for processing. Modern materials from fill (i.e., plastics, cellophane, aluminum beverage cans or tabs, rubber, candy wrappers, plywood) were noted but not retained. All ceramics, glass, non-recent metal artifacts, and bone were recovered.

No wood flooring or charcoal was present from undisturbed contexts for analysis. A piece of wood recovered in sand dug out from behind stones in the chamber entrance wall by the stone masons was sent for AMS dating.

Standard EU forms were filled out for each unit level, and soil profiles and EU plans were drawn and photographed. The locations of EUs were plotted on a map of the project area and throughout the archeological testing, field activities were photographed and field notes recorded the methods and results of the excavation.

2.4 LABORATORY PROCESSING AND ANALYSIS

Cultural materials from the Site Examination were cleaned, identified, described, and entered into an Alpha 4 computer cataloguing system for analysis. Once processed, the artifacts were placed in labeled resealable polyethylene bags and acid-free containers for short-term curation at the collection storage facility of John Milner Associates, Inc., at 410 Great Road, Littleton, Massachusetts, pending transfer to the Robbins Museum of Archaeology in Middleborough, Massachusetts for long-term curation following completion of the archeological investigation. The artifact analysis described the material, period of manufacture, possible use, and interpretive implications of the recovered cultural materials and to interpret the activities that they represent in light of the background contexts (environment, pre-Contact and historic).

3.0 PROJECT CONTEXT

3.1 ENVIRONMENTAL CONTEXT

The proposed Upton Chamber Masonry Rehabilitation and Drainage Improvement Project for the Upton Chamber is located at 18 Elm Street, assessor's parcel # 28, in the town of Upton, Massachusetts (Figure 1). The town of Upton lies at the eastern boundary of the uplands and lowlands of Worcester County and consists of an interior upland between the Blackstone River Valley and Upper Sudbury River Basin. Its uneven, hilly terrain rises in elevation to over 600 ft asl in the northwest. The hills are broken by several southerly-flowing streams and rivers which form a broad outwash valley nearly two miles wide south of Upton Center and West Upton. The West River is joined by Warren Brook in West Upton and by Center Brook to the south. The town's eastern boundary is formed by the Mill River, a major tributary of the Blackstone River (MHC 1983:1-2).

Upton's soils are generally gravelly, composed largely of glacially-formed and deposited soils. Hinckley gravelly sandy loam is found in the outwash plain of the Mill River valley and Gloucester stony and stony fine sand loam and Gloucester loam occupy the hillsides and hilltops. The latter type is one of the most agriculturally important soils of the county and had been heavily cultivated and used for orchards. A large patch of this soil type occurs in the eastern portion of the town (MHC 1983:1).

The project area is located at the eastern end of Upton at an elevation of approximately 300 ft asl. Water resources adjacent to the project area include an unnamed brook that feeds into Mill Pond, located 50 m to the west, and Pratt Pond, located 300 m north of the project area (Figure 1). Soils within the project area consist of Canton fine sandy loam on 3-8% slope from Elm Street and west 70 m and Canton fine sandy loam, extremely stony on 8-15% slope 70 m west of Elm Street to Mill Pond (Table 1). Generally speaking, these soils tend to be deep, with slight to moderate slopes and well drained (Taylor 1998).

Table 1. Soils within the project area.

#	Soil	Slope	Drainage	Description	Usage
420B	Canton fine sandy loam	3-8%, gently sloping	Well drained	Very deep soil on the lower slopes of hills	Most areas farmed, some covered with trees, and a few used for residential development; well suited for cultivated crops, hay, and improved pasture but erosion is a hazard; no major limitations restrict woodland management; suited for development but excavations need stabilization and poor filter capacity can result in the pollution of ground water.
422B	Canton fine sandy loam, extremely stony	3-8%, gently sloping	Well drained	Very deep soil on the lower slopes of hills and the top of ridges, stones are 2-5 feet apart and cover 3-15% of the surface	Most areas are covered with trees, some used for residential development; poorly suited to cultivated crops, hay, and improved pasture due to stoniness and erosion; woodland use is limited by large stones and boulders on the surface; poor filtering capacity of effluent in septic tank absorption fields, which can result in pollution of the ground water, and large stones in this soil may hinder the installation of distribution lines.

3.2 PRE-CONTACT CONTEXT

The following section presents a general summary of the archeological research on Native American societies that inhabited southern New England following the end of the last Ice Age. The prehistory (pre-Contact period) of eastern North America is divided into three major chronological stages of cultural development: Paleoindian (12,000-9,000 Before Present or BP), Archaic (9,000-3,000 BP), and Woodland (3,000-450 BP). The Archaic and Woodland periods are further divided into Early, Middle, and Late sub periods. Subsequent research and radiocarbon dating have helped to refine the chronology, cultural trends and artifact traditions as discovered on sites from these periods.

The purpose of this introductory section is to sketch the main trends of Massachusetts prehistory and to identify evidence pertinent to the project area, in order to provide the pre-Contact background necessary for assessing the potential for archeological resources within the project area.

For most of the pre-Contact period in the region, river drainages define physiographic units within which human communities operate. This pattern follows from the longitudinal diversity of habitats that occurs along drainages, forming ecologically unique wetland habitats, together with the transportation routes afforded by their water courses. In the clearest examples, rivers provide access to maritime and upland resources at each end of the drainage, and to the diverse habitats in between. The exploitation of those habitats can be integrated into a seasonal round that differs at various historical moments.

The following review is arranged chronologically by major periods recognized for New England. Each chronological section will present the major trends and patterns.

Paleoindian (12,000-9,000 BP) and Early Archaic (9,000-8,000 BP)

The late Pleistocene geological period witnessed major environmental changes which, in time, impacted the peopling of the Americas, and thus the earliest Native American occupations in the New England area. Southern New England was covered by a sheet of ice 1.5 km. thick, which extended over what are now Long Island, Martha's Vineyard and Nantucket. At this time, the sea level was about 100 m lower than it is at present, because of the enormous amount of water tied up in the glacial ice sheets. Only when the ice sheet began to melt, beginning ca. 15,000 BP, was southern New England habitable; by ca. 13,000 BP the ice sheet had retreated to expose Connecticut, Rhode Island, and southeastern Massachusetts and by ca. 12,000 BP all of New England was uncovered (Stone and Borns 1986).

During this time, sea levels rose sharply as deglaciation liberated enormous amounts of water, while isostatic rebound of land depressed by the weight of the former ice sheet quickly elevated large regions, especially in Maine. The physical landscape of New England in the terminal Pleistocene period was very different from that of today. The coastline was well seaward of its present position, and the modern coastal configuration was not reached until about 3000 BP, when sea levels were still several meters below those of the present. Deglaciation created large lakes in the Hudson-Champlain drainages and in the Connecticut Valley and many other smaller bodies of water in Massachusetts (Curran and Dincauze 1977, Dincauze 1974, Koteff 1982, Larsen and Hartshorn 1982, Stone and Peper 1982). The major lake systems were drained by 12,500 BP, while the smaller bodies of water gradually filled with sediment, leaving marshes, bogs, ponds and small lakes. With progressive deglaciation and rising regional temperatures,

vegetation changed relatively quickly, from tundra to spruce parkland (by ca. 9000 BP) to an oak-hemlock association (by 7000 BP); at the same time, general climatic conditions shifted from cool and dry (ca. 11,000 BP) to warmer and moister (ca. 9000 BP) and then warmer and drier again (ca. 8000-5000 BP). The human communities that initially colonized southern New England thus were faced with a rapidly changing landscape, one in which resources were of low density and relative unpredictability.

This condition resulted in a very generalist adaptation, with emphasis on flexibility, mobility, large and probably loosely defined foraging territories, and maintenance of wide kinship ties (Dincauze 1980; Snow 1980). While subsistence strategies for Paleoindians have not been determined, Snow (1980) has argued that Paleoindian subsistence was focused on migratory big game animals such as caribou, mammoth or mastodon, while exploiting other food resources as the people chanced upon them. An alternate view by Dincauze (1981) is that the Paleoindians were generalist foragers. One proposed model for this period postulates that glacial lake basins were the focus of occupations; these areas included a mosaic of habitats that provided richer subsistence possibilities than elsewhere in New England (Nicholas 1988). In New England, Paleoindian sites often reflect occupations of the recently drained proglacial lake bottoms and wetlands (Thorbahn 1982, Thorbahn and Cox 1983). Another model proposes the possibility that Paleoindians may have used pioneering or staging areas from which large, more-or-less permanent groups sent out smaller groups to colonize or pioneer the newly deglaciated terrain (Dincauze 1993, 1996). As the physical environment began to stabilize (i.e. changed less quickly and became more predictable), human groups grew less generalized in adaptation and settled into more restricted foraging territories.

Diagnostic artifacts from the Paleoindian period include finely flaked fluted lanceolate points (Clovis and Folsom), with three phases identified on the basis of point styles (Spiess et al. 1998). Other Paleoindian tools include scrapers, (presumably for working animal hides), graters and bifacial blades. Lithic materials used consisted primarily of fine quality microcrystalline rock, often from sources more than a hundred miles away from the site of recovery.

The nearest well documented Paleoindian site is the Bull Brook site in Ipswich, Massachusetts, which covered an area of about 20 acres (Dincauze 1996). Bull Brook is one of six large Paleoindian non-quarry sites that have been documented in the Northeast. These sites contain the earliest point styles for their respective areas and are believed to date from the eleventh millennium BP (Dincauze 1974, Spiess et al. 1998, Curran 1999). According to the pioneering model advanced by Dincauze (1996:10), these sites may represent marshaling areas for people who had just crossed into new, unoccupied terrain. These sites would be used for the gathering, arranging and allocating of resources and information preparatory to dispersing in smaller groups. Analysis of metric data of fluted point assemblages and raw material sources has added insight for an alternate chronological sequencing of sites reflecting exploration and early colonization of the Northeast (Curran 1999).

The Early Archaic period is still being evaluated as to whether the changes in artifacts used to define this period represent continuity of Paleoindian populations. Dincauze (1990) used the common term pioneers for Paleoindian and Early Archaic populations (Pioneers and Late Pioneers, respectively). Snow (1980:171) considered that there was continuity from the Paleoindian Period into the Early Archaic Period, with “restricted wandering” of groups within territories during the Early Archaic. As the physical environment began to stabilize (i.e., changed less quickly and became more predictable) into a closed boreal environment dominated by spruce,

fir and birch, human groups grew less generalized in adaptation and settled into more restricted foraging territories (Dincauze 1980, Meltzer 1988).

A major change in artifacts from the Early Archaic period was that fluted points were no longer used. Late Paleoindian diagnostic artifacts include Dalton-like points and unfluted Eden lanceolate points; the latter are rare in Eastern Massachusetts, while the former may date into Early Archaic times (E. Johnson and Mahlstedt 1984). Early Archaic diagnostic points include Bifurcate Base, Kirk Stemmed, and Kirk Corner Notched points. Overlapping dates for the late Paleoindian and Early Archaic as well as the small number of Early Archaic sites in the Northeast still challenge this research issue. The latter may reflect low population numbers during the Early Archaic (Salwen 1978), the combined outcome of site destruction and meager or inadequate surveys, or our inability to recognize the entire range of artifact types for the period (Dincauze and Mulholland 1977). Some Early Archaic sites may have been buried or destroyed by rising sea levels or river alluvium (Dincauze and Meyer 1977). Subsequent collection research has found a wider range of sites with Bifurcate Base points than had previously been recognized (E. Johnson 1984). This may reflect a wider range of food resources being exploited.

Most Early Archaic sites have been discovered in southern New England and in coastal areas. These small groups, it appears, did not camp together in larger numbers as did the earlier Paleoindians, with the result that there may be fewer recognized sites with sparse evidence of human presence. Sites from the Early Archaic period are perhaps best known in southeastern Massachusetts, especially in the Taunton River drainage (for example, the Titicut and Seaver Farm sites, Dincauze and Mulholland 1977; Double-P site, Thorbahn 1982; the upper Taunton concentration, Taylor 1976). The Titicut site is the largest site identified from the Early Archaic period. It has been interpreted as a base camp for several families. Several Early Archaic sites identified in Massachusetts contained evidence that suggests that small hunting groups returned to camps with seasonal regularity. Deep pit features that may have been used for storage were discovered in the Taunton and Shawsheen River drainages (Simon 1982; Harrison and McCormack 1990, Glover and Doucette 1992). These sites contained material suitable for radiocarbon age determinations, stone tools diagnostic of the Early Archaic Period, or both.

During the Paleoindian and Early Archaic periods, most diagnostic tools were made of non-local or exotic stone, a pattern that generally is predominant throughout southern New England. However, it has recently been argued that until more Paleoindian and Early Archaic components are excavated and archeologists achieve better microscopic identifications of stone types and their origins, this pattern may be an artificial one reflecting biases in sample size and archeological recovery history (Moeller 1999:72-73).

Sites containing a predominately non-bifacial quartz tool tradition referred to as the Gulf of Maine tradition are commonly found in Maine and northern New England (Robinson 1992) from this time period. Similar sites containing this tool tradition have been found at Lake Winnepesaukee (Bolian 1980) and within the Merrimack River drainage (Robinson 1992; Dudek 2005). At least two significant habitation sites utilizing a similar quartz tool technology have been found in southern New England on south-facing hillsides – the Sandy Hill site in Connecticut and the Whortleberry Hill site in Dracut, Massachusetts; these sites had deep pit features, interpreted as pit houses, with an abundance of charred hazelnut shells at Sandy Hill (Forrest 2000; Jones and Forrest 2003) and charred hazelnut and acorn shells at Whortleberry Hill (Dudek 2005).

No Paleoindian or Early Archaic period sites have been identified within 3 km of the Upton Chamber.

The Middle Archaic (8000-6000 BP)

Throughout southern New England, human occupation becomes more evident and apparently more complex during the Middle Archaic. In southern New England, a mixed pine-oak forest was established and expanding north by 8500 BP, followed by an oak-hemlock forest in southern New England by about 6000 BP (Dincauze 1976:119). The greater number of sites from this time relates to a presumed increase in population density, while the greater disparity in size and differentiation of individual sites suggests a more complexly ordered social landscape than previously found. Stemmed bifacial points, atlatls (spear-thrower weights), pecked, ground and polished woodworking tools such as axes, adzes and celts, and plant-processing tools, such as mortars, pestles, grinding stones and nutting stones, are new forms in use during this time. The cultural traditions of the Middle Archaic complexes, as seen at the Neville site, reveal a close relationship to the Atlantic seaboard (Mid-Atlantic) and piedmont (Southeast) regions during the Middle Archaic period (Dincauze 1976:124).

Dincauze and Mulholland (1977) have suggested that effective integration of seasonally available resources into a single adaptive schedule appeared during this period, while maintenance of territorial boundaries between groups intensified in consequence of this emergent adaptation; this response may have been a consequence of more stable regional environments. The predominant settlement pattern would be one of small sites oriented toward seasonally abundant resources, including spring fish runs. The earliest documented or inferred harvesting of anadromous fish during spring runs up the Connecticut (Thomas 1980) and the Merrimack (e.g., Dincauze 1976, Barber 1980) rivers, marks both a fundamental adaptation to foraging possibilities and a seasonal determinant of site location, meaning spring occupations at rapids, falls and constrictions on larger river courses. Exploitation of anadromous fish would continue throughout the rest of regional prehistory as a principal component of aboriginal economies. On the Mashantucket Pequot Reservation in southeastern Connecticut, the Great Cedar Swamp was important in seasonal subsistence rounds during the Neville phase from 8000 to 7000 BP. Several settlement models for New England “suggest that subsistence activities became more intensively focused on the valley floors of the major river drainages with the onset of the Hypsithermal after about 7500 radiocarbon years ago” (Jones 1999:120).

During the Middle Archaic period, there is a wide variety of environmental settings for sites, including the margins of bogs, swamps, rivers, lakes and ponds, with differentiation of sites based on size and apparent function. This may reflect the incipient seasonal rounds or scheduled subsistence activities, possibly related to a growing territoriality within drainage areas (Dincauze and Mulholland 1977). Site types include semi-permanent base camps along rivers, streams or wetlands, special-purpose camps in uplands or near wetlands, rockshelters, stone quarries, and workshop areas.

Evidence of site differentiation and a more complexly ordered social landscape can be extrapolated from a number of large Middle Archaic sites containing a variety of features. At the Annasnappet Pond site in the Taunton River drainage, 119 cultural features were identified, while three of nine loci formed a nearly continuous distribution of Middle Archaic and Late Archaic material over nearly 14,000 sq. m. A mortuary feature containing calcined human cranial fragments, winged atlatl weights and Neville points at the Annasnappet Pond site was radiocarbon-dated to 7570 ± 150 BP (Cross 1999); it is the only known human burial associated with Neville points in the Northeast. Middle Archaic radiocarbon dates were obtained from nine features, while the overall Middle and Late Archaic assemblage from the site included 70,000 pieces of debitage, 166 Neville points, 31 Neville Variants, 38 Stark points, four Merrimack

points, cylindrical and winged atlatl weights, ground hematite, bifaces, drills, cores and unifaces (Cross 1999:60-63).

Extensive archeological excavations along the Merrimack River relating to this time period have been conducted at the Shattuck Farm site in Andover and at the Neville and Smyth sites in the Manchester/Amoskeag falls area of southern New Hampshire. Dincauze identified three distinct temporal complexes of tools spanning the Middle Archaic period ($7,740 \pm 280$ to $5,910 \pm 180$ BP); these were the Neville, Stark, and Merrimack complexes, stratigraphically separated at the site (Dincauze 1976). Circumstantial evidence revealed a focus on fishing at the Neville site during most of the Middle Archaic, with a reduced emphasis on fishing in the Merrimack complex.

Cross (1999), examining the distinction between the Neville and Stark point types, has demonstrated differences in production technology and functional qualities of Neville and Stark points at the Annasnappet Pond site that imply differences in use (Neville points being used on atlatl darts while Stark points may have used on thrusting spears). Cross posits that, to judge from the functional and technological differences, the two kinds of bifaces may therefore be contemporary (Cross 1999:72). While Dincauze (1976) has argued for temporal overlap with Starks' becoming more common over time, a closer examination of different temporal contexts in southern New England throughout the entire span of the Middle Archaic may resolve this issue.

No Middle Archaic period sites have been identified within 3 km of the Upton Chamber.

Late Archaic Period (6000-3000 BP)

Many attributes of this period are well rooted in the Middle Archaic, but become much more evident in the Late Archaic. In some regions outside New England, the period is characterized by a shift to reliance on protocultigens or intensive gathering, perhaps precipitated by environmental changes. In southern New England, however, no one has yet identified cultivated or domesticated plants in a context earlier than the Woodland period. In the Southeast, in the Savannah River area of Georgia and South Carolina and in northeast Florida, the emergence of pottery has been dated as far back as 4500 BP (Sassaman 1999). In the Northeast, pottery did not come into use until around 3200 BP, while soapstone vessels were in use during the latter part of the Late Archaic into the Early Woodland, from about 3700 to 2400 BP (Sassaman 1999).

Another marker of the period is the proliferation of archeological tool traditions and phases: Laurentian (Brewerton), Narrow Point (Small Stemmed), and Broadpoint or Susquehanna (Cook 1976, Custer 1984). A fourth tradition, the Maritime Archaic, is found primarily in coastal areas of northern New England, Nova Scotia, New Brunswick, Newfoundland, and Labrador. These Late Archaic traditions have been long-standing topics of discussion on their relationship to each other and their social and adaptational placement in Southern New England prehistory (W. Ritchie 1971; Dincauze 1975). Each of these artifact assemblages has identifiable antecedents, originating mostly in the Middle Archaic (Cross 1996:48). Dincauze associates the Laurentian Tradition with the west, in the Great Lakes and Ohio River drainages, rather than the Atlantic drainage (Dincauze 1976:125). Pfeiffer (1990:85-104) has argued that the Late Archaic Laurentian tradition, or Lake Forest adaptation, of southern New England was the progenitor of both the Susquehanna tradition, or River Plain adaptation, and the Narrow Point tradition, or Mast Forest adaptation. These adaptations were coexistent, and may have vied for territory (Pfeiffer 1990:85). The Narrow Point appears to have been a local development not derived from outside the region (Dincauze 1976).

Debate about the Late Archaic Period centers on what the observed relationships of the tools mean in terms of the people behind them. Some of the tools co-occur at sites sequentially, others contemporaneously. The orthodox view is that correctly tying an artifact assemblage to one of these traditions allows an archeologist to infer an adaptation category, including subsistence adaptation and possibly a belief system (Dincauze 1972, 1975; Pagoulatos 1988; Pfeiffer 1984; Turnbaugh 1975). Some archeologists also tie these artifacts to genetic populations, and believe that they imply the movement, contemporaneity, or physical descent of the actual people who used the tools. Susquehanna Broad-like projectile points (E. Johnson and Mahlstedt 1984) and Wayland Notched (Hoffman 1991:20) have, in some cases, also been associated with mortuary sites (Dincauze 1968; Hoffman 1991:20). Stone-tool production may have been undertaken by a small group of experienced, older artisans whose skills and knowledge were respected and called upon. The lithic assemblages of such artisans would look very much the same and exhibit fewer signs of accidental breakage. There may also have been specific spaces set aside for use by such artisans in some settlements (Cross 1990 has an in-depth discussion of these possibilities in New England).

The Late Archaic is the most visible period of Massachusetts prehistory, in terms both of numbers of sites and of typological attribution of materials. Even allowing for the chronological ambiguity of Small Stemmed points (cf. Mahlstedt 1987) and their use into the Middle Woodland in the Connecticut River Valley (Hasenstab et al. 1990), and Late Woodland/Contact Period use on Martha's Vineyard (Herbster and Cherau 2003), Late Archaic patterns in Massachusetts indicate unprecedented population density, with communities well settled into narrow foraging territories defined by drainages and highly specialized to the habitats within these drainages. Confined to these territories, extractive activities were seasonally adjusted to meet the opportunities of the annual cycle. Sites were located in a wide variety of topographic situations -- river banks; margins of lakes, ponds, bogs and springs; around meadow lands; in rockshelters and at quarries; and along the coastline. The differentiation of site sizes suggests use of a radiating, seasonally-dynamic settlement pattern (Dincauze 1974, 1975, 1980; Thorbahn and Cox 1983). Although some technological innovations (e.g., the stone bowl) are apparent in this period, and some long-distance exchange of materials occurred, emphasis seems to have been placed increasingly on locally available raw materials for chipped stone tools, often distributed within river drainages.

The settlement pattern of human communities during this period is best viewed as a response to establishment of the temperate forest in which resources are heterogeneous but relatively stable and predictable. This period was marked by a progressive drying and warming trend, beginning perhaps ca. 6000 BP and peaking at ca. 4000-3000 BP. In southeastern Massachusetts, the water table was significantly lower and surface-water flow was reduced, leading to a disappearance of all but the largest bodies of water (Thorbahn 1982). The latter changes may not have been the result of climatic drought, but rather of local geomorphic changes causing lowered stream flow (Simon 1991:69). These climatic trends, if regional in scale, would intensify the association between human communities and water, particularly in summer. As sea levels approached those of the present, shorelines stabilized and extensive shellfish beds developed, while anadromous fish populations may have benefited from the expanded continental shelf (Luedtke 1985:289). The Boylston Street Fish Weir site in Boston reveals intensive estuarine exploitation of fish populations by Late Archaic peoples (F. Johnson 1942, 1949). The Boylston Street Fish Weir is an extensive structure of wooden stakes set in the tidal mud flats of the Back Bay some 4,000 years ago, and was presumably designed to capture fish and other marine resources at low tide.

Around 4600 BP (Webb 1982:570) there was a dramatic decline in hemlock pollen, which is attributed by Davis (1981) to an as-yet-unidentified insect predator and/or disease rather than

climate. Hemlock is today a very competitive species in the region, the loss of which caused what appears to have been a long-term increase in species diversity. At approximately this time oak, white pine, and hickory increased dramatically throughout the region, while chestnut first appeared. This combination of events (added to warm temperatures) would have created a very suitable environment for aboriginal populations (Mulholland 1984:335). Oak and to some extent white pine provide food for game animals like deer and turkeys, while hickory and chestnut provide food for both game animals and people. At Kampoosa Bog in Stockbridge, Massachusetts, this environmental change coincided with evidence that people began visiting the bog more often and in greater numbers. There was also evidence to suggest that the people used fire to improve and maintain the natural abundance of important plants and animals in the area (E. Johnson 1996:22; E. Johnson et al. 1994).

The pattern of a riverine-uplands subsistence settlement system apparently emerged during the Middle Holocene, between 6000 and 5000 BP, when the climax oak-hickory forest had matured and population levels increased, leading to regional Late Archaic strategies of extensive and intensive resource exploitation (Dincauze 1974, 1990). In the Sudbury-Assabet region, the number and diversity of Late Archaic sites and their distribution in riverine and inter-riverine, upland settings suggest a "broad-base [collecting, see Binford 1980] approach to resource use and considerable attention to small scale environmental features," including "bogs and kettle-hole swamps" (D. Ritchie 1983:89). Duncan Ritchie's work in the Sudbury-Assabet area (1980:87-88, 1983), indicates that patterns of upland use became more intensive about 4,500 years ago; more activities were now taking place there and some localities began to be reused time and again. Evidently, these shifts were shaped by ongoing environmental histories; as the region's deciduous forest ecosystems became more varied and productive, longer settlement occupations became possible (D. Ritchie 1983:89-91).

Research by Curtiss Hoffman (1985) suggests that the process of diversifying and intensifying land and resource use increases measurably in many southern New England regions between 5000+ and 2700 BP. In these regions, some landscapes became a locus for year-round settlement and resource exploitation in the Middle Holocene, a pattern seen in some coastal settings and along major rivers (Bernstein 1990 and 1993, Handsman 1995, Kenyon and McDowell 1983). Studies of collections and excavations indicate that some parts of the Sudbury-Assabet uplands contained extensive and diverse complexes of Late Archaic sites where Native people hunted deer, collected and processed hickory nuts and aquatic plants, and fished. Sites are so numerous and sometimes so often reused that Hoffman is certain that the archeological record between 4500 and 4000 BP (and for some time after) represents a "climax" of extensive, year-round occupation by sedentary groups of hunter-gatherers (Hoffman 1990:110-149).

The Late Archaic archeological record in the uplands of the Assabet and Sudbury rivers reveals that a greater range of activities took place on a seasonal, multiseasonal, or even year-round basis. Along the upper reaches of the Assabet in Marlborough, a complex of sites (19-MD-489 to -493) discovered near I-495 suggests a pattern of upland adaptation. Features such as hearths and concentrations of chipping debris (stone-tool manufacture, repair, and resharpening) from the Robin Hill, Cook, and Howe sites are evidence of the periodic use of particular localities by successive generations during the Late Archaic (D. Ritchie et al. 1984). Similarly, multiple surface hearths, tool-making workshops, and activity areas at the Old Stony Brook site near Crane Swamp in Marlborough are cited as evidence of recurrent use of a short-term campsite (Dudek, et al. 2001). The archeological record at the Flagg Swamp Rockshelter, excavated in 1980 as part of a larger study of Route 85 in Hudson and Marlborough, suggested a "winter camp repeatedly inhabited by small, complete social and economic groups," who went there to hunt deer and

turtle, to fish, and then to return to their base settlements, possibly located along the Concord or lower Merrimack rivers, or along the nearby coast (Huntington 1982). Further east, a town historian in the 1890s described a site next to a small wetland in Sudbury where hundreds of points, some woodworking tools, and burned rock features were found (D. Ritchie 1980:87).

Late Archaic cemetery sites also suggest that native communities were well established within river drainages and upland areas. At the Millbury III cremation cemetery, located near the Blackstone River in Millbury, Massachusetts, sixteen cremation burials spanned from 3500 BP to 2500 BP and contained a mixture of human and animal remains within the same burial. On average, non-humans represented 79% of all skeletal elements identified, while human remains represented only 21% (Bellantoni 1998:4). This may indicate that animals were integral aspects of the ceremonial complex associated with burials from the Late Archaic to Early Woodland. The site Wapanucket 8 is located in the Taunton River drainage and contained a ceremonial complex, around 4,300 years old, with 11 cremation burials clustered within a larger pit (Robbins 1968). The Mansion Inn and Vincent sites, both located in the uplands above the Sudbury River, are cremation cemeteries about 3,500 years old. Habitation areas do not seem to be directly associated with either site. At each, assemblages of burned artifacts, cremated human remains, and burned wood and reddened earth (both from the nearby crematories) were deposited into shallow pits; some pits were used only once while others were the locus of multiple reburials. Typically, the artifacts in the pits included a full range of household and subsistence technologies such as wood- and hide-working tools, projectile points and knives, pestles, and hammer stones. Less abundant were single specimens or sets of finely flaked bifaces, known as Mansion Inn blades (Dincauze 1968:16-17, 48, 64-66). At Mansion Inn, the archeological data indicate "the cemetery was used repeatedly through a fairly long span of time" (Dincauze 1968:66), leading one to infer that the surrounding region was home to generations of Native people.

Four Late Archaic period sites have been identified within 3 km of the Upton Chamber. Site locations include the Pratt Hill site (19-WR-19-WR-523), the Fowler St. Rockshelter/Quarry (19-WR-522), the Hopkinton Road site (2) near Pratt Pond (19-WR-524), and the Pratt Pond Terrace site (19-WR-526). At the Pratt Hill site, a felsite (a.k.a. rhyolite) Brewerton Broad-Eared point, five quartz flakes, a quartzite biface and flake, and an argillite flake were recovered and a fire pit feature was identified, suggesting use as a campsite (Mulholland et al. 1991a; Holmes et al. 1992). At the Hopkinton Road site (#2), located 130 m from Pratt Pond, a small campsite was identified with Brewerton/Susquehanna Broad-like felsite point, a quartz biface, 12 quartz flakes, 29 quartzite flakes, and a possible hearth feature (Mulholland et al. 1991b, Mulholland et al. 1992). At the Pratt Pond Terrace site, a small campsite was identified with two Squibnocket Triangle points, and 16 chert, 36 rhyolite, two argillite, 261 quartz, and eight quartzite flakes, as well as three hearth features (Mulholland et al. 1991b, Mulholland et al. 1992). The Fowler St. Rockshelter/Quarry consisted of a quartz quarry and rockshelter, with the recovery of a Brewerton Eared point and a Small Stemmed point, 393 quartz flakes and 15 quartzite flakes (Mulholland et al. 1991a; Holmes et al. 1992). As a result of archeological investigations at Pratt Hill and near Pratt Pond, Late Archaic settlement of the area is evident, with campsites, a quartz quarry, and rockshelter use. At least two of the sites, the Fowler St. Rockshelter/Quarry and the Pratt Pond Terrace site, continued to be used during the Woodland period.

The Woodland Periods (3000-450 BP)

The Woodland is traditionally divided into Early (3000-1700 BP), Middle (1700-1000 BP) and Late (1000-500 BP) periods, defined by changing artifact types.

This period is marked by basic technological and economic changes, notably the production and use of pottery and a gradual shift to food production (maize, beans, squash, sunflower and other vegetables). Horticulture is documented for the Late Woodland on Martha's Vineyard (W. Ritchie 1969) but perhaps began by ca. 2000 BP (Thorbahn 1982). Within Massachusetts generally, the Woodland periods are best known in the coastal regions and in the Connecticut River Valley. In both cases, this higher visibility may be ascribed to local opportunities for increasing sedentism and larger communities – in the former area due to a combination of horticulture with rich marine resources and in the latter area to large expanses of soils well suited to horticulture in combination with rich fishing, harvesting and other terrestrial resources.

The Early Woodland Period (3000 to 1700 BP)

The shift from the Late Archaic period to the Early Woodland period includes several changes on which archeologists generally agree. These changes consist of the introduction of ceramics, the formation of stable estuaries with tidal flats (Cross 1996:5-6), an apparent increase in the amount of exotic raw materials used such as non-local chert, red ochre, and copper (especially in mortuary contexts), and an inferred increase in formalized trade and communication. Some influences from the Adena culture to the west have been noted in artifact types of the period.

While some archeologists have suggested that there was a regional demographic collapse and a shift during the Terminal Archaic to coastal settings, thus largely depopulating interior upland regions (Dincauze 1974:49-50), survey information from southeastern Massachusetts shows no decline in numbers of sites during the Early Woodland (Thorbahn 1982), and comparable patterns are evident in other parts of Massachusetts. Loring (1985) found continuity of subsistence patterns from the Late Archaic, with little more change than the grafting of long-distance trade onto existing developments, such as increasing sedentism, evident in the Late Archaic period.

Archeologists have since improved their ability to recognize habitation assemblages of the Early Woodland period, as Shaw (1996a:67-79) points out. In addition to classic Meadowood and Rossville projectile points and cache blades and Vinette I ceramics, thicker side-notched bifaces, lobate-stemmed Adena, rare Fulton Turkey Tail, Small Stemmed points, and modified Vinette I ceramics are consistently reported from Early Woodland contexts. It is clear that pre-Contact peoples used some tools for much longer than just one period. Small Stemmed points are associated with the Late Archaic and Early Woodland periods and may have been in use as late as the Middle Woodland. Rossville points also occur in Middle Woodland contexts, and perhaps Late Woodland.

At least two sites have been identified within 3 km of the Upton Chamber that appear to have been utilized during the Late Archaic and Early Woodland periods: the Fowler St. Rockshelter/Quarry (19-WR-522) and the Pratt Pond Terrace site (19-WR-526). At the Pratt Pond Terrace site, a small campsite was identified with two Squibnocket Triangle points, and chert, rhyolite, argillite, quartz, and quartzite flakes, as well as three hearth features (Mulholland et al. 1991b, Mulholland et al. 1992). The Fowler St. Rockshelter/Quarry consisted of a quartz quarry and rockshelter with the recovery of a Small Stemmed point and quartz and quartzite flakes (Mulholland et al. 1991a; Holmes et al. 1992).

The Middle Woodland Period (ca. 1700-1000 BP)

This period is marked by an increase in the number of exotic lithic materials, indicating long-distance trade, and by changes in mortuary practice (increase in secondary interments, less use of

ocher, fewer grave goods, and more variation in preparation of the dead). While the roots of ceramic and lithic variability are found in the preceding periods, more rapid variation in sequence through time and more regional variation characterize this period. Ceramics vary more in decoration and form. Lithic projectile points are less important in the tool kit, and bone and antler tools are preserved at some sites where matrix conditions are appropriate (Shaw 1996b:84-87). By the end of the period there is evidence of maize horticulture (Thorbahn 1982).

There is overlap in the dates of ceramic types formerly considered diagnostic of the Early and Middle Woodland. Some Vinette I ceramics date to the first few centuries of the new period. The new Middle Woodland ceramics are cord-impressed, fabric-impressed, or smoothed in Southern New England. Most are decorated with dentate or cord-wrapped-stick impressions. Dentate-stamped, scallop-shell-impressed and cord-wrapped-stick-impressed decorations characterize the middle Middle Woodland, with decoration at times confined to the rim or shoulder. Scallop-shell-impressed or pseudo-scallop-shell-impressed ceramics are recovered more commonly in Northern New England (Shaw 1996b:90). Decoration may be only around the rim or shoulder. These designs are often applied in a rocker fashion, or in vertical or horizontal zones. Undecorated fabric-paddled pieces with smoothed interiors also occur.

Fox Creek and Steubenville bifaces characterize this part of the period (Moore 1997). There is some overlap in time between the Fox Creek and Jack's Reef points during this part of the Middle Woodland. Jack's Reef points, often made of non-local chert (Shaw 1996b:92-93), continue to be used into the Late Woodland. Exotic lithic materials increase in the Middle Woodland, except in the Champlain drainage. Some lithic tool types, such as Rossville (Shaw 1996b:90) and Small Stemmed (Hasenstab et al. 1990) continue into the Middle Woodland.

Late Middle Woodland ceramics include types that continue in the Late Woodland, such as the cord-wrapped-stick-impressed ceramics. Projectile points now include concave-base triangular points often made of local materials. These points also continue into the Late Woodland period (Shaw 1996b:93).

Settlement and subsistence are similar to the Early Woodland period, but sedentism increases. Stays at large sites along waterways increase in duration, while upland areas are used short-term for procurement. Long-distance communication and exchange appear to shut down by the end of the period. Middle Woodland sites in coastal areas and New York have produced house remains. Middle Woodland sites tend to have more pit features, which vary greatly in shape and size, and are frequently dug out and reused for trash (Shaw 1996b:94-100).

Research issues for the period are similar to those of the Early Woodland period, from which it is divided only by arbitrary artifact style boundaries. These issues include explanation of the quick adoption of ceramic styles, the role of exchange networks, and the description of the behavior behind increasing regional style variation in artifacts (Shaw 1996b:100).

At least two sites have been identified within 3 km of the Upton Chamber that may have been utilized during the Middle Woodland period: the Fowler St. Rockshelter/Quarry (19-WR-522) and the Pratt Pond East site (19-WR-525). At the Pratt Pond East site a campsite is suggested, with seven pieces of pottery and 14 pieces of quartz debitage recovered (Mulholland et al. 1991b, Mulholland et al. 1992). The Fowler St. Rockshelter/Quarry consists of a quartz quarry and rockshelter (Mulholland et al. 1991a; Holmes et al. 1992).

The Late Woodland Period (ca. 1000-500 BP)

The Late Woodland represents the regional demographic peak prior to European contact, a florescence that may be related to increasing food production, sedentism, and population agglomeration. The period is characterized by changes in burial ceremony. Burials can be single or mass, as in ossuaries, and can be primary, secondary, or cremation. Group interments tend to be at special mortuary sites, while single burials are usually at habitations.

Ceramics are often shell-tempered or made with fine grit temper and thinner bodied; there is a shift to globular forms, and the addition of collars, sometimes decorated with human faces. Elaborate collars similar to those of Iroquois ceramics are found in the Merrimack and Champlain drainages. Triangular projectile points consisting of smaller Madison points or larger Levanna points are diagnostic for this period. This period is marked by an increasing importance of food production (maize, beans, squash, sunflower and other vegetables) in coastal or riverine zones, which begins by ca. 840 BP on Martha's Vineyard (W. Ritchie 1969).

These changes in assemblage, and by implication, adaptation, are attributed to increasing population and concentration of people at larger sites. Research issues include the extent of permanency in Late Woodland settlements, the nature of such settlements (i.e., whether such settlements were villages; Hasenstab 1999; Kerber 1988; Luedtke 1988; Thorbahn 1988) and the identification of horticulture with non-native plants and definition of the effects on humans. In addition, researchers might ask about the use of different ecozones, the reality of population growth, and whether or not climate change (e.g., the Little Ice Age), affected settlement and subsistence. There is some evidence of the development of long-distance exchange again, and some workers have suggested that a native beaver trade was developed before Contact. Regional differences are visible; in Vermont, there are fewer late Late Woodland sites than early Late Woodland. This may be a response to Iroquois settlement changes. In southern New England, horticulture did not replace existing gathering and hunting strategies and large settlements did not replace small seasonal sites. Differential dependence on horticulture is likely to have affected society and politics. Cultural differentiation of the Iroquois from the Algonquin also presents research opportunities (Shaw 1996c).

At least two sites have been identified within 3 km of the Upton Chamber that may have been utilized during the Late Woodland period: the Fowler St. Rockshelter/Quarry (19-WR-522) and the Pratt Pond East site (19-WR-525). At the Pratt Pond East site a campsite is suggested, with seven pieces of pottery and 14 pieces of quartz debitage recovered (Mulholland et al. 1991b, Mulholland et al. 1992). The Fowler St. Rockshelter/Quarry consists of a quartz quarry and rockshelter (Mulholland et al. 1991a; Holmes et al. 1992).

The Contact Period (AD 1500-1620) and post-Contact Native American Settlement (AD 1620-1700)

This period marks the initial presence in the region of European explorers and fishermen, followed in the early seventeenth century by English colonization. From the Native viewpoint, the period was one of intense social, economic and demographic disruption and depopulation for native inhabitants due to disease, warfare and displacement related to European contact and colonization.

Native American base camps, established as Praying Towns by 1674 (Carlson 1987:16), were located at Waentug to the east in Uxbridge, Chaubunagungamaug to the west in Webster, and Manchaug in Sutton and Hassanamisco in Grafton to the north. Of the seven original so-called Praying Indian villages established, five were founded within the cores of Nipmuc homelands,

precisely because these were important social and settlement places for Native Americans (Carlson 1987). One such place, where the later seventeenth century praying town of Hassanamesit was established (in present-day Grafton in southern Nipmuc country), was described in 1674 by Daniel Gookin as "rich land" which produced "plenty of corn, grain, and fruit" and was an "apt place for keeping cattle and swine" (Gookin 1674:45). Following King Philip's War (a.k.a. Metacom's Rebellion), in 1675-1676, the Native American population decreased in these towns and most of the land was either taken, sold or otherwise redistributed among European-American settlers. Despite what happened, no homeland core appears to have been entirely depopulated or abandoned and, by 1700, the southern Nipmuc Country persisted as an important social and settlement landscape (Mandell 1996).

During this period the Upton area served as seasonal hunting and gathering grounds from the larger base camps located to the west in Grafton or to the south in Uxbridge. Warren and Center brooks, in the east, Pratt Pond in the center, and Taft Pond to the south provided sites for fishing and agriculture and therefore were used more intensively than the area to the north and the west (MHC 1983:2).

Native American trails in Upton include a juncture of main trails from the northeast, southeast, and northwest. The main southeast/northwest trail from Mendon to Grafton was along Mendon Street-Grafton Road-Old Grafton Road. An alternate southeast route is inferred east of Center Brook along South Street. The northeast route past Pratt Pond to North Pond (Maspenook) in Hopkinton is conjectured as Main Street-Elm Street-Hager Road and a possible branch to Milford is on Taft Street. The north trail is conjectured along Westborough Road-North Street, with a possible branch on Westborough Road-Spring Street to Whitehall Pond in Hopkinton (MHC 1983:2). Elm Street has also been identified as a branch of the Connecticut Path (Goodwin 1946:43).

3.2.1 KNOWN PRE-CONTACT SITES IN THE PROJECT VICINITY

A review of the site files at the MHC indicates that five pre-Contact archeological sites listed are within 3 km of the Upton Chamber. Table 2 summarizes the pre-Contact archeological sites near the project area.

Table 2. Recorded pre-Contact archeological sites within 3 km of the project area.

Site	Town	Location	Period	Site Data
19-WR-443 Hopkinton Road site	Upton	West of Forest St	Unknown	Quartz point tip and 4 pieces of chipping debris from one test pit (Elia et al 1986).
19-WR-522 Fowler St. Rockshelter/ Quarry	Upton	65 m from Warren Brook	Late Archaic to Late Woodland	Quartz quarry and rockshelter, Brewerton Eared point and Small Stemmed point, 393 quartz flakes and 15 quartzite flakes (Mulholland et al. 1991a; Holmes et al. 1992).
19-WR-523 Pratt Hill site	Upton	Near unnamed brook	Late Archaic	Brewerton Broad Eared felsite point, 5 quartz flakes, quartzite biface and flake, and argillite flake; fire pit feature (Mulholland et al. 1991a; Holmes et al. 1992).

Site	Town	Location	Period	Site Data
19-WR-524 Hopkinton Road site (2)	Upton	130 m from Pratt Pond	Late Archaic	Small campsite: Brewerton/ Susquehanna Broad-like felsite point, quartz biface, 12 quartz flakes, 29 quartzite flakes, and possible hearth feature (Mulholland et al. 1991b, Mulholland et al. 1992).
19-WR-525 Pratt Pond East	Upton	200 m from Pratt Pond	Woodland	Small campsite: 7 pre-Contact ceramics, 14 pieces of quartz debitage (Mulholland et al. 1991b, Mulholland et al. 1992).
19-WR-526 Pratt Pond Terrace	Upton	Along Pratt Pond	Late Archaic, Early Woodland	Small campsite: 2 Squibnocket Triangle points, flakes: 16 chert, 36 rhyolite, 2 argillite, 261 quartz, 8 quartzite flakes, 3 hearth features (Mulholland et al. 1991b, Mulholland et al. 1992).
19-WR-546 Warren Brook Findspot	Upton	20-80 m from Warren Brook	Unknown	3 quartz flakes with 1 each from isolated test pits (Mulholland et al. 1991a).
19-WR-653 Site 4-1	Upton	West River adjacent	Unknown	1 piece of quartz chipping debris on trail (D. Ritchie and King 1988).
19-MD-693 Elm St #2	Hopkinton	40 m from wetland	Unknown	One piece of bifacial worked crystal quartz from a test pit (Macomber et al. 1992).
19-WR-694 Elm St #1	Hopkinton	50 m from wetland	Unknown	One crystal quartz flake from a test pit (Macomber et al. 1992).
19-WR-496 Berkland site	Milford	240 m from Mill River	Unknown	1 quartz flake and Small Stemmed point fragment on dirt road (Elia et al. 1986).
19-WR-497 Edna Site	Milford	Along Mill River	Unknown	2 quartz debitage on river bank road (Elia et al. 1986).

Of the 12 recorded pre-Contact Native American archeological sites in Table 2, five sites have a temporal attribution based on diagnostic artifacts. Four Late Archaic sites have been identified, with Laurentian/Brewerton tradition points representing the earliest sites identified in the area. In addition, one Woodland site, a possible Early Woodland, and a multicomponent Woodland site have been identified. Site types include small campsites, a quarry with a rockshelter, and isolated finds or findspots of chipping debris. Quartz was the preferred lithic material at these sites, followed by quartzite, with rhyolite (a.k.a. felsite), chert and argillite also represented. Site locational preference is varied and includes Pratt Pond, the West and Mill Rivers, Warren Brook and an unnamed brook on Pratt Hill, and wetlands. Only one site was not within 250 m of a water resource. Sites range in distance from 750 m to 3 km from the Upton Chamber.

3.2.2 POTENTIAL FOR PRE-CONTACT SITES

Pre-Contact archeological sites have been identified in a variety of settings, but are found most often in particular environmental contexts (Funk 1972; Root 1978; Thorbahn et al. 1980; McManamon 1984; Mulholland 1984; Thorbahn 1984; Nicholas 1990). In southern New England archeology, pre-Contact site location is typically linked to three variables: terrain, soils, and water

-- in the formula level to low slope, well-drained sandy soil, near water. These variables, in turn, combine with other factors, which include the collection of special resources (e.g., lithic material for tools; clay; seasonal nuts, fruits, seeds, small fishes, and game,), the pursuit of special tasks, often seasonally determined (e.g., exploitation of fish runs), and the use of transportation routes (provided by bays and rivers). The combination of all these factors provides a framework within which the pre-Contact settlement of the project area, and indeed of most of southern New England generally, can be analyzed, and by which archeological site location can be predicted through archeological models (Casjens 1979, Dincauze 1974, Hoffman 1985, Kenyon and McDowell 1983, D. Ritchie 1983). A study of site locations and catchments conducted for the Concord River watershed (Casjens 1979) found that sites were located on floodplains, flat uplands, knolls, ridges and an island; gentle terrain with arable soil and variety in the form of wetlands in the surrounding catchments also seem to factor in site locations.

The project vicinity contains archeological sites associated with Native American activities. Activities included tool production and maintenance and probable hunting and foraging and possibly fishing activities. The area also has rockshelters that have been utilized for small campsites of various durations and possibly outcrops where the procurement of lithic materials (quartz) for tool making took place. A number of wetlands are present near the project area that would have been attractive resources for Native American hunting and foraging activities in pre-Contact times.

Based on the above information, pre-Contact archeological sensitivity for the project corridor is assessed as follows:

High sensitivity: Areas within 100 m of fresh water or wetlands; on low to moderate slopes (0 - 15 percent); on moderately well drained to excessively drained soils; and/or within 100 m of a reported archeological site or natural resource area (i.e. steatite or quartz vein outcrops or rockshelters), and with no apparent/moderate disturbance.

Moderate sensitivity: Areas between 100 m and 200 m of fresh water or wetlands; on low to moderate slopes (0 - 15 percent); and on moderately well drained soils; and/or between 100 m and 200 m of a reported archeological site or natural resource area (i.e. steatite or quartz vein outcrops or rockshelters), and with no apparent/moderate disturbance.

Low potential: Areas greater than 200 m of fresh water or wetlands, on moderate to steep slopes (15 – 25+ percent); on poorly drained soils, more than 200 m of a reported archeological site or natural resource; and/or with extensive disturbance.

The Upton Chamber (UPT-HA-15) is located in a well drained knoll with low to moderate slope and approximately 85 m from Mill Pond to the west and 60 m from an unnamed brook to the south and west. Pratt Pond is located 300 m to the north, and Mill Pond would have been a brook prior to historic alterations. A number of brooks and wetlands that would have been appealing to Native Americans for hunting and gathering activities are located within 3 km of the Upton Chamber. Tool production and tool maintenance areas may also be present, especially if quartz or quartzite outcrops are present in the area. Campsites, probably of short duration, are possible on undisturbed portions of the knoll where the Upton Chamber is situated.

The Upton Chamber (UPT-HA-15) is presently inventoried as an historic archeological site, and will be discussed in more detail in Section 4.3. There have been a wide variety of suggestions from professional and avocational archeologists and others as to the age and cultural affiliation of the Upton Chamber. To date no pre-Contact artifacts have been identified as such from previous investigations of the rock chamber. The association of historic artifacts of uncertain antiquity with the stone chamber will be discussed in Section 4.3.

3.3 HISTORIC CONTEXT

The proposed 18 Elm Street Project is located in the town of Upton in Worcester County Massachusetts (Figure 1). The town of Upton borders Grafton to the northwest, Westborough to the north, Hopkinton to the northeast, Milford and Hopedale to the southeast, Mendon to the south and Northbridge to the southwest.

Upton was established as a town in 1735 from parts of Hopkinton, Mendon, Sutton and Uxbridge. During the Plantation Period (1620-1675), the southern portion of Upton was included in the 1667 Mendon Grant, while the northern section was unincorporated. No notable colonial settlement took place during this period. Seasonal use by the native population probably decreased with the increase of European-American settlers in the area and the concentration of Native Americans in the Uxbridge praying town. There was occasional use of the area by settlers from surrounding communities as outlying fields, pasturage and mowing land (MHC 1983:3).

Increased use of the lands in Upton by colonists took place with resettlement after King Philip's War (a.k.a. Metacom's Rebellion, 1675-76). European-American settlement in the second half of the Colonial Period (1675-1775) was characterized by dispersed farmsteads and began in the 1700s in the south portion from Mendon, followed in the north by settlers from Hopkinton and Westborough and Boston in the east. Hopkinton was incorporated as a town in 1715, composed of 25,000 acres including former Praying Town lands called "Moguncoy" (now Ashland) and adjacent "waste lands" purchased on behalf of Harvard University (MHC 1980:1). The southern end of Hopkinton was reallocated to form the northeastern part of Upton in 1735. The initial petition for independence took place in 1731 by eleven inhabitants from the east part of newly incorporated Sutton. With the incorporation of Upton acreage was taken from Hopkinton (3,130), Mendon (2,933), Uxbridge (1,850), and Sutton (5,030).

At incorporation in 1735 there were about 50 families in Upton, half of whom owned their own land. Much of Hopkinton, where the Upton Chamber is located, was owned by a trust and rented to its inhabitants (MHC 1983:3-4). The meetinghouse was established in 1736 south of the present center off Mendon Road. Trails were improved as local roads, with the addition of radiating routes to West River meadowlands (Pleasant Street, West River Street) and the eastern uplands (Prospect Street, Christian Hill/Pearl Street). A saw and grist mill had been established in West Upton on Beaver Brook in 1712 and another sawmill was located in southeast Upton prior to incorporation. A saw and grist mill was later located in Upton Center during the 1750s, and later in the east near Milford. By the end of the period (1770) the meetinghouse location shifted north to more logical local transport route confluence. Grafton Road-Mendon Street became important as the regional post road from Worcester to Providence (MHC 1983:3-4).

By 1765, the town's population numbered 614, with a settlement shift to Pratt Pond by 1770 around the new meetinghouse center. During the Federal Period (1775-1830), the population of the town grew from 702 in 1776 to 1,167 in 1830. Settlement still consisted predominately of dispersed farmsteads, but some residential growth took place along Elm, Prospect, Main and

Pleasant Streets near the meetinghouse. By 1795 there were four saw and grist mills in operation; the economy during this time was based on general agriculture. In 1824, the east-west Central Turnpike (High Street-Hopkinton Road) was incorporated and completed by 1830, providing an alternate Boston-Hartford highway (MHC 1983:4-5).

The Early Industrial Period (1830-1870) in Upton saw the population grow from 1,167 in 1830 to 1,989 in 1870. There was significant residential development in Upton Center and West Upton from 1840 to 1850, including Elm Street (Figures 4 and 5), while rural areas had little growth (MHC 1983:5-6). By 1830, a small wool spinning mill was located along the Mill River, which in 1831 employed ten persons and produced \$8,400 worth of hosiery yarn. A fire in 1843 ended textile manufacturing as the woolen mill was destroyed and not rebuilt. The 1837 production figures for the small mill indicated 31,200 yards of cloth were produced, valued at \$15,600 (MHC 1983:5-7).

Shoemaking and straw braiding were important cottage industries that expanded into major enterprises. In 1832, 87,000 pairs of cheap brogans were produced and over 100 persons were employed in this \$78,000 industry; by 1837 the figures increased to 3,500 pairs of boots and 117,000 pairs of shoes valued at \$107,000 with 237 persons employed. The manufacture of boots and shoes dominated the town's industry until the 1860s when straw bonnet manufacturing exceeded production. By 1865 factories and centralized production appeared in Upton. As a result, only 156 people in three factories and a number of shops were able to produce 97,000 pairs of boots worth \$238,000 (MHC 1983:5-7). In 1831 more than 400 women braided straw at home, which was then collected and sewn into hats and bonnets in a shop. Production totaled \$48,000 worth of braid and bonnets that year. By the Civil War, up to 1,200 women were employed in their homes producing braid, which was then collected and sewn into hats and bonnets in the factories. Straw braiding and bonnet manufacture grew from a business operating from a country store to two large factories in 1875 producing \$800,000 worth of men's and ladies' bonnets, nearly 90% of the value of the town's manufactured goods (MHC 1983:5-7).

Other smaller industries included the manufacture of saddles, harnesses, and trunks, railroad cars, coaches, wagons, and sleighs, and a soap works. A sash and blind manufactory and a blacksmith, who made straw machines and cutlery, were also present in 1831. Another important industry during the period was lumbering and woodworking from Upton's 2,300 acres of woodland. In 1865, seven sawmills cut 1.5 million feet of boards and 1,200 cords of firewood for market, while a box manufactory for boot, shoe and bonnet boxes and a planing mill and sash, door, and blind manufactory converted the lumber into finished products. Together they employed about 30 men and produced goods valued at \$29,000 (MHC 1983:5-7).

Agriculture also prospered during this period with 306 people employed on 149 farms in 1865. The raising of livestock and hay were the major activities. Other crops included corn, rye and oats, potatoes, and cranberries. Orchards of apple, pear, peach, and plum trees were also cultivated. Dairying was a minor concern, with much milk diverted to butter making (MHC 1983:7).

During the Late Industrial Period (1870-1915) the population of Upton varied little, from 1,989 in 1870 to 2,036 in 1915. Roadways remained virtually unchanged and there is little development in town. The Grafton and Upton railroad opened to West Upton in 1889 with service to Milford in 1890. The line became electric powered by the early 1900s, with electric street railway service through town (MHC 1983:9-10). The shoe industry diminished significantly by 1885, with factory centralization and concentration in nearby Milford and other factors; however, the straw

and palm-leaf hat industry continued to expand until the late 1890s with sales exceeding \$1,000,000. Other industries continuing past 1900 included the manufacture of boxes, bone cutting machines and tools, and several sawmills. Upton's agricultural base remained strong throughout the period, increasing in total value of agricultural goods from \$104,000 in 1875 to \$173,000 in 1905, with increases in dairy, vegetables and poultry (MHC 1983:10-11).

During the Early Modern Period (1915-1940) streetcar service was discontinued in the 1920s as local roads were improved as automobile highways; the main north-south road was the Worcester-Milford highway (Route 140), and the east-west Central Turnpike was developed as a secondary highway. The population continued to fluctuate, with overall growth from 2,036 in 1915 to 2,249 in 1940. Very little local development took place. During the 1920s and 1930s woodworking, hat manufacture, and agriculture were the base of Upton's economy. In 1925 the Merrimac Hat Corporation, formerly the William Knowlton and Sons Company of West Upton, capitalized at \$250,000 and employed between 400 and 800 operatives. At least one saw and planing mill in West Upton and a grist mill in Upton Center continued to operate. Farms and farm acreage decreased, with more land going to intensive use for dairying, poultry raising, and flower gardens (MHC 1984:12-13).

3.3.1 KNOWN HISTORIC SITES

The project area includes the Upton Chamber, recorded in the MHC inventory as historic archeological site UPT-HA-15. The Upton Chamber (a.k.a. Pearson Chamber) consists of an underground bee-hive shaped dry-laid masonry structure. In addition to the Upton Chamber, five reported historic archeological sites are located within a 3 km radius of the project area. These sites consist of a sawmill (UPT-HA-14), two residential or farmstead sites (UPT-HA-10, UPT-HA-12), a possible residential or mill site (UPT-HA-08), and stone features including rock piles on Pratt Hill (UPT-HA-16). Table 3 summarizes this data.

Table 3. Recorded historic archeological sites within 3 km of the project area

Site	Town	Location	Occupation Range	Site Data
UPT-HA-15 Upton Chamber	Upton	18 Elm Street	Unknown	Underground bee-hive shaped dry-laid masonry structure.
UPT-HA-08 A. Thurber, Site No. 17	Upton	West River & Pleasant St	19 th century	Site not located, based on structure shown on the 1857 map (Ritchie and King 1988)
UPT-HA-10 Houghton-Morrison Farm	Upton	Fowler Street and transmission lines	Late 18th-19 th century	Stone foundation and level platform (Elia et al. 1986)
UPT-HA-12 McIntyre House	Upton	Elm St and transmission lines	19 th century	Stone foundation, filled cellar and outbuilding, 2 wells (Strauss and McDermott 1990)
UPT-HA-14 Dean Pond Sawmill	Upton	Southwest corner of Dean Pond	19 th century	"remains of a sawmill" (Macomber et al. 1992)
UPT-HA-16 Pratt Hill Stone Features	Upton	Pratt Hill off High Street	Unknown	A series of stone field walls and rock piles on Pratt Hill

Historic archeological sites located near the Upton Chamber include historic residences, farmsteads, and a mill site. Stone piles on Pratt Hill have been cited by some authors as associated with astronomical sitings from the Upton Chamber (Dix and Mavor 1980, 1982, Mavor and Dix 1989). In addition to the historic archeological sites, numerous historic architectural properties and two cemeteries are near the project area. At least 39 historic properties are within 500 m of the Upton Chamber (Table 4). These properties indicate that the Elm Street area was settled by the mid eighteenth century, with over a score of residences by the early to mid nineteenth century, many of which show on the 1857 and 1870 maps of Upton (Figures 4 and 5). As Table 4 indicates, Elm Street has a house dating to ca. 1750; Christian Hill Road has a house dating ca. 1745; and North Main Street has a house dating ca. 1740. The Pine Grove Cemetery on North Main Street dates to 1756. A residence is apparent at the 18 Elm Street parcel on the 1851, 1857 (Figure 4) and 1870 maps (Figure 5), which predates the present house on the parcel. The date of construction for the former house has not been established. Adjacent houses at 20 to 22 Elm Street date to the mid nineteenth century.

Table 4. Historic Properties within 500 m. of the project area

MHC#	Town	Location	Year Built	Comments
UPT.274	Upton	1 Elm St	1784	Ruggles, Jeremiah Double House
UPT.275	Upton	4 Elm St	1900	Queen Anne Style House
UPT.276	Upton	5 Elm St	1835	Hill, John House
UPT.277	Upton	7 Elm St	1822	Hill, John House
UPT.278	Upton	20 Elm St	1849	Rockwood, Francis Alexis House
UPT.279	Upton	21 Elm St	1851	Fisk, Levi House
UPT.280	Upton	22 Elm St	1850	Fisk, Eron Augustus House
UPT.281	Upton	24 Elm St	1824	Ruggles, Luther House
UPT.282	Upton	28 Elm St	1848	Harrington, Charles P. House
UPT.283	Upton	32 Elm St	1848	Harrington, Curtis N. House
UPT.284	Upton	45 Elm St	1851	Goddard, George House
UPT.285	Upton	52 Elm St	1750	Hayward, William House
UPT.308	Upton	10 Christian Hill Rd	1745	Smith- Johnson House
UPT.261	Upton	10 Brooks Street	1830	Stoddard, Elijah House
UPT.185	Upton	1 River Street	1860	Forbush House
UPT.262	Upton	12 Milford Street	1812	Ward, Nahum House
UPT.263	Upton	31 Milford Street	1844	Gore, Herrick House
UPT.264	Upton	33 Milford Street	1844	Lee, Henrietta House
UPT.10	Upton	1 North Main St	1836	Arcade Block
UPT.4	Upton	2 North Main St	1948	
UPT.9	Upton	3 North Main St	1848	Upton First Unitarian Church
UPT.3	Upton	4 North Main St	1848	Upton First Congregational Church
UPT.6	Upton	8 North Main St	1894	Boston Branch Grocery Store
UPT.7	Upton	9 North Main St	1884	Wood, George W. Blacksmith Shop
UPT.164	Upton	10 North Main St	1844	Bradish, Polly Dean House
UPT.165	Upton	14 North Main St	1740	Wood, Jonathan - Fish, Elisha House
UPT.166	Upton	17 North Main St	1817	McFarland, Thomas House
UPT.167	Upton	18 North Main St	1840	Lesure, John Harvey House
UPT.184	Upton	19 North Main St	1885	Lincoln House
UPT.168	Upton	20 North Main St	1828	Childs, Fisher Hill House
UPT.169	Upton	22 North Main St	1830	Childs, John House
UPT.170	Upton	23 North Main St	1826	Childs, John House
UPT.182	Upton	27 North Main St	1885	Flagg House
UPT.183	Upton	28 North Main St	1915	

MHC#	Town	Location	Year Built	Comments
UPT.186	Upton	35 North Main St	1915	
UPT.171	Upton	36 North Main St	1819	Fisk, Dea. Daniel Jr. House
UPT.334	Upton	45 North Main St		Lakeview Cemetery Shed
UPT.802	Upton	45 North Main St	1756	Pine Grove Cemetery
UPT.803	Upton	45 North Main St	1849	Lakeview Cemetery

3.3.2 POTENTIAL FOR HISTORIC SITES

A predictive model for historic potential is developed through the synthesis of historic data such as early maps, town histories, deed research, other historic sources, and environmental characteristics. Historic geographers and historic archeologists have developed general models of settlement patterns in New England. These models are useful in estimating the distribution of historic archeological sites during different periods (Waldbauer 1986; J. Wood 1978). In addition, economic geographers have formulated models of historic settlement systems that rely on proximity to natural resources such as bodies of water, arable soils, granite outcrops, and gravel or clay beds (Haggett et al. 1977). These variables can affect transportation, communication, and trade networks. Proximity to settlement concentrations, freshwater springs or streams, or water-power sources is a positive element of historic archeological potential. Environmental data can contribute to an understanding of locational patterns of property types such as farmsteads, cranberry bogs, gravel or sand quarries, mills, and maritime industries.

Historic potential is stratified as follows:

High sensitivity: Areas within 100 m. of a historic road or known historic site; on low to moderate slopes (0 - 15 percent); within 100 m of fresh water and/or a water-power source; within 1,000 m. of a settlement concentration; and with no apparent/moderate disturbance.

Moderate sensitivity: Areas greater than 100 m of a historic road but within 100 m. of stone walls; on low to moderate slopes (0 - 15 percent); within 200 m of fresh water and/or a water-power source; and within 1,000 m. of a settlement concentration, with no apparent/moderate disturbance.

Low potential: Areas greater than 100 m of historic roads and stone walls; on moderate to steep slopes (15 – 25+ percent); no fresh water and/or power source in the vicinity; a settlement concentration > 1,000 m. away; and/or an area with extensive disturbance.

The project area is located at 18 Elm Street, near a small brook east of Mill Pond. Elm Street is a conjectured Contact Period trail which was in use as a road during the colonial period. Settlement of the surrounding area was underway by the 1740s and by the mid nineteenth century the area had a settlement concentration. By the 1850s a house was located on the 18 Elm Street parcel (Figure 4), which is identified with G. Aldrich on the 1870 map (Figure 5). The Mill Pond is evident on maps from the 1850s and on subsequent maps (Figures 4, 5 and 6), and a saw and grist mill was located on the south side of Milford Street at the pond outlet (Figure 5). The Upton Chamber (UPT-HA-15) is a potentially significant archeological site located on a residential parcel that was settled by the early to mid nineteenth century. Whether the Upton Chamber was built after residential settlement of the parcel or before has not been determined. The function of the Upton Chamber has also not been determined.

4.0 RESULTS OF THE SITE EXAMINATION

4.1 PREVIOUS ARCHEOLOGICAL WORK IN THE PROJECT VICINITY

A total of 12 Cultural Resource Management (CRM) reports are on file for the town of Upton in the MHC's *Bibliography of Archaeological Survey & Mitigation Reports* (2010). These studies include three reconnaissance level surveys (Davis 1976, Mulholland et al. 1989, D. Ritchie and King 1991), one literature review (O'Steen 1987), a management plan (Atwood 1998), five intensive surveys (Elia et al. 1986, Strauss and McDermott 1990, Mulholland et al. 1991a, Mulholland et al. 1991b, Macomber et al. 1992) and two site examination projects carried out on multiple sites (Holmes et al. 1992, Mulholland et al. 1992). The reconnaissance and intensive surveys have been responsible for the identification of all 12 pre-Contact period sites within 3 km of the project area (Table 2). A number of these sites have been further evaluated at the site examination level and include one quarry/rockshelter, and several small campsites. In addition, several historic archeological sites have been identified or investigated at the reconnaissance or intensive survey level. These studies provide helpful insight into the types of pre-Contact and historic sites that are present within 3 km of the project area. Pre-Contact campsites are evident during the Late Archaic period (6000-3000 BP), and continued use of a quartz quarry and adjacent rockshelter and of Pratt's Pond during the Woodland period has been documented. Historic archeological sites include eighteenth and nineteenth century farmstead or residential sites, a sawmill site, and stone piles (Table 3).

4.2 PREVIOUS INVESTIGATIONS OF STONE CHAMBERS IN MASSACHUSETTS AND VERMONT

Stone chambers as a class of archeological sites in New England occur widely but are relatively scarce and few have been investigated by professional archeologists. A total of two Cultural Resource Management (CRM) reports are on file in the MHC's *Bibliography of Archaeological Survey & Mitigation Reports* (2010) that pertain to stone masonry chambers (excluding chambers used for water or wastewater, e.g., Heitert and Cherau 2003). One study involved identification of a possible farmstead with a cellar hole, an above-ground stone chamber, and a stone well by an archeological survey in Southborough (Edens et al. 1995). The other study, the most relevant archeological investigation to date on a stone chamber in Massachusetts, was conducted by Craig Chartier on the Acton stone chamber. The Acton chamber was investigated at the site examination level for a stone-work reconstruction project similar to that presently proposed by the town of Upton (Chartier 2007). The Acton stone chamber had been known for many years, but due to human and environmental factors suffered deterioration to the point where it was in danger of collapse and had to be rebuilt or demolished. The town decided to restore the structure, which included removal of the soil on the roof of the chamber and the walls of the passage leading into it. Archeological testing was conducted for areas adjacent to the interior and exterior walls of the passage and the adjacent stone foundation before the soil was removed. The archeology revealed information on the methods of construction for the walls, the original depth of the floor of the passage and the purpose of the foundation adjacent to the stone chamber, identified as likely components of a nineteenth-century farmstead. Artifacts associated with the Acton Chamber dated from the late eighteenth century and nineteenth century and included creamware and pearlware ceramics and hand-wrought nails (Chartier 2007). In summary, the Acton stone chamber was identified as "an example of colonial architectural construction that

likely served a variety of purposes such as root cellars, animal shelters, feed storage, dairy and cider or vinegar storage and aging” (Chartier 2007:1, 5).

Other relevant studies on stone chambers in New England include stone structures in western Massachusetts and in Vermont, both discussed by Chartier (2007). John R. Cole (Cole 1981, Chartier 2007:18-19) examined stone structures identified as Irish "Monk's Caves" in western Massachusetts. Archeological investigation of nine structures and two related sites found that the structures were built of dry-laid local natural stone, most of which had no drill holes, were rectangular and partly aboveground. Every site identified once stood very close to previously settled but now abandoned major settlements and communication routes that are now wooded. All sites showed close associations with nineteenth-century settlement remains, and the limited number of artifacts recovered were all nineteenth century in date. Cole concluded that the structures were constructed in the nineteenth century by local settlers operating within an agrarian system and were aspects of vernacular architecture that had been built for diverse reasons (root storage, ice houses, cider storage, cemetery cold storage, etc.) (Chartier 2007:18-19).

In the study of 52 stone chambers in Vermont by Giovanna Neudorfer, two types of chambers were noted: Type A was integrated into the stonework of or within an existing building or foundation hole, while Type B which was built into a hillside or sloping bank, freestanding and embanked on one or more sides with earth like the Upton Chamber or freestanding without embankments. One-third of those surveyed were found to be Type A with two-thirds comprised of Type B (Neudorfer 1980:13). Historically, the stone chambers were associated with farmsteads from the late eighteenth or nineteenth century and were for dairy use and for the storage of root crops fed to livestock during the winter, as well as for cider and vinegar storage or aging (Neudorfer 1980:38). Another feature of the Vermont stone chambers is that they were located close to domestic/farm complexes, close to roadways and to some sort of water supply (Neudorfer 1980:38). In the case of the Upton Chamber, the chamber is located near Elm Street, a colonial road, near a former historic dwelling as evident from nineteenth century maps (Figures 4 and 5), and also near a brook and Mill Pond, all locational characteristics noted in Vermont for stone chambers.

4.3 RESULTS OF DOCUMENTARY RESEARCH AND PREVIOUS ARCHEOLOGICAL WORK AT THE UPTON CHAMBER (UPT-HA-15)

Preliminary deed research was conducted at the Worcester County Registry of Deeds pertaining to the 18 Elm Street property. The deed research traced the property from the present town ownership back to 1869 (Table 5). Prior to this time the property may have been part of a larger parcel that was subdivided before 1869. Examination of a number of deeds from the 1840s relating to the last owner in 1869, John Hill, was conducted, but the identification of the 18 Elm Street property with respect to these deeds could not be clarified.

Table 5. Chain of title for the 18 Elm Street Upton property.

Grantor	Grantee	Date	Deed Book: Page	Comments
Robert J. Cotton, Commissioner	Town of Upton	Nov. 16, 2006	40195/291	2 Parcels involved. Parcel 1 is the 18 Elm Street parcel.
Chase Manhattan Mortgage	Navinchandar Parthasarathy and Gerald	June 14, 2004	33872/258	2 Parcels involved. Parcel 1 is the 18 Elm Street parcel.

Corporation	Cuccione			
Gen Wal Construction Company, Inc.	Kathleen R. O'Neil	Aug. 3, 1984	8307/285	2 Parcels involved. Parcel 1 is the 18 Elm Street parcel.
Robert F. Ramsey et ux.	Gen-Wal Construction Company, Inc	Oct. 11, 1979	6847/235	Parcel 1 only, the 18 Elm Street parcel.
Malcolm D. Pearson	Robert F. Ramsey et ux.	Sept. 7, 1973	5383/54	Estate of Charles N. Pearson.
John A. Thiel	Charles N. Pearson et ux.	Aug. 25, 1928	2479/217	"... a certain tract of land situated in said Upton on the road leading to Hopkinton and thus described to wit: Beginning at a point on said road at land of or formerly of Forbush . . ."
Donald P. Lyford et ux.	John A. Thiel	Sept. 13, 1921	2252/307	"... a certain tract of land situate in said Upton on the road leading to Hopkinton and thus described, to wit: Beginning at a point on said road at land of Forbush . . ."
Charles E. Brooks	Donald P. Lyford et ux.	Oct. 29, 1918	2163/328	"in consideration of One Dollar" "... a certain tract of land situated in Upton on the road leading to Hopkinton and thus described viz Beginning at a point on said road at land of Forbush . . ."
Charles E. Brooks	Grafton Co-op Bank	Jan. 2, 1911	1952/281	Mortgage. "... a certain tract of land situated in said Upton on the road leading to Hopkinton and thus described viz- Beginning at a point on said road at land of Forbush . . ." "... and will execute and deliver to the purchaser an assignment of all policies of insurance on the buildings upon the land covered by this mortgage . . ."
George I. Aldrich Estate	Charles E. Brooks	Dec. 19, 1910	1952/281	"for the sum of Fifteen Hundred Dollars", "... a certain tract of land with the buildings thereon, situated in Upton in the County of Worcester on the westerly side of the road leading from Upton to Hopkinton, bounded and described as follows, viz.: Beginning at the road leading from Upton to Hopkinton at the southwest corner of Holland E. Forbush land (so called) . . ."
Fred E. Cook	Philena A. Aldrich	Sept. 26, 1893	1421/546	Same parcels as noted in deed below.
George I. Aldrich and Philena A. Aldrich	Fred E. Cook	Sept. 26, 1893	1421/545	2 Parcels involved. The first parcel (18 Elm Street) described as : "... with buildings thereon contains 1¾ acres more or less being all the premises conveyed to us by deed of John Hill and Eunice S. Hill dated December 2d A.D. 1869 and recorded with said Deeds Book 813, Page 207 . . ."
John Hill and Eunice S. Hill	George I. Aldrich and	Dec. 2, 1869	813/207	2 Parcels involved. The first parcel described as "... a certain piece of land

	Philena A. Aldrich			with all the buildings thereon situated in said Upton in said County of Worcester containing one acre and three fourths more or less . . .” The second parcel consisted of 3 acres of wood land. “. . . Reserving however the use occupation and improvements of the aforementioned pieces of land and all the buildings thereon to the said John Hill and Eunice S. Hill and the survivor of them for and during the life of the said John Hill and Eunice S. Hill and the survivor of them . . .”
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The 18 Elm Street property was described on deeds from 1973 to 2006 as follows:

PARCEL ONE: A certain tract of land, together with the buildings thereon, situated on the Northwesterly side of Elm Street, in said Upton, bounded and described as follows: Beginning at a point on said road at land now or formerly of Forbush; THENCE: Westerly by said Forbush land, 11 and 91/100 rods corner of Walls; THENCE: N. 24 degrees E., by said Forbush land 5 and 8/100 rods to a corner at land now or formerly of J. E. Ward; THENCE: by said Ward's land, westerly 20 and 84/100 rods to a corner; THENCE: 5. 7 and 2/3 degrees E., by said Ward land, 12 and 36/100 rods to land now or formerly of Rockwood; THENCE: by said Rockwood land 14 and 36/100 rods to a corner; THENCE: by said Rockwood land 11 and 91/100 rods to said road; THENCE: by said road 6 and 72/100 rods to the place of beginning.

This layout of the property and its present configuration is seen in Figure 3. A plan showing property, buildings and gardens as well as the abutters referenced in the deeds has also been illustrated on a plan of the property drafted by M. D. Pearson sometime between 1928 and 1972 (Figure 7), but possibly dating ca. 1938 based on a letter from that year by Malcolm Pearson that makes mention of sketches he had made (M. Pearson to W. B. Goodwin, Sept. 20, 1938).

The 1910 deed describes the bounds of the land as follows: “Beginning at the road leading from Upton to Hopkinton at the southeast corner of Holland E. Forbush land (so called), thence westerly bounding on said Forbush land as the wall now stands 11.91 rods to a corner of the wall, thence N. 24° E. 5.08 rods bounding on said Forbush land to land formerly owned by J. E. Ward a corner; thence westerly 66 2/3° N. bounding on said Ward's land 20.84 rods to a stake and stones a corner, thence S. 7 2/3° E. bounding on said Ward's land as the wall now stands 12.36 rods to a corner of land formerly owned by the late T. M. Rockwood, thence E. 63½° S. bounding on said Rockwood land 14.36 rods to corner of wall, thence bounding on said Rockwood land 11.91 rods to the road aforesaid, thence on said road to the bound first mentioned 6.72 rods.”

The 1869 deed contains almost the same wording and the same names of abutters. The continued use of the land and buildings reserved by the Hills in the 1869 deed seems to indicate that although the Aldriches purchased the land, the Hills had continued use rights of the land.

Prior to 1869, in the 1840s, a number of land purchases were made by John Hill:

- Elisha B. Fisk to John Hill (1844), 80 acres of the estate of insolvent debtor Lewis Rockwood, book 390, pages 523-525;
- Lewis Rockwood to John Hill (1843), 9 acres, book 384, pages 315 and 316
- Lydia Harrington to John Hill (1840), 21 acres, book 350, pages 274 and 275

- Halford Forbush to John Hill, book 341, page 402

Examination of these deeds has not been successful in determining when John Hill purchased the property and from whom, although a reconstructed map of land ownership for 1798 indicates that Jonathan & Nahum Ward owned the land in 1798 (Blomquist and Morrel 1983). More thorough deed research is necessary to sort out the chain of title prior to John Hill, as the property was one of a number purchased by John Hill and may have been part of a larger parcel that was subdivided.

According to Barbara Burke, chair of the Upton Historical Commission, the deeds for the property go back to 1829 to Josiah Rockwood when Josiah Rockwood deeded 181 acres to his son. The land was originally part of Hopkinton, and in 1807 Josiah petitioned to the town to be included in Upton (Barbara Burke personal communication, 2011). Additional deed information is referenced in an article by James P. Whittall II (1979), included as Appendix III in the permit application. It was noted that the Pearsons, after purchasing the property traced the deeds back to the early 1700s at the Worcester County Registry of Deeds and that the land was a Harvard College grant from common lands of the Bay State Colony (Whittall 1979:32). It has not been possible to confirm this information.

Information on John Hill is available from a number of sources. According to the inventory form for 7 Elm Street (UPT.277), south of the project area and across Elm Street, John Hill built this brick house around 1822 and the adjacent wood clapboard house at 5 Elm Street (UPT.276) ca. 1835. In all, John Hill built two houses on Elm Street and owned the tan yard north of Elm Street at the corner of Elm Street and Christian Hill Road (a.k.a. Pearl Street on the 1870 Beers map, Figure 5). The tan yard was north of his home just across Elm Street and tanning hides was important for the town's boot industry (inventory form UPT.277).

In the 1879 *History of Worcester County, Massachusetts* by Abijah Perkins Marvin it was noted that in Upton that "early in the history of the town considerable attention was paid to the manufacture of boots and shoes. In the early settlement William Howe had quite an extensive tannery business. He was succeeded by John Hill; but the business is now discontinued and the "vats" filled up" (Marvin 1879:417). John Hill was also noted as a boot and shoe manufacturer.

The 1893 Account of the Upton Chamber (UPT-HA-15)

The earliest recorded reference to the Upton Chamber comes from an 1893 article published in the Milford Journal by Daniel Fiske (a.k.a. Pratt Pond Jr.)(Whittall 1979:29, 31; Appendix III):

A Deserted Haunt of Unknown Origin

"Our main object in penning this legend is to rescue from oblivion a relic of the unknown past within our own environments, forgotten by a few of our oldest citizens and unknown to all others around which may linger an atmosphere of mystery or of romance.

We venture to assert that on account of its secluded location there are not fifty living citizens who have ever been within this mouldering enclosure and many hundreds who born in Upton for a period of four-score years, were ignorant of its existence.

In our younger days in company with other small boys, when playing "Injun", we should occasionally enter its portals and ruminate on its

unknown origin, the object of its construction, and its occupants as our untutored intellects would admit. It was one of the fine days of last October that we in company with an old schoolmate visited this haunt for the first time within the past forty years and after considerable perambulation among rocks and brush, one succeeded in finding the entrance to the walled cavern, and we compelled to here acknowledge our lack of courage, for we insisted on our companion entering first for fear we might be a victim of some venomous reptile. If our pen has already created a desire in the mind of the reader to visit this relic, we advise no one to make this attempt without a guide and with a lighted lantern.

The best time to visit it is in October or November when the foliage of the trees and brush has fallen. It has been completely obscured by the snow the past winter. Its location is near the old Hopkinton road which is well known to have existed nearly 200 years. From our youth we have occasionally sought information of our oldest citizens whose ancestors lived on this road from 150 to 200 years ago and they were as ignorant of its origin as we of today. In outward features it resembles the mounds of western states and may have been constructed by the same race existing before the red men.

Though the entrance is partially obstructed by crumbling rocks, enough remains to indicate that it was originally in the form of a common door. From the entrance is a narrow rolled passage of some twelve feet in length leading to the cavern or chambers some fifteen feet in dimensions. The walls are built of small stones easily handled, but the canopy is of stones mammoth in size, which in our imagination could only be placed in position by sliding down from the declivity above.

The floor is the same material. The mind of the visitor on entering this mysterious place, is immediately led to muse or ponder on its origin, its builders and purpose of erection. Speculation only may lead to a conclusion that may be some consolation for lack of historical proof.

It is well known that the eastern portions of Massachusetts and Rhode Island were visited by Norwegians at the beginning of the eleventh century and it is thought the stone tower at Newport was erected by them and the hieroglyphic marks on the Dighton Rock are their work. They may have visited distant inland portions leaving their imprint in lasting monuments. It has been thought by some that this relic was erected as a place of refuge from the attack of some warlike nation previous to the Indian race. Since its abandonment by man, no doubt it has been a refuge for bears, wolves, and other wild animals, as well as of the bat, lizard, venomous reptiles or worms of the slimy brood. Near by the entrance is a portion of a curiously wrought stone, partially imbedded in the earth. Some of the lines represent portions of a circle, others resemble those of the Dighton Rock. It is possible this stone may have been part of the original gate or door.

If one well versed in anthropography or in archaeology could have a chance to inspect and give a thorough study to this curious stone, it is possible some insight might be gained that would lead to an interesting local history of the past. Till then doubtless the origin of the subject of this legend will remain as oblivious as to those of former generations."

The account by Daniel Fiske is significant for its early description of the stone chamber as well as the indication by Fiske that he had visited it sometime around the early 1850s with other boys and that adults they inquired were either unaware of its existence or had no idea who built it or when. As for its secluded location, the Upton Chamber was located in George Aldrich's backyard in

1893, and in the 1850s there was a house on the property (Figures 4 and 5). The account also gives us the earliest speculations on the origin of the Upton Chamber.

Malcolm Pearson's observations on the Upton Chamber (UPT-HA-15) ca. 1930s

Following the purchase of the 18 Elm Street Property by Charles N. and Sarah E. Pearson in 1928, the Upton Chamber (a.k.a. Pearson Chamber) was rediscovered by Malcolm Pearson and made public shortly thereafter. The significance of the discovery to Malcolm led to a lifelong interest in archeology:

Malcolm Pearson was born in Plymouth, NH, son of Charles N. and Sarah E. (Persons) Pearson. When he was a teenager, the family moved first to Milford, where Malcolm graduated from high school, then to Upton. . . . While living in Upton, Malcolm discovered a beehive-shaped underground stone chamber on his family's property. The discovery launched a life-long avocation in archeology. In 2008 the former Pearson property was acquired by the Town of Upton for the purpose of creating a park and preserving the beehive chamber known as the "Upton Cave." Recently this structure was renamed the Pearson Chamber at Upton in recognition of Malcolm's contribution to furthering archeological research at the site. Malcolm was a founding member of the New England Early Sites Foundation, which transformed into the current New England Antiquities Research Association. From 1950 to 1965 he owned "Mystery Hill" in Salem, NH, now known as America's Stonehenge (<http://www.thefreelibrary.com/Malcolm+D.+Pearson.-a0241839775>).

In 1935 Malcolm published a one-page summary on the Upton Chamber in a town history that includes the following description of the chamber along with theories on its historic function:

"Approaching the entrance one sees a portal some three by four and one-half feet square, admitting one to a tunnel built into the hillside beyond. The passage is constructed of fair sized stone, roofed with huge flat stones, weighing several tons. Traversing the tunnel, one enters an inner chamber, twelve feet in diameter and eleven feet high, resembling an Eskimo igloo. The walls are irregular shaped stones laid by the skilled hands of expert artisans. A large oval shaped stone serves as a canopy for the chamber . . .

Several theories exist as to what the structure was intended for, namely; the tanning of hides, storage for vegetables, water wheel pit, and several others. Inspection reveals no fire ashes from the sweating of hides, an entrance too narrow for the conveyance of hides inside, no ventilation for the preservation of perishables, and no water wheel shaft bearings for water power in connection with a granary, besides which the erosive action of water would undermine the stone work . . ." (Poor 1935:150).

Malcolm worked to get professional archeologists involved in investigation the stone chamber. In a copy of a transcribed letter from Malcolm Pearson to William B. Goodwin dated Sept. 20, 1938 the discovery of additional stonework to the south and east of the stone chamber was noted:

"I shall try to be brief and clear in my statements. There is stone work underground in the garden whose nature is unknown to us and bears earmarks that it is part of extensive stone work in connection with the stone beehive. There is no record of buildings being erected on the garden site for which stone piers were placed. We never knew the stone work existed until we dug for the septic tank and on digging two holes in the garden to empty the contents of the old cesspool we found more of the stone work. Whitney uncovered more stone work when he dug down last June adjacent to one of the holes where we emptied the contents of the cesspool. Now, when you were present we found more stone work on the other side of the spot where the cesspool content is buried. After you left we followed the wall Whitney uncovered last Wednesday PM for a few

inches and the formation of the wall runs toward the stone beehive. Saturday this exposed wall was viewed by a man competent to judge what he saw and he definitely said it is a laid wall.

Some of the stone which came out of the hole were worked by human hands and not glacial deposit as suggested by Roscoe. You could see for yourself the sand around the stonework had not been disturbed for a great long time. It is in strata formation - top soil to gravel, to sand, to hardpan.

The most convincing reason why I believe we have stone work underground in the garden is because of information received lately to this effect. Please follow this carefully: Mr. Darling 62 years old, who sold the small cottage next to my parents' property about seven years ago, has related that when he was a boy he remembers Mr. Harrington who built the barn on the corner of the foundation just in back of the stone beehive, telling him (Mr. Darling) [that he (Mr. Harrington)] had obtained some of the stone from a tunnel and fallen-in chamber which connected to the back of the beehive and that he, Mr. Harrington, filled up the doorway in the back of the beehive house and graded in level to the top of the beehive. Mr. Harrington was 84 years old and died about fifty years ago. I can verify that there is no stone back of the beehive chamber because I dug down about six years ago to investigate the back of the blocked up doorway and I have always wondered why I did not find stone work underground beyond this blocked up doorway. Now the reason is known.

Furthermore Mr. Darling related stone work was on the surface near the garden and the surplus was dumped over where the hen yards are found today. The pile of stone is exactly where he states and I can show it to you. Here is positive evidence double checked that there was known to exist more stonework in direct connection with the present beehive. Why not more stonework underground in the garden? Here we have the only opportunity to dig and open up undisturbed handiwork of what we are studying and why not go ahead?

I will not argue the point why Mr. Whitney does not believe there is artificial stonework underground. He has his own opinion and while I would like to know why he thinks as he does, I know it is a mutual thought of both my parents and I that we do not think it advisable to have him supervise any future work in connection with digging around in the garden. On the last trip here his man did not take the proper precaution to separate the garden top soil and gravel so when the hole is filled up that the productive soil is restored to its original state and this condition is the most important one my parents insisted should be observed if they permitted digging in the garden. Their reason is an acute one to them as it means about fifty dollars a year to them in garden produce and it takes years to cultivate a top soil properly. If upon finding out positively there is stone work underground which warrants extensive digging then some agreement must be drawn up to protect them. Meanwhile the temporary work must be conducted in such a manner as not to leave the garden plot in an unusable condition for the raising of the garden truck next season. I trust I make this point clear concerning the removal and replacing of top soil.

The second main reason why we should like to have competent parties undertake the digging is the conclusion drawn after watching certain stones belonging to the stone wall which was uncovered last Wednesday PM were thrown aside as not being part of the wall. Saturday we had expert advice on this angle.

Understand I have absolutely every personal regard for Mr. Whitney but at the same time I want to make every effort to assure myself that this underground work in the garden that is of vital importance must be undertaken by most expert hands.

At the same time I wish to cooperate fully with you and I will do all in my power to solve this problem of the underground stonework in Upton, I am convinced there is a solution somewhere of this unexplained stonework in New England and I am sure Upton holds a part of the solution.

Before doing any actual work I would like to see you and talk the matter over. I know you are busy but we must go ahead carefully and look over every possible angle. I

would like to drive to Hartford in the near future and go over the whole Upton question with you. I have sent you diagrams and sketches of the layout at Upton and we can clarify the project. The best time for me to be in Hartford is a Saturday evening or a Sunday.” (Excerpt from Letter from M. Pearson to W.B. Goodwin dated Sept. 20, 1938, courtesy the Upton Historical Commission).

The Mr. Harrington that Malcolm Pearson relates was probably the same H.O. Harrington who is identified with the abutting house on the 1870 Beers map (Figure 5). The events related from Mr. Harrington to Mr. Darling probably took place in the late 1880s based on the age of Mr. Darling at 62 in 1938 and the story having been related to him when he was a boy. Of equal significance is the presence of stonework in the garden. Malcolm’s plan of the family property (Figure 7) reveals the extent of the garden plot, as well as the location of the house, garage, hen house and yards, driveway, and of course the stone chamber, identified as “cave.” Harrington’s property was the “Forbush Land” in Figure 7. If a second tunnel and/or chamber existed, it would appear from the description to be east of the main chamber on land formerly owned by George Aldrich, not Harrington. The presence of a blocked doorway, witnessed by Malcolm, seems to support the claim of an extended underground tunnel or chamber. The presence of stonework in the garden indicates that more extensive architecture was present at the site, much of which was disturbed by the garden work done in 1938. Another important detail evident from the property plan (Figure 7) is that the nineteenth century house evident on the 1870 map (Figure 5) was along Elm Street, while the Pearson house was set back from the road. Deeds from 1869 to 1911 mention buildings on the property, but not deeds from 1918 to 1928. This suggests that the Pearson house may not have been the same house shown on the 1870 map (Figure 5). That there was a house when the Pearsons purchased the property in 1928 is evident from Goodwin’s account of the Pearson’s being shown the stone chamber by the previous owner after purchase of the property (Goodwin 1946:41). Foundations from the nineteenth-century house would be expected in the front yard between the house on the Pearson Plan (Figure 7) and Elm Street, while outbuildings could have been present in the garden area. The existing house at 18 Elm Street was built in 1962, according to online sources (<http://www.trulia.com/homes/Massachusetts/Upton/sold/204671-18-Elm-St-Upton-MA-01568>). As a result, there has been considerable alteration of the 18 Elm Street property within the past century.

The 1955 Archeological Investigation of the Upton Chamber (UPT-HA-15)

The most important information to date comes from the 1955 archeological excavation of the Upton Chamber by David H. Kelly and John B. Glass, graduate students at Harvard University at the time. The project team included with James Whittall II, who later published a summary of the excavations written by David Kelly, included here as Appendix III (Whittall 1979). Work was funded by the American Museum of Natural History (Upton Historical Commission Interview notes from an interview with Dr. John B. Glass, May 20, 2005). Prior to the 1955 excavations, between the 1930s and 1954, a number of professional and amateur archeologists visited the stone chamber. Correspondence from these visits and the publication by William Goodwin (1946), which included conjectural suggestions that the Upton Chamber was constructed by Irish Culdee Monks around 900 AD, are related in the Whittall article (Whittall 1979). Goodwin’s work included the earliest photographs of the chamber entrance and beehive chamber (Figures 8 and 9) and the earliest drawing of the Upton Chamber, dated 1934 with Malcolm D. Pearson’s initials (Figure 10). Additional plans of the chamber were made in 1944 by Vincent Fagan (Figure 11). These photographs and drawings are instructive for documenting the condition of the chamber prior to the 1955 excavation (Figures 12a, 12b, 13 and 14).

As described by Jonathan Meagher of the Upton Historical Commission, the Upton Chamber is "Constructed of dry stone and buried in the earth, it is situated near a corner of the Elm Street property by the intersection of two great stone walls. A casual observer might easily overlook the roughly four-foot entrance just to the left of a massive, craggy oak tree. A nearly fourteen foot stone corridor, high enough and wide enough to accommodate a stooping visitor, extends back from the entrance. At its end, the entry corridor opens into a circular room just under twelve feet in diameter and more than ten feet high at its apex. The roof is formed of massive stones arranged to form a great corbelled "beehive" dome topped by a large, flat capstone" (Meagher 2004:1). A photograph of the Upton Chamber's entrance taken in 1955 can be seen in Figure 12a.

The 1955 archeological excavation of the Upton Chamber by David H. Kelly and John B. Glass are described as follows (Appendix III, Whittall 1979: 35-39):

"Excavations were begun with a trench about 18 feet west of the tunnel entrance, to determine the local stratigraphy and see if the debris extended that far. No artifacts were found. A humus level sat upon yellow gravel, and the water table was reached at a few inches into the gravel. An area in front of the tunnel entrance was then cleared away, and a pit put in across the width of the tunnel just outside the entrance. The extensive root system of a nearby maple tree made digging very difficult and, in the area where they were found, the roots could easily have displaced artifacts from one level to another.

Most of the artifacts found were broken white china, and Mr. Charles Pearson said that children used to break pottery there for amusement. This does not mean that all broken chinaware belonged to playing children, but it does introduce an unforeseeable amount of error, as they might have had old plates which had been around the house for a long time. In any case, it is not of much importance as a large sterile layer (or rather, zone, as there was no natural distinction in the soil) underlay the deposit which contained white china. Further clearing revealed two large stones in the entrance way, one fairly flat, the other nearly perpendicular. These were at first thought to be sill stones. Subsequent work in the tunnel indicated that artifacts ceased about 4 or 5 inches from the top surface of the flat zone. There is a large gap in the stonework of the south wall just above this point, and the stones may have fallen from there. However, Mr. Charles Pearson is of the impression that the missing stones were in place about 30 years ago. If these two stones were deliberately placed in position, it is difficult to see why and when. Trenchers were put inside the tunnel to about the level of the top of the first flat stone, taken down in levels so that a sterile layer was distinguishable above the level of the stone. The stones were then photographed, and the perpendicular one removed. Excavation continued where it had been, and parts of three large flat stones became visible, apparently placed to form a floor. The remainder of the dirt in the tunnel was then removed to this level, and ten other stones of varying size were uncovered. Some had decidedly uneven faces and their tops were at different heights by several inches. In the southeast corner of the tunnel none were found in an area more than 5 feet long by more than 2 feet wide. There was no place that they could have fallen from, and several of them might once have been sitting more nearly level, so it seemed likely that they had been deliberately placed, despite their irregularity. In clearing down in the southeast corner of the tunnel, a wooden floor was found. It was traced out back towards the entrance, and was found to go under the large stones. About 2 inches of soil had been left upon it throughout this area. Several badly rusted pieces of iron, probably nails, were found in clearing

the area at the level of the large stones and down to just above the floor. Frequent patches of rust were also observed, too badly corroded to be sure that they had ever been artifacts, particularly since a local rock frequent in the gravel, showed a heavy concentration of iron, usually rusting a slightly lighter color than the demonstrable artifacts. The large stones were then removed. Some were found to be sitting directly on the wooden floor, while others were on the sandy fill above the floor.

In clearing the small amount of dirt remaining after the removal of the large stones, Glass encountered a very small and delicate sherd. This was a rim sherd with what appeared to be a lead slip -- at any rate, a hard metallic gray (actually silver, see photo). A reddish tinge was visible along the rim, which apparently curved both vertically and horizontally. A molded design of three lines formed a chevron pattern. The sherd broke into 3 pieces while being wrapped, indicating the extreme delicacy of the specimen. The sherd is very distinctive and should eventually be clearly identifiable. Inasmuch as great care had been taken to remove excess dirt as the excavation proceeded, there is every reason to suppose that the sherd approximately dates the wooden floor. The floor over most of the tunnel was in a badly rotted condition and in some places, either turned to a black soil or vanished completely. In the vicinity of the stones 7 and 9 of the sketch map of the tunnel, where the sherd was found, it was impossible to be sure whether the sherd came from just above the wooden floor or from below it at a point where it had rotted away, as it was not seen in situ.

A sufficient amount of the floor proper remained to give a specimen from which a C-14 date could be obtained. However, the sample was badly contaminated with both living and dead roots which had penetrated it. The level of the floor was about 2 inches above water level at the time of the excavation, and even with the bottom course of stones in each of the tunnel walls. In some places it appeared to go partly under the stones, but in other places clearly abutted the side of some of the stones. Probably during the course of rotting the pressure of the earth above had forced the remnants of the boards hard up against the stones or under them, depending upon their level relative to the basal course. The same factor may well be responsible for the first fact that at no place in the tunnel was there a visible line of demarkation between two boards, in either direction. Occasional large chunks suggested that the original thickness of the floor may have been about 2 inches. One rusted artifact was found in sandy gravel beneath the floor, apparently a large spike, bent at right angles.

The presence of the water table so near the present floor level, and the knowledge that it rises to considerably above the old floor level during wet seasons, strongly suggests that the old wooden floor was built during a dry period by people who did not realize that the water table was so close, and that the large stones were piled in on top of the floor as stepping-stones during the first wet period. This likewise suggests that the purpose of the "beehive" was a year round matter, and is some slight evidence against such suggestions as a spring house. This argument, of course, is only valid if the water level at the time of building was approximately the same as now in its yearly fluctuations.

The wooden floor is presumably a part of the original structure, since it ties in so closely with the basal course of the tunnel walls, and since there is no positive evidence of any other occupation. The use of the large flat granite stones put on top of the floor tends to confirm this view, as whoever put them in was in the habit of moving large stones. The thought of putting a stone the size of number 3 for a stepping-stone would never have occurred to me, but to anyone who had put the much large capstones of the tunnel in place it would probably have seemed simple.

After completing the clearing of the tunnel, a section of the chamber was excavated. A layer of humus, full of roots and containing very few artifacts, extended down to a level of gray clay and rotten granite which is apparently the basic local soil. In the northwest corner of this trench, some boards appeared sitting on the gray clay. When we realized that the gray clay was probably an undisturbed original deposit, we decided that the boards must be the original floor, although, it was here considerably higher than in the original tunnel. Indeed the basal course of the chamber appeared to be about two courses higher than the basal course of the tunnel. Since only a small section of flooring was found and its association with the tunnel floor was not absolutely certain, most of it was not kept, although a rounded log which may have been part of a cross-beam was kept. A cross-cut from this trench to the tunnel would have revealed the relationship of the two floor levels positively, but it seemed more worthwhile to examine the extent of the wooden floor outside the entrance to the "beehive".

At the entrance, our original pit had not gone as deep as the floor, so the remaining overburden was removed in two levels. The floor was found to cover the entire bottom of the excavation and to extend into the profile on all sides. When it was removed, a cross-piece was found. Since it sat down into a yellowish sand and small gravel deposit, its dimensions were easy to determine even where it had rotted away to black soil; there were 2 inches by 6 inches. It extended into the profile both north and south of the excavation. Ten nails were found in this cross-piece in various degrees of preservation. Probably some of the nails found can be restored to good enough condition to enable an approximate date to be determined from their type.

A small test pit was put in near the northwest corner of the beehive, where it joins a stone wall, in order to check whether a retaining wall had been built on the west face of the beehive, to hold back the earth piled on it. No evidence of such a wall was found, but within the top foot of the excavation were found numerous sherds of blue-on-white straffordshire ware. There is no reason to suppose that these all derive from playing children, who left no other later, pottery, but neither is there anything to indicate that these sherds are contemporary with the building of the beehive. I incline to think that they represent a later occupation, perhaps contemporary with the building of the stone wall.

When the sherd, the nails, and the wood from the old floor have been dated, it will be time enough to decide whether more work is desirable. Since no clear evidence of use was found in the area so far excavated, it seems unlikely that further excavation would answer the problem, since a fairly extensive section of the chamber was dug. The materials already found should be sufficient to date the structure, and further evidence would only be confirmatory. However, if the evidence seems indecisive, or no one can identify the sherd, it would be possible to clear the rest of the chamber, to excavate to the edge of the wooden floor, in order to check the exact relationship of the pottery to the "beehive", and to the stone wall, as well as making certain that the "beehive" antedates the stone wall."⁶

(Appendix III, Whittall 1979: 35-39).

Cultural materials identified in the excavation include a wood floor approximately two inches thick, a 2-in by 6-in wood cross piece with nails embedded in it from under the floor, iron nails, a large iron L-clinched spike, indeterminate iron – possibly nails, an incised ceramic sherd, "blue-on-white straffordshire [sic] ware" and "broken white china" (the latter attributed to children from a later date). The wood from the Upton Chamber floor has never been dated. A photograph of the ceramic rim fragment with a "molded design of three lines" is shown in Figure 12b. It was recovered from the passageway in the vicinity of boulders 7 and 9 shown in Figure 14. The mention of what appears to be a lead slip of hard metallic gray suggests that the sherd is of lead-

glazed earthenware. Incised decoration was used on certain types of lead-glazed earthenware, including English sgraffito ceramics from the seventeenth and eighteenth centuries. The photograph identified the sherd as being 9/32 inches in size but no scale is present in the photograph.

Artifacts apart from the wood floor were sparse within the chamber. The wood floor elements, iron nails and spike indicate historic use. If the incised ceramic sherd is of lead-glazed earthenware, that would also date from the colonial period or early nineteenth century. Blue decorated Staffordshire ceramics from northwest of the beehive chamber may be of variable date and depending upon ceramic type could date from the eighteenth century to as late as the twentieth century. As the Staffordshire ceramics came from the northwest corner of the beehive chamber where it joins a stone wall (Trench 7?), this could be the area Malcolm Pearson mentions in his 1938 letter that was walled up by Mr. Harrington by the late 1880s. The white china ceramics likewise could date anywhere from the eighteenth century to the twentieth century. No artifacts were noted that were of likely pre-colonial origins. Wood samples were retained by James Whittall and the incised pottery sherd was in the possession of Malcolm Pearson, according to a 2005 interview with Dr. John B. Glass (Upton Historical Commission Interview notes from an interview with Dr. John B. Glass, May 20, 2005). There is no information on the whereabouts of the white china and Staffordshire ceramics or iron nails and spike that were recovered.

The plan of the 1955 archeological excavations indicates that all of the entrance and the passageway, and half of the beehive chamber have been excavated, leaving only a portion of the beehive chamber unexcavated (Figure 14). In addition, an excavation unit measuring approximately 4-x-4 ft (1.2-x-1.2 m) was excavated outside the entrance to the stone chamber and a trench 18 ft (5.5 m) west of the chamber entrance that encountered yellow gravel below the humus, with the water table a few inches below. The “cobblestones” depicted in Figure 14 (top) refer to the gravel, not a cultural pavement. No artifacts were encountered there.

Recent Observations on the Upton Chamber (UPT-HA-15)

Several recent observations are available on the Upton Chamber that bear on the possible origin and function of the stone chamber. In an unpublished report on file with the Upton Historical Commission, Jonathan Meagher (2004) has written a scholarly discussion of the competing theories regarding the Upton Chamber’s origins and significance. Mr. Meagher notes that in Neudorfer’s study of stone chambers of Vermont at least one featured a corbelled dome like the Upton Chamber. Neudorfer concluded that most of the chambers were built as storage cellars for root crops, dairy products, or cider because their common southeasterly orientation would have made them more easily accessible in the winter and, therefore, ideal for such a purpose. Neudorfer noted, however, that one north-facing chamber might have been an ice house, instead of a storage cellar. Since the Upton Chamber faces roughly in a northwesterly direction, the ice house theory is of particular relevance (Meagher 2004:25-26).

Meagher relates:

“There can be little disputing that ice was a valuable enough commodity to Americans of previous centuries that it was well worth it to them to go to great lengths to build elaborate structures to preserve it. Ice industry historian Joseph C. Jones notes that early colonial Virginia governor William Berkeley was, in 1665, granted a patent “to preserve snow and ice . . . in such pits, caves, and cool places as he should think fit. None other than George Washington solicited the advice of Robert Morris on how best to construct

an ice home in 1784. Morris responded to Washington's inquiry with a letter that details the construction of his own ice house. "The walls of my ice house are built of stone without mortar," wrote Morris, referring to those walls of his ice house that stood below grade. He continued, "The walls [above grade] are very thick, built of stone and mortar." He then supports Neudorfer's assertion about the likely orientation of ice houses of his time by stating that "the door for entering the ice house faces the northern." Finally, he touches upon another characteristic that the Upton Chamber shares, as he suggests, "The side of a hill is generally preferred for digging an ice house, as if needed a drain can easily be cut from the bottom of it through the side of the hill to let the water run out." Morris' description is not alone in mentioning a drain to allow water from melting ice to exit the ice house.

"Drains are commonly mentioned throughout the literature on antique ice houses. The presence of a drain in the Upton structure would, then, be a key piece of evidence pointing toward its past use as an ice storage chamber. When queried recently about the possible existence of a drain in the Upton Chamber, Malcolm D. Pearson adamantly denied that he had ever found anything that could have acted as a drain in all his years of investigating the chamber. A 1934 sketch of the chamber, presumably by Pearson since it is initialed "MDP," might indicate otherwise, however. The sketch depicts the chamber's floor from above and clearly indicates a "well" that has been "filled up" in the middle of the chamber's main, circular room. If the chamber were used as an ice house, such a "well" could have been a dry well or a drain built to accommodate run off from slowly melting ice. If some such feature were proven to exist in the chamber, its finding would constitute a significant breakthrough in explaining the chamber's origins and uses. It is important to note, however, that no other evidence to suggest that the chamber ever contained any sort of dry well or drain exists. Despite the lack of conclusive evidence that the chamber contained a drain, it does, for the most part resemble Robert Morris' description of a late-eighteenth century ice house, and a late eighteenth century date for the Upton Chamber's construction would not be out of line with what is known about its age. . . .

"One final theory related to the many in the storage cellar/outbuilding genre was put forth by longtime Upton resident Roy Johnson in a 1957 letter to his granddaughter Carol, who is now associated with the Upton Historical Society. Mr. Johnson and his family lived in the vicinity of the Elm Street chamber. In his letter, he reveals that a tannery once stood near the brook that crosses Elm Street in the vicinity of the chamber. This tannery was owned by a "Mr. Hill," owner of a conspicuous brick home on Elm Street and employed Roy Johnson's grandfather, William Johnson. Roy Johnson's letter describes the use of native white oak trees in the vicinity to provide "tanbark" for the tannery's leather-treating operations. Nowhere in the letter does he speculate about any role that the chamber might have played in the tanning operation, but Carol Johnson Blomquist has reported that some members of her family believed the chamber was used for the storage of hides. Further research into early American tanning procedures in general and the tanning operation on Elm Street in Upton specifically might help in assessing the plausibility of this interesting theory. As of now, however, no other evidence to support this theory seems to exist.

"Whether the chamber was ever used in connection with the local tannery or not, one thing in Mr. Johnson's letter stands out because of an interesting connection that it creates with another source. Johnson mentioned the use of trees in the chamber's vicinity to provide "tanbark" for the tannery. Ice house historians Hill and Hughes note in their book that "tanner's bark" was among the "best fillings" for ice houses. It is not entirely clear that Johnson and the two historians were even making reference to the same substance when they mentioned "tanbark" and "tanner's bark," but the coincidence is remarkable enough to be of interest and it does provide another shred of circumstantial evidence possibly linking the Upton Chamber to the storage of ice." (Meagher 2004:26-30).

Meagher concludes:

“After decades of study by scholars and theorists of all kinds the Upton Chamber mystery remains just that, its genesis as obscure today as it was when "Pratt Pond, Jr." visited it for his 1893 Milford Journal article. No one has proven a link between the chamber and pre-colonial European visitors! In fact, the alleged visits of pre-colonial Europeans, be they Irish or Iberian, have never been documented to the satisfaction of the archeological establishment. The theories of professional archeologists and historians as to the genesis of the chamber, however, remain likewise unproven. That it may have been built by settlers of the colonial or early national periods as a place to store ice or roots or perhaps even hides has been convincingly demonstrated using information gathered from the studies of similar structures in other places and historical accounts. That it was built for such purposes has not been convincingly demonstrated. Whether the professional archeological community considers the chamber too mundane or too vexing, they appear content to let it rest in its current mystery-shrouded state. The unfortunately flawed Kelley and Glass excavation of the 1950s may have ensured that the chamber itself will never yield incontrovertible evidence of its own origins since any crucial artifacts it might contain may have been disturbed or already removed. However, the potential to learn from the chamber certainly still exists. Modern technology and the careful investigation of a team of skilled professional archeologists may still yield significant pieces of evidence relating to the chamber's origins and the lives of the people who built it. The chamber's wooden floor, remnants of which may still exist on site, offers perhaps the greatest potential to provide at least a partial portrait of the chamber's past. (Meagher 2004:26-30).

The 1934 plan of the Upton Chamber that Meagher mentions was included in Goodwin (1946:50; Figure 10 this report) and it does show a ring of stones in the center of the chamber identified as “Well (Filled up).” Goodwin interprets the ring of stones as being fire-related, and he discusses similar structures used as sweat houses in ancient and medieval Europe, as well as a beehive chamber from Hopkinton, Massachusetts locally known as “the Old Indian Tannery” (Goodwin 1946:41-44, 50). In addition to Meagher's ice house and tannery theory, archeologist Alan Leveillee visited the Upton Chamber and related several observations reproduced here and in Appendix IV:

1. There is no question that the chamber was built above grade and covered with earth only after its completion.
2. It is most likely that the chamber was built during the 1700s to serve a purpose related to agriculture or life in an eighteenth-century agrarian society. Potential purposes of the chamber in this context would include shelter (possibly from Indian raids), cold storage of unknown commodities, or ice storage. The chamber's relatively small opening is good evidence that it was designed for one of the aforementioned purposes because it is not large enough for people to comfortably pass through on a regular basis and suggests that the intent of the chamber's architect(s) was to limit airflow in the chamber. There may also be some chance that the chamber could have been designed as a winter mausoleum, but that is not terribly likely because, due to the time and effort undoubtedly involved in constructing the chamber, its builders would have had to have anticipated significant need for such a structure well in advance of such a need being generated by epidemics and the like.
3. It is not likely that Native Americans built the chamber. Animal technology would most likely be used in the construction of such a structure, and local Native Americans did not possess such technology. There is also no record of local Native Americans being responsible for major stonework. Use of the chamber as an astronomical observatory by

- either Native Americans or European colonial settlers would have been unlikely despite the astronomical alignments that have been suggested by some.
4. It may or may not be possible to arrive at a definite explanation of the chamber's genesis. The remnants of a wood floor that were removed from the chamber during the 1950s could be carbon dated. The carbon dating, however, would only determine when the trees that produced the wood died, and it is entirely possible that the chamber itself predates the wood floor. It might be possible for a trained archeologist to determine the age of the silver shard removed from the chamber during the 1950s excavation by simply examining it. It is also possible that a process called thermoluminescence could help to date the shard.

In summary, the Upton Chamber has been the subject of public evaluation and speculation since 1893. The colonial agrarian history of the property has not been well explored, and the use of the property by John Hill for his tannery business in the early to mid nineteenth century has also not been well researched. A case can be made for the Upton Chamber having been built as a root cellar, ice house, cold storage for hides, or for sweating hides. Dating of the stone chamber has not been previously conducted, although a wood floor with associated ferrous nails had been excavated during the 1955 archeological investigation. No definite pre-Contact Native American or pre-colonial European artifacts have been identified, and the only temporally ambiguous artifact recovered to date consists of a small incised ceramic sherd. Unpublished information on buried stonework south and east of the chamber has been included in this section. The Upton Chamber may be part of a larger stone masonry construction that has been buried, disturbed, and partially removed between the late nineteenth century and the mid twentieth century.

4.4 RESULTS OF THE SITE EXAMINATION FIELD INVESTIGATION

JMA conducted an archeological site examination for the Upton Chamber Masonry Rehabilitation and Drainage Improvement Project under Permit # 3276, which was issued to JMA by the State Archeologist at the Massachusetts Historical Commission (MHC) on September 8, 2011, in compliance with Massachusetts General Laws Chapter 9, Sections 26-27c (950 CMR 70-71). The archeological field work for this project was conducted under the direction of Principal Investigator Martin Dudek between September 26 and October 10, 2011, with assistance by field archeologists T. Arron Kotlensky and Alan F. Smith. Archeologist David Gutbrod also assisted the field work by supplying and managing a Zoeller 0.3 HP pump to dewater the chamber.

The plan of the 1955 archeological excavations at the Upton Chamber indicates that all of the entrance and the passageway, and half of the beehive chamber had been excavated, leaving a portion of the beehive chamber unexcavated (Figure 14). In addition, an excavation unit measuring approximately 4-x-4 ft (1.2-x-1.2 m) was excavated outside the chamber entrance and a trench was excavated 18 ft (5.5 m) west of the chamber entrance that encountered cobbles. The Upton Chamber Masonry Rehabilitation and Drainage Improvement Project was located within an area that had been mostly excavated in 1955. A portion of the area outside the entrance proposed for drainage improvements was outside of the 1955 excavation. Within the chamber it was not clear if the 1955 investigation excavated down into sterile natural substratum or if any remnants of the wood floor were left in-situ inside the chamber's passageway. Back dirt from the 1955 excavation might also contain artifacts that had not been recovered at that time. Staffordshire and white china ceramics were noted from the 1955 excavation and could range in date from the eighteenth to the twentieth century. If present, these ceramics might be dated more specifically. By the 1850s the chamber appears to have been abandoned. If the ceramics were

earlier in date, they might aid in refining the date when the chamber was in use after the wood floor was built. If the artifacts dated after the 1850s, then they were probably discarded from the Harrington/Aldrich occupation of the property or later, after the chamber had been abandoned.

Existing Conditions in 2011 and Property Alterations ca. 1980-2011

The existing conditions of the Upton Chamber entrance at the time of the 2011 field work included a forward-shifted lintel and loss of stone work under the lintel and inside in the passageway near the entrance. There was also partial filling of the entrance and passageway with soil and boulders (Plate 1). In addition, the chamber was flooded with water approximately 33 cm deep which needed to be siphoned out (Plate 2). When compared to a photograph taken prior to 1946 (Figure 8, Goodwin 1946), possibly dating from the 1930s, it is evident that all of the boulders on the slope and entranceway had been displaced. Figure 12a, a photograph taken in 1955, also reveals that the depth of prior excavation at the chamber entrance exposed the entrance to a depth of 5 ft or more. There were no loose stones evident in these two older photographs. The existing conditions in 2011 of the loose boulders, the low entrance, and the high water table are the result of post-1955 events.

Several changes had taken place since 1955 which have altered the landscape around the chamber and the chamber itself. The 18 Elm Street property had been owned by the Pearson family from 1928 to 1973, and around 1962 the Pearson house had caught fire and had been rebuilt. The assessor's records list the date of construction for the 18 Elm Street house as 1962, but the house location had not changed since the Pearson map had been created (Figure 7). From 1973 to 1979 the property was owned by Robert Ramsey. During the time from 1955 to 1979 no significant alterations of the landscape are reported.

In October, 1979 the property was purchased by Gen-Wal Construction Company, Inc from Robert Ramsey, with the intent of using part of the property, a hill across Mill Brook, as a gravel mine. On January 7, 1980, there was a public hearing in Upton on the issuance of a three-year gravel permit to Gen-Wal Construction Company, Inc, with Walter Cyr, Treasurer, and Gene Cyr, President of Gen-Wal present. Their intent as stated was to remove gravel across the property but maintain an 8-ft elevation above the water table. By the time of the meeting the property had already been clear-cut. Work had started on bridge construction over the brook to access the graveling area from the 18 Elm Street driveway, and Jane Robinson of 16 Elm Street expressed concern that the access road was partly on her property. Other property owners expressed concern over the water table rising in the area and getting flooding in their basements. Carl Rooney and Barbara Burke of the Upton Historical Commission also expressed concern over the preservation of the cave [Upton Chamber] on the property, which Walter Cyr said they would not go near (Town of Upton, Minutes of the Meeting, January 7, 1980). The meeting was also reported on the following day in the Worcester Evening Gazette (Anderson 1980).

Gen-Wal Construction Company Inc. owned the property from 1979 to 1984, during which time the mill pond brook was bridged, the hill on parcel 2 (Parcel 28 on Figure 3) was graveled out and lowered, and the low-lying ground on parcel 1 west of the 18 Elm Street house was filled in. Jim Laucis, a local resident who had visited the Upton Chamber since the 1960s, attested to the lowering of the hill across the brook by Gen-Wal in the 1980s. He said formerly the chamber was dry most of the year, with water present in it mainly in the spring. Now the chamber had water in it during most of the year. The filling of the adjacent lowlands and the lowering of the hill has raised the water table and flooded the Upton Chamber within living memory.

Direct and damaging effects to the Upton Chamber have also taken place within the last decade. Jane Robinson, a neighbor at 16 Elm Street who has lived there since the 1970s, reported that the last owner before the town purchased the property in 2006 had put up a gate in front of the Upton Chamber's entrance to keep people out. After an intruder had removed the gate, the owner had decided to collapse the entrance to the chamber to keep people from going in there. According to Ms. Robinson, the owner tied rope onto a boulder below the lintel and pulled it out with his pickup truck. When the boulder was pulled out some stones fell down but the chamber did not collapse (Jane Robinson, personal communication 2011). The event did apparently lead to the loss of stonework. A ceiling slab lying in the passageway inside the chamber probably fell at this time. The event also caused the lintel to shift forward to the west, with slumping of the lintel on the north side of the entrance and loss of stonework on the north side of the passageway.

The most recent alteration of the property took place in late March to early April, 2011 when the house at 18 Elm Street was used for fire-fighter training exercises, followed by razing of the house (<http://www.wickedlocal.com/upton/news/x796071290/Upton-Hopkinton-firefighters-get-real-life-experience-with-house-burn#axzz264YvsibX>; <http://www.milforddailynews.com/news/x481348526/PHOTOS-Burning-to-learn-in-Upton>). By September, 2011, the former Pearson house location had been leveled and filled, and a grassy lawn was in place. What is now level grassy yard southwest of the Upton Chamber had formerly been low-lying ground or wetlands along the brook that feeds into the mill pond (Plate 3). Approximately 2 m of fill had been added to this area in the early 1980s. The ground slopes more gradually downward to the northwest, an area used for screening soils from the excavation (Plate 4). However, to the north near the Upton Chamber the ground slopes sharply down to the entrance of the chamber. The location of the former Pearson House and adjacent backyard is level and grassy, and a large quarried granite block has been brought on-site from unknown provenience and placed under a tree (Plate 5).

The existing conditions inside the Upton Chamber in September-October 2011 consisted of an entrance partly filled with boulders and earth, and a flooded passageway and chamber (Plate 6). The measured depth of water was 33 cm, which was found to be at a level only a few centimeters higher than the standing water in the wetlands approximately 10-m west of the chamber. As a result, it was necessary to pump the water out of the chamber using an electric pump (Plate 7). The water was pumped out using a Zoeller 0.3 HP pump (courtesy of David Gutbrod), capable of removing 43 gallons per minute. The chamber was pumped out in half an hour, the equivalent of approximately 1350 gallons, with a continuous stream of about 15 gallons per minute afterwards. The inner chamber passageway once pumped had a floor of sandy gravel interspersed with boulders, wood boards and sticks. Numerous boards were also present in the vaulted chamber, most boards consisting of plywood but with some lumber present (Plate 8). The wood boards were the result of recent attempts to create drier routes into the chamber over the water. None of the boards were from the historic wood floor noted in the 1955 excavation. Once the pump was turned off, the chamber filled with water within a few minutes to the original level of the water encountered before pumping. As a result, it was apparent that the water was coming from the water table, not a perched pool of water that could be pumped out once for all.

4.4.1 EXCAVATION UNITS OUTSIDE THE CHAMBER ENTRANCE

Excavation of the EUs outside of the Upton Chamber started with the EU "NW1" (for Northwest 1) northwest/outside of the chamber entrance (in line with two EUs inside of the chamber entrance - CH1 and CH2). Following this, the second EU to the northwest (NW2) outside the chamber was excavated. It was necessary to shift this EU 50 cm north abutting EU NW1 due to the steep sloping bank covered by a massive maple tree to the south (Figures 15 and 16). EU

NW1 outside the chamber was excavated down into the water table, to the base of the stone chamber entrance. In this way the depth and extent of the 1955 excavation was determined, although no intact archeological deposits were present in EU NW1. The second EU (NW2) encountered natural strata that had not been previously excavated as part of the 1955 investigation. Excavation of this EU was severely hindered by massive tree roots from the large maple tree which were left intact so as not to undermine the stability of the hill outside of the chamber where the tree is situated. This was at the request of the Upton Historical Commission. A third abutting EU (NW3) was necessary to the northwest of EUs NW1 and NW2 to allow for drainage. This EU encountered natural strata and hydric conditions, and was excavated in the sterile substratum. Soil from the exterior EUs was excavated by natural strata or by 5-cm levels where natural strata exceeded 5-cm in depth. All excavated soil was passed through one-quarter inch hardware cloth to ensure uniform recovery of artifacts.

EU NW1

EU NW1 abutted the chamber entrance on its west side [northwest]. The location of the EU was over the location of Trench 2 excavated in 1955 (Figure 16). The EU extended west to EU NW2, north to laid stonework on the north side of the chamber entryway, and south to a root mass of a huge maple tree that covered the steep bank of the sloping hill (Plate 9). The growth of the maple tree root mass since 1955 had pinched the entryway into a width varying from 90 to 100 cm.

The first thing that needed to be done was to remove a boulder weighing several hundred pounds from the center of EU NW1. The boulder had been rolled down from the north slope into the chamber entryway after November 16, 2008, but prior to June 23, 2009 based on dated photographs (2008 photograph - <http://stoneruins.cellarwalls.com/#15.3>; 2009 photograph - courtesy Cathy Taylor, Upton Historical Commission). The boulder was unable to be moved with two people manually pushing it up a board, so a winch was used to shift it out of the excavation area (Plate 10). The boulder was later reused in the rebuilding of the entryway stonework.

Excavation then proceeded with 5-cm levels. The soil consisted of very dark grayish brown (10YR 3/2) to very dark brown (10YR 2/2) humic silt loam fill (F1) with dense roots, decaying leaves, branches, twigs, and bark fragments, the accumulation of post-1955 humus (Figure 17). Artifacts recovered from the first four levels (0-5 cm below surface (cmbs), 5-10 cmbs, 10-15 cmbs, 15-20 cmbs) included modern machine-made clear and amber bottle glass, window glass, clear lamp glass, plain whiteware ceramics (ca. 1820-present), and plain ironstone ceramics (ca. 1842-present) (Appendix V). Plastic bags, wrappers, and sheet plastic, soda can pop-tab, candy wrappers, cellophane, nylon ribbon, aluminum foil, one piece of coal clinker, bark, and a paraffin wax candle fragment were noted and discarded. By 20 cmbs, boulders were exposed along the north and east sides of the EU (Plate 11).

Loose rocks in fill that were not part of the entryway stonework were mapped and removed as excavation continued (Plate 12). Any rocks that were part of the original stonework to the entryway or chamber were left in situ. The 5-cm levels from 20 to 35 cmbs consisted of very dark brown (10YR 2/2) humic silt loam with roots, sticks, and bark fragments, as well as loose pebbles, cobbles and boulders. Along the north wall, boulders were found in-situ that supported the stonework above, including the chamber entrance. Despite the original stonework being exposed, all the soil consisted of post-1955 fill. Artifacts recovered from these levels (20-35 cmbs) included modern machine-made clear bottle glass, plate/window glass, clear lamp/light bulb glass, plain whiteware ceramics (ca. 1820-present), plain ironstone ceramics (ca. 1842-present), and a fragment of unglazed molded redware that may be from a flowerpot (Appendix

V). Plastic bags, candy wrappers, sheet plastic, an aluminum soda can top with pop-tab, cellophane, aluminum foil, bark, and a “styrofoam” [polystyrene] cup base were noted and discarded. By 30 cmbs, the water table was encountered and could not be pumped out due to the boulders that were exposed across the EU (Plate 13). Due to the potential for the shifting or slumping of weight-bearing boulders supported in place by adjacent boulders under the hydric conditions, the removal of supportive boulders in the EU was halted. Not all of the boulders remaining were from in-situ stonework of the entryway. One boulder in the southwest corner of the EU had an aluminum beer can pinned under the rock, indicating post 1962 deposition. By 35 cmbs, all soil that could be excavated had been removed and lodged boulders and original stonework were all that remained. No further excavation was possible without the risk of slumping to the original stonework of the entryway and boulders that supported the chamber entrance.

EU NW2

EU NW2 extended east to EU NW1 and west to EU NW3. EU NW2 was staggered 50-cm north from EU NW1 due to the dense root mass-covered slope to the south and the prevalent lower elevation route from the stone chamber westward to the wetlands. Since the primary purpose of EUs NW1, NW2 and NW3 was to provide for a drainage route, these EUs followed the low-ground between the north and south slopes (Figure 15).

The existing conditions of the EU included several surface boulders in the northern half and the large root mass from the huge maple tree to the south (Plate 14). The eastern 30-cm of EU NW2, except in the northeast corner, was over the location of old excavation Trench 2 excavated in 1955 (Figure 16). Throughout the excavation of EU NW2, the loamy post-1955 soil from this area was excavated and screened separately from the rest of the EU and artifacts were bagged separately. The remainder of the EU encountered natural soil layers that had not been previously excavated.

The post-1955 fill in the southeast quarter of the EU consisted of very dark brown (10YR 2/2) loose spongy humic silt loam with sticks, bark, nuts, plastic, and beer bottle glass. Artifacts were recovered from the upper seven 5-cm levels of the post-1955 fill in this southeastern end of EU NW2. Artifacts recovered from the fill levels consisted of modern machine-made clear and amber bottle glass (1903+), and one fragment of whiteware ceramic (ca. 1820-present) (Appendix V). A plastic B-B pellet, plastic spray cap, plastic strip label stamped “GRADE 1”, aluminum foil, one piece each of coal and coal clinker, bark, a “styrofoam” [polystyrene] cup base fragment, and paraffin wax candle fragments were noted and discarded from these levels. By 35 cmbs, the fill tapered and ended on boulders and large roots from the large maple tree. The western limits of 1955 excavation Trench 2 had been fully exposed.

For the undisturbed portion of EU NW2 (the northeastern, northwestern and southwestern portions of the EU), the first three 5-cm levels consisted of A1 topsoil (0-5 cmbs, 5-10 cmbs, 10-15 cmbs), described as very dark brown (10YR 2/2) silt loam with numerous roots and pebbles and some cobbles. By 15 cmbs surface boulders were exposed across the EU and underlain with large roots from the maple tree (Plate 15). The boulders were removed, as their placement had been recent, as evident by the discovery of cellophane under one of the boulders, and excavation proceeded below them but between the large tree roots (Plate 16).

Artifacts recovered from the first three levels of the natural A1 horizon (0-5 cmbs, 5-10 cmbs, 10-15 cmbs) included modern machine-made clear bottle glass (1903+), plate glass and window

glass, brick chunks, painted wood, plain ironstone ceramics (ca. 1842-present), plain whiteware ceramics (ca. 1820-present), blue-edged whiteware (1820-1890) and a fragment of green transfer-printed whiteware (1828-1860), unglazed redware, and a 1993 Lincoln cent (Appendix V). A plastic B-B pellet, one piece each of coal and coal cinder, bark, “styrofoam” [polystyrene] cup base fragments, cellophane, and a cigarette filter were noted and discarded from these levels.

Below 15 cmbs, excavation in the undisturbed portion of EU NW2 encountered a deeper layer of loam identified as the A2 horizon (15-20 cmbs, 20-25 cmbs, 25-30 cmbs, 30-35 cmbs.), described as very dark grayish brown (10YR 3/2) sandy silt loam with pebbles and cobbles. These levels were excavated from between the large roots of the massive maple tree, cutting smaller roots but leaving large roots intact, as requested by the Upton Historical Commission (Plate 16). The large roots were not cut since loss of these roots could harm the health of the tree and destabilize the slope.

Artifacts diminished in the 15-20 cmbs level of the natural A2 horizon and included a fragment of redware ceramic missing surfaces, two fragments each of window glass and plain whiteware ceramic (ca. 1820-present), and a flat strip of black Bakelite, an early plastic common from the early to mid twentieth century. No recent materials were encountered. The 25-30 cmbs level did not produce any artifacts, and the 30-35 cmbs level produced a single piece of plain ironstone ceramic (ca. 1842-present).

Below 35 cmbs, excavation in the undisturbed portion of EU NW2 encountered a gravelly substratum identified during excavation as the A3 horizon of brown (10YR 4/3) gravelly wet silty sandy loam with pebbles and cobbles and numerous roots (Figure 17). By 45-50 cmbs, water was flowing into the EU, and excavation was stopped at 50 cmbs, due to large roots at lower levels prohibiting access to any soil (Plate 17). No cultural materials were encountered from the A3 horizon, indicating that it was culturally sterile. The gravelly stratum (USDA soil type - Canton fine sandy loam, extremely stony, Taylor 1998) is consistent with a wetland substratum such as the natural gravel layer encountered in the 1955 excavation at Trench 1.

EU NW3

EU NW3 abutted EU NW2 to the east and was staggered 50-cm north from EU NW2 due to the prevalent lower elevation route from the stone chamber westward to the wetlands. Since the primary purpose of EUs NW1, NW2 and NW3 was to provide for a drainage route, these EUs followed the low-ground between the north and south slopes (Figure 15).

The existing conditions of EU NW3 included several surface boulders in the EU and additional boulders adjacent to the east and west (Plate 18). Less than 20 cm to the north, an east-west stone field wall was located that followed along the property boundary of what was once land owned by the Ward family (Figures 7 and 15). EU NW3 encountered natural soil layers that had not been previously excavated. EU NW3 was in an area that had not been excavated in 1955.

The first two 5-cm levels consisted of Ao topsoil root mat (0-5 cmbs, 5-10 cmbs), described as a very dark grayish brown (10YR 3/2) silt loam of humic soil with leaf litter and a moderate root mat. By 10 cmbs surface boulders were exposed across the EU and one large flat boulder underlain the others at a depth comparable to the base of the stone field wall to the north (Plate 19). Boulders that were situated no deeper than 10 cmbs were removed as their placement had been recent (Plate 20).

Artifacts recovered from the first two levels of the natural Ao horizon (0-5 cmbs, 5-10 cmbs) included modern machine-made clear and amber bottle glass (1903+), window glass, lamp or light bulb glass, and an opaque (black) glass spherical bead 10mm in diameter. The bead was cast in two halves, possibly with a hollow center. It is likely modern in origin. Modern machine-made clear bottle glass (1903+), and an encrusted ferrous sheet fragment – possibly from a can - were recovered from below the removed stones (Appendix V). A plastic film canister cap, pink plastic tube, and clear plastic bag fragments were noted and discarded from these levels.

The next two 5-cm levels consisted of A1 topsoil (10-15 cmbs, 15-20 cmbs), described as very dark grayish brown (10YR 3/2) silt loam with a moderate density of roots (Plate 20). The large flat boulder had been exposed. It was left in-situ as it appeared to be intentionally situated level and perpendicular to the base of the stone field wall to the north and forming a step to the sloping ground to the west where wetlands are situated (Plates 20 and 21).

Artifacts recovered from the two levels of the natural A1 horizon (10-15 cmbs, 15-20 cmbs) included modern machine-made clear bottle glass (1903+), frosted lamp glass, plain whiteware ceramic fragments (1820-present), and encrusted ferrous fragments, a ferrous strip, ferrous sheet fragments – from a can or container, and two butchered long bones from a large mammal (Appendix V). The large mammal bones were long bone shafts likely from a cow or a large pig, with articular ends butchered and removed. One long bone shaft was half of a shaft midsection 16.5 m long, sawn lengthwise by a hand saw. The other long bone shaft was a 15 cm long complete midsection with sawn ends cut by a hand saw. A clump of electrical tape, tar paper and asphalt roof shingle fragments were noted and discarded from these levels.

The recovery of butchered mammal bone is interesting in light of the property having been owned by tanner John Hill prior to 1869. It is not known whether John Hill butchered cattle and processed the cattle hides at the tannery, or if hides arrived at the tannery and butchering took place elsewhere. If cattle were butchered at the tannery, which was located near the 18 Elm Street property, the Upton Chamber could have been used for cold storage of meat for a time. The recovery of the butchered bone from the same levels as twentieth century roof shingles and bottle glass indicates a mixed context at best, and there is the possibility that the butchered bones post-date the Hill ownership of the land.

Below 20 cmbs, excavation in EU NW3 encountered the A2 horizon (20-25 cmbs, 25-30 cmbs, 30-35 cmbs), described as very dark grayish brown (10YR 3/2) silty sandy loam with dense roots and pebbles and sparse cobbles. The main distinction between the A1 and the A2 was the amount of sand and pebbles in the soil, and a decrease in the rootlets. Artifacts diminished in these levels as well. From 20-25 cmbs of the natural A2 horizon, a fragment of frosted lamp glass and an encrusted indeterminate nail were recovered. No recent materials were encountered. The 25-35 cmbs levels did not produce any cultural materials.

Below 35 cmbs, excavation in EU NW3 encountered a gravelly substratum identified during excavation as the A3/B horizon (35-40 cmbs, 40-45 cmbs) of very dark grayish brown (10YR 3/2) wet gravelly silty sandy loam with pebbles and cobbles and moderate roots (Plate 22). Only one artifact was encountered in this stratum, a piece of light green tint window glass from 35-40 cmbs. The 40-45 cmbs level was sterile and had reached the basal depth of the large boulder in the west half of the EU (Plate 22).

By 45-50 cmbs, water was flowing into the EU from the water table and excavation stopped at 50 cmbs. The final A3 level was described as an A3/B substratum horizon of brown (10YR 4/3) silty

sandy gravel with pebbles and cobbles and lots of roots. No cultural material was encountered from this level, indicating that it was culturally sterile. Coring was conducted from 50 cmbs to 94 cmbs and encountered brown (10YR 4/3) hydric sandy clay with gravel to 72 cmbs and very dark grayish brown (10YR 3/2) hydric clay from 72 to 94 cmbs (Figure 17). The gravelly substratum (USDA soil - Canton fine sandy loam, extremely stony, Taylor 1998) is consistent with a wetland substratum such as the natural gravel layer encountered in the 1955 excavation at Trench 1.

Following excavation of EU NW3 and during restoration of the Upton Chamber masonry, a portion of the north profile of EU NW3 partly collapsed. One fragment of an aqua-tint mold-blown octagonal bottle was recovered from the loose soil from the profile. The bottle fragment likely dates from the mid nineteenth century Hill ownership of the property, or possibly later from the late nineteenth century.

With EUs NW1, NW2, and NW3 excavated, a drainage route was possible from the Upton Chamber westward to the wetlands (Plate 23). This would involve installing a drainage pipe under the maple tree roots in EU NW2 and going under the boulder in EU NW3. As later decided by the stone masons, the drainage plan as originally proposed would not work because the water in the Upton Chamber was from the water table, not a perched pool of water that needed a drainage outlet. The drainage route would have been gravity-based, but since the water in the wetlands was at water table, it was nearly the same level as the water in the Upton Chamber.

4.4.2 EXCAVATION UNITS WITHIN THE CHAMBER ENTRANCE AND PASSAGEWAY

The excavation of the two EUs inside the Upton Chamber started with EU CH1 inside the chamber entrance. Following this, the second EU (CH2) was excavated to the east [southeast] inside the chamber. Both EUs encountered fill and debris post-dating the 1955 investigation. As the chamber was flooded with approximately 30-33 cm of water, it was necessary to pump water out continuously. Soil from the EUs was excavated by 5-cm levels. All excavated soil was passed through one-quarter inch hardware cloth to ensure uniform recovery of artifacts. The EUs were excavated as deeply as possible, exposing large boulders across the chamber floor. The stability of the chamber's walls was poor in this area, however, and it was not possible to remove large boulders from the floor of the excavation without risking further shifting of the walls and collapse of the lintel, which was held up on its north corner by several inches of contact with the boulder below it. The removal of any boulders in EUs CH1 and CH2 had to wait for the installation of a timber support crib directly under the lintel. Some of the boulders were removed during the masonry rehabilitation. However, no intact flooring - whether of wood, stone or earth, or other structural elements (i.e., wood, post holes), were identified on the floor of the chamber.

EU CH1

EU CH1 abutted the chamber entrance on its west side [northwest] and EU NW1 outside the chamber. The location of EU CH1 was over the location of Trench 3 and part of Trench 4 excavated in 1955 (Figure 16). The EU extended west to EU NW1, north and south to the laid stonework on the north and south sides of the chamber passageway, and east to EU CH2 (Plates 24 and 25). Elevations were as much as 20 cm higher at the west end of the EU than the east end due to boulders and fill.

Excavation proceeded with 5-cm levels. The soil consisted of wet very dark brown (10YR 2/2) humic silt loam fill (F1) with leaves, sticks and bark fragments, the accumulation of post-1955 humus (Figure 17). Artifacts recovered from the first three levels (0-5 cmbs, 5-10 cmbs, 10-15

cmbs) included modern machine-made clear and amber bottle glass, window glass, clear lamp glass, and plain whiteware ceramics (ca. 1820-present) (Appendix V). Plastic bags, wrappers, a plastic star and a spray cap, candy wrappers, cellophane, painted fiber board, and bark were noted and discarded.

By 15 cmbs, boulders were exposed across the EU. These boulders were lodged in place against the slumping walls of the Upton Chamber passageway. Smaller rocks in fill that were not part of the passageway stonework were mapped and removed as excavation continued (Plate 25). Any rocks that were part of the original stonework to the chamber passageway were left in situ.

The final 5-cm level was from 15 to 20 cmbs and consisted of very dark brown (10YR 2/2) wet silt loam with gravel from between the large boulders that covered the floor of the excavation. A large elongated boulder was exposed (Plate 26) that apparently had fallen from the chamber ceiling as there was a gap in the stonework behind the lintel. EU CH1 was now hydric and excavated below the water table to the extent possible without removal of the large boulders. Any removal of the large boulders would have destabilized the chamber passageway walls due to the inward shifting of supporting stones in the hydric mud.

Artifacts recovered from the 15-20 cmbs level consisted of one fragment each of plain ironstone ceramic (ca. 1842-present) and light aqua tint window glass (Appendix V). Cellophane and painted fiber board fragments were noted and discarded. The excavation did not identify any historic remnants of flooring.

EU CH2

EU CH2 abutted EU CH1 to the west and was over the location of Trench 4 excavated in 1955 (Figure 16). The EU extended north and south to the laid stonework on the north and south sides of the chamber passageway (Plates 27 and 28). Most of EU CH2 was under the water table and had to be pumped out continuously during excavation.

Excavation proceeded with 5-cm levels. Elevations were about 20 cm higher at the west end of the EU than the east end due to boulders and fill. The soil consisted of water-saturated very dark grayish brown (10YR 3/2) silty sandy loam fill (F1) with gravel, sticks and bark, partly the accumulation of post-1955 soil and detritus mixed with gravel and sand from the chamber or from wall fall. The soil stratum remained the same to the base of the excavation.

During excavation, a lead-glazed rim fragment of a redware jar was uncovered in-situ, underlain by rock (Plates 29 and 30). Initially this was thought to be the floor of the chamber and that the rim fragment had been somehow missed during the 1955 excavation. Lead-glazed redware was a common utilitarian ceramic throughout the colonial period and into the first half of the nineteenth century. As the excavation proceeded, however, it became clear that the rocks across EU CH2 were the result of post-1955 accumulation, as a black plastic bag was underneath one of the lower boulders. The rim fragment was 5.5 cm in size, the largest piece of ceramic uncovered by the project. Very few pieces of redware were recovered from outside the stone chamber, so it is likely that the redware was not a recent arrival in the chamber, but was originally buried inside the chamber or had come from soil dislodged from the walls. A second mending fragment of lead-glazed redware was uncovered in the 5-10 cmbs level of EU CH2.

Artifacts recovered from the first three levels (0-5 cmbs, 5-10 cmbs, 10-15 cmbs) included modern machine-made clear and amber bottle glass, window and plate glass, clear lamp glass, a

broken light bulb, lead-glazed redware (17th-mid 19th century), plain whiteware ceramics (ca. 1820-present), blue transfer printed whiteware (1820-present), and plain ironstone ceramics (ca. 1842-present) (Appendix V). A plastic label and cap, broken prescription glasses (plastic, glass and metal), cellophane, painted fiber board, a ferrous metal beer bottle cap, a piece of coal clinker and bark were noted and discarded.

By 15-20 cmbs, boulders were exposed across EU CH2 (Plate 31). These boulders were lodged in place against the slumping walls of the Upton Chamber passageway. Smaller rocks in fill that were not part of the passageway stonework had been mapped and removed as excavation continued. Any rocks that were part of the original stonework along the chamber passageway were left in situ. EU CH2 was excavated below the water table to the extent possible without removal of the large boulders. Any removal of the large boulders would have destabilized the chamber passageway walls due to the inward shifting of supporting stones in the hydric soil. The excavation did not identify any historic remnants of flooring.

During excavation of both EUs CH1 and CH2 the condition of the north passageway wall was of great concern (Plates 32 and 33). There was previous loss of stonework and soil was coming in from around the stones, which could account for the occurrence of lead-glazed redware in EU CH2. As the water was pumped out, muddy water was percolating into the chamber from the floor and walls. This was also a concern, since it meant that soil from behind the base of the stone walls was coming into the chamber and could further destabilize the walls through soil loss and cause shifting or slumping of the stonework. As a result, water was only pumped out when excavation was in progress. Once the excavation was halted by boulders across the EU, the pump was turned off and the water table resumed its previous level within the chamber.

4.5 MONITORING OF THE MASONRY REHABILITATION FOR OSL SAMPLING

At the encouragement of Dr. Frederick W. Martin, the Upton Historical Commission requested that Optically Stimulated Luminescence (OSL) sampling be conducted as the stonework rehabilitation provided opportunities to take OSL samples from behind the stones in the chamber's passageway walls. JMA was contracted to monitor the work by the Upton Historical Commission when it was conducted. JMA presented a request to the MHC to include the OSL sampling and monitoring as part of the site examination work in a letter dated October 19, 2011, and the MHC approved the request and modified and extended the permit to include the OSL sampling and reporting on October 24, 2011. On October 25 and 26, 2011, Principal Investigator Martin Dudek monitored the Upton Chamber masonry rehabilitation of the destabilized and slumping entrance/front passageway of the Upton Chamber by stonemason Dr. David Stewart-Smith.

Prior to the monitoring of the masonry rehabilitation for Optically Stimulated Luminescence (OSL) sampling on October 25 and 26, 2011, the lintel had been cleared of stones that were on top of it. The lintel was restrained by a waistline belt and chain fastened to a tree located over the back chamber. As noted by Dr. David Stewart-Smith in Appendix I, the lintel at the entrance of the Upton Chamber appeared to have been shifted out of true but was fairly stable. The southwest wall supporting the lintel was stable but extensively involved with the roots of the large maple tree, which were not removed as pulling out tree roots would dislodge the stonework. The northeastern wall had lost some stonework compared to historical photographs from 1955 and prior. Dr. Stewart-Smith noted that the left hand side supporting the lintel also appeared to have been inexpertly rebuilt sometime after the earlier photographs; and that a stone lying on the floor

of the entrance may have fallen from part of the original lintel support and was then used to cover the opening.

Using a crib 8-x-8 inch timbers and two 4-x-4 inch stringers directly under the lintel (Plate 34), the lintel was supported in place while Dr. Stewart-Smith rebuilt the northeast wall to support the lintel, leaving as much of the original stonework in place as possible. It was necessary to remove the upper courses of stonework where stones had been lost and soil was washing in (Plate 35). During this work the south end of the lintel rested on the southwest wall. Dr. Stewart-Smith then disassembled the lower three courses of stonework.

The soil from behind the already removed upper courses of stone was brown and included many stones, which according to Dr. Stewart-Smith indicated that it was backfill from a previous repair. The fill included a loose boulder above and behind the lintel that was later noted as having a quarry mark (Plates 36 and 37) unlike boulders in the Upton Chamber which exhibit no evidence of quarrying. It is important to note that small-scale granite quarrying of bedrock or large boulders had taken place west across the brook from the 16 Elm Street property adjacent to and southwest of the project parcel. Several types of quarry chisel marks were present in these small quarries, including $\frac{3}{4}$ -inch drill holes employing plug-and-feather splitting techniques and elongated quarry marks. These stone quarries may date to the ownership of the land by tanner John Hill, who was active in the area by the 1820s and owned the project parcel until 1869. Additional quarried boulders were also noted in the field stone wall along the property line north of the Upton Chamber. The stone field wall had quarried rock in the middle height of the wall and on top, but not in the lowest level of the wall.

With respect to the quarry hole identified on the boulder above the Upton Chamber passageway and in the stone field wall, James Gage, a New England author and specialist on stone quarrying techniques, has the following comments:

Fred Martin kindly supplied us with a CD with photos of the lintel repairs and soil sampling at the Upton Chamber. In previous emails there was discussion concerning a round drill hole. We may be able to shed some additional light on this matter.

The partial remains of a round drill hole estimated by Fred Martin to be 2 inches in diameter was found in a stone on the exterior of the chamber above the lintel stone on the right [north] side. Based upon the photos and Fred Martin's description, the stone was not integrated into the structure of the chamber. It was placed on the chamber at a later date. A similar drill hole was found in a boulder integrated into the adjacent stone wall. It is likely the stone on the chamber is related to the adjacent stone wall construction.

Both the drill hole in the stone wall boulder and the stone on the chamber are consistent with 19th century blast holes. 19th century blast holes in boulders can be identified by the presence of a single hole drilled in the center of the boulder with a diameter of to 1 $\frac{1}{4}$ inches or greater drilled to a depth of 8 inches or more. (Pre-1800 blast holes are 1 $\frac{1}{8}$ inches in diameter or less and drilled to a depth of no more than 6-8 inches.) Blast holes were charged with black powder filling $\frac{1}{4}$ to $\frac{1}{2}$ the length of the hole. The remainder of the hole was filled with a tamping material (stone dusts, clay, sand, etc). A fuse was inserted and the charge detonated. Depending on the characteristics of the stone, the blast would split the boulder into 2 to 3 pieces. The blast could either split the boulder in half with a straight line split or split the boulder in a "V" shaped split pattern. The boulder in the stone wall exhibits the straight line split and the stone on the chamber a "V" split.

We toured the Upton chamber several years ago. We took a good look at the adjacent stone wall. We noted that the large heavy boulders and stone were used in its construction. The width of the wall was also substantial. Both of these are characteristics we have seen with 19th century barn foundations.

(James Gage, email communication to Dr. F. W. Martin, May 1, 2012).

No quarry marks have been identified on any of the boulders used in the construction of the Upton Chamber. Boulders were used in their natural state, with the possible exception of stone-ground modification of the rear edge of the lintel noted by Dr. Stewart-Smith. Dr. Stewart-Smith stated that the joint between these slabs was formed by battering the edge, and then abrading it, so that the edges matched. The lack of any quarried stone in the Upton Chamber stonework makes it likely that it was built prior to active quarrying in the area. If the quarrying was related to the land ownership by tanner John Hill, then it would imply that the Upton Chamber predates the Hill ownership of the land. Use of the Upton Chamber by John Hill would not necessarily be for the same purpose that the chamber was originally constructed for.

While Dr. Stewart-Smith disassembled the lower three courses of stonework, locations were selected for OSL sampling by Dr. Stewart-Smith behind or adjacent to in-situ stones and driven in using a sampling tube (Plate 38). The work was assisted by Dr. Frederick Martin who readied each sampling tube and packaged them following the sampling (see Section 4.5.1 below). A total of six OSL samples were taken from behind boulders in the lower north wall. During the course of the masonry rehabilitation of the north wall, a large stone ("stone d" in Appendix VII) of the first course of stones was removed that rested on a "big flat stone." The big flat stone appeared wet because water was encountered (Plates 39 and 40). To establish a good foundation, the gravelly soil was removed above the flat stone and carried out in buckets. During this activity, a weathered fragment of wood was recovered from the gravelly soil (discussed in Section 4.5.2). Pockets of slumping soil from behind the stonework was excavated by trowel and repacked with trap rock. The north wall near the entrance was then rebuilt with original boulders, leaving the lowest course intact and several other boulders that were in-situ and held in place with temporary wood blocks.

Following the rebuilding of the north wall, the two 4-x-4 inch stringers directly under the lintel (Plate 34), were replaced with a single 8-x-8 inch stringer at the center (Plate 41) to better support the weight of the lintel to the south and reduce the risk of timber failure. On October 26, 2011, the lintel was restrained by the midline belt as before, but rested on the single 8-x-8 inch stringer and on the rebuilt stone wall on the north (left) side of the passageway. Using the belt, the stone masons pulled the lintel back toward the beehive chamber (Plate 42), forming a close fit with the next roof slab to its rear. Both the roof slab and the lintel had been relieved some 3 inches, as if to support a covering stone above this joint. The stone masons then rebuilt the south wall, which was only necessary to do for the upper courses of stonework, as the lower courses of stonework were set firm and tight. Two OSL samples were taken from the south wall at this time. The hydraulic jack under the 8-x-8 inch stringer that supported the south side of the lintel was then slowly lowered to situate the lintel onto the south (right) wall once the wall was rebuilt.

The final step of chamber stonework rehabilitation for the chamber entrance involved removing the timber cribbing and using a winch to extract the fallen ceiling boulder from EUs CH1 and CH2 for reuse behind the lintel (Plate 43). The boulder was winched out and moved up ramps to the top of the chamber entrance and situated behind the lintel in the gap between the lintel stone and the next roof slab. Following completion of the stonework rehabilitation on the chamber

entrance, the remaining loose boulders were reused to create a low entryway wall outside the chamber entrance on the north side of the entryway, similar to that seen in the earlier photographs of the chamber entrance (Figures 8 and 12a). This work took place after the monitoring for the OSL sampling and was not monitored by the Principal Investigator. Photographs of the completed outer entryway from November 2011 can be seen on Pages 12 and 30 of Appendix VIII.

4.5.1 *OPTICALLY STIMULATED LUMINESCENCE SAMPLING (OSL)*

Luminescence dating is a chronological method that has been used extensively in archaeology and the earth sciences. It is based on the emission of light, luminescence, by commonly occurring minerals, principally quartz. The method can be applied to a wide range of materials that contain quartz or similar minerals. For pottery, bricks and burnt stones, the event being dated is the last heating of the objects. Another very common application is to date sediments, where the event being dated is the last exposure of the mineral grains to daylight. The age range over which the method can be applied is from a century or less to over one hundred thousand years (Duller 2008:4). Optically stimulated luminescence has become the most commonly used method of luminescence dating. As soon as the stimulating light is switched on luminescence is emitted by the mineral grains releasing electrons stored within the minerals. As measurement continues, the electrons in the traps are emptied and the signal decreases. The signal is termed optically stimulated luminescence (OSL) (Duller 2008:6).

As reported by Dr. Martin (Appendix VII), the aim of the OSL sampling at the Upton Chamber was to get soil samples from behind the lowest stones in the wall of the chamber suitable for dating, with a sample being sent to the US Geological Survey lab (USGS) in Boulder, Colorado, for an age determination of the last time the sample was exposed to daylight. Dr. Frederick W. Martin, a semi-retired physicist, coordinated the sampling and has provided a reliable account of the sampling, which along with the report on the results of the OSL age determination, are included in Appendix VII of this report.

On October 25 and 26, 2011, Principal Investigator Martin Dudek monitored the OSL sampling during the masonry rehabilitation by stonemason Dr. David Stewart-Smith. Dr. Martin supplied the equipment and sampling tubes for the OSL and Dr. Stewart-Smith hammered in the OSL sampling tubes due to safety concerns and limited work space within the timber support crib inside the chamber. Peter Wiggin, a stonemason, took photographs of the OSL sampling from inside the chamber for public safety reasons, while Brendan Strickland assisted them. Visitors included Barbara Burke and Cathy Taylor of the Upton Historical Commission, which approved financial support for the OSL dating during the monthly meeting on October 18, 2011.

OSL sampling was conducted on the north passageway wall of the chamber on October 25 while the 3-ton stone lintel was restrained by a waistline belt and resting on two 4-x-4 inch stringers placed between cribs of 8-x-8 inch timbers built inside and outside of the chamber, with its right end resting on the south chamber wall. The upper courses of the north wall had already been removed and Dr. David Stewart-Smith was disassembling the lower three courses of stonework.

Dr. Stewart-Smith selected locations behind in-situ stones and hammered in the sampling tube (Plate 38), Mr. Wiggin took a near and a far picture of each sampling, and Dr. Martin received and secured each sample in turn. A red plastic cap was put on the end of the steel pipe sample tube by Dr. Stewart-Smith immediately as he withdrew it from the hole, and the description of location given by Dr. Stewart-Smith was recorded by Dr. Martin. Dr. Martin then put the assembly under a rubber raincoat; unscrewed the 6-inch sample tube from the reducing coupling

to the 24-inch long driving pipe; tested for soil at the driving end; added a red plastic cap at the driving end; added a numbered label to the tube; rolled the tube up inside a light-tight black plastic bag; and sealed the bag with a numbered label. If the tube was less than half full, it was discarded as a failed sample; if it was more than half but not full, newspaper was pushed into the driving end of the tube to keep the sample from mixing during transit. Sample tubes consisted of 1¼ inch nominal blacked steel pipe with an inside diameter of 1-3/8 inch. The red plastic end caps had an inside diameter 1-5/8 inch and the light-tight black plastic bags were Delta Safe-T bags for photographic paper. Where possible a bulk sample of soil was taken from the sampling location for measuring background radiation.

OSL Samples #1 to #6: Samples #1 to #6 were taken on October 25, 2011. Dr. Stewart-Smith noted that bleached oxidized soil (a.k.a. subsoil) was above the third course, and down at least to the level of the joint between 2nd and 3rd courses. He drove sample #1 horizontally into the region behind the removed 3rd course, above a stone of the 2nd course. This stone is located about 24 inches (61 cm) into the tunnel from the exterior face defined by the final placement of the lintel and the north wall above EU CH1. Later samples were placed in sequence in a roughly vertical line at this depth into the passageway. He drove sample #2 down at an angle behind the second course, reaching a distance about 18 inches (46 cm) behind the face. He drove sample #3 horizontally at the bottom of the second course, to a verbally-stated depth of 3 ft (91 cm). At the same level he drove a "deeper" sample #4 starting at a verbally stated 1 m from the face. Sample #5 was driven behind a stone of the 1st course. The stone was verbally estimated as 18 inches wide by 24 inches deep by 10 inches high (46-x-61-x-25 cm), and the sample was recorded as 2½ ft (76 cm) behind the wall surface. Dr. Stewart-Smith stated that there is fine-grain gravel with pebbles behind the first course, which did not look like backfill from repairs. Sample #6 was driven vertically downward in a space beside a stone at a location verbally stated to be 18 inches (46 cm) from the face of the wall, and at the base of the 1st course of stones. No depth was recorded. Another attempt to reach a lower level was made, but it failed due to presumed rock refusal at 4 inches (10 cm) depth under the wall, resulting in specimens which did not fill the sample tube.

OSL Samples #7 to #8: Samples #7 to #8 were taken on October 26, 2011. Dr. Stewart-Smith conducted the sampling under the lintel stone which remained unsupported by the south (right) chamber wall. The masons had removed the upper courses from the south chamber wall and then began sampling. Sample #7 was taken at the back end of a previous repair at the level behind the top remaining course. A bulk sample was collected but no depth was recorded. A sampling attempt was made at the middle of the previous repair through a hole at the bottom of the 3rd course of stones, but failed to recover a sample. Likewise an attempt at the middle of the repair, at the level of "the fourth course from the top" failed to recover a sample. Possibly stones in the backfill from a previous repair blocked the end of the collecting pipe. Finally sample #8 was obtained near the front face, at the same level as the 4th course from the top remaining course. This sample only filled 1/3 of the collecting tube length, but was saved nevertheless. No bulk sample was collected. Sample #8 was the last OSL sample taken from walls of the stone chamber.

OSL Samples #9 to #10: Samples #9 to #10 were taken by Dr. Martin and Principal Investigator Martin Dudek on October 26, 2011 as geological control samples from below the base of excavation in EU NW3, outside the stone chamber. The stratum at the base of excavation consisted of silty sandy gravel sterile of cultural material and overlaying a clay deposit. Initial attempts failed due to the wet condition of the soil which fell out of the sampling tube. Mr. Dudek used a 4-inch diameter bucket auger to bore a hole at the bottom of EU NW3. This hole quickly filled with water from the surrounding water table. Its bottom was measured at 29 inches (74 cm)

from the ground surface and the sampling pipe was driven in from this level. Sample #9 was thus obtained with 4 inches (10 cm) recovered in spite of the wet conditions. A bulk sample was also collected. After two more attempts sample #10 was obtained by driving the pipe in at an angle to the vertical. The top of the driving pipe went to 8 inches below the base of the auger hole in EU NW3 and the hole was measured at 37 inches (94 cm) deep. A bulk sample was also obtained.

Age Determination on OSL Sample #5 (Mahan 2012 – Appendix VII)

OSL Sample #5 was submitted October 31, 2011 to Shannon A. Mahan, Director of the Luminescence Dating Lab at the U.S. Geological Survey, Crustal Geophysics and Geochemistry Science Center, Denver, Colorado for age determination. The following results on the OSL age determination are presented in the report by Ms. Mahan in Appendix VII in the report entitled *Optically Stimulated Luminescence (OSL) data and ages from an archeological non-destructive field investigation at the stone chamber in the town of Upton, Massachusetts* (Mahan 2012).

Most minerals react to ionizing radiation by essentially gaining energy at the electron level, which accumulates through time if that energy is not released by some outside stimuli (sunlight or intense heat over 200 °C). Thus, sediment grains can record their exposure history to ionizing radiation, which can then be “read” in the laboratory and used as a clock. This procedure is referred to as luminescence geochronology, the goal of which is to establish the timing of the burial of mineral grains in sedimentary deposits. In terrestrial environments, exposure to sunlight during sediment transport resets the clock and it is also why a luminescence age is considered to be a burial age. In the laboratory, sediment is stimulated to emit light, which is measured. The sediment is stimulated by exposure to light of specific wavelengths (optically stimulated luminescence, OSL) or heat (thermoluminescence, TL) in a prescribed manner. The intensity of emitted light measured in the laboratory is proportional to the trapped charge population, which is proportional to the total absorbed radiation dose that the sedimentary deposit experienced, and that relation is proportional to the time elapsed since burial (Mahan 2012 - Appendix VII).

The aim of this project is to obtain and document the sampling of sediment taken from behind the rock walls during the masonry reconstruction of the Upton Chamber in Massachusetts. The rationale for using luminescence to put an age to the Upton Stone Chamber construction is that sediments within the top few centimeters of a stable surface will get brought to the surface through bioturbation and thereby bleached during normal geological processes. Bleaching is a process that is curtailed by placement of a rock on the surface. Only the top grains are expected to be fully bleached, but the application of any luminescence dating should yield the age of the retaining rock wall of a passage or at least the bottom or floor of the rock emplacement (Mahan 2012 - Appendix VII).

Field sampling and protocol:

The procedure prescribed by the US Geological Survey for obtaining samples suitable for dating by OSL was used. The contractor had to dig out behind the walls in order to stabilize them, and after OSL samples were taken and other in-situ studies completed, masonry reconstruction took place (Fredrick Martin, written communication, 2011). The report by Mahan (Appendix VII) presents the final data and ages for Sample #5, which was deemed as having the best chance for unbiased dating out of the samples collected. The archeological sample is expected to come from the bottom of a narrow trench, about 4' deep x 1' wide x 2' long (122 cm x 30.5 cm x 61 cm), dug behind a stone retaining wall which forms the entrance passageway of the ancient stone chamber.

Source geology for the stone wall was determined to be granite and mafic rocks of Cretaceous age, which correlates with the surficial geology of the area.

Steel pipes were used as sample containers and sampling was completed in the daytime but care was taken to limit exposure of the tube ends to light while capping. A bulk sample of the sediment and cobbles of rock of the same material in the wall were collected at each OSL sample site for dose rate calculation purposes. No modern sample was collected.

Determining the Dose Rate (DR) from elemental concentrations of the sediment and rocks:

Most ionizing radiation in the sediment that gives rise to the luminescence phenomenon is from the decay of isotopes in the uranium and thorium decay chains and the radioactive potassium (40K) element. The dose rate was obtained using elemental concentrations (K, U, Th, and Rb) as determined from Gamma Spectrometry. The gamma spec provides the isotopic discrimination of gamma rays; correspondingly, beta and alpha dose rates may be estimated. In the laboratory, the bulk sample was counted in a high-resolution gamma spectrometer fitted with a germanium detector. Cosmic-ray dose rate data was estimated for each sample as a function of depth, elevation above sea level, and geomagnetic latitude. Sample processing and analysis technical procedures are detailed in Mahan's report in Appendix VII.

RESULTS:

1. Partial bleaching or dispersion of the equivalent dose analyses and preferred statistical methods. The dispersion on the equivalent doses obtained in the sample (Upton #5) do show skewness (distortion or bias or not having equal properties above and below the mean), which is normal for samples which have had a shallow fluvial or alluvial origin or many generations of depositional cycles with extensive bioturbation within the sediment. Since the dispersion and skewness are generally high for these samples, the minimum age model was used to calculate the equivalent doses and thus the ages.

2. Strength of the luminescence signal from Sample #5. In many samples of quartz, three main components have been observed and are informally called the "fast", "medium", and "slow" components. The fast component of OSL is usually required for accurate analyses and reliable age determination, unless one wishes to engage in time-consuming efforts to de-couple the growth curve components. The initial part of the signal in these samples was observed to have the fast component and thus de-coupling was not needed. However, fully one-third of the aliquot samples either had a very dim signal or no signal at all. The dim signal was not unexpected; after all the sediment could have been covered by the rocks at any time in the past, but it was estimated, before actual OSL measurements were carried out, not to have been more than one thousand to five hundred years ago. More than likely the dim signal was simply measuring a modern component of grains or grains with no luminescence. Because the dose rate was moderate, a signal would have developed rather quickly; in this case that was an unexpected bonus. The data then did not suffer from signals that were barely above background or were insensitive to stimulation and measurement.

3. Dose rate heterogeneities and comparisons between techniques. This is a definite uncertainty in the dose rate data. The sediment is assumed at the time of sampling to be derived solely from the bedrock and to suffer no disequilibrium in the uranium decay chain throughout the lifetime of the luminescence being measured. Only one technique was used to detect the elemental concentrations (gamma spectrometry), and by measuring both original and storage

sealed gamma rays from the packaged sample, disequilibrium does appear to be small to non-existent.

Because the pervasive rock was the granite or metamorphosed granite, both of which could contain large crystals of potassium feldspar, there is a strong probability that microdosimetry may have occurred to and within some of the grains. That is, a grain of quartz lying next to a grain of feldspar may have been “dosed” more than a quartz grain lying next to a biotite, another quartz, or other heavy mineral (such as hornblende or augite). This probability was not pursued in much detail because there was only one sample from the site that was analyzed and no reasonable comparison could be made of differing sample locations within the wall. It would, however, look very similar to a partial bleaching problem (i.e. aliquots or grains with a larger measured equivalent dose than about 80% of the other measured equivalent dose values).

One other potential cause for concern could be that no in-situ dose rate data was taken, but the alternatives (leaving a copper capsule buried for several months or digging deeper and wider holes for a large probe) would not have left the site as intact as did taking smaller, representative samples.

Radioactive disequilibrium was not assessed by looking at the differences in the isotopes measured for uranium and thorium (for example, using differing techniques that may measure varied isotopes of the uranium-thorium decay series). However, based on previous studies in similar rock type and the timed gamma spectrometry tests, the author did not believe any significant disequilibrium exists.

4. Severity of the bioturbation. The radial plots do not seem to show extensive bioturbation. One way to test this in future samplings would be to take one sample from beneath the center of a rock as well as a sample from the edge of the rock to determine horizontal turbation; in other words whether modern grains would have been brought in under the rocks through normal geomorphic processes of soil swell and shrink, biologic agents like ants, small mammals, or from other anthropogenic activities.

5. The probable age of Upton Sample #5 is as follows:

The age associated with Upton Sample #5 is 363 years (± 16 years) or 1664-1632 A.D. in calendar terms (calculated from 2011 A.D.) or 393 years (± 26 years) between 1644-1592 A.D., depending on how the data is graphed and shifted. The age from the same Upton Sample #5, when some of the higher equivalent dose population is included, is 490 (± 25 years) or 1546-1496 A.D. in calendar years or 554 years (± 35 years) or 1422-1492 A.D. in calendar years. There are no calibration curves or adjustments that need to be made as there would be with radiocarbon ages. Luminescence is not an isotopic decay method and quotes to calendar years by default.

There were groups of outliers in the equivalent dose and Upton Sample #5 had some aliquots that were thrown out before radial plotting (see Appendix VII). The ages come from two populations of equivalent doses; one at 1664-1592 A.D. and one at 1546-1422 A.D. The uncertainty in the ages is one sigma (68% confidence level), errors include both random and systematic errors, and the ages were rounded up to the nearest tens in the text to facilitate easy discussion. The ages should be considered to start from the year 2011; the year of sample collection (i.e. if we went back to sample five years from now the ages would be five years older than the ages obtained in 2011). I will discuss the implications of these ages below.

There are five results discussed with respect to the probable age of Upton Sample #5: equivalent dose heterogeneities and partial bleaching, strength of the OSL signal, dose rate heterogeneities, implication of the severity of any bioturbation, and the range of ages as measured from the luminescence.

1. Evaluation of the equivalent dose analyses. The quartz grains had the “fast” component of OSL, there were some grains that returned a signal considered to be either modern or background, and statistical analyses of the scatter in the equivalent doses show clear signs of partial bleaching that could be separated from the rest of the grain sediment populations. However the introduction of modern grains deep within the sediment profile (bioturbation) is not a common problem at this site. Plotting of the equivalent doses show scatter above the radial plot two-sigma bar that points to partial bleaching tendencies but there was also a clear grouping of equivalent dose populations that were not related to partial bleaching; enough to conclude that an anthropogenic influenced signal is present. However the presence and complications of beta microdosimetry are more than possible and so the most conservative estimate of the equivalent dose population should be used to avoid overestimating the true age. These points strongly suggest that the age model the author used (Minimum Age Model) will return the most reliable and reproducible amalgamation of equivalent dose analyses until such time as a five or more samples from the same site have been analyzed.

2. Strength of the luminescence signal from the samples. The quartz had a beautifully clear and strong signal and was sensitive to the blue light stimulation. There was absolutely no problem with the strength of the signal, unless the grain was modern or had no luminescence. This was due to the moderately high dose rate that creates luminescence in a very short time. In spite of the young age of the sites there was enough precise data to return reliable and accurate ages. A failure rate of 35% is considered to be acceptable in this case, especially when the failure rate was mostly that there was simply no signal to measure and not a failure of the sample to pass protocols. The lack of signal could have been due to grains that would never emit any luminescence because they did not have the proper mineral characteristics or simply due to those very young grains that had not “grown in” any luminescence.

3. Dose rate heterogeneities and comparisons between techniques. There were no in-situ methods taken for dose rate data, and this is a major concern in the dosimetry because of the unknown uniformity of the geological source of the rocks at the sites. There was no radioactive equilibrium detected within the gamma spectrometry lab (samples measured before and after a time-delay), so this factor would seem to be negligible. The dose rates as calculated from the elemental concentrations are accurate and well reflect the amount of ionizing radiation the grains would have been subjected to after the rock was placed over them. The biggest concern, iterated from above, is that that microdosimetry may have occurred to and within some of the grains. This would look, to varying degrees, like partial bleaching which is why Mahan recommended the lowest equivalent dose population until such time as the variation in other samples from the site have been tested and a more detailed geological survey is done of the rock in the wall.

4. Severity of the bioturbation. There was no test of bioturbation taken; such as taking one sample from the center and one from the edge of rock to determine the degree of horizontal turbation (modern grains brought in under and around the rocks). One test would not completely rule out the significance of horizontal turbation disrupting the results, but it at least would show that it is not a critical component to factor into the age of the sediment beneath the stone wall.

5. The ages of the sediment beneath the rock. Based on the data measured, and in the strictest sense of the data, the sampled layers beneath the rock mean only that that particular rock was emplaced there at the calculated age that has been assigned to the sediment beneath or behind the rock. It is entirely possible that placement of the other rocks in the walls could be younger, but it is also possible that they could be older. If we look critically at the data, it looks as though the one population is about a hundred years older than another, but it could also mean that we sampled older rock-building at that site. The errors on the equivalent dose measurements are about 4 to 5 percent (at one sigma). In general, these errors are small and much better than expected to get without running the samples to another 100 aliquots and taking even more time to measure.

The data does tell us that the minimum age of the wall rock emplacement for Upton Sample #5 is either between 1664 A.D. and 1632 A.D, or (using another method to calculate the equivalent doses) between 1644 and 1592 A.D. The age from the same Upton Sample #5, when some of the questionable higher equivalent dose population is included, is either between 1546 A.D. and 1496 A.D or between 1492 A.D. and 1422 A.D. in calendar years, which could make the site pre-Columbian (Mahan 2012 – Appendix VII).

Discussion of OSL Results by Principal Investigator Martin Dudek

While luminescence dating and OSL in particular have been extensively used in Europe, the technique has not been widely used in New England for dating archeological contexts. The author is not aware of any colonial or historic features in New England where OSL has been used for dating, much less stone architecture of undetermined age. The lower age limit or limit of effective dating for more recent archeological contexts is difficult to define but controlled by two factors: 1) how well the luminescence signal was reset at the time of the event being dated; and 2) the luminescence sensitivity of the mineral being studied (Duller 2008:21). For young samples the quantity of the equivalent dose - the dose or measure of the amount of energy absorbed by a sample - is likely to be small and so the luminescence signal maybe weak. Recent OSL studies show that in favorable conditions ages in the last few centuries can be achieved, even for heated materials such as bricks. For young samples it is particularly important to undertake luminescence measurements to determine the most appropriate preheat treatment. This is because thermal transfer can erroneously increase the apparent age of sediments if too high a preheat temperature is used (Duller 2008:21).

In recent years luminescence dating has been applied to the construction of brick-built structures in England. To evaluate and demonstrate this potential, samples of bricks were collected from several buildings whose ages were well known from documentary evidence or from dendrochronology, with their ages ranging from AD 1390 to AD 1737 (Duller 2008:35). The comparison between the OSL ages and the assigned dates was “extremely good” and the typical error on the OSL ages was only 25 years, even allowing for systematic errors. Analysis of bricks from another site, Alford Manor, gave OSL dates some 55 years earlier than the assigned ages, and subsequent structural analysis showed that the part of the building that had been sampled had been rebuilt, possibly re-using bricks from an older structure (Duller 2008:35-37).

OSL dating lacks similar studies applied to New England sites of known ages. How well the luminescence signal was reset at the time of the event being dated is of critical evaluation for backfilled builder’s trenches and fill horizons related to construction events. It would be very interesting to see OSL dating applied to earthworks from colonial or historic forts of known age, as well as builder trench fill from houses or buildings of known age, to better assess the ability of applying OSL to stone structures of unknown age in New England. Mahan’s recommendations in

her report (Appendix VII) includes running at least four more OSL samples from the Upton Chamber, assessing mineralogical content, analyzing a modern sample from near the site, applying single grain dating, and having a geological survey of the rock wall for better refinement, corroboration or assessment of data and site processes with respect to the results. Given these recommendations, the OSL results from the Upton Chamber are both intriguing and preliminary.

Seventeenth Century Context of Upton

The age associated with Upton Sample #5 is 363 years (± 16 years) or 1664-1632 A.D. in calendar terms (calculated from 2011 A.D.) or 393 years (± 26 years) between 1644-1592 A.D. These dates are preliminary, pending further evaluation of additional OSL samples and further analysis of site processes. If the OSL results have erroneously increased the apparent age of sediments, then a colonial/eighteenth century date of construction for the Upton Chamber is reasonable. If the chamber was built in the eighteenth century, it would most likely have been built for cold storage of crops and food products by one of the early settlers of the property, such as the Ward family (Blomquist and Morrel 1983), prior to the later subdivision of the land. If the seventeenth century date is accurate for the construction of the Upton Chamber, it would be earlier than the eighteenth century settlement of Upton by Euro-American colonists and possibly prior to King Philip's War in 1675-76. During this period the Upton area served as seasonal hunting and gathering grounds from the larger base camps located to the northwest in Grafton or to the southwest in Uxbridge. Warren and Center brooks, in the east, Pratt Pond in the center, and Taft Pond to the south provided sites for fishing and agriculture and therefore were used more intensively than the area to the north and the west (MHC 1983:2).

The seventeenth century was a time of rapid change and significant European Contact for the Native American communities. In the neighboring town of Grafton northwest of Upton, the third of the seven original so-called Praying Indian villages had been established by Christian missionary John Eliot at Hassanamesit in 1654 in what was then southern Nipmuc country (MHC 1984:3, Carlson 1987). In 1674 Hassanamesitt was described by Daniel Gookin as "rich land" which produced "plenty of corn, grain, and fruit" and was an "apt place for keeping cattle and swine" (Gookin 1674:45). Following King Philip's War (a.k.a. Metacom's Rebellion) in 1675-1676, Hassanamesit was re-established, and Native Americans of Hassanamesitt affiliation continued to live in Grafton, Upton and neighboring towns from the seventeenth century onward (See Doughton in A. Forbes, 1991). However, the Native American population decreased and most of the land was otherwise redistributed among European-American settlers over time. In 1704, when the town of Sutton was granted to the English, the area that is now Grafton was reserved for the Hassanamesit (Nipmuc) Indians under the name of Hassanamisco. Prior to 1728 nine English families had been granted permission to buy land within Hassanamisco's bounds, and in 1728 the General Court sanctioned the purchase of nearly all of Hassanamisco, an area of nearly 8,000 acres, from the Nipmuc, setting aside only this small tract of 4.5 acres as Indian property for eternity, which has persisted to this day at Hassanamisco (A. Forbes 1991).

If a seventeenth century date of construction can be established for the Upton Chamber, there could be a direct connection between Hassanamesitt in Grafton and the construction of the Upton Chamber. One possibility is that the Upton Chamber could have been constructed as a safe house or place of refuge for Native Americans. The distance from the Upton Chamber and Hassanamesitt in Grafton is less than five miles. The route from Elm Street where the Upton Chamber parcel is located to Hassanamesitt in Grafton was fairly direct from Main Street (Route 140) in Upton to Old Upton Road in Grafton. Native American trails in Upton included a

northeast route past Pratt Pond to North Pond (Maspenook) in Hopkinton conjectured as Main Street-Elm Street-Hager Road (MHC 1983:2). Elm Street has also been identified as a branch of the Connecticut Path (Goodwin 1946:43).

The possibility of a constructed chamber or “cave” of refuge is not entirely unknown from the area. A nineteenth century history of Westborough, which neighbors Upton to the north, mentions that “One of the most interesting Indian relics is on the old Johnson farm, now owned by Mr. Daniel Ruggles. This is a large cave, made by its aboriginal owners into two rooms. In one of them was a well-constructed fireplace. Many years ago it was struck by lightning. It is still occasionally frequented by strolling Indians, as is shown by bows and arrows and other material left by them” (H. Forbes 1889:176). The location of the Ruggles farm, formerly the Johnson farm, is presumably in Westborough. The reference is interesting in that it mentions continuity in use or visits to a cave by Native Americans. The cave had constructed elements, but whether the cave was entirely built by Native Americans or was a natural rockshelter that was modified is not clear from the text.

Prior to the incorporation of Upton in 1735, the portion of Upton where the Upton Chamber is located was within the town of Hopkinton, which was incorporated in 1715. Part of Hopkinton was formerly land purchased on behalf of Harvard University (MHC 1980:1), and Whittall states that the Pearsons traced the 18 Elm Street property deeds back to the early 1700s and that the land was part of a Harvard College grant of common lands from the Bay State Colony (Whittall 1979:32). The possible connection of the Upton land to Harvard University brings up questions into the nature of land use and involvement with the Native communities in and around the land grant. Harvard University established the Indian College ca. 1655 (<http://www.peabody.harvard.edu/node/477>), and John Eliot was actively involved during the early years of the Indian College. At the same time, Elliot was actively involved in promoting the economic development of the Native community.

At the Praying Indian Town of Magunkaquog established in Ashland, John Eliot taught the natives to make cedar shingles and clapboards in 1669. Eliot writes of the natives: “Unto which work in moiling in the swamp they are fitter than many English, and many English choose to buy them of the Indians than to make them themselves” (Metcalf 1988:19-20). Wood products from the Praying Indian Towns benefited the local and regional economy. At Ponkapoag Plantation, a Praying Indian town of about 6000 acres established by Elliot in 1657 on the western side of Ponkapoag Pond, the inhabitants also integrated more traditional foraging patterns with new activities oriented toward the neighboring colonial communities. These activities included planting, keeping cattle and swine, and fishing in the ponds and the Neponset River, as well as the production of cedar shingles, timber and other wood commodities, and the sale of labor as itinerant construction workers (Carlson 1987). By teaching the natives to make cedar shingles and clapboards for sale to colonists, Eliot was doing more than teaching a useful skill; he was actively involved in trying to integrate the Native Americans of the Praying Towns into the market economy at the local and regional level.

The relationship of stone structures to the Praying town Elliot established as Chaubunagungamaug (Webster) has been suggested for three stone structures identified in an archeological survey in Douglas, southwest of Upton. Two stone structures consisted of “U”-shaped stacks, possibly stone chimneys, while a third stone structure consisted of a stacked stone pile associated with hand-molded bricks. Archeological test pits at one stone structure did not recover cultural material while testing at a second stone structure identified charcoal-rich features associated with a green siltstone celt, a quartz bifacial tool, and a wrought/cut nail fragment. All

three stone structures were considered to be potentially significant archeological sites that may be related to the historic/Praying Village occupation of the Lake Chaubunagungamaug area by Native Americans. These sites may be dwelling locations related to the use of the Douglas Woods area for timber-related products that included cedar shingles, hoops and barrel staves that Douglas supplied to Boston in the eighteenth century (Dudek and Smith 2010).

The OSL date for the construction of the Upton Chamber raises more questions than it answers. At the most basic level is the question of accuracy. Is the mid seventeenth century OSL date accurate for the construction of the Upton Chamber? More OSL analysis and other lines of investigation, both archeological and documentary, would be beneficial to address the issue of the chamber's age. If the date of the Upton Chamber's construction is from the mid seventeenth century, then the purpose and relationship of the chamber to the Native community, Hassanamesitt, and possibly to Harvard University needs to be investigated.

4.5.2 *RADIOCARBON DETERMINATION ON WOOD SAMPLE*

Radiocarbon dating was conducted on a piece of wood recovered during the masonry rehabilitation. As the wood was not recovered in-situ, the context of its origin was uncertain.

During the course of the masonry rehabilitation of the north wall, a large stone ("stone d" in F. Martin's report – Appendix VII) in the first course of stones was removed that rested on a "big flat stone." The flat stone appeared wet because water was encountered (Plates 39 and 40). Mr. Wiggin, one of the stone masons, said that when he pulled out a tree root, there was a flow of clear water, as of "a spring from below." To establish a good foundation, the gravelly soil was removed over the big flat stone, and carried out in buckets and dumped into the previously excavated EU NW3, which was no longer needed for drainage. Principal Investigator Martin Dudek went through the dumped sediments and recovered a weathered fragment of wood from the sandy gravel that measured 11.2-x-3.3-x-1.2 cm (Lot # 42, Catalog # 30- Appendix V). The fragment did not appear to be from a board or cut wood, and was similar in appearance to large bark fragments found in the fill during the excavation of EUs CH1, CH2 and NW1. Dr. Stewart-Smith noted that the gravel came "from the bottom two courses." Due to the resemblance between the wood fragment and bark fragments common throughout the hydric fill in EUs CH1, CH2, and NW1, Mr. Dudek asked Dr. Stewart-Smith and Mr. Wiggin if the wood might have been placed in the bucket from the passageway floor, or if it had actually come from behind the stonework (note - even though EUs CH1 and CH2 had been excavated down to boulders, the chamber passageway was flooded with water table and wood fragments had been floating throughout the area). It was insisted that all the sandy gravel had come from behind the stonework, although the wood fragment had not been seen during the course of the removal of the sand and gravel. It was conjectured that the wood had been buried in the sandy gravel.

At the request and funding of the Upton Historical Commission, the recovered wood specimen was sent for radiocarbon dating. The results by Beta Analytic (Beta # 313229, Appendix VI) indicates an age of post 0 BP and has been reported as a % of the modern reference standard, indicating the material was living about the last 60 years or so ("pMC" = percent modern carbon). The specimen provided plenty of carbon for an accurate measurement and the analyzed material had more ¹⁴C than did the modern (AD 1950) reference standard. The source of this "extra" ¹⁴C in the atmosphere is thermo-nuclear bomb testing which on-set in the 1950s. Its presence generally indicates that the material analyzed was part of a system that was respiring carbon after the on-set of the testing (AD 1950s)(Appendix VI).

In summary, the wood specimen is modern and most likely was not buried in-situ behind the stone wall of the Upton Chamber passageway. A review of the photographs of the Chamber passageway wall both prior to the rehabilitation and during the rehabilitation (Plates 33-35, Plates 38- 40) reveals loose dark soil and rootlets around the boulders in the wall, with the possibility that leaves and organic detritus could have fallen from above the stonework rehabilitation work area into the area where the sand and gravel was removed. Due to the focus of the work being on resetting the stonework, and the limited workspace and liability of the rehabilitation work, there was no reliable assessment of the contextual integrity for the sand and gravel sediments where the wood apparently came from. The wood fragment is not considered to be from the sand and gravel behind the lower level of stonework, but was introduced erroneously into the sediment.

4.6 RECOVERED MATERIALS

Cultural materials from the site examination were cleaned, identified, described, and entered into an Alpha 4 computer cataloguing system for analysis. Once processed, the artifacts were placed in labeled resealable polyethylene bags and acid-free containers at JMA's laboratory facility in Littleton, MA, pending transfer to the Robbins Museum of Archaeology in Middleborough, MA for long-term curation following completion of the archeological reporting.

A total of 261 items were recovered from the site examination and monitoring. Of these, 259 items were recovered from the EUs (Table 6), a piece of wood was recovered during the masonry rehabilitation and one piece of thick plate glass was uncovered behind the stone lintel during monitoring. These numbers do not reflect modern items such as plastic wrappers, cellophane, aluminum can tabs or foil, asphalt roof shingles and cigarette filters which were noted but not retained. All ceramics, glass, bone, and non-aluminum metals were recovered. No stone artifacts or shell was encountered.

No pre-Contact Native American artifacts were recovered from the site examination. Colonial-era historic artifacts consisted of lead-glazed redware ceramics, which were common utilitarian ceramics from the earliest colonial settlements until the mid nineteenth century, by which time stoneware, ironstone or refined earthenware replaced most utilitarian redware forms. Redware continues to be produced to the present time for flower pots, and to a lesser extent as decorative wares such as historical reproductions produced at Sturbridge Village or Colonial Williamsburg.

Other ceramics recovered include whiteware (1820+) and ironstone (1842+). Broken white china uncovered in the 1955 excavation and attributed to children playing by Charles Pearson (Section 4.3) most likely refers to the plain whiteware and ironstone ceramics. The fragments recovered in the 2011 site examination were small in size and typical of sheet refuse and not a refuse midden. The five pieces of transfer-print and blue-edged whiteware date from the nineteenth century and may be the ceramic type referred to as blue-on-white Staffordshire ware identified in the 1955 excavation. Some of the plain whiteware fragments may have come from blue-edged whiteware (1820-1890). The whiteware and ironstone ceramics may have been deposited after the stone chamber had been abandoned. All the fragments were small in size, most measuring less than 2 cm across.

Architectural materials recovered consisted primarily of window and plate glass, and a few pieces of brick and a ferrous nail. More recent asphalt roof shingle and tar paper were also noted at EU NW3. The indeterminate nail from EU NW3 may be a cut or wrought nail but it was too corroded to identify. No nails from wood flooring were encountered inside the stone chamber. A large

thick piece of plate glass was recovered from the ground surface behind the stone lintel. It is possible that a door. The plate glass is relatively recent.

Table 6. Artifacts recovered from the site examination at the Upton Chamber.

Material	EU	CH1	CH2	NW1	NW2	NW3	Totals
Brick					2		2
Redware, lead glazed (17 th -19 th century)			3				3
Redware unglazed/molded (flower pot?)				1			1
Redware unglazed, beveled rim of small pot					1		1
Redware, missing surfaces					1		1
Whiteware, plain, 1820+	6	19	13	17	7		62
Whiteware, blue-edged plate, 1820-1890				2			2
Whiteware, blue transfer-print, 1820+		2					2
Whiteware, green transfer-print, 1828-1870				1			1
Ironstone, plain, 1842+	1	4	6	3			14
Bottle glass, mold-blown						1	1
Bottle glass, mold-blown/machine-made					1		1
Bottle glass, machine-made, 1903+	6	16	41	43	4		110
Lamp/light bulb glass		1	1			1	3
Lamp glass	1		1	1	1	11	14
Window glass	4	1	4	3		2	14
Plate (window) glass			3	2	1		6
Glass bead, molded						1	1
Cuprous/zinc 1993 Lincoln cent					1		1
Ferrous nail, indeterminate						1	1
Ferrous strip						1	1
Ferrous can/sheet metal						8	8
Ferrous indeterminate						4	4
Wood, painted (knot from board)					1		1
Wood, unburned	1*	1					2
Bone, large mammal long bone shafts, butchered						2	2
Bakelite strip					1		1
Totals	19	50	69	79	43		260

*Wood found in sand and gravel from behind chamber passageway stones and sent for C14 dating.

The most common artifact type recovered consisted of modern clear or amber machine-made bottle glass. One piece of mold-blown aqua tint glass from an octagonal bottle was recovered from EU NW3 which is typical of mid to late nineteenth century medicine bottles. Lamp glass was widely distributed and includes chimney glass as well as thin glass that could be from a lamp chimney or a light bulb. An opaque (black) glass spherical bead 10mm in diameter was also recovered. The bead was cast in two halves, possibly with a hollow center. It is likely machine-made and modern in origin as it was recovered from an upper level with modern bottle glass and plastic items.

Two large mammal (cow/large pig) bones were recovered that had been butchered. Both bones came from EU NW3 and consist of long bone shafts with the articular ends removed, either by cleaver or handsaw. One of the shafts was also sawn longitudinally by handsaw. Other than asphalt roofing shingles (1917+) and tar paper that were noted, there were few artifacts

encountered in the same levels at EU NW3 as the two bones, so the mammal bones do not appear to have been part of an historic midden layer. The butchered mammal bone could date from the nineteenth century. If so, there is the possibility that the Upton Chamber could have been used for cold storage of meat for a time. The recovery of the butchered bone from the same levels as twentieth-century roof shingles and bottle glass indicates a mixed historic context at best. There is also the possibility that the butchered bones date from the twentieth century.

4.7 REMOTE SENSING AT THE UPTON CHAMBER

Following the completion of the archeological site examination at the Upton Chamber and the masonry rehabilitation, the Upton Historical Commission contracted directly with archeologist David Gutbrod to conduct a non-invasive remote sensing project at the Upton Chamber. The advantage of remote sensing is that it leaves no footprint on the landscape. Although not part of the scope of the archeological site examination, the results of the remote sensing project are included in this report as Appendix VIII at the request of the Upton Historical Commission (courtesy of David Gutbrod and with the approval of the Upton Historical Commission) so that these results will be more readily available to other researchers.

The summary of the remote sensing project presented here is taken from David Gutbrod's report (Gutbrod 2012), also attached as Appendix VIII.

Ground Penetrating Radar

Ground Penetrating Radar (GPR) is a method of remote sensing that can report back certain material signatures and characteristics of the ground beneath the surface by sending radar waves in distinct pulses from a surface antenna into the ground and measuring the time and strength in the return reflection by a receiving antenna. The Relative Permittivity or dielectric constant of different materials can then change the velocity of the wave as it hits individual materials. The greater the contrast in this measurement results in the greater the resolution in the data. When the travel times of energy pulses are measured and their velocity through the ground is known, depth can be measured to produce a three-dimensional data set.

The GPR equipment used at the Upton Chamber was the SIR3000 unit with Survey wheel made by GSSI Inc. It was used with a 400 MHz antenna which reaches a depth of about 3 meters or just under 10 feet. As an added measure of detail and to have additional data in the grid above the Upton Chamber, a deeper penetrating antenna, the 200 MHz was used.

It is possible to identify the extent of buried walls and other possible buried features with GPR. If additional tunnels or buried stone structures exist near the Upton Chamber, they may be located with the 400 MHz antenna and subsequent data visualization.

Methodology

The survey grid (systematic placement of transect lines) was placed over the top of the Upton Chamber and extended to the property borders and up to the former (filled) marsh and shrub area. Grid layout was accomplished with the use of a Topcon 2B total survey station. The constraints of the grid size were based on several parameters. The property width (north-south) and the driveway limited data collection to 140 ft at its widest extent. Fill added to the west marsh area to the west and debris from the former house foundation to the east of the grid would flood both the GPR and Magnetometer data with readings which would offset the sensitivity settings needed for

the rest of the survey area. Therefore, the former house area was abutted to but not included in the grid layout. Transects of 3 ft were measured and marked rope was stretched the entire length of the grid to enable 1.5 ft measured lines for the GPR and Magnetometer. The 400 MHz antenna was used over the largest extent of the grid. The 200 MHz was used over the 30-x-45 ft square that included the Upton Chamber while the magnetometer was run the full length of the central portion of the grid measuring 30 ft by 140 ft.

GPR using 200MHz

Starting with the 200 MHz antenna, the grid utilized 3 ft transects as the size of the antenna was nearly 3 ft. The signal or pulse from the 200 MHz reaches deeper depths but does not have the resolution of the 400 MHz antenna. After processing with RADAN software, the initial 2-d image shows preliminary anomalies in the soil as light grey and white areas highlighting the greatest difference in the measurements of the two-way travel time as it is collected by the receiving antenna. The depth conversion between 1.5 and 2.5 ft (Appendix VIII Figure 7) begins to show the difference in the dielectric in the northwest corner (the Upton Chamber location) and the rest of the collection grid. If this same slice is made into a 3-D visualization, the relative depth and relationship to the full data set is seen (Appendix VIII Figure 8). At the depth of 4 to 5 ft the contrast of the chamber walls with surrounding soil and the beginning of an anomaly south of the Upton Chamber location can be seen (Appendix VIII Figure 9). The depth slice at 10 to 11 ft highlights another area where the Relative Dielectric Permittivity is different than the surrounding area, changing the two-way travel time back to the receiving antenna (Appendix VIII Figures 10 and 11). Water has a very high Dielectric of 81 (also termed Relative Permittivity) and because the depth is at 10 to 11 ft, this could be an area of saturated soil or a signal for bedrock. There was no signal difference in this area in the first 9 ft of depth slices and no change from the surrounding area to suggest that the material changes occurred before this depth. Any fill on top or disruption of the soil above this area would have had a specific signature to offset it from nearby soil. This leads to the conclusion that the material composition that is highlighted at 10 ft by the 200 MHz is natural and has been undisturbed, most likely natural glacial till with high moisture content. If human disturbance or influence were to be suggested at this depth, more soil signatures would be needed.

GPR using 400MHz

Shifting to the 400 MHz antenna the GPR grid size was much larger, and because the antenna size was shorter the transect width was reduced to 1.5 ft. The resolution of the data and depth slices is greater in comparison to the 200 MHz visualization (Appendix VIII Figures 12 to 16). The application of the 400 MHz antenna resulted in the maximum depth of 8 to 9 ft. The resolution however, allows for clearer observation of the anomalies in the ground and even possible shapes. For example, the southern section of the grid in Appendix VIII Figure 13 (also Appendix VIII Figure 17), which is displaying a depth of 3.0 ft to 4.0 ft, appears to reveal a linear feature made of three equally spaced pipe-like structures. Given that this is in back of the former Pearson house and at an ideal depth for water pipes, these may represent water pipes or PVC drainage pipes from a septic leaching field.

Appendix VIII Figures 14 and 15 capture a rectangular anomaly in the 4.8 ft to 6.0 ft depth interval. The feature may have a quadrangular edge, possibly outlining a wall of soil where stone was removed or alternately where stone was positioned. The size of each linear contrast is approximately 16.5 ft on the three most visible sides. In each case, the GPR is recording a different signature of the highlighted material versus the surrounding material. The feature

disappears after the 6.5 ft mark. In Appendix VIII Figure 19, the same data is viewed in planar or top-view with an adjusted value for gain resulting in a higher contrast. This depth holds the greatest potential for discovery of a buried wall or other stonework. Two areas highlighted in Appendix VIII Figure 19 are approximately 15 to 17 ft on edge. The data along the edge of the transect running along the uncollected northwest grid corner appears to hold a linear feature that could possibly be a buried wall. The depth of this feature is more specific than the Upton Chamber, which exhibits a noticeable reflection in the first foot of depth recording slices. The Upton Chamber is visible in subsequent depths due to partial signal reflections from stone, partly traces getting through the stone ceiling, and finally partial radar measurements coming into contact with the water in the Upton Chamber floor which is at a depth of 10 to 12 ft below the ground surface. The feature that appears in Appendix VIII Figures 14, 15, and 19 with the rectangular edge may have a human origin or influence and further investigation would be needed for identification of the anomaly.

The following recommendations are given for further investigation of the GPR anomalies: 1) Investigation of the linear feature at y=30 feet running east to west behind the former Pearson house. This offers the least disturbance with the most accurate depth calculation (Appendix VIII Figures 13, 17, 20, 24). It is believed to be a pipe associated with the house and not of historic value. The results will then clarify the depth readings for the entire GPR grid; 2) Investigation of a potential wall running along transect x=32 and from y=105 to y= 120 (Appendix VIII Figure 19). A trench measuring 1-x-4 m would cover the area highlighted in Appendix VIII Figure 19; and 3) A second trench could capture the feature highlighted in yellow in Appendix VIII Figure 19 at x= 32 and y=75 to y=85 (Gutbrod 2012, Appendix VIII).

Magnetometry

While GPR was the primary tool for remote sensing, multiple methods of remote sensing can capture characteristics missed by using one technique. Therefore, a cesium vapor gradient magnetometer was chosen to compliment the data from the GPR. Magnetometry is a prospecting method that maps local variations of the earth's magnetic field in the near-surface. It is a passive method of remote sensing since it utilizes the earth's magnetic field rather than generating its own artificial energy wave such as GPR and resistivity:

- 1) Fired artifacts can produce detectable anomalies such as ceramic vessels.
- 2) Accumulations of topsoil associated with constructed features can cause positive anomalies.
- 3) Intensive firing can create pronounced anomalies (hearth or burning episode).
- 4) The removal of magnetically enriched topsoil can produce negative anomalies.
- 5) Imported stone can be more or less magnetic than surrounding soil, introducing significant anomalies in either case.
- 6) Iron and ferrous compounds produce strong anomalies readily detected by Magnetometry.

Magnetometry data were collected using a Geometrics G-858 gradiometer. This equipment utilizes the characteristics of cesium gas and uses a counter which measures teslas per root Hertz. Magnetometer data does not allow for depth calculations but the display has several processing options and choices for visualization. The software package MagMap 2000 designed by GEOMETRICS is the first consolidation of the data where errors are detected and removed, and the data can be seen in visual form.

In Appendix VIII Figure 20 the dark areas in the Grey-Scale Data are noted for higher readings from the gradient cesium sensors. This is the result of the sensors having a change in the magnetic field measurement or in the case of the gradient the largest change in the material composition of the soil. The lower right or the back side of the former Pearson house exhibits most of the higher readings, with the likelihood of an iron or ceramic pipe exiting the house. A second longer pipe runs linearly at the 30 ft mark that may be a drainage pipe or similar structure.

The northeast corner of the grid has an unknown anomaly that could be iron rebar or a modern ferrous compound, as this was in the area where rebar was found loose on the surface during branch cleanup. During the pre-walk of the site, a small modern ball of concrete mix with a foot of rebar imbedded into it was located on the ground surface. This was removed out of the grid, but there is the possibility that additional iron rebar pieces could be buried in the vicinity as the rear of the Upton Chamber has higher readings than the surrounding soil which may be influenced by a spike where the data give a dark black display. If the data is viewed with several other methods, the size and location become clearer. In Appendix VIII Figure 21 the highest values show where large inclines in contour lines reveal pronounced inclines in the data collected. The second representation in color designates areas or contours within a range of data values. Each range is given a different shade and contour. These readings highlight regions in the data that stand out. This method directs the interpretation toward the anomalies in the soil and highlights the extremes. However, as seen in following models, the use of a greater range of color employed with smaller data-value separation can highlight more subtle changes in the data. It is not clear if this area (directly behind the Upton Chamber) has a continuous higher reading or if it is a side effect of the large spike in the data. A small pile of stones on the surface in the area of this high reading could also be responsible for the data. Conclusive identification of the anomaly would require excavation under an archaeological permit as outlined in Massachusetts General Laws (950 CMR 70). Further remote sensing using resistivity and conductivity may produce data that is washed out if this “high point” is not explored first. It is recommended that the identification of this near-surface anomaly be investigated before any further remote sensing techniques are used in the northeast corner of the grid.

Appendix VIII Figures 22, 23 and 24 represent the same grid, the common elements with the most notable features being the area adjacent to the house and the northeast corner of the grid. The rear of the house may have either an iron or ceramic pipe running east-west at or near the 30 ft grid mark as noted. The two areas on either side of the linear feature seem to line up with a surface gravel-cement area near the 45 ft mark and the path which was highlighted in the GPR sensing section.

The Magnetometry suggests another interesting peak at $x=42$, $y=104$. This coordinate is just north of the rectangular feature highlighted in Appendix VIII Figure 19. It could be an iron or ceramic artifact and would require further investigation to identify.

With respect to the rectangular feature highlighted in the GPR data at 4.5-6.0 ft (Appendix VIII Figure 19), the Magnetometry had a low signal coming from the area, which seems to suggest that this is not a modern structure that used nails or any iron in its formation. This would eliminate a former water well or outbuilding/shed foundation.

4.8 RECOMMENDATIONS FOR RESEARCH OBJECTIVES AND FUTURE INVESTIGATIONS

The Upton Chamber is consistent with a class of agrarian stone features generally referred to as stone chambers, which had variable functions but were usually related to cold storage during the eighteenth and nineteenth centuries. Dating of the Upton Chamber's construction and determination of its origin and function are crucial to its interpretation but beyond the limited scope of the archeological work necessary for the Upton Chamber Masonry Rehabilitation and Drainage Improvement Project. The following possible origins for the Upton Chamber are discussed with respect to archeological and historical data; suggestions for additional documentary research and investigation are given.

- 1) **John Hill's Tannery ca 1820s-1840s** - If the Upton Chamber is related to John Hill's tannery business, then the layout of the tannery operation with its spatial organization of processing areas and the evidence of craft specialization will enable an understanding of the function of the chamber as part of an early industrial enterprise (Clark 1990). Features that have the potential to add to our understanding of these topics include the builder's trench associated with the stone chamber, deposits on the floor of the chamber and passage, and deposits outside of the chamber. These findings combined with documentary research - industrial censuses and federal/state/town censuses, deed records or plans, tax records, and possibly probate records may aid in identifying the scale and organization of the tannery operation. The recovery of wood flooring and nails in the 1955 excavation, and butchered mammal bone, lead-glazed redware, and lamp glass by the 2011 investigation could date from this era, or possibly earlier. The framework of site-specific and regional issues include the identity, occupation(s) and socio-economic statuses of the site's inhabitants and their relationship to the local economy, the development of Upton, and the broader theme of the transformation of agrarian and craft economies to one driven by a market-based economy. If documentary research on identifying the ownership and occupancy of the parcel can be clarified, then information on the occupation and/or socio-economic status of the owner or occupant may be available from tax and census records. Archeological data on the occupation of inhabitants may be cautiously addressed through artifacts such as through profession-related tools and refuse (Mrozowski 1988:20). The likelihood that the Upton Chamber was built by John Hill seems diminished in light of the preliminary seventeenth century OSL date, the apparent abandonment of the chamber by the 1850s, and the use of undressed and unquarried boulders in its construction. West of the chamber across the brook about 100 m away (behind 16 Elm Street) several small granite quarry areas are present that were likely in operation at the time of John Hill's land ownership. These quarries may have been utilized by or for the tannery. If the Upton Chamber was built in the 1820s to 1840s era, most likely quarried and/or dressed stone would have been used. An earlier date of construction appears more likely.
- 2) **Historical Agrarian Construction, ca. 1710s-1810s** - If the Upton Chamber is related to cold storage for an earlier farmstead, then the archeological findings may address topics relating to the agrarian life before and after the American Revolution. The recovery of wood flooring and nails in the 1955 excavation, and butchered mammal bone, lead-glazed redware, and lamp glass by the 2011 investigation could date from this era, or possibly earlier. Topics include material culture and the spatial organization of the farmstead, evidence of any change or evolution in that organization, and evidence of

specialized work areas (Clark 1990). As with the tannery, features that have the potential to add to our understanding of these topics include the builder's trench associated with the stone chamber, deposits on the floor of the chamber and passage, and deposits outside of the chamber. These findings combined with documentary research may aid in identifying the owners of the property that were responsible for the construction and use of the stone chamber. The 1798 reconstructed land ownership map (Blomquist and Morrel 1983) indicates that Jonathan & Nahum Ward owned a large parcel of land that included where the Upton Chamber is situated, prior to the subdivision of the land (Blomquist and Morrel 1983). The land was also located within Hopkinton from its incorporation in 1715 until the incorporation of Upton in 1735, although settlement of the area was greater after 1740. Understanding the land ownership and land utilization of the agrarian owners is important if the chamber was built at this time: What was the layout of the farmstead? Where was the dwelling, the outbuildings, the livestock areas? What examples of other stone constructions remain from this period and how does their construction compare with the Upton Chamber? The stone field wall that trends northeast from the Upton Chamber includes natural massive boulders in its lowest course as large as the largest boulders in the Upton Chamber construction, as well as later quarried blocks placed vertically higher in the field wall. These findings combined with documentary research – federal and town/state censuses, deed records or plans, tax records, and probate records may aid in identifying the land ownership, buildings, livestock – including oxen used to move heavy loads, scale and organization of the farmstead, and possibly some obscure reference to the chamber itself. The framework of site-specific and regional issues include the identity, occupation(s) and socio-economic statuses of the site's inhabitants and their relationship to the local economy, the development of Upton, and the broader theme of the transformation of agrarian and craft economies to one driven by a market-based economy. If documentary research on identifying the ownership and occupancy of the parcel can be clarified, then information on the occupation and/or socio-economic status of the owner or occupant may be available from tax and census records. Archeological data on the occupation of inhabitants may be cautiously addressed through artifacts such as through profession-related tools and refuse (Mrozowski 1988:20).

- 3) **Seventeenth-century Construction, ca. 1650-1700** – If the Upton Chamber was built in the mid to late seventeenth century, its function and purpose can be expected to be different than if built by later farmers. This is the earliest period that the wood flooring and nails from the 1955 excavation, and the butchered large mammal bone, lead-glazed redware, and lamp glass by the 2011 investigation could date from. The Praying Indian village had been established by Christian missionary John Eliot at Hassanamesit in 1654, which included nearly 8,000 acres, and Harvard University was granted a large tract of land adjacent in what would later become part of Hopkinton in 1715. What was the reason for this large transfer of land to Harvard University, and was it related to some vision of land use with respect to the Praying Indian villages in this area and with the Harvard Indian School? The historic context of Hassanamesit and the John Elliot/Harvard University connection to this area would be important to investigate. If the Upton Chamber was built at this time, as the preliminary OSL results suggests, it could have had a function related to the Praying Indian (Nipmuc) population, whether for protection of travelers or as a meeting place, or as a refuge during unsettled times such as raids from outside tribes like the Mohawks. The Nipmuc, in whose land the Upton Chamber lies, occupied a position as a buffer between the Mohawk and the Massachusetts confederation to the east. This probably put them in the tenuous position of split

- alliances. It is known that in the middle to late seventeenth century they allied with the Massachusetts and were attacked by the Mohawk (S. Johnson 1995:27). The Mohawk, being land-locked and isolated from the Lake Champlain, Long Island and East Coast trade relations with the French, Dutch, and English began extensive warfare with the Algonquian Nations to the east to acquire European goods and Native-made wampum (Malone 1991:49). Warfare with the Mohawk may have occurred prior to European contact, but it appears, as the seventeenth century progressed, that it significantly intensified. Algonquian troubles with the Mohawk culminated in the Mohawk War (1664-1671), which spread as far east as Cambridge, Massachusetts (S. Johnson 1995:170). Documentary research on early land and deed records, the origin and administration of the Praying Indian villages, and any reports or travel literature pertaining to the Hassanamesitt area may aid in understanding the context of the land use and the purpose for the Upton Chamber. Other records from Harvard University relating to their use and vision for the land in this area may also yield important clues.
- 4) **Pre-Colonial Construction, ca. pre-1650** – If the Upton Chamber was built prior to 1650, a suitable cultural and historical context needs to be established from as many lines of evidence as possible. Research issues related to a pre-colonial origin and function of the Upton Chamber will be considered if material evidence (i.e., artifacts, cultural deposits) of a pre-colonial nature is identified at the chamber. Presently, the artifactual evidence consists of a wood floor with nails, a molded rim fragment of ceramic described as having a lead slip (from the 1955 excavation), several pieces of lead-glazed redware ceramic, two butchered large mammal bones, and several pieces of lamp glass. These artifacts are consistent with a colonial to early nineteenth-century occupation and may come from different time periods. The earliest artifacts may include the wood floor and associated ferrous items and the molded rim fragment. The butchered large mammal bones and lamp glass may date from a later occupation. No pre-Contact Native American artifacts have been recovered to date. The earliest date for the Upton Chamber comes from the results of the OSL dating, which yielded a minimum age of between 1664 A.D. and 1632 A.D., or (using another method to calculate the equivalent doses) between 1644 and 1592 A.D., which is preliminary at present. Future archeological investigation may be able to establish the date of construction for the Upton Chamber as well as any related features within or outside of the chamber. If the chamber was built by Native Americans prior to 1650, evidence is likely to come from nearby features, from filled excavation areas such as a builder's trench, from buried natural land surfaces if covered with fill, and from the previously unexcavated portion of the beehive chamber itself. Caves and rockshelters have been important places for Native Americans in eastern New England, as reported from the 1600s on. Samuel de Champlain reported that when he sailed into Gloucester Harbor in September of 1605, his group traded with Onemechin, whose name can be translated as blue feather of a place called Chouacoet (Grant 1959:91; translated with Trumbull 1903). Chouacoet can be translated as the "place of the little cave," so it can be seen that people recognized caves and rockshelters and even identified a community with an area where one was present. The mental and physical landscape of the Native world is filled with stones and locations where, as Edward Winslow stated in 1624, "any remarkable act is done." The acts that are remembered or commemorated at these sites may be of a corporal or spiritual nature. The rocks may represent a place such as the Devil's Den in the territory of the Western Niantic where a group of Niantic fooled a band of Mohawk and thus saved themselves (Simmons 1986:273). Another example would be Witch Rock in Rochester, Massachusetts, which represents a place where Native "Pau-Waus" are said to have sat and watched the mist rise from the cracks in this large erratic. Another story is related of two stones located on the side of the road from Plymouth to Sandwich. Kendall, in 1807, reported

that “[o]ne of them may be six feet high, and the other four; and both are of ten or twelve feet in length; and they differ in nothing as to their figure, from the masses of granite and other rock which are scattered over the surface of all the adjacent country. Indians do it [cast stones and sticks on the stone] because they were told to and because they expect blessings from the observance of the practice, and evils from the neglect. When asked to whom is this worship offered? [they replied] To a Manitou...” (Simmons 1986:253). In Mashpee, Massachusetts, it was reported in the nineteenth century that at “sacrifice rocks,” as the English came to call them, that the Natives who passed by these rocks would always cast a stone or stick upon the rock. It was believed that the reason why they did this was perhaps that it was an “acknowledgement of an invisible agent, a token of the gratitude of the passenger on his journey for the good hand of providence over him thus far, and may imply a mental prayer for its continuance...” (Simmons 1986:253). In Mashpee, sacrifice rocks eventually evolved into what were called “taverns.” These were stick and brush structures located along the side of roads where food, property, or whisky libations were offered to the ghosts that were believed to wander the roads. The practice of putting whiskey or alcohol at these sites led to their being called taverns (Simmons 1986:254, 255). Simmons characterized so called “sacrifice rocks,” “wishing rocks,” and “taverns” as “an attempt by living Native Americans to keep in touch with the dead” and the spirit world through memorials and shrines (Simmons 1986:251; the above references are cited in Dudek and Chartier 2002). As can be seen, there is a Native precedent for recognizing large stones in the landscape and acknowledging them as special sites. If the Upton Chamber was built prior to 1650 by Native Americans, then understanding the historic context, age, construction, and most importantly, the purpose from the Native American perspective will be important to understanding the historic and cultural significance of the site.

Recommendations for Future Archeological Investigation

While the origin and function of the Upton Chamber have yet to be clarified, there may be the potential for intact features, cultural deposits and artifact concentrations to address research questions about the age and function of the Upton Chamber. Preserved features and cultural deposits can address the spatial organization of the site and may include evidence for other related activity areas near the stone chamber.

Beehive Chamber

The portion of the beehive chamber that was not excavated in 1955 (between Trench 5 and Trench 6 in Figure 14) may be the only archeological context with integrity inside the Upton Chamber. This portion is where David H. Kelly noted that the relationship between the wood floor excavated in the passageway and the wood floor excavated at a higher level in the beehive chamber can be established with a cross trench (Appendix III and also this report page 36). In addition, the 1934 sketch of the chamber, presumably by Pearson since it is initialed “MDP,” indicates a “well” that had been “filled up” in the middle of the beehive chamber (Figure 10). As noted by Meagher (2004:27), if the chamber were used as an ice house, such a “well” could have been a dry well or a drain built to accommodate run off from slowly melting ice. Such a feature would constitute a significant breakthrough in explaining the chamber’s origins and use. Even if no such feature exists, the recovery of floor samples for AMS dating will be worthwhile. The extent of damage from a high water table and possible post-1955 disturbance of the chamber floor will need to be assessed. Any excavation of this area will be complicated by the high water table.

Builder’s Trench and/or Buried Paleosols

The most certain date for the construction for the Upton Chamber is likely to come from the excavation of a builder's trench for the vaulted chamber and for the chamber passageway. North-south trenches off the south side of the chamber and passageway would be able to determine whether the chamber and passageway were built as free-standing structures and later filled over or if the hillside was excavated and the chamber and passageway built within the excavated area. If the former took place, then intact buried land surfaces, or paleosols, are likely to be intact under the fill. Paleosols could be dated through associated artifacts, OSL dating or AMS dating of organic remains such as charcoal fragments buried in the paleosol. If the Upton Chamber was built within an excavated pit, then a builder's trench will be located between the masonry walls and the limits of the original excavation. Builder's trenches may contain associated artifacts and could also be dated through OSL dating and dating of charcoal from undisturbed builder's trench fill. Other features may also be located to the north, south or east of the Upton Chamber. North and east of the chamber there is limited room for investigation, as the property limits are close by. The greatest potential for investigation without involving property abutters is to the south of the chamber where remote sensing has identified anomalies.

GPR Anomaly

One anomaly has been identified by the GPR that could be investigated through excavation trenches to determine if it is a buried cultural feature. Appendix VIII Figures 14 and 15 captured an anomaly in the 4.8 ft to 6.0 ft depth interval that may have a quadrangular edge, possibly outlining a wall of soil where stone was removed or alternately where stone was positioned. This depth holds the greatest potential for discovery of a buried wall or other stonework. The possible size of the anomaly is approximately 16.5 ft on the three most visible sides. Investigation of a potential wall running along GPR grid transect $x=32$ and from $y=105$ to $y=120$ (Appendix VIII Figure 19) could be accomplished with a trench measuring 1-x-4 m. A second trench could capture the feature (highlighted in yellow in Appendix VIII Figure 19) at GPR grid transect $x=32$ and $y=75$ to $y=85$ (Gutbrod 2012, Appendix VIII). If the anomaly does represent buried stone architecture, there is a strong likelihood that it is related to the Upton Chamber and may contain intact buried archeological deposits that would help date and address the function of this anomaly while adding contextual data that would help address the age and function of the Upton Chamber.

Magnetometry

Several anomalies have been identified by the Magnetometry. The northeast corner of the remote sensing grid has an unknown anomaly that could be iron rebar or a modern ferrous compound, as this was in the area where rebar was found loose on the surface during branch cleanup. Further remote sensing using resistivity and conductivity may produce data that is washed out if this "high point" is not explored first. It is recommended that the identification of this near-surface anomaly be investigated before any further remote sensing techniques are used in the northeast corner of the grid. Additional remote sensing may be worthwhile once this anomaly is identified and removed if modern. The Magnetometry suggests another interesting peak at grid coordinates $x=42$, $y=104$. This coordinate is just north of the rectangular feature highlighted in Appendix VIII Figure 19. It could be an iron or ceramic artifact and would require further investigation to identify.

These recommendations are not exhaustive, but they provide a range of the types of documentary research, archeological investigation, and remote sensing that could help define the history of the Upton Chamber and the land-use history it is imbedded in and offer evidence on the age, specific construction methods, and function of the Upton Chamber.

5.0 CONCLUDING SUMMARY AND RECOMMENDATIONS

The Town of Upton, through the assistance of the Upton Historical Commission, has rescued the Upton Chamber, a rare vaulted stone “beehive” chamber (UPT-HA-15, a.k.a. the Pearson Chamber) from almost certain oblivion. From 1979 until the purchase of the Upton Chamber property by the town in 2006, the Upton Chamber has been at risk of being destroyed through gravelling operations, vandalism, and deliberate destruction by private owners. Since 1893 the Upton Chamber has been the focus of speculative claims about its builders, its age and its function. During 1955 most of the interior of the stone chamber and the area immediately outside the chamber’s entrance had been excavated by Harvard University archeologists John Glass and David H. Kelly. The 1955 work uncovered a wooden floor with corroded nails, ferrous stains, and a small ceramic rim fragment with molded decoration and a “lead slip.” From current deed research it was determined that the property was owned in the mid nineteenth century by a tanner, John Hill, whose business was discontinued and the “vats filled up” by 1879.

The 2011 site examination was focused within the area of the masonry rehabilitation and drainage improvements, both inside and outside of the chamber’s entrance. The site examination consisted of five excavation units (1-x-1 m), with two units inside and three units outside the chamber entrance. The archeological testing did not encounter any intact strata within the flooded interior of the chamber’s entrance, although lead-glazed redware ceramics typical of the colonial era were recovered in disturbed strata within the chamber’s passageway. The area immediately outside of the chamber’s entrance consisted of recent (post-1955) soil and rock accumulation. From 1.2 m to 3 m outside the chamber’s entrance, intact strata were identified, but with little cultural material. Two large mammal bone shafts were recovered that had been butchered (chopped and/or hand sawn) and several pieces of lamp glass and an unidentified nail were recovered. Other artifacts included nineteenth to twentieth century whiteware and ironstone ceramics, a glass bead that may be machine-made, and more recent bottle glass and modern synthetic materials.

Optically Stimulated Luminescence (OSL) dating by USGS of a sediment sample (Upton Sample #5) from behind a boulder in the chamber passageway yielded a minimum age of between 1664 A.D. and 1632 A.D, or (using another method to calculate the equivalent doses) between 1644 and 1592 A.D. Remote sensing has not identified any substantial below-ground stonework or chambers in proximity to the Upton Chamber, although at least one anomaly has been identified that could be architectural in nature and could be further investigated through archeological excavation.

To date no conclusive evidence for a pre-colonial origin of the Upton Chamber has been identified. Various theories on the function of the Upton Chamber include possible agrarian use as an ice house or root cellar, and possible use as a shelter of refuge for Native Americans or settlers during times of colonial or inter-tribal warfare. Future documentary and archeological investigation of the Upton Chamber is warranted. The property is located within a colonial and historic landscape that included colonial farms, an early nineteenth-century tannery, stone quarry operations, and the construction of stone field walls that included massive unquarried boulders. The history of the property during the seventeenth to early nineteenth century needs to be carefully researched to determine the chain of ownership and land use. Deeds and probate records will advance our understanding of the historic use of the property and may give specific information on the age or function of the Upton Chamber.

Additional professional archeological work at the Upton Chamber will be important to determine the age of the chamber’s construction. Carefully excavated trenches along the south side of the

chamber's passageway or the vaulted chamber will aid in determining the extent to which the hill has been built up with fill or if a builder's trench is present, either of which will aid in dating the construction of the chamber through associated artifacts, OSL dating of fill or paleosols, or through AMS dating of associated organic material.

The Upton Chamber is a rare and unusual example of a vaulted "beehive" chamber built of un-quarried boulders. While it appears to be an isolated feature of great antiquity, it is nestled within an area of early colonial development along an even older road, Elm Street, which is conjectured as a Contact-period trail (MHC 1983:2), possibly a branch of the Connecticut Path (Goodwin 1946:43).

In 2011 the Federal Communications Commission (FCC) in Washington, D.C. made a determination that the cultural landscape known as the Pratt Hill - Upton Chamber Historic District is a discontinuous historic district that is eligible for listing on the National Register of Historic Places under Criterion A for its role in the religious and cultural traditions of three tribes - the Narragansett Tribe, the Wampanoag Tribe of Gay Head (Aquinnah), and the Mashpee Wampanoag Tribe. Based upon the limited excavation from the site examination, the Upton Chamber is also recommended as eligible for the National Register of Historic Places under Criterion D: Information Potential ("has yielded, or may be likely to yield, information important in prehistory or history"), at the local level. Despite much of the Upton Chamber's interior having been excavated previously, a portion of the beehive chamber floor has not been excavated. In addition, the exterior slope that the chamber has been built into is likely to retain important evidence on the chamber's construction and age, as well as yard deposits contemporary with the construction and use of the chamber. The Upton Chamber may also be eligible under Criterion C at the local or regional level: sites that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction (National Park Service 1991). The Upton Chamber is representative of a vanishing but once significant vernacular architectural form referred to as stone chambers, of which beehive/corbelled dome stone chambers are one type of construction.

The Upton Chamber is likely to continue to be at the center of controversy regarding its origins, age and purpose. Multiple groups - the citizens of the Town of Upton, the Narragansett Tribe, the Wampanoag Tribe of Gay Head (Aquinnah), the Mashpee Wampanoag Tribe, and interested scientific and archeological communities are stakeholders in its preservation.

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FIGURES

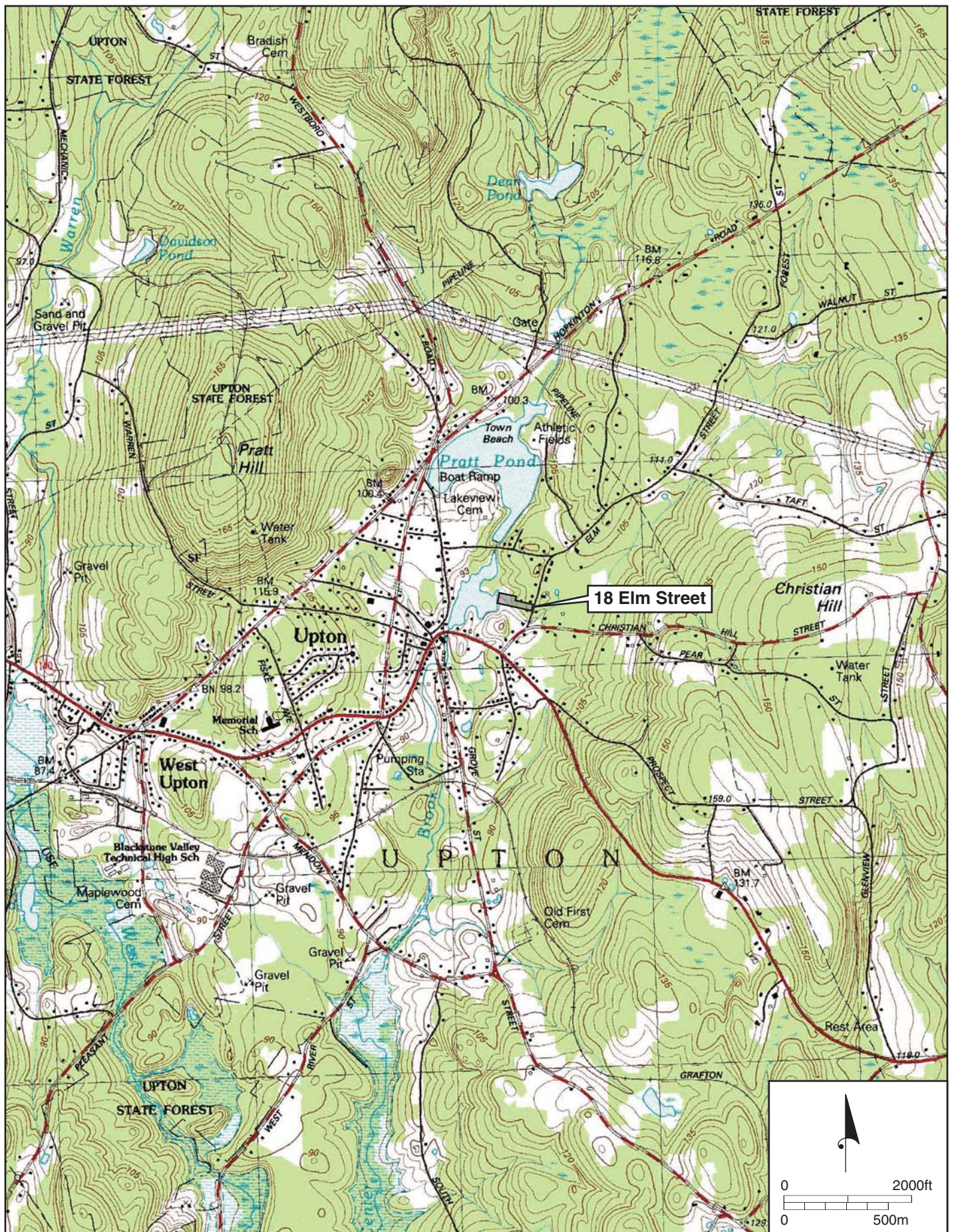


Figure 1. The 18 Elm Street, Upton parcel location on the Milford USGS Quadrangle.



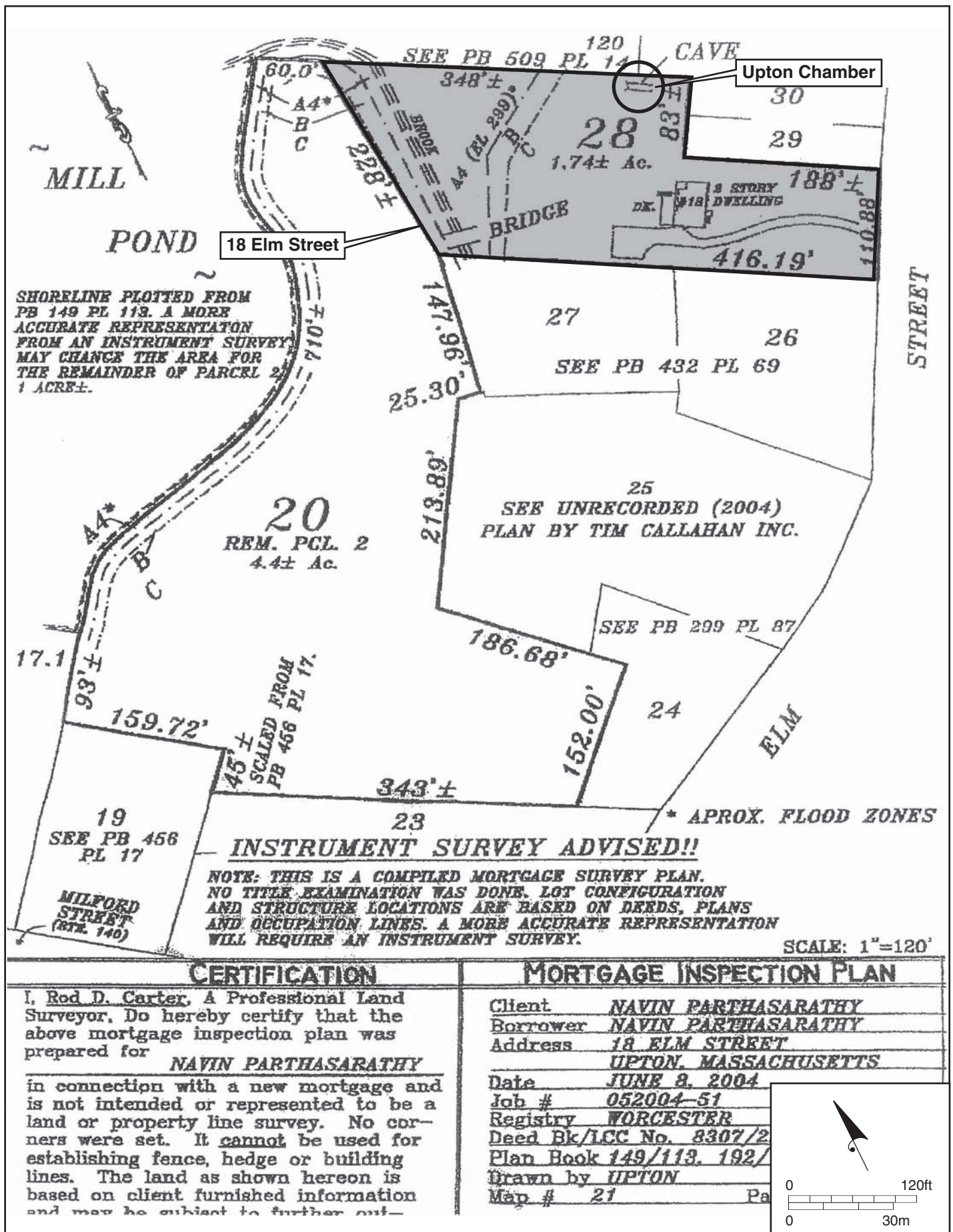


Figure 3. Mortgage Inspection of Parcel 28 at 18 Elm Street (June 8, 2004).

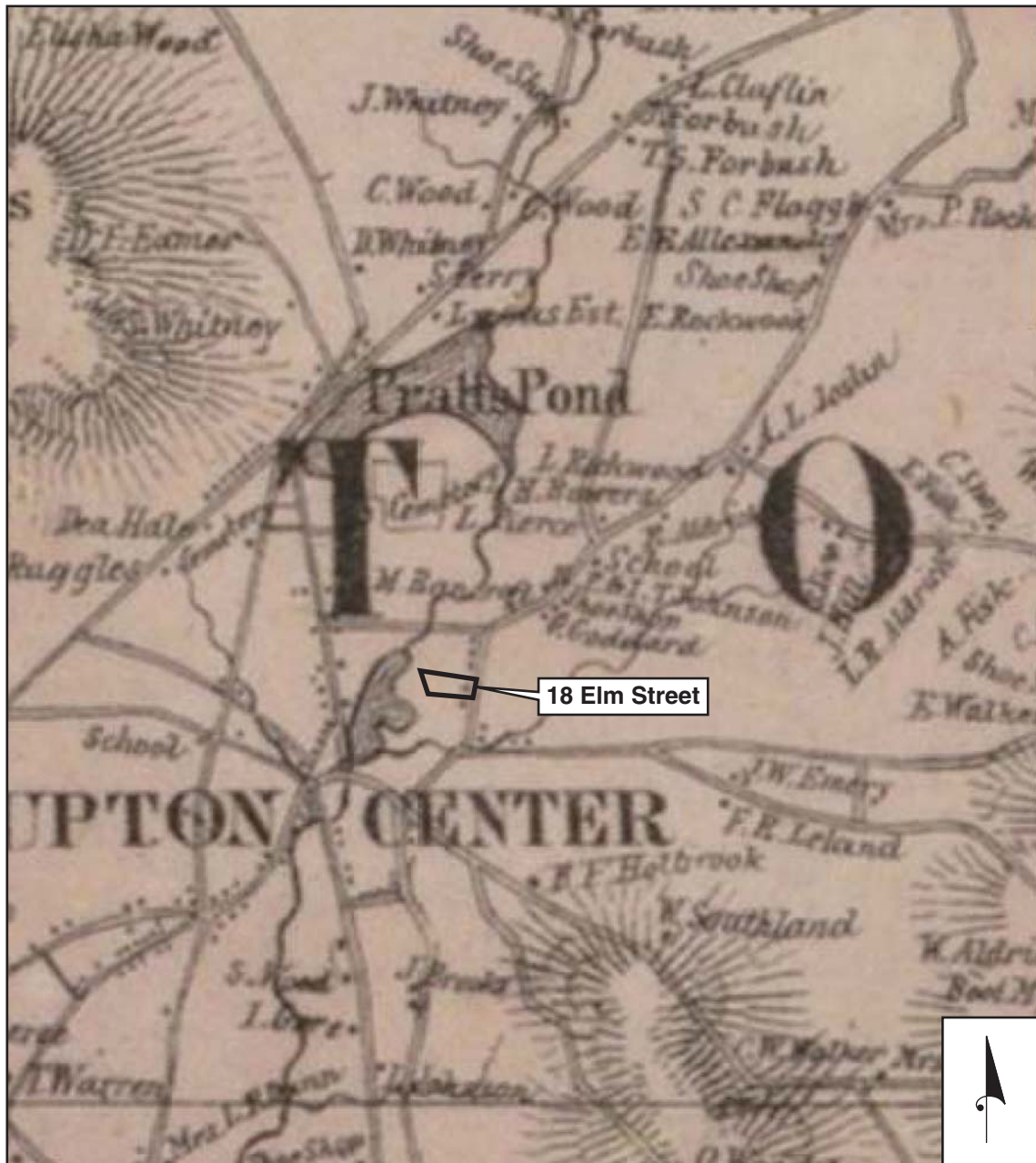


Figure 4. Approximate project location on a detail of the 1857 map of Upton (Walling 1857).



Figure 5. Approximate project location on a detail of the 1870 map of Upton (Beers 1870).

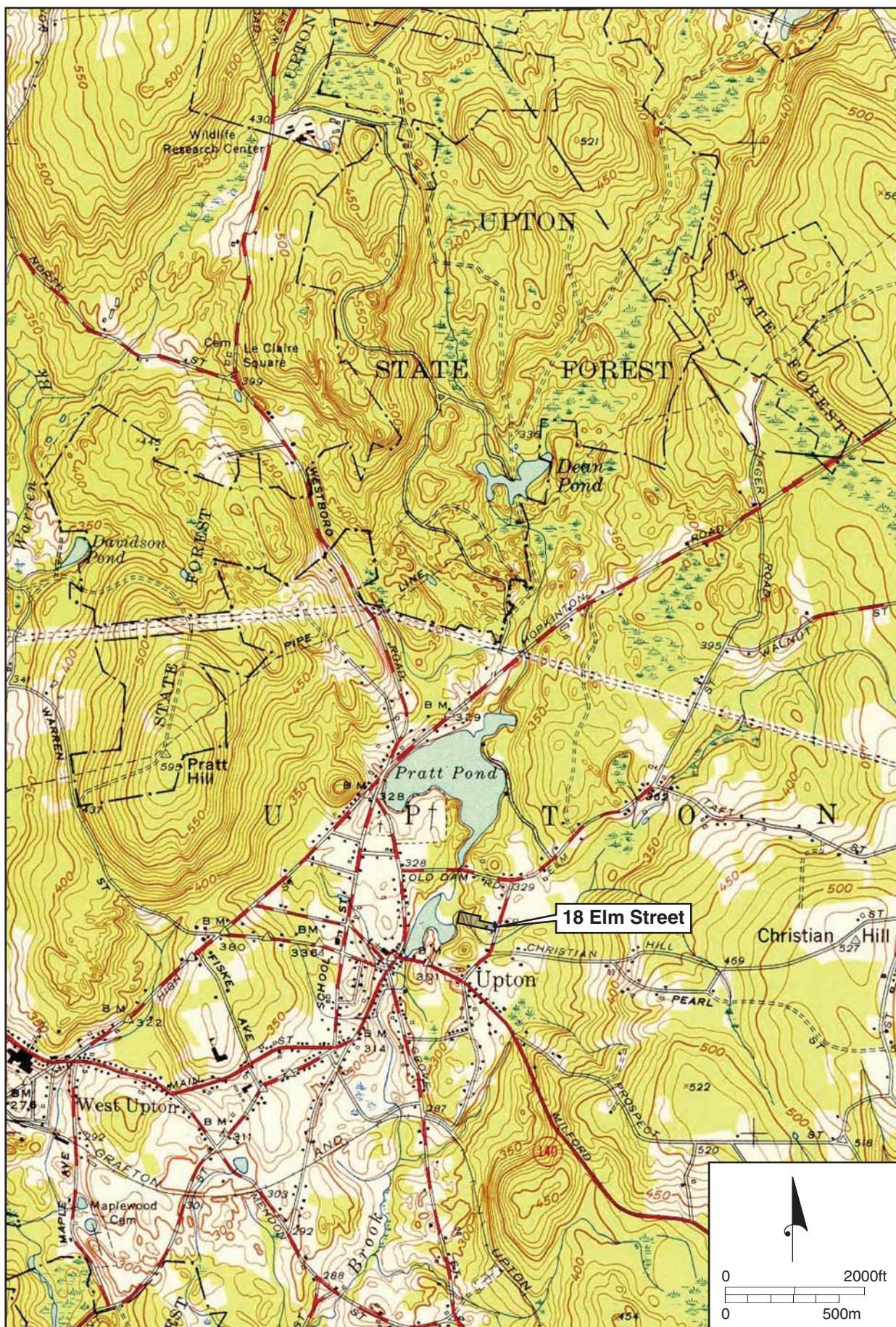


Figure 6. Approximate project location on the 1953 Milford USGS Quadrangle (<http://docs.unh.edu/MA/mlfr53sw.jpg>).

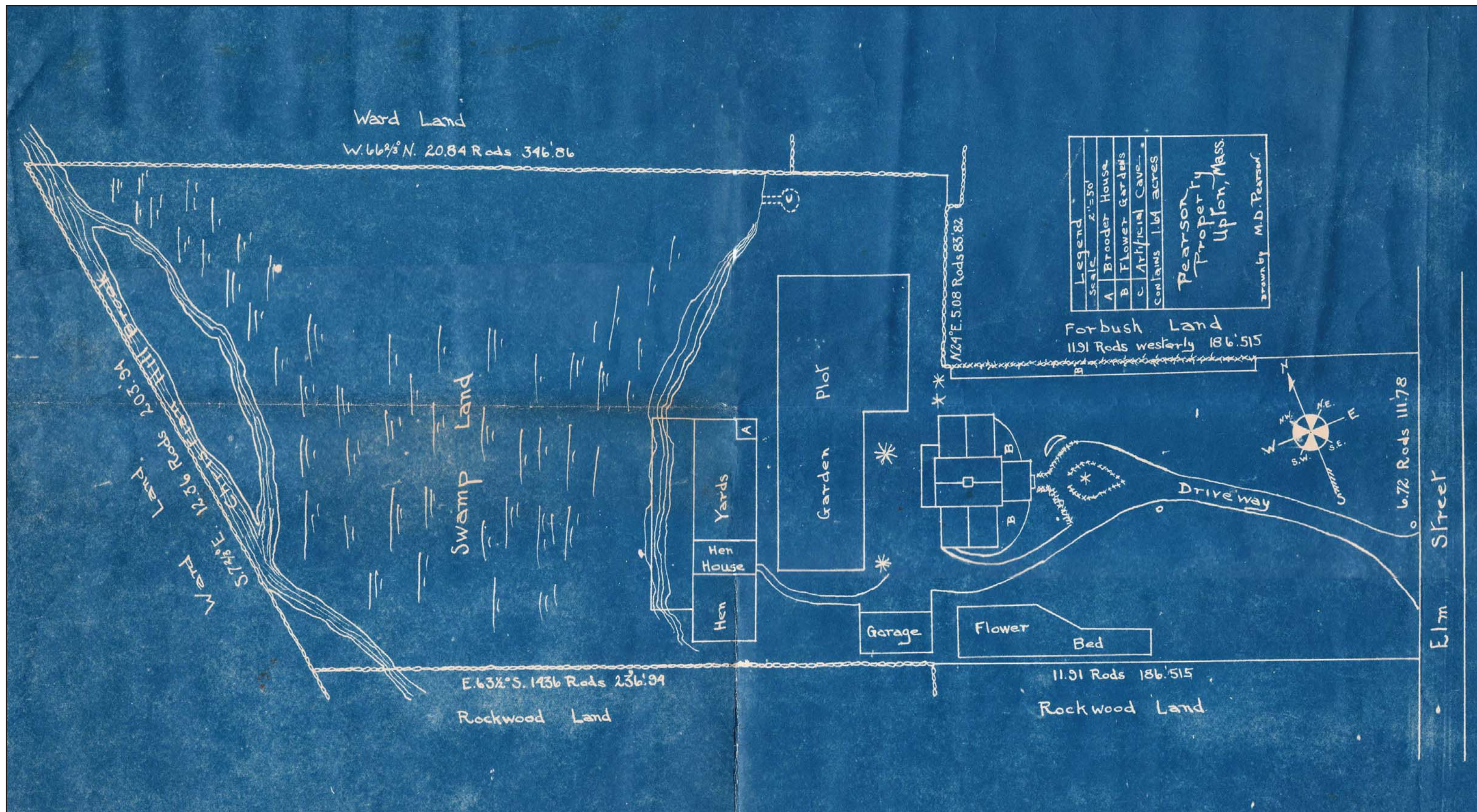


Figure 7. Plan of Pearson Property drawn by M.D. Pearson (nd.; Pearson ownership of property from 1928-1973).



Figure 8. Photograph of the Upton Chamber entrance in Goodwin 1946 (Goodwin 1946:46).



Figure 9. Photograph of the Upton Chamber beehive chamber in Goodwin 1946 (Goodwin 1946:48).

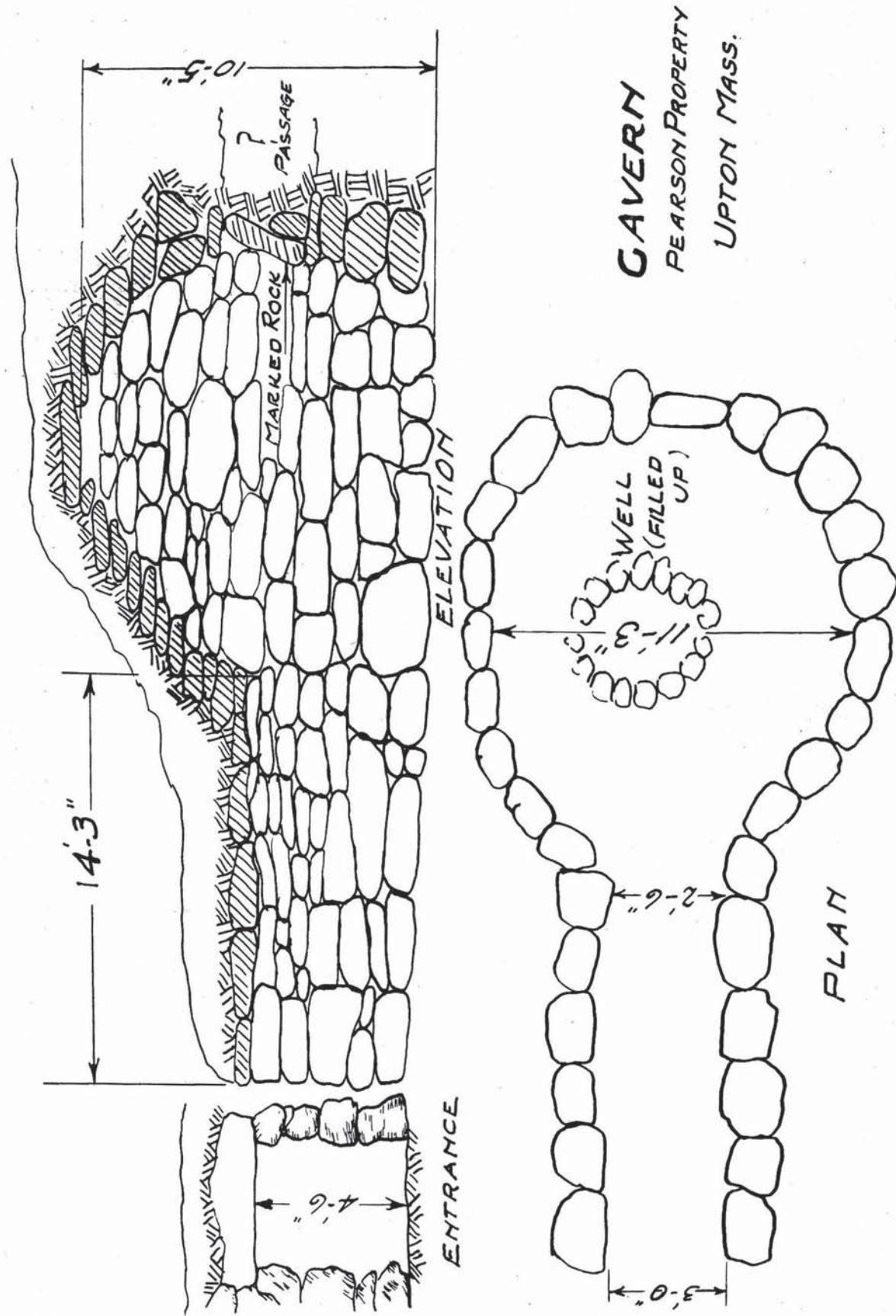


Figure 10. Plan and profile of the Upton Chamber apparently made by Malcolm D. Pearson in 1934 (Goodwin 1946:50).

**DRY MASONRY UNDERGROUND BEE-HIVE
UPTON MASS.**

V.F.F. 1/8/44

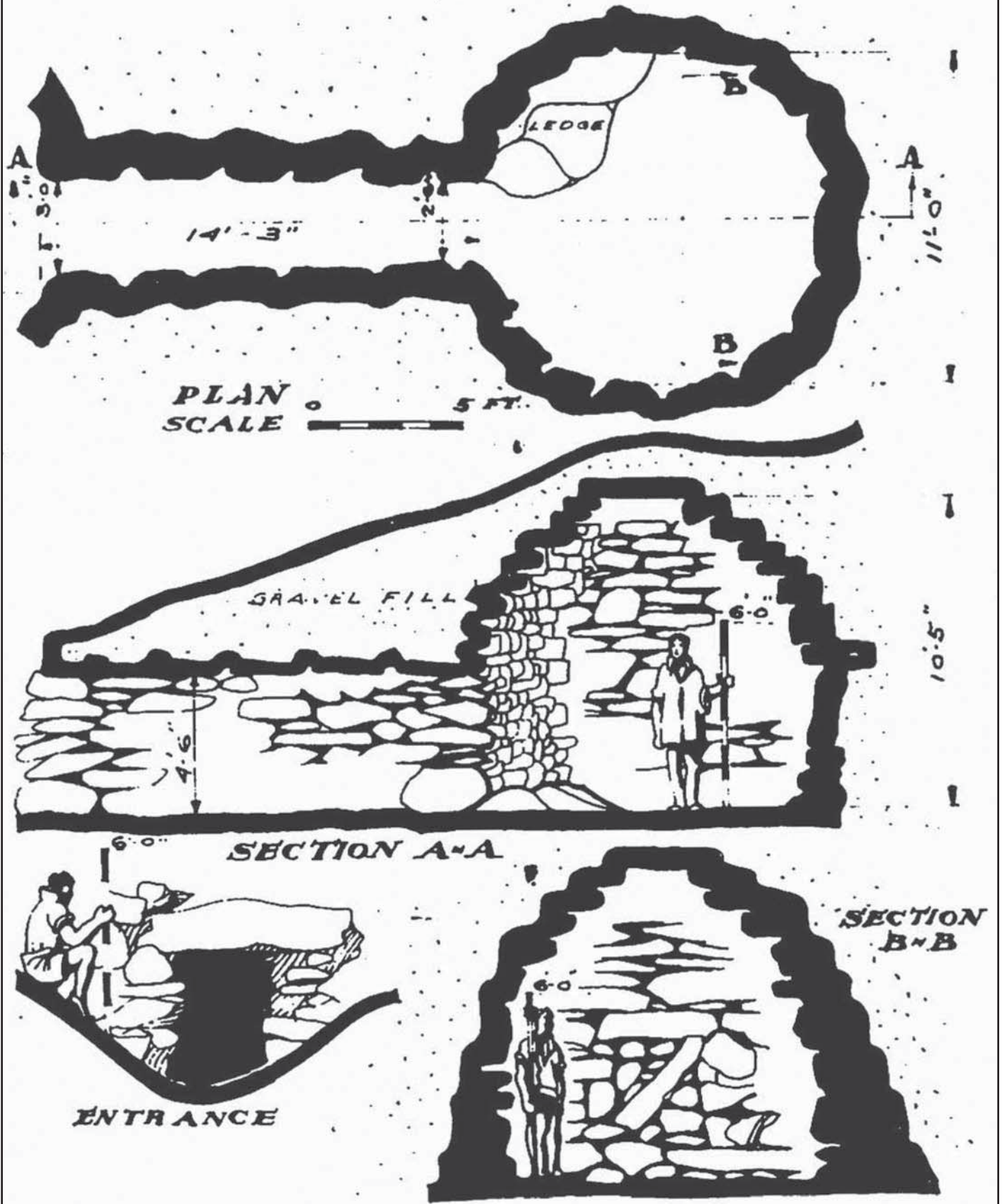
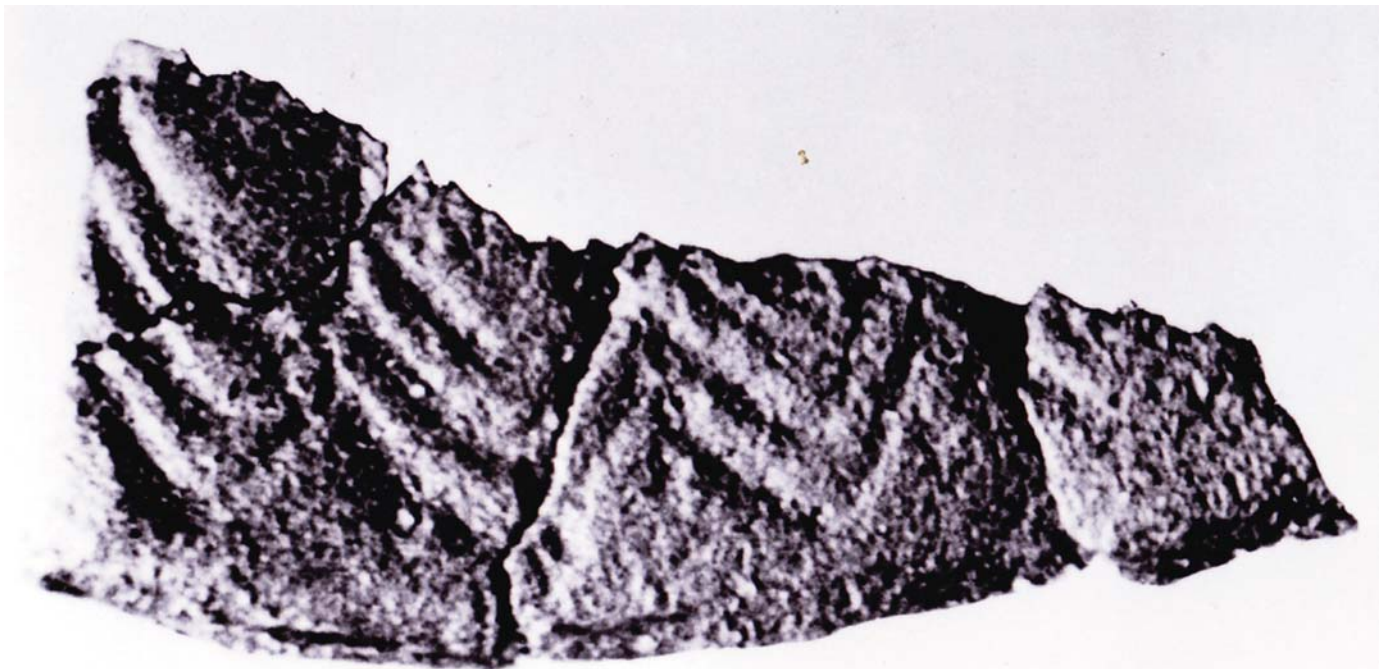


Figure 11. Plan and profile of the Upton Chamber made by Vincent Fagan in 1944 (Whitall 1979:30).



Figure 12a. Photograph of the excavated entrance of the Upton Chamber in 1955 with Dr. David Kelly standing in front (courtesy of the Upton Historical Commission).



Original 9/32 Inches Long • Enlarged 29X

Figure 12b. Photograph of pottery sherd recovered from the Upton Chamber in 1955 (courtesy of the Upton Historical Commission, no scale).



Figure 13. Photograph of the excavated passageway taken from the Upton Chamber entrance in 1955 (courtesy of the Upton Historical Commission).

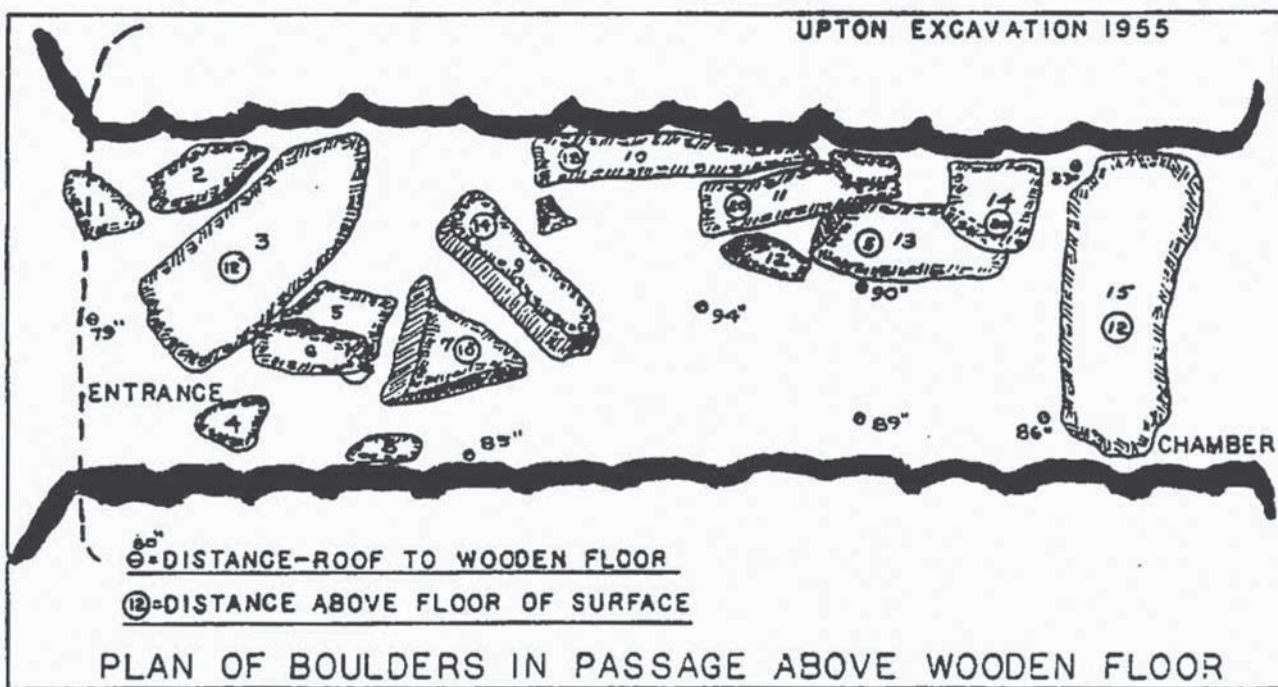
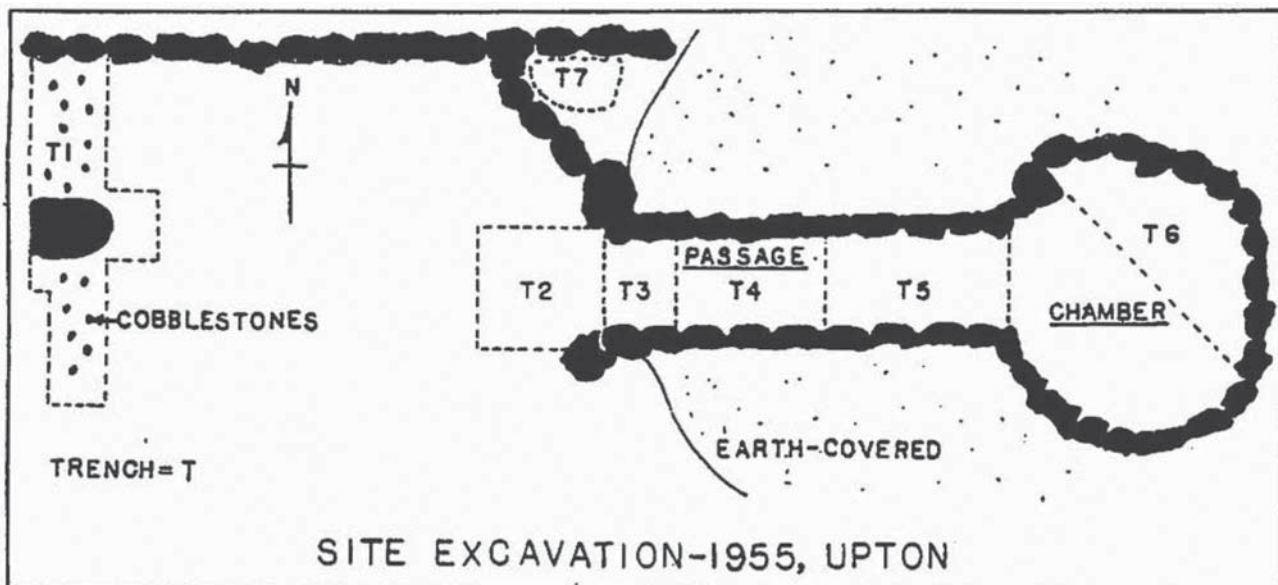


Figure 14. Overview plans of the Upton Chamber excavation units and the passageway by archeologists John Glass and David H. Kelly in 1955 (Whitall 1979:36).

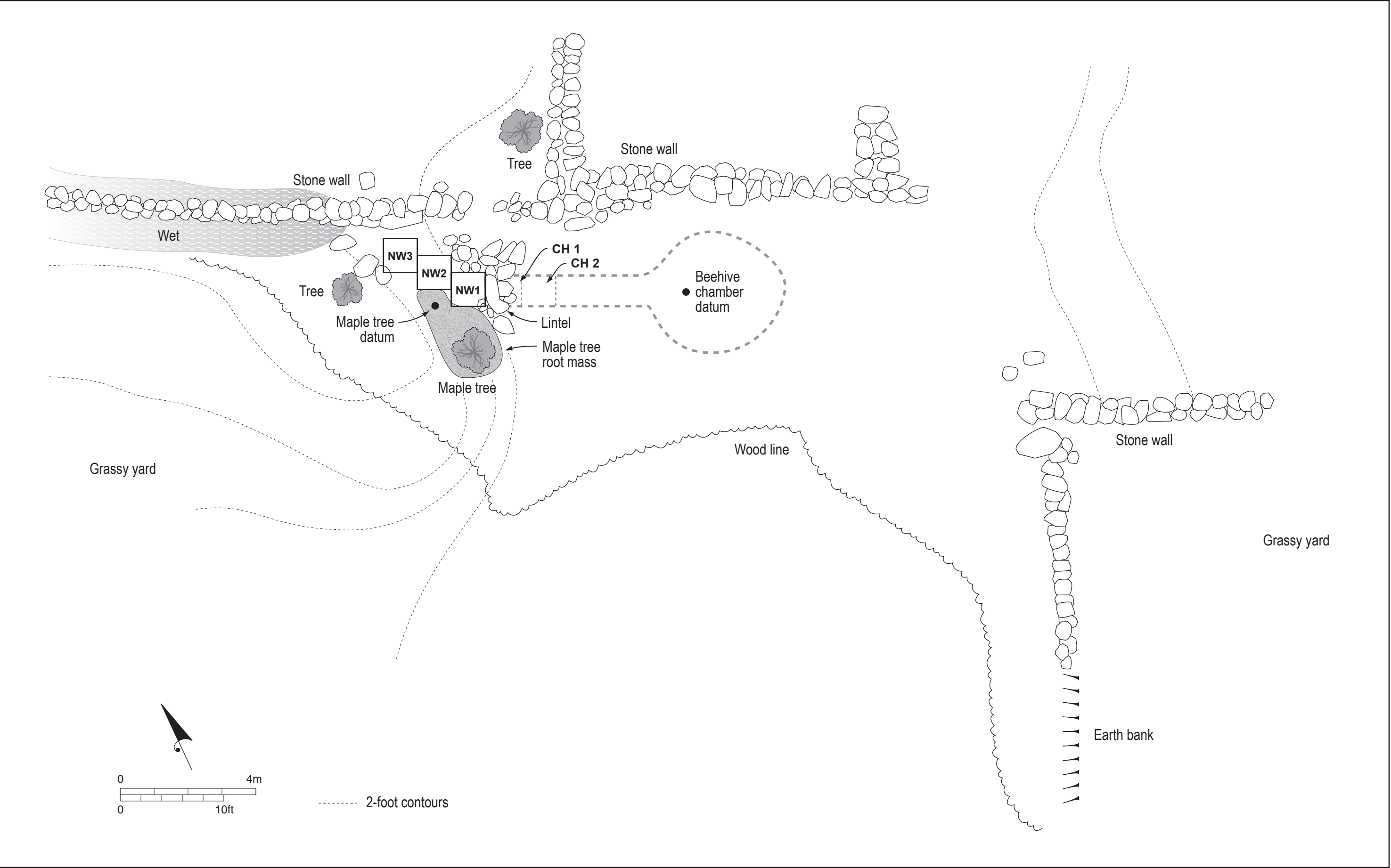
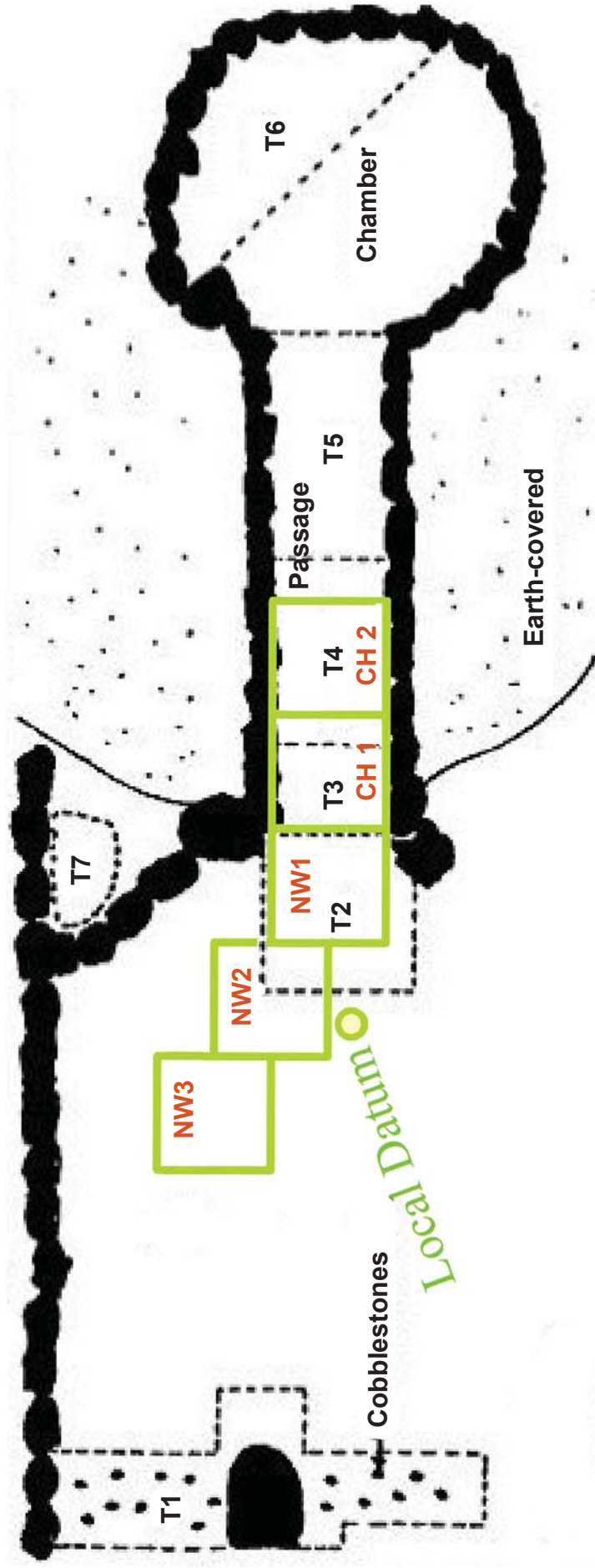


Figure 15. Site Plan of the Upton Chamber and the site examination excavation units.

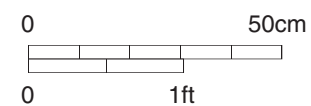
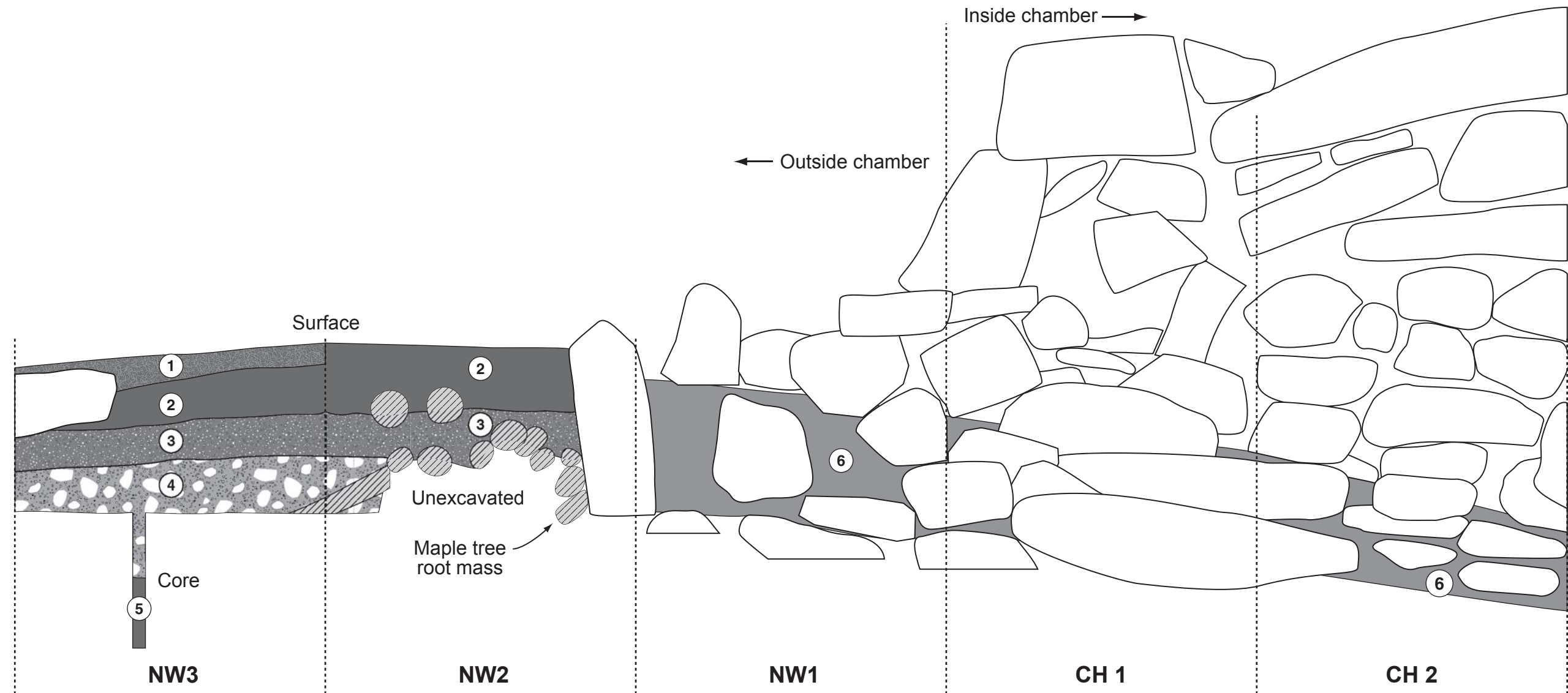


SITE EXCAVATION - 1955, UPTON

T1 Trench

NW1 Excavation Unit

Figure 16. Plan of 2011 site examination excavation units on the overview plan of the 1955 Upton Chamber excavation.



- 1 10YR 2/2 very dark brown silt loam root mat; A0 horizon
- 2 10YR 2/2 very dark brown silt loam; A1 horizon
- 3 10YR 3/2 very dark grayish brown silty sandy loam with pebbles and some cobbles; A2 horizon
- 4 10YR 4/3 brown silty sandy gravel with pebbles and cobbles (Hydric); A3/B horizon

- 5 10YR 3/2 very dark grayish brown hydric clay; C horizon
- 6 10YR 2/2 very dark brown silt loam with sticks and bark; F1 horizon
- Boulders
- Roots

Figure 17. North-east wall profile of EUs NW1, NW2 and NW3 (outside stone chamber) and EUs CH1 and CH2 (inside stone chamber).

PLATES



Plate 1. Existing conditions of the Upton Chamber entrance prior to field work, view southeast.



Plate 2. Draining the flooded chamber, view east.



Plate 3. Grassy yard southwest of the Upton Chamber, formerly wetlands that were filled in; view southwest.



Plate 4. Yard area where soil was screened for cultural materials, formerly wetlands that were filled in, view northwest.



Plate 5. View northeast of the yard west of the former Pearson House (razed March-April, 2011). The trail goes to the Upton Chamber, located in the wooded area in the background. The granite block in the center of the photograph was brought to the site recently.



Plate 6. View northwest of flooded chamber passageway from inside the vaulted main chamber.



Plate 7. Pumping water from the main chamber; view southeast of flooded chamber passageway from the chamber entrance.



Plate 8. View northwest of chamber passageway from inside the vaulted main chamber after water removal; note debris of wood boards on chamber floor.



Plate 9. EU NW1 existing conditions prior to excavation, view southeast.



Plate 10. Removal of surface boulder from EU NW1 using winch, view north.



Plate 11. EU NW1 at 20 cmbs, view northeast.



Plate 12. EU NW1 during excavation, view south; note root mass of large maple tree covering the adjacent slope.



Plate 13. View southeast of EU NW1 at 30 cmbs - the level of the water table; due to the potential for the shifting of weight-bearing boulders under hydric conditions, removal of boulders in the EU was halted.



Plate 14. EU NW2 existing conditions prior to excavation, view southeast.



Plate 15. EU NW2 at 15 cmbs with surface boulders exposed, view northeast.



Plate 16. EU NW2 at 30 cmbs with surface boulders removed, view northeast.



Plate 17. EU NW2 at 50 cmbs with root mat excavated, view southeast.



Plate 18. EU NW3 existing conditions prior to excavation, view north.



Plate 19. EU NW3 at 10 cmbs with surface boulders exposed, view northeast.



Plate 20. EU NW3 at 15 cmbs with surface boulders removed, view northeast.



Plate 21. Stone field wall adjacent to EU NW3, view northwest.



Plate 22. EU NW3 at 40 cmbs below basal depth of boulder, view northeast.



Plate 23. EUs NW1, NW2, and NW3 excavated, view northwest from top of chamber entrance.



Plate 24. EU CH1 existing conditions prior to excavation, view southeast.



Plate 25. EU CH1 during excavation, view southeast.



Plate 26. EU CH1 at 20 cmbs with boulders exposed, view southeast.



Plate 27. EU CH2 existing conditions prior to excavation, view southeast.



Plate 28. EU CH2 during excavation, view southeast.



Plate 29. EU CH2 at 5 cmbs with boulders partly exposed; note ceramic redware rim fragment adjacent to north arrow scale, view northwest.



Plate 30. EU CH2 at 5 cmbs, close-up of lead-glazed redware rim fragment in-situ, view northeast.



Plate 31. EU CH2 at 15 cmbs with boulders exposed, view northwest; the north arrow is resting on top of a ceiling boulder that had fallen in leaving a gap behind the lintel stone.



Plate 32. EU CH1 northeast profile of chamber wall, view east.



Plate 33. EUs CH1 and CH2 northeast profile of chamber wall, view east; note gaps in stonework where soil is infilling.



Plate 34. Wood cribbing in place at the Upton chamber entrance with the in-situ lintel further secured with a strap, view south.



Plate 35. In-situ lintel secured with a strap and supported by cribbing, view south; note large gap behind lintel caused by loss of ceiling boulder and forward shifting of the lintel.



Plate 36. Loose boulder in fill above and behind lintel (above north arrow) has quarry mark, unlike boulders in the Upton Chamber, view east.



Plate 37. Close-up of loose boulder with quarry mark, view east.



Plate 38. Taking an OSL sample by hammering sampling pipe into sediments behind boulder in the north chamber wall above EU CH1, view east.



Plate 39. Stonework rehabilitation in progress in the north chamber wall above EU CH1, view east; the trowel is pointing to lowest course of stones in the chamber wall.



Plate 40. Close-up of the trowel pointing to lowest course of stones in the chamber wall, view northeast; note loose soil and small roots (outside chamber wall).



Plate 41. Stonework rehabilitation in progress in the north chamber wall above EU CH1, view southeast.



Plate 42. Stonework rehabilitation in progress, lintel shifted back with gap to be closed with re-use of fallen ceiling boulder from EUs CH1 and CH2, view southwest.



Plate 43. Stonework rehabilitation of chamber entrance completed and cribbing removed; the fallen ceiling boulder from EUs CH1 and CH2 is being winched out for reuse behind the lintel, view southeast.

Appendix I –

Revised Upton Chamber Masonry Repair Proposal by David Stewart-Smith, PhD

David Stewart-Smith, PhD

877 Battle Street
Webster NH 03303
603 648-2109

April 19, 2010

Cathy Taylor
Upton Historical Commission
Upton Massachusetts

RE: Revised Upton Chamber Masonry Repair Proposal

Pete Wiggin and I revisited the site on April 5, 2010 to consult with Doug Schwartz and Ulric Doejay about the best approaches for structural repair to the chamber. I believe a consensus was achieved with some realistic goals to promote the structural integrity and access to the site. The presence of water in the corridor is of immediate concern. Any freezing and thawing along the walls seems to have created voids in the stonework, especially along left-hand wall (north east). The tree root is also a concern, having expanded toward the wall on the right (south west). The main entryway lintel has tipped forward and moved out from the mound. Both lintel movement and tree growth are documented by photography at the site over the past 70 years.

Interior Corridor – My first proposal addressed a dislodged stone on the left hand wall of the entrance corridor. A second inspection confirms that there are distinct voids in the stonework that give this stone the appearance of having been shifted out from the wall. However, the inner face of the stone appears to be intact while the end of the stone nearest the entrance has lost stonework underneath it and behind. Several stones have fallen out from under this stone and there is visible soil slump behind the stonework.

Process: The chamber entryway needs to have the ability to drain off water. We believe that establishing the original floor level would accomplish this. The floor can be excavated down to its original level and the entrance yard leveled so that water will flow out of the chamber. Our initial water level survey indicates that the floor levels could be corrected to promote natural drainage. The other alternative is to dig in and install a drain pipe for the corridor. We will drain out the water using a portable generator and submersible pump. Excavation of the floor would be the first step. Once the floor level is established, I recommend putting down a layer of gravel to establish a level floor in the entryway. We would then repack the walls with stonework from the bottom up. We believe most of the stones on the floor have come away from the wall originally and can be used to repack the walls. Pockets of slump behind the walls will be excavated using a trowel and then repacked with trap rock and stone. Estimated time for this process – 2 days.

Entrance Lintel -- The lintel at the entrance appears to be out of true but is fairly stable. I did examine the southwest wall supporting the lintel which is extensively involved with the roots of a large maple tree. I feel the tree and the stonework here seem to be reasonably stable but further concerns have been raised about the tree's future growth. I

do not recommend removal of the tree under any circumstances. The tree roots and stonework are inseparably involved deeper in the hill so that pulling out the tree roots would simply dislodge the stonework. Over the years the tree has grown around behind the stonework. The northeastern wall also appears to have lost some material over the years, compared to historical photographs. Upon further examination, I believe the left hand side supporting the lintel was rather inexpertly rebuilt, sometime after Mr. Pearson's photographs. I also believe that a stone lying on the floor of the entrance may have fallen out from part of the original lintel support and was then used to cover the opening – this will be removed when the drainage is dug out.

Process: We would clear the lintel of the stones on top and pick up any structural stones lying in the entryway. Using a crib directly under the lintel, we would jack the northeast side of the lintel up while correcting its tipped angle to the front. It is important the northwest wall be disturbed as little as possible while doing this. The northeast wall will need to be rebuilt to support the lintel while leaving as much of the original stonework in place. We will then dismantle the northwest wall and expose the root ball behind it. It is proposed to cut away part of the root ball from the back of the wall. We would then rebuild the northwest wall packing the back with trap rock. We will make every effort to replicate the historical façade and course of stones on top of the lintel while meeting structural concerns. Estimated time for this process -- two days.

Estimate Proposal – We charge a per diem rate of \$1200 for two men and includes any equipment we bring to the site. The only equipment charge we make is for yarding work done prior to and after the job, loading and unloading the truck, travel expenses, and the like. Yarding charge is \$400.

For purposes of raising funds for this project our estimate comes in at \$5200, which is the same as the original proposal. We have made every effort to keep to the original price. We carry liability insurance for our jobs and references are available.

Further Recommendations: We feel that an arborist should be consulted to identify the tree species and approximate age. The arborist should be able to forecast how many more years are left in the tree's lifespan. This may help determine the tree's fate.

If the town has available trap rock, we could use this for packing and drainage. A load of about three cubic yards would be good to have on hand. Otherwise we will have to transport trap rock from our yard at an additional charge.

As discussed, the small trees on top of the chamber have been cut, consequently the top of the site has suffered some erosion during the extraordinary rainfall of the past year. The top should be planted with small shrubs and ground cover to preserve the soil. Topsoil and plantings should be added this summer and banked with straw to protect new growth.

Under no circumstances should cement or concrete be used to “seal” the stonework or backfill. Concrete on a site like this will start breaking down within a matter of a few years and will promote frost displacement of stonework in the future. All dry stone construction should last hundreds of years.

David Stewart-Smith, stone mason

Appendix II –

FCC Statement of Eligibility to the National Register of Historic Places for the Pratt Hill-Upton Chamber Historic District



Federal Communications Commission
Washington, D.C. 20554

October 20, 2011

**Pratt Hill – Upton Chamber Historic District
A Discontinuous Historic District determined eligible by
The Federal Communications Commission**

FEDERAL UNDERTAKING & DETERMINATION:

The Federal Communications Commission (FCC) has determined that the construction of communications towers for FCC licensees is a Federal undertaking that requires its licensees to have completed a review of the project pursuant to Section 106 of the National Historic Preservation Act. An FCC licensee, Industrial Wireless, has proposed the construction of a communications tower on Pratt Hill, Upton, MA. Accordingly, Industrial Wireless was required to complete the Section 106 process prior to construction. A required element of that Section 106 process is consultation with interested Federally-recognized Indian Tribes.

During the Tribal Consultation, the following facts were discovered by the FCC:

- The communications tower was proposed for a parcel on Pratt Hill at or near map 15, lot 152 off Warren St, Upton, Massachusetts,
- The Tribal Historic Preservation Officers (THPO) for the Narragansett Tribe, the Wampanoag Tribe of Gay Head (Aquinnah), and the Mashpee Wampanoag Tribe revealed to the Federal Preservation Officer (FPO) for the FCC that Pratt Hill was part of an extensive, unmapped Tribal ceremonial stone landscape,
- After the Tribes revealed the importance of Pratt Hill, several of the ceremonial stone features were impacted by the landowner,
- As a condition of moving forward with the project, the FPO asked Industrial Wireless to work directly with the three Tribes to map and document the ceremonial stone features at Pratt Hill and to determine their relationship with the Upton Chamber which is located across the valley from Pratt Hill,
- Industrial Wireless engaged the cultural resource management firm of John Milner Associates to complete that process and to follow the advice and guidance of the three Tribes during that documentation project,
- That documentation project made clear that the Upton Chamber and the ceremonial stones on Pratt Hill were a cultural landscape that is important to the religious and cultural practices of the three Tribes,
- Based on the assembled documentation, the FCC FPO determined that the cultural landscape known as the Pratt Hill – Upton Chamber Historic District is a discontinuous

historic district that is eligible for listing on the National Register of Historic Places under criterion A for its role in the religious and cultural traditions of the three Tribes.

IMPACTED HISTORIC DISTRICT AND CULTURAL LANDSCAPE: The “Pratt Hill Stone Features archaeological site (UPT.HA.16)” encompasses the parcels cited as (map 15, lot 154) and (map 15, lot 152). A formal archaeological survey designated the Upton Chamber as site #UPT.HA.15. The “cultural landscape” is made up of archaeological sites (UPT.HA.16) and (UPT.HA.15) combined. (UPT.HA.16) and (UPT.HA.15) combined, form the “*discontinuous* historic district” determined eligible for the National Register of Historic Places by FPO for the FCC.

Prepared by:



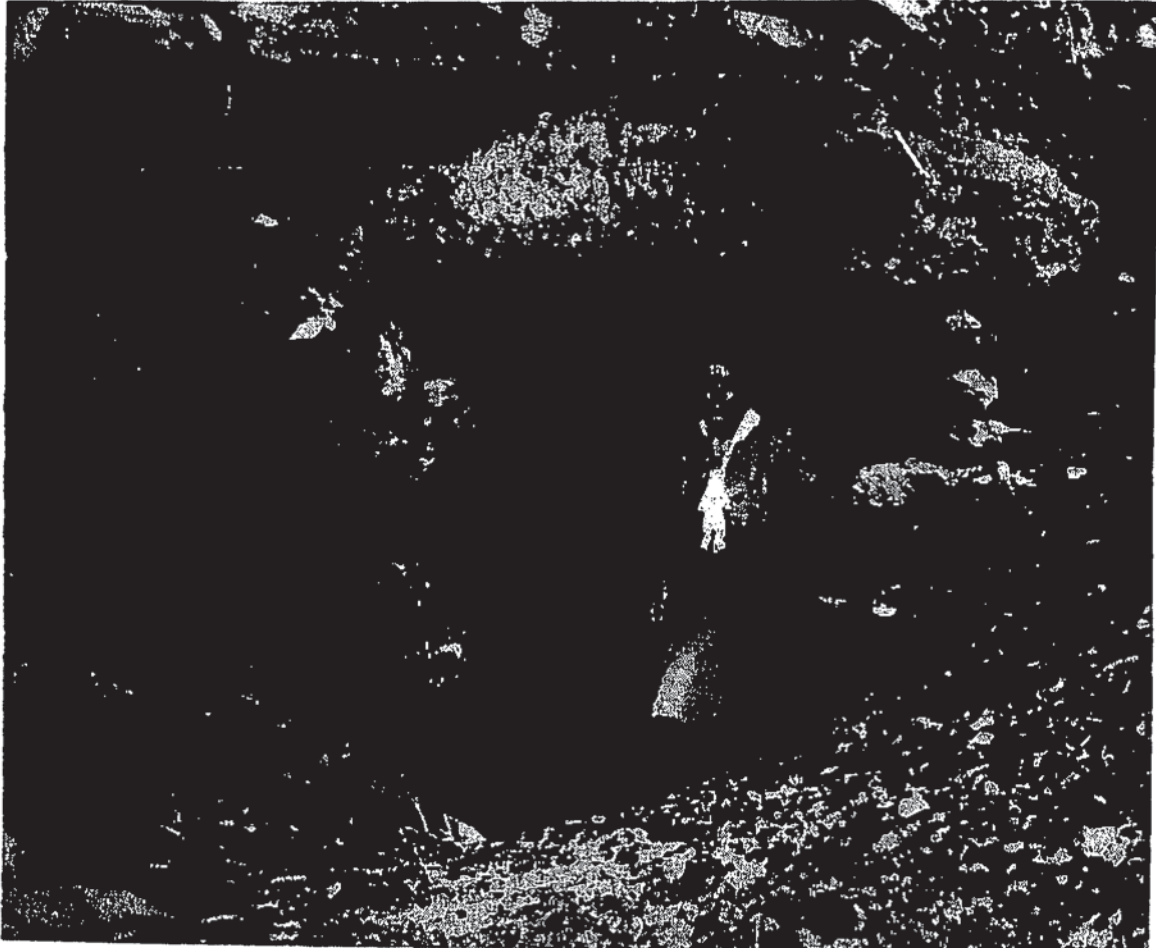
Stephen G. DelSordo
Federal Preservation Officer
Federal Communications Commission
Washington, DC

Appendix III –

**A Report on the Pearson Stone Chamber,
Upton, Massachusetts
by James P. Whittall II (1979)**

* A REPORT ON THE PEARSON STONE CHAMBER
UPTON, MASSACHUSETTS

James P. Whittall, II



M. Pearson

On April 26, 1893, under the non-de-plume "Pratt Pond", Jr.", Daniel Fiske wrote the following story for the Milford Journal.

A Deserted Haunt of Unknown Origin

"Our main object in penning this legend is to rescue from oblivion a relic of the unknown past within our own environments, forgotten by a few of our oldest citizens and unknown to all others around which may linger an atmosphere of mystery or of romance.

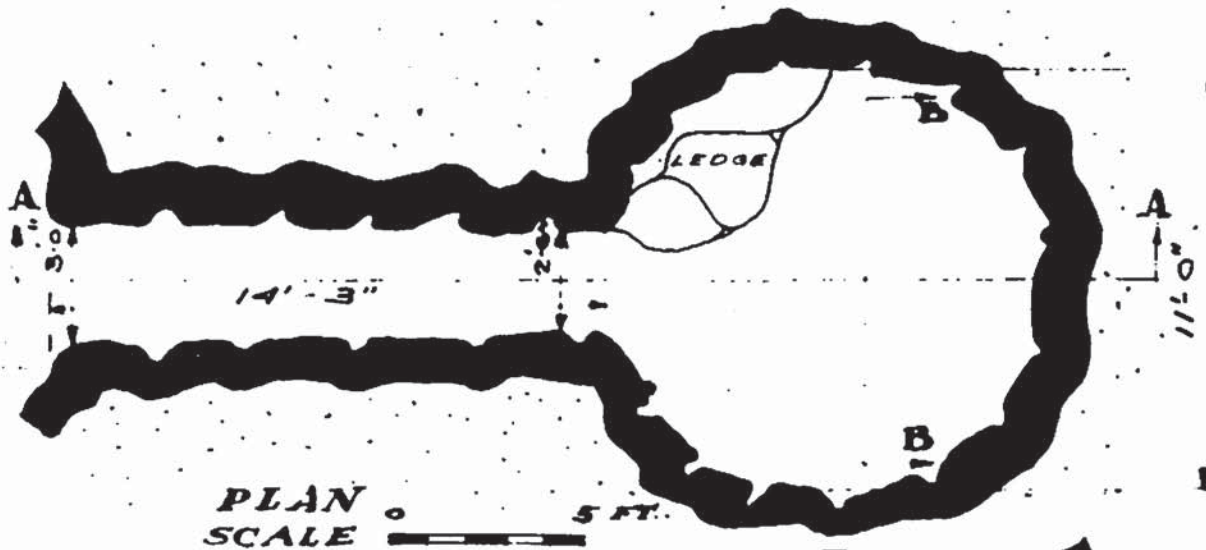
We venture to assert that on account of its secluded location there are not fifty living citizens who have ever been within this mouldering enclosure and many hundreds who born in Upton for a period of four-score years, were ignorant of its existence.

In our younger days in company with other small boys, when playing "Injun", we should occasionally enter its portals and ruminate on its

* Reprinted from BULLETIN, Early Sites Research Society, Vol. 1, No. 1, 1973

DRY MASONRY UNDERGROUND BEE-HIVE
UPTON MASS.

VFF 1/8/44



unknown origin, the object of its construction, and its occupants as our untutored intellects would admit. It was one of the fine days of last October that we in company with an old schoolmate visited this haunt for the first time within the past forty years and after considerable perambulation among rocks and brush, one succeeded in finding the entrance to the walled cavern, and we compelled to here acknowledge our lack of courage, for we insisted on our companion entering first for fear we might be a victim of some venomous reptile. If our pen has already created a desire in the mind of the reader to visit this relic, we advise no one to make this attempt without a guide and with a lighted lantern. The best time to visit it is in October or November when the foliage of the trees and brush has fallen. It has been completely obscured by the snow the past winter. Its location is near the old Hopkinton road which is well known to have existed nearly 200 years. From our youth we have occasionally sought information of our oldest citizens whose ancestors lived on this road from 150 to 200 years ago and they were as ignorant of its origin as we of today. In outward features it resembles the mounds of western states and may have been constructed by the same race existing before the red men.

Though the entrance is partially obstructed by crumbling rocks, enough remains to indicate that it was originally in the form of a common door. From the entrance is a narrow rolled passage of some twelve feet in length leading to the cavern or chambers some fifteen feet in dimensions. The walls are built of small stones easily handled, but the canopy is of stones mammoth in size, which in our imagination could only be placed in position by sliding down from the declivity above.

The floor is the same material. The mind of the visitor on entering this mysterious place, is immediately led to muse or ponder on its origin, its builders and purpose of erection. Speculation only may lead to a conclusion that may be some consolation for lack of historical proof.

It is well known that the eastern portions of Massachusetts and Rhode Island were visited by Norwegians at the beginning of the eleventh century and it is thought the stone tower at Newport was erected by them and the hieroglyphic marks on the Dighton Rock are their work. They may have visited distant inland portions leaving their imprint in lasting monuments. It has been thought by some that this relic was erected as a place of refuge from the attack of some warlike nation previous to the Indian race. Since its abandonment by man, no doubt it has been a refuge for bears, wolves, and other wild animals, as well as of the bat, lizard, venomous reptiles or worms of the slimy brood. Near by the entrance is a portion of a curiously wrought stone, partially imbedded in the earth. Some of the lines represent portions of a circle, others resemble those of the Dighton Rock. It is possible this stone may have been part of the original gate or door.

If one well versed in anthropography or in archaeology could have a chance to inspect and give a thorough study to this curious stone, it is possible some insight might be gained that would lead to an interesting local history of the past. Till then doubtless the origin of the subject of this legend will remain as oblivious as to those of former generations."

The preceeding is the first known written report on the Pearson stone chamber; a structure of undetermined antiquity located in Upton, Massachusetts on Elm Street. When the property was acquired in 1928 by Charles N. Pearson, nothing was mentioned by the former owners about the chamber until the deeds had been transferred. The curiosity of the Pearsons' concerning the chamber caused them to seek out all the information they could find about the "cave" in their back yard. Quizzing older residents, one answer was common: their forebearers had always known of its existence and it pre-dated anyone's memory. The land deeds were studied at the Worcester County Registry of Deeds, but no mention of the "cave" was made. The deeds were checked to the early 1700's. (Previous to that time the records were kept in Cambridge.) The land was a Harvard College grant from common lands of the Bay State Colony.

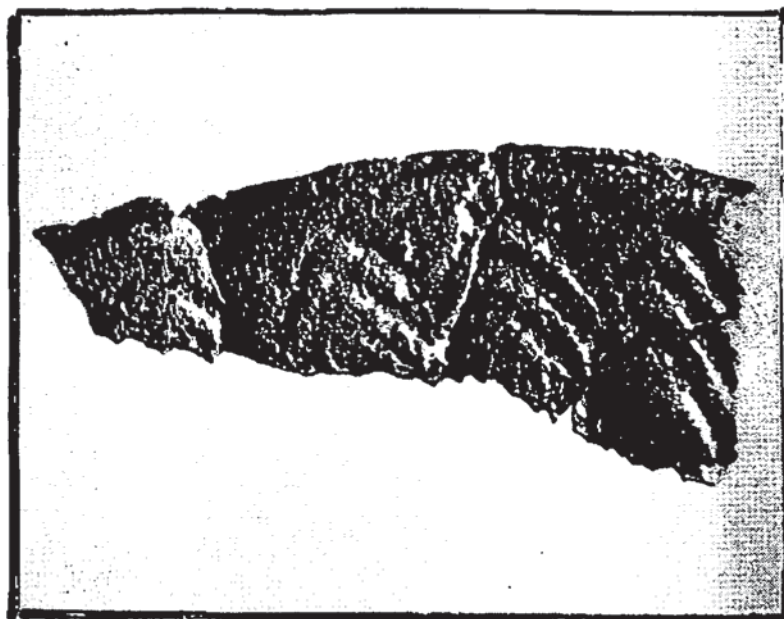
In 1936, Professor Hugh Hencken and an assistant, Hallam Movius of the Peabody Museum of Harvard, visited the site. They felt that there were some parallel features with ancient Irish stone dwellings. They felt though, that they could give no opinion or plausible reason for this structure's existence.

Several theories were advanced over the years: tanning of hides; storage for vegetables; and a waterwheel pit. Inspection revealed no fire ashes from hides inside, no ventilation for the preservation of vegetables, and no waterwheel shaft bearing points. Besides which, water action would undermine the stonework which was constructed on earth.

In 1946, Mr. William Goodwin, an amateur archaeologist, very interested in stone structures in New England, mentioned the Upton site to some extent in his book, The Ruins of Great Ireland in New England. He suggested that the chamber was constructed by the Irish Culdee Monks around the period 900 A.D.²

In 1954, after viewing photographs of the Upton chamber and others in New England, Dr. T.C. Lethbridge, the noted English archaeologist wrote, *"Some of those stone structures in New England reminded me very much of storehouses (?) I have seen in Southwest Ireland. Others are more like Hebridean structures. I could not be certain of the date of any of them"*.⁵

In 1954, Professor Vilhjalmur Stefansson, Artic Consultant to Dartmouth College, stated that he suggested 500 A.D. as a minimum antiquity and a much higher one more probable. This could be through a culture which arrived (a) across the Atlantic, then probably by the stepping-stone route, or (b) across the Pacific, then probably by Alaska. It seemed to him likely that the same people, or at least the same culture, built the Upton chamber in New England and the conical stone houses that are scattered through out the North American Artic. He further felt that the underground beehive problem was in the field of prehistoric archaeology and the history of geographic discovery.³



M. Pearson

*SILVER RIM SHERD RECOVERED DURING THE 1955 EXCAVATION
AT THE UPTON STONE CHAMBER.*



M. Pearson

PASSAGEWAY INTO THE UPTON STONE CHAMBER

Dr. Stefansson further goes on to state in another letter to Mr. J. Beadsley, a Director of Early Sites Foundation, the following: "This memo concerns itself with the problems related to Upton, the remarks are in main bibliographic. My own experience with structures similar to what Professor Fagan represents on page 49 of Goodwin's The Ruins of Great Ireland in New England is touched upon in my 1913 Eskimo book, with text on pages 274-5 and a photo (opposite to) page 174; the like is covered in my 1914 Anthropological Papers, text on pages 293 and 297, no photo. Diamont Jenness, anthropologist of my 1913-18 expedition, was in the same region and saw a similar structure, but not the same one; his discussion is in Report of the Canadian Arctic Expedition, 1913-18, The Copper Eskimos, pages 17, 57, 58; his photo is on page 57. (His picture shows a structure less definitely conical than the one I saw.) Jenness says, page 57: 'The early explorers found stone huts on the islands of the Perry Archipelago similar to those that are still used at Smith Sound. Mr. Stefansson discovered one of these huts near the mouth of the Kimiryak River.' In connection with the first of these two sentences Jenness cites C.R. Markham and the impression Jenness gives is that Markham reports huts similar to those he (Jenness) and I described and photographed; this is correct in the sense that Markham's wording gives this impression; but I have followed up on the authors Markham quotes and find that some of them have in mind huts such as J. and I had in mind but that many of Markham's references are not properly applicable. The first of them which appears to me correctly applicable is Sherard Osborn: Stray Leaves from an Arctic Journal which has a description and sketches on pages 142-143. Markham mentions the view of others that all these are Eskimo remains, 'But I still think that the stone huts and tombs are the remains of a more ancient race.' Jenness and I agree in reporting the Eskimos told us that a non-Eskimo people built these; he says of the one he photographed: 'The natives gave varying accounts of its origin. Some said it was made by white men long ago, possibly Rae's party; 'since I also was told white men might have made it and was assured this must have been many generations ago, I infer that Jenness is quoting his informants on the "white men" part and that "possibly by Rae" is his own suggestion. Markham who was Rae's contemporary, thinks the structures very ancient -- pre-Eskimo. C.R. Markham knew personally most of the men he quotes and had himself seen some of the ruins they describe; so it would be well to read his, "On the origin and migration of the Greenland Eskimo", page 169, et seq. in A Selection of Papers on Arctic Geography and Ethnology, London, 1875. Like most naval men of his time, Markham is strongly prejudiced against Edward Belcher, whom he accordingly does not quote; but there is a good reference in Belcher's Last of the Arctic Voyages, Vol. 1, pages 94-96, with a drawing.

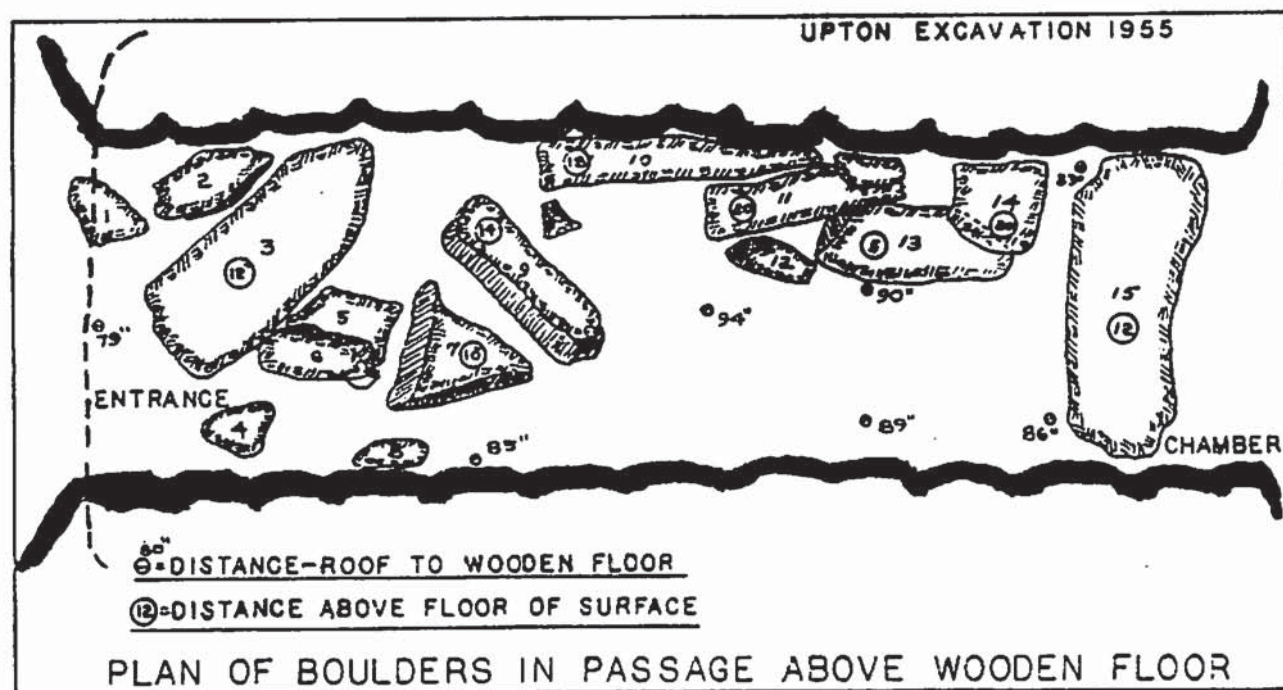
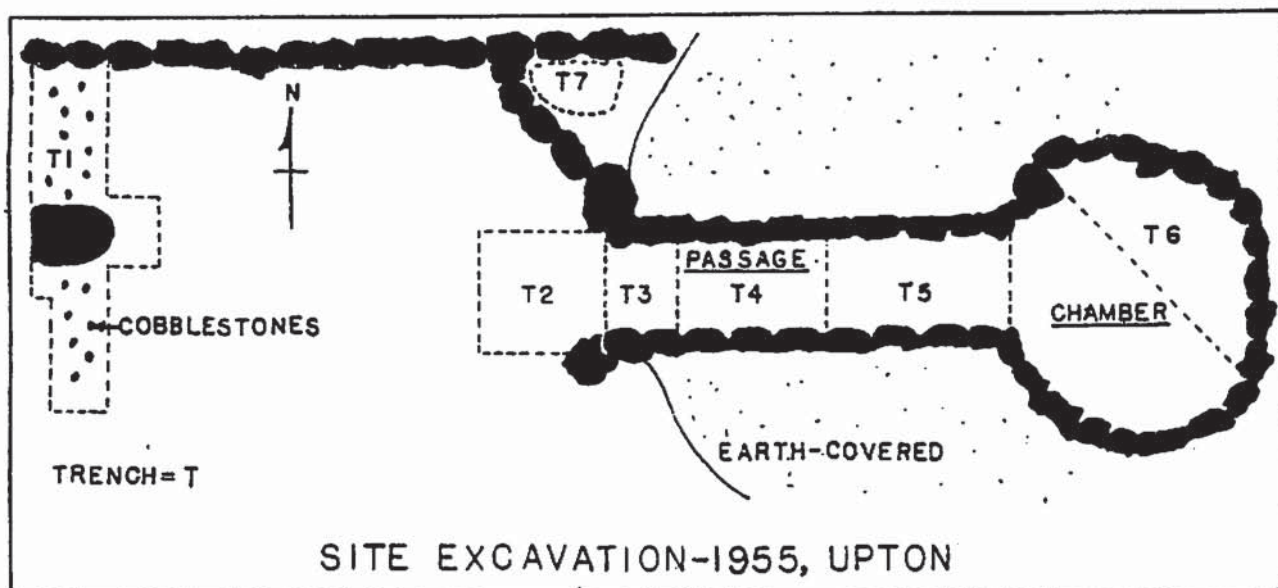
The cited Jenness references are important to read. It is probable that if one had time to search the literature a good many references to stone houses would come to light. I have checked only about half of the C.R. Markham references -- it may be more of them are applicable than I now think.

The underground or conical beehive house of New England look like the over-ground conical structures of the Arctic. The Arctic houses may very well have been earth covered at the time they were in use, for if they are of Dorset or greater age the wind would have had plenty of time to blow all the sod away, as all sod has been blown out of Scandinavian stone walls of Greenland in a corresponding length of time." 4

In 1954, an organization called Early Sites Foundation (since dissolved), was founded by persons interested in the study and determination of the origin of all unknown stonework in New England. Among the original directors' was Malcolm Pearson, who had dedicated many years of research to the stone-structure problem since he first started studying the chamber on his father's land. Early Sites Foundation in 1955 sponsored an archaeological investigation at the Upton Stone Chamber. Below is a report of this archaeological study undertaken by two graduate students, David H. Kelly and John Glass. The report was prepared by Mr. Kelly.

"Excavations were begun with a trench about 18 feet west of the tunnel entrance, to determine the local stratigraphy and see if the debris extended that far. No artifacts were found. A humus level sat upon yellow gravel, and the water table was reached at a few inches into the gravel. An area in front of the tunnel entrance was then cleared away, and a pit put in across the width of the tunnel just outside the entrance. The extensive root system of a nearby maple tree made digging very difficult and, in the area where they were found, the roots could easily have displaced artifacts from one level to another.

Most of the artifacts found were broken white china, and Mr. Charles Pearson said that children used to break pottery there for amusement. This does not mean that all broken chinaware belonged to playing children, but it does introduce an unforeseeable amount of error, as they might have had old plates which had been around the house for a long time. In any case, it is not of much importance as a large sterile layer (or rather, zone, as there was no natural distinction in the soil) underlay the deposit which contained white china. Further clearing revealed two large stones in the entrance way, one fairly flat, the other nearly perpendicular. These were at first thought to be sill stones. Subsequent work in the tunnel indicated that artifacts ceased about 4 or 5 inches from the top surface of the flat zone. There is a large gap in the stonework of the south wall just above this point, and the stones may have fallen from there. However, Mr. Charles Pearson is of the impression that the missing stones were in place about 30 years ago. If these two stones were deliberately placed in position, it is difficult to see why and when. Trenchers were put inside the tunnel to about the level of the top of the first flat stone, taken down in levels so that a sterile layer was distinguishable above the level of the stone. The stones were then photographed, and the perpendicular one removed. Excavation continued where it had been, and parts of three large flat stones became visible, apparently placed to form a floor. The remainder of the dirt in the tunnel was then removed to this level, and ten other stones of varying size were uncovered. Some had decidedly uneven faces and their tops were at different heights by several inches. In the southeast corner of the tunnel none were found in an area more than 5 feet long by more than 2 feet wide. There was no place that they could have fallen from, and several of them might once have been sitting more nearly level, so it seemed likely that they had been deliberately placed, despite their irregularity. In clearing down in the southeast corner of the tunnel, a wooden floor was found. It was traced out back towards the entrance, and was found to go under the large stones. About 2 inches of soil had been left upon it throughout this area. Several badly rusted pieces of iron, probably nails, were found in clearing



the area at the level of the large stones and down to just above the floor. Frequent patches of rust were also observed, too badly corroded to be sure that they had ever been artifacts, particularly since a local rock frequent in the gravel, showed a heavy concentration of iron, usually rusting a slightly lighter color than the demonstrable artifacts. The large stones were then removed. Some were found to be sitting directly on the wooden floor, while others were on the sandy fill above the floor.

In clearing the small amount of dirt remaining after the removal of the large stones, Glass encountered a very small and delicate sherd. This was a rim sherd with what appeared to be a lead slip -- at any rate, a hard metallic gray (actually silver, see photo). A reddish tinge was visible along the rim, which apparently curved both vertically and horizontally. A molded design of three lines formed a chevron pattern. The sherd broke into 3 pieces while being wrapped, indicating the extreme delicacy of the specimen. The sherd is very distinctive and should eventually be clearly identifiable. Inasmuch as great care had been taken to remove excess dirt as the excavation proceeded, there is every reason to suppose that the sherd approximately dates the wooden floor. The floor over most of the tunnel was in a badly rotted condition and in some places, either turned to a black soil or vanished completely. In the vicinity of the stones 7 and 9 of the sketch map of the tunnel, where the sherd was found, it was impossible to be sure whether the sherd came from just above the wooden floor or from below it at a point where it had rotted away, as it was not seen in situ.

A sufficient amount of the floor proper remained to give a specimen from which a C-14 date could be obtained. However, the sample was badly contaminated with both living and dead roots which had penetrated it. The level of the floor was about 2 inches above water level at the time of the excavation, and even with the bottom course of stones in each of the tunnel walls. In some places it appeared to go partly under the stones, but in other places clearly abutted the side of some of the stones. Probably during the course of rotting the pressure of the earth above had forced the remnants of the boards hard up against the stones or under them, depending upon their level relative to the basal course. The same factor may well be responsible for the first fact that at no place in the tunnel was there a visible line of demarkation between two boards, in either direction. Occasional large chunks suggested that the original thickness of the floor may have been about 2 inches. One rusted artifact was found in sandy gravel beneath the floor, apparently a large spike, bent at right angles.

The presence of the water table so near the present floor level, and the knowledge that it rises to considerably above the old floor level during wet seasons, strongly suggests that the old wooden floor was built during a dry period by people who did not realize that the water table was so close, and that the large stones were piled in on top of the floor as stepping-stones during the first wet period. This likewise suggests that the purpose of the "beehive" was a year round matter, and is some slight evidence against such suggestions as a spring house. This argument, of course, is only valid if the water level at the time of building was approximately the same as now in its yearly fluctuations.

The wooden floor is presumably a part of the original structure, since it ties in so closely with the basal course of the tunnel walls, and since there is no positive evidence of any other occupation. The use of the large flat granite stones put on top of the floor tends to confirm this view, as whoever put them in was in the habit of moving large stones. The thought

of putting a stone the size of number 3 for a stepping-stone would never have occurred to me, but to anyone who had put the much larger capstones of the tunnel in place it would probably have seemed simple.

After completing the clearing of the tunnel, a section of the chamber was excavated. A layer of humus, full of roots and containing very few artifacts, extended down to a level of gray clay and rotten granite which is apparently the basic local soil. In the northwest corner of this trench, some boards appeared sitting on the gray clay. When we realized that the gray clay was probably an undisturbed original deposit, we decided that the boards must be the original floor, although; it was here considerably higher than in the original tunnel. Indeed the basal course of the chamber appeared to be about two courses higher than the basal course of the tunnel. Since only a small section of flooring was found and its association with the tunnel floor was not absolutely certain, most of it was not kept, although a rounded log which may have been part of a cross-beam was kept. A cross-cut from this trench to the tunnel would have revealed the relationship of the two floor levels positively, but it seemed more worthwhile to examine the extent of the wooden floor outside the entrance to the "beehive".

At the entrance, our original pit had not gone as deep as the floor, so the remaining overburden was removed in two levels. The floor was found to cover the entire bottom of the excavation and to extend into the profile on all sides. When it was removed, a cross-piece was found. Since it sat down into a yellowish sand and small gravel deposit, its dimensions were easy to determine even where it had rotted away to black soil; there were 2 inches by 6 inches. It extended into the profile both north and south of the excavation. Ten nails were found in this cross-piece in various degrees of preservation. Probably some of the nails found can be restored to good enough condition to enable an approximate date to be determined from their type.

A small test pit was put in near the northwest corner of the beehive, where it joins a stone wall, in order to check whether a retaining wall had been built on the west face of the beehive, to hold back the earth piled on it. No evidence of such a wall was found, but within the top foot of the excavation were found numerous sherds of blue-on-white straffordshire ware. There is no reason to suppose that these all derive from playing children, who left no other later, pottery, but neither is there anything to indicate that these sherds are contemporary with the building of the beehive. I incline to think that they represent a later occupation, perhaps contemporary with the building of the stone wall.

When the sherd, the nails, and the wood from the old floor have been dated, it will be time enough to decide whether more work is desirable. Since no clear evidence of use was found in the area so far excavated, it seems unlikely that further excavation would answer the problem, since a fairly extensive section of the chamber was dug. The materials already found should be sufficient to date the structure, and further evidence would only be confirmatory. However, if the evidence seems indecisive, or no one can identify the sherd, it would be possible to clear the rest of the chamber, to excavate to the edge of the wooden floor, in order to check the exact relationship of the pottery to the "beehive", and to the stone wall, as well as making certain that the "beehive" antedates the stone wall."6.

The material recovered by Kelly and Glass has never been dated up to this time, and only recently it has been turned over to the Early Sites Research Society for further analysis and study. No further investigation at the site has been carried out since the Kelly-Glass project.

In closing, I would like to mention another area of the world that should be considered in regard to the Upton Chamber. I feel the investigation of the 'tholos' tombs in the Iberian Peninsula should be undertaken to study the parallels between them and the Upton structure. As an example, the collapsed 'tholos' of A Comenda, Reguengas de Monsaraz, in Evora, Portugal bears a strong resemblance in its construction to that at Upton. Numerous other structures, especially in the Almeria area of Spain also bear similarities to the Upton chamber. Only through a thorough study can any possible determination be made as to the validity of the parallels of these structures in the Iberian Peninsula and the Upton structure. 7.

As it now stands, there is no final answer for the age of construction or the culture responsible for the building of the Pearson stone chamber in Upton, Massachusetts.

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2. Goodwin, William B., (1946) THE RUINS OF GREAT IRELAND IN NEW ENGLAND
3. Stefansson, V. (1954) letter to Robert A. McKennan, April 19, 1954
4. Stefansson, V. (1954) letter to J.H. Beardsley, February 15, 1954
5. Lethbridge, T.C., (1954) letter to V. Stefansson, May 8, 1954
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7. Savory, H.N. (1968) SPAIN AND PORTUGAL, Thames & Hudson, London, England

Appendix IV –

**Upton Historical Commission: A
summary of archeologist Alan Leveillee's
impressions of the Upton Chamber (2005)**

UPTON HISTORICAL COMMISSION

A summary of archeologist Alan Leveillee's impressions of the Upton Chamber

On July 20, 2005, archeologist Alan Leveillee from Public Archeological Laboratories of Pawtucket, Rhode Island visited the Upton Chamber at the request of the Upton Historical Commission. Present with Mr. Leveillee were Historical Commission members Jonathan Meagher and Jerry Owczarzak.

Mr. Leveillee examined the exterior of the chamber, looked into the interior of the chamber with the help of a flashlight, and took note of the surrounding landscape. Though Mr. Leveillee's visit could not by any means be considered a formal archeological investigation, he did offer his impressions of the site. His preliminary analysis can be summarized as follows:

1. There is no question that the chamber was built above grade and covered with earth only after its completion.
2. It is most likely that the chamber was built during the 1700s to serve a purpose related to agriculture or life in an eighteenth-century agrarian society. Potential purposes of the chamber in this context would include shelter (possibly from Indian raids), cold storage of unknown commodities, or ice storage. The chamber's relatively small opening is good evidence that it was designed for one of the aforementioned purposes because it is not large enough for people to comfortably pass through on a regular basis and suggests that the intent of the chamber's architect(s) was to limit airflow in the chamber. There may also be some chance that the chamber could have been designed as a winter mausoleum, but that is not terribly likely because, due to the time and effort undoubtedly involved in constructing the chamber, its builders would have had to have anticipated significant need for such a structure well in advance of such a need being generated by epidemics and the like.
3. It is not likely that Native Americans built the chamber. Animal technology would most likely be used in the construction of such a structure, and local Native Americans did not possess such technology. There is also no record of local Native Americans being responsible for major stonework. Use of the chamber as an astronomical observatory by either Native Americans or European colonial settlers would have been unlikely despite the astronomical alignments that have been suggested by some.
4. It may or may not be possible to arrive at a definitive explanation of the chamber's genesis. The remnants of a wood floor that were removed from the chamber during the 1950s could be carbon dated. The carbon dating, however, would only determine when the tree that produced the wood died, and it is entirely possible that the chamber itself predates the wood floor. It might be possible for a trained archeologist to determine the age of the silver shard removed from the chamber during the 1950s excavation by simply examining it. It is also possible that a process called thermoluminescence could help to date the shard.

5. Exploration of the site with a ground-penetrating radar/sonar system may or may not yield further significant information about the site. The number of large rocks in the Upton area's soil might make it difficult to obtain helpful readings from the radar/sonar system. Even if something of interest showed up on a radar/sonar reading, digging would be required to determine its significance.

6. It may be possible to convince a local college archeological department to study the chamber and its environs. The site would make a good subject for a summer "field school" with a curriculum including surveying, documenting, recording, photographing, and performing background research. Clark University and Holy Cross would be worth approaching.

7. Short of a formal archeological investigation, researching the property's deeds and owners may provide clues as to who might have built the chamber and for what purpose. Things to look for include individuals with the wealth, time, and wherewithal to undertake such a significant construction project.

8. The Upton Chamber and the surrounding property are definitely worthy of preservation. The town should acquire the property with an eye toward making it the subject of future historical and archeological consideration. Currently, the site is significant more for the questions it raises than the answers it provides, but future investigations may provide valuable new insights. The origins of the Upton Chamber remain open to question.

9. Mr. Leveilee agrees with the conclusion of John Glass, a former Harvard archeological student and member of the party that investigated the chamber in the 1950s, that regardless of whether the chamber is hundreds or thousands of years old "it is a unique and important example of a class of New England architecture that is fast disappearing."

**Appendix V –
Site Examination Artifacts Catalogue**

Upton Chamber (UPT-HA-15) Site Examination Catalog: Upton, MA

December 30, 2011

Page 1

Lot#	Unit	Layer	Depth	Cat.#	Era	Class	Material	Color	Description	Detail	Qty	Portion	Comments
1	CH1	Fill 1	0-5 cm.	1	Historic	Ceramic	Earthenware		Whiteware	Plain		1 Rim Fragment	
1	CH1	Fill 1	0-5 cm.	2	Historic	Glass	Flat Glass	Lt Aqua Tint	Window Glass			1 Fragment	
1	CH1	Fill 1	0-5 cm.	3	Historic	Glass	Vessel Glass	Amber	Bottle Glass	Machine-Made		1 Lip/Neck Frag.	Modern, crown top.
2	CH1	Fill 1	05-10 cm.	4	Historic	Ceramic	Earthenware		Whiteware	Plain		5 Fragments	
2	CH1	Fill 1	05-10 cm.	5	Historic	Glass	Flat Glass	Lt Aqua Tint	Window Glass			2 Fragments	
2	CH1	Fill 1	05-10 cm.	6	Historic	Glass	Vessel Glass	Amber	Bottle Glass	Machine-Made		2 Body Fragments	Modern.
2	CH1	Fill 1	05-10 cm.	7	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		1 Body Fragment	Modern.
2	CH1	Fill 1	05-10 cm.	8	Historic	Glass	Vessel Glass	Clear	Lamp Glass	Thin		1 Body Fragment	
3	CH1	Fill 1	10-15 cm.	9	Historic	Glass	Vessel Glass	Amber	Bottle Glass	Machine-Made		2 Body Fragments	Modern.
4	CH1	Fill 1	15-20 cm.	10	Historic	Ceramic	Ironstone			Plain		1 Fragment	
4	CH1	Fill 1	15-20 cm.	11	Historic	Glass	Flat Glass	Lt Aqua Tint	Window Glass			1 Fragment	
5	CH2	Fill 1	0-5 cm.	12	Historic	Ceramic	Earthenware	Tan/Pink Glaze	Redware	Lead-glazed		1 Rim Fragment	8 cm fragment; jar form; leached interior glaze, exterior wash; mends to cat# 16.
5	CH2	Fill 1	0-5 cm.	13	Historic	Ceramic	Earthenware		Whiteware	Plain		2 Fragments	
5	CH2	Fill 1	0-5 cm.	14	Historic	Ceramic	Ironstone			Plain		2 Fragments	
5	CH2	Fill 1	0-5 cm.	15	Historic	Glass	Vessel Glass	Amber	Bottle Glass	Machine-Made		2 Body Fragments	Modern.
6	CH2	Fill 1	05-10 cm.	16	Historic	Ceramic	Earthenware	Tan/Pink Glaze	Redware	Lead-glazed		1 Body Fragment	Jar form; leached interior glaze, exterior wash with incised horizontal line; mends to cat# 12.
6	CH2	Fill 1	05-10 cm.	17	Historic	Ceramic	Earthenware	Tan/Pink Glaze	Redware	Lead-glazed		1 Fragment	Leached interior glaze, missing exterior.
6	CH2	Fill 1	05-10 cm.	18	Historic	Ceramic	Earthenware	Blue Transfer	Whiteware	Transfer-Printed		2 Rim Fragments	
6	CH2	Fill 1	05-10 cm.	19	Historic	Ceramic	Earthenware		Whiteware	Plain		13 Fragments	2 are missing glaze.
6	CH2	Fill 1	05-10 cm.	20	Historic	Ceramic	Ironstone			Plain		2 Fragments	
6	CH2	Fill 1	05-10 cm.	21	Historic	Glass	Flat Glass	Clear/Tint	Plate Glass			3 Fragments	
6	CH2	Fill 1	05-10 cm.	22	Historic	Glass	Vessel Glass	Clear	Lightbulb	Small Bulb		1 Base Fragment	
6	CH2	Fill 1	05-10 cm.	23	Historic	Glass	Vessel Glass	Amber	Bottle Glass	Machine-Made		2 Body Fragments	Modern.
6	CH2	Fill 1	05-10 cm.	24	Historic	Wood	Bark		Unburned			1 Fragment	Bark fragments were commonplace in the fill; this piece was retained as a representative specimen.
7	CH2	Fill 1	10-15 cm.	25	Historic	Ceramic	Earthenware		Whiteware	Plain		3 Rim Fragments	
7	CH2	Fill 1	10-15 cm.	26	Historic	Ceramic	Earthenware		Whiteware	Plain		1 Fragment	
7	CH2	Fill 1	10-15 cm.	27	Historic	Glass	Flat Glass	Lt Amethyst Tint	Window Glass			1 Fragment	
7	CH2	Fill 1	10-15 cm.	28	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		1 Body Fragment	Modern.
7	CH2	Fill 1	10-15 cm.	29	Historic	Glass	Vessel Glass	Amber	Bottle Glass	Machine-Made		11 Body Fragments	Modern.
8	NW1	Fill 1	0-5 cm.	31	Historic	Ceramic	Earthenware		Whiteware	Plain		1 Rim Fragment	
8	NW1	Fill 1	0-5 cm.	32	Historic	Ceramic	Ironstone			Plain		1 Fragment	
8	NW1	Fill 1	0-5 cm.	33	Historic	Ceramic	Ironstone			Missing Glaze		1 Fragment	
8	NW1	Fill 1	0-5 cm.	34	Historic	Glass	Flat Glass	Lt Aqua Tint	Window Glass			1 Fragment	

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Lot#	Unit	Layer	Depth	Cat.#	Era	Class	Material	Color	Description	Detail	Qty	Portion	Comments
8	NW1	Fill 1	0-5 cm.	35	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		1 Body Fragment	
8	NW1	Fill 1	0-5 cm.	36	Historic	Glass	Vessel Glass	Amber	Bottle Glass	Machine-Made		5 Lip/Neck Frags.	Modern; Bud Light label; twist/threaded lip.
9	NW1	Fill 1	05-10 cm.	37	Historic	Ceramic	Earthenware	Bluish Pooling	Whiteware	Plain		1 Base Fragment	Plate fragment.
9	NW1	Fill 1	05-10 cm.	38	Historic	Ceramic	Earthenware		Whiteware	Plain		1 Fragment	
9	NW1	Fill 1	05-10 cm.	39	Historic	Ceramic	Ironstone			Plain		1 Fragment	
9	NW1	Fill 1	05-10 cm.	40	Historic	Glass	Flat Glass	Lt Aqua Tint	Window Glass			1 Fragment	
9	NW1	Fill 1	05-10 cm.	41	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		5 Body Fragments	Modern.
9	NW1	Fill 1	05-10 cm.	42	Historic	Glass	Vessel Glass	Clear	Lamp Glass			1 Body Fragment	
10	NW1	Fill 1	10-15 cm.	43	Historic	Ceramic	Earthenware		Whiteware	Plain		2 Fragments	
10	NW1	Fill 1	10-15 cm.	44	Historic	Glass	Flat Glass	Lt Aqua Tint	Window Glass			1 Fragment	
11	NW1	Fill 1	15-20 cm.	45	Historic	Ceramic	Earthenware		Whiteware	Plain		2 Fragments	
11	NW1	Fill 1	15-20 cm.	46	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		1 Body Fragment	
12	NW1	Fill 1	20-25 cm.	47	Historic	Ceramic	Earthenware	Terracotta	Redware	Molded/Unglazed		1 Body Fragment	Molded exterior, may be flowerpot.
12	NW1	Fill 1	20-25 cm.	48	Historic	Ceramic	Earthenware		Whiteware	Plain		3 Fragments	
12	NW1	Fill 1	20-25 cm.	49	Historic	Ceramic	Ironstone			Plain		1 Fragment	
12	NW1	Fill 1	20-25 cm.	50	Historic	Glass	Flat Glass	Clear	Plate Glass			1 Fragment	
12	NW1	Fill 1	20-25 cm.	51	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		4 Body Fragments	
12	NW1	Fill 1	20-25 cm.	52	Historic	Glass	Vessel Glass	Clear	Lamp/Lightbulb	Thin		1 Body Fragment	
13	NW1	Fill 1	20-25 cm.	53	Historic	Ceramic	Earthenware		Whiteware	Plain		2 Fragments	1 missing glaze.
13	NW1	Fill 1	20-25 cm.	54	Historic	Ceramic	Ironstone			Plain		1 Fragment	
13	NW1	Fill 1	20-25 cm.	55	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		1 Bottle Base	Modern; "61" on base.
13	NW1	Fill 1	20-25 cm.	56	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		9 Body Fragments	Modern; same bottle as base.
14	NW1	Fill 1	25-30 cm.	57	Historic	Ceramic	Earthenware		Whiteware	Plain		1 Fragment	
14	NW1	Fill 1	25-30 cm.	58	Historic	Ceramic	Ironstone			Plain		1 Fragment	
14	NW1	Fill 1	25-30 cm.	59	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		1 Bottle Neck	Modern; same bottle as level above;
14	NW1	Fill 1	25-30 cm.	60	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		13 Body Fragments	twist/threaded lip. Modern; same bottle as level above.
14	NW1	Fill 1	25-30 cm.	61	Historic	Glass	Flat Glass	Lt Green Tint	Plate Glass			1 Fragment	
15	NW1	Fill 1	30-35 cm.	62	Historic	Glass	Flat Glass	Lt Amethyst Tint	Window Glass			1 Fragment	
15	NW1	Fill 1	30-35 cm.	63	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		1 Neck Fragment	Modern.
16	NW2	A1	0-5 cm.	64	Historic	Ceramic	Earthenware	Pink	Brick	Small Chunks		2 Fragments	
16	NW2	A1	0-5 cm.	65	Historic	Ceramic	Earthenware	Blue Edged	Whiteware	Plate		2 Rim Fragments	Pieces mend.
16	NW2	A1	0-5 cm.	66	Historic	Ceramic	Earthenware		Whiteware	Plain		5 Fragments	Includes 1 foot fragment.
16	NW2	A1	0-5 cm.	67	Historic	Glass	Flat Glass	Clear	Plate Glass			1 Fragment	
16	NW2	A1	0-5 cm.	68	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		1 Body Fragment	Stippled.
16	NW2	A1	0-5 cm.	69	Historic	Metal	Copper/Zinc		Coin/Lincoln Cent	1993		1 Intact	

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Lot#	Unit	Layer	Depth	Cat.#	Era	Class	Material	Color	Description	Detail	Qty	Portion	Comments
16	NW2	A1	0-5 cm.	70	Historic	Wood	Painted Wood	Gray Paint	Worked/Knot			1 Fragment	Probably from board.
17	NW2,E	Fill 1	0-5 cm.	71	Historic	Glass	Vessel Glass	Amber	Bottle Glass	Machine-Made		17 Body/Neck Frags	Modern; Anheuser-Busch beer; east end of unit.
17	NW2,E	Fill 1	0-5 cm.	72	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		1 Body Fragment	East end of unit.
18	NW2,E	Fill 1	05-10 cm.	73	Historic	Glass	Vessel Glass	Amber	Bottle Glass	Machine-Made		1 Lip Fragment	Modern; twist/threaded lip; east end of unit.
19	NW2	A1	05-10 cm.	74	Historic	Ceramic	Earthenware	Terracotta	Redware	Unglazed		1 Rim Fragment	Beveled lip; small pot.
19	NW2	A1	05-10 cm.	75	Historic	Ceramic	Earthenware	Green Transfer	Whiteware	Transfer-Printed		1 Body Fragment	Floral.
19	NW2	A1	05-10 cm.	76	Historic	Ceramic	Earthenware		Whiteware	Plain		3 Fragments	
19	NW2	A1	05-10 cm.	77	Historic	Glass	Vessel Glass	Amethyst Tint	Bottle Glass	Mold-Blown/Machine-Made		1 Body Fragment	
19	NW2	A1	05-10 cm.	78	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		1 Body Fragment	
20	NW2,E	Fill 1	10-15 cm.	79	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		2 Body Fragments	East end.
21	NW2	A1	10-15 cm.	80	Historic	Ceramic	Earthenware		Whiteware	Plain		6 Fragments	
21	NW2	A1	10-15 cm.	81	Historic	Ceramic	Ironstone			Plain		1 Fragment	
21	NW2	A1	10-15 cm.	82	Historic	Glass	Flat Glass	Clear	Window Glass			1 Fragment	
21	NW2	A1	10-15 cm.	83	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		1 Body Fragment	
22	NW2	A1	10-15 cm.	84	Historic	Ceramic	Ironstone			Missing Glaze		1 Fragment	Under central rock.
22	NW2	A1	10-15 cm.	85	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		1 Base Fragment	Under central rock.
22	NW2	A1	10-15 cm.	86	Historic	Glass	Vessel Glass	Clear	Lamp Glass	Free-Blown		1 Body Fragment	Under central rock.
23	NW2,E	Fill 1	15-20 cm.	87	Historic	Ceramic	Ironstone			Missing Glaze		1 Fragment	East end.
23	NW2,E	Fill 1	15-20 cm.	88	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		3 Body Fragments	East end.
24	NW2	A2	15-20 cm.	89	Historic	Ceramic	Earthenware	Pink	Redware	Missing Surfaces		1 Fragment	
24	NW2	A2	15-20 cm.	90	Historic	Ceramic	Earthenware		Whiteware	Plain		2 Fragments	
24	NW2	A2	15-20 cm.	91	Historic	Glass	Flat Glass	Lt Amethyst Tint	Window Glass			1 Fragment	
25	NW2	A2	15-20 cm.	92	Historic	Glass	Flat Glass	Lt Green Tint	Window Glass			1 Fragment	Under rock in NW corner.
25	NW2	A2	15-20 cm.	93	Historic	Synthetic	Bakelite	Black	Flat Strip	14mm Wide		1 Small Fragment	
26	NW2,E	Fill 1	20-25 cm.	94	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		6 Body Fragments	East end.
27	NW2,E	Fill 1	25-30 cm.	95	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		3 Body Fragments	Modern; east end of unit.
28	NW2,E	Fill 1	30-35 cm.	96	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		6 Body Fragments	Modern; east end of unit.
29	NW2	A2	30-35 cm.	97	Historic	Ceramic	Ironstone			Plain		1 Fragment	
30	NW3	Ao	0-5 cm.	98	Historic	Glass	Flat Glass	Clear/Tint	Window Glass			1 Fragment	
30	NW3	Ao	0-5 cm.	99	Historic	Glass	Vessel Glass	Clear	Lamp/Lightbulb	Thin		1 Body Fragment	
31	NW3	Ao	05-10 cm.	100	Historic	Glass	Vessel Glass	Amber	Bottle Glass	Machine-Made		1 Body Fragment	
31	NW3	Ao	05-10 cm.	101	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		1 Body Fragment	
31	NW3	Ao	05-10 cm.	102	Historic	Glass	Bead	Opaque	Molded, Spherical	10mm Diameter		1 Intact	2 piece mold; may be recent.
32	NW3	Ao	05-10 cm.	103	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		1 Body Fragment	From below stones.
32	NW3	Ao	05-10 cm.	104	Historic	Metal	Ferrous Metal		Sheet	Encrusted		1 Fragment	From below stones; possible can fragment.

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Lot#	Unit	Layer	Depth	Cat.#	Era	Class	Material	Color	Description	Detail	Qty	Portion	Comments
33	NW3	A1	10-15 cm.	105	Historic	Ceramic	Earthenware		Whiteware	Plain		3 Fragments	2 mend.
33	NW3	A1	10-15 cm.	106	Historic	Glass	Vessel Glass	Clear	Bottle Glass	Machine-Made		1 Lip/Neck Frag.	Modern, threaded lip.
33	NW3	A1	10-15 cm.	107	Historic	Glass	Vessel Glass	Clear/Frosted	Lamp Glass	Thin		9 Body Fragments	
33	NW3	A1	10-15 cm.	108	Historic	Metal	Ferrous Metal		Indeterminate	Encrusted		2 Fragments	
34	NW3	A1	10-15 cm.	109	Historic	Bone/Teeth	Bone, Unburned		Large Mammal	Split Longbone		1 Shaft	From beneath south stone; leg bone hand-sawn length wise, with butchered ends; 16.5-x-4.9-x-3.8 cm.
35	NW3	A1	15-20 cm.	110	Historic	Bone/Teeth	Bone, Unburned		Large Mammal	Butchered Longbone		1 Shaft	Leg bone shaft with ends hand-sawn/removed; 15-x-4.1-x-3.5 cm. Badly spalled.
36	NW3	A1	15-20 cm.	111	Historic	Ceramic	Earthenware		Whiteware	Plain		1 Base Fragment	
36	NW3	A1	15-20 cm.	112	Historic	Ceramic	Earthenware		Whiteware	Plain		3 Fragments	
36	NW3	A1	15-20 cm.	113	Historic	Metal	Ferrous Metal		Sheet/Can			7 Fragments	2 pieces have thick edges.
37	NW3	A1	15-20 cm.	114	Historic	Glass	Vessel Glass	Clear/Frosted	Lamp Glass	Thin		1 Body Fragment	
37	NW3	A1	15-20 cm.	115	Historic	Metal	Ferrous Metal		Indeterminate	Encrusted		2 Fragments	
37	NW3	A1	15-20 cm.	116	Historic	Metal	Ferrous Metal		Strip	2.0x0.5x0.25"		1 Fragment	
38	NW3	A2	20-25 cm.	117	Historic	Glass	Vessel Glass	Clear/Frosted	Lamp Glass	Thin		1 Body Fragment	
38	NW3	A2	20-25 cm.	118	Historic	Metal	Ferrous Metal		Nail, Indeterminate	Encrusted, 2.5" Long		1 Intact	
39	NW3	A3	35-40 cm.	119	Historic	Glass	Flat Glass	Lt Green Tint	Window Glass			1 Fragment	
40	NW3	N. Wall		120	Historic	Glass	Vessel Glass	Aqua Tint	Bottle Glass	Mold-Blown		1 Body Fragment	Octagonal paneled bottle; from soil disturbance from stone mason's work.
41	Surf.	Lintel	0 cm.	121	Historic	Glass	Flat Glass	Lt Green Tint	Plate Glass	Thick		1 Edge Fragment	9.8 cm fragment from window or door; found on surface behind lintel stone above chamber entrance.
42	N/CH1	N Wall	2nd/Base	30	Historic	Wood	Wood, Unburned		16g	11.2x3.3x1.3cm		1 Fragment	During excavation of the north wall of passageway, soil behind the bottom 2 courses of stone was dug out by the stone masons and this wood piece was found in the soil from behind the wall. The wood is not visibly worked and is uneven, possibly thick bark. Sent to Beta Analytic for C14 dating.

Appendix VI –
Radiocarbon Determination on Wood
Sample by Beta Analytic, Inc.



*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

January 27, 2012

Mr. Martin Dudek
John Milner Associates
410 Great Road
B-14
Littleton, MA 01460
USA

RE: Radiocarbon Dating Result For Sample Upton Chamber #1 Cat. 30

Dear Mr. Dudek:

Enclosed is the radiocarbon dating result for one sample recently sent to us. It provided plenty of carbon for an accurate measurement and the analysis proceeded normally. As usual, the method of analysis is listed on the report sheet and calibration data is provided where applicable.

You will notice that this sample (Upton Chamber #1 Cat. 30) is reported with the units "pMC" rather than BP. "pMC" stands for "percent modern carbon". Results are reported in the pMC format when the analyzed material had more ^{14}C than did the modern (AD 1950) reference standard. The source of this "extra" ^{14}C in the atmosphere is thermo-nuclear bomb testing which on-set in the 1950s. Its presence generally indicates the material analyzed was part of a system that was respiring carbon after the on-set of the testing (AD 1950s). On occasion, the two sigma lower limit will extend into the time region before this "bomb-carbon" onset (i.e. less than 100 pMC). In those cases, there is some probability for 18th, 19th, or 20th century antiquity.

As always, no students or intern researchers who would necessarily be distracted with other obligations and priorities were used in the analysis. It was analyzed with the combined attention of our entire professional staff.

If you have specific questions about the analyses, please contact us. We are always available to answer your questions.

Thank you for prepaying the analysis. A receipt is enclosed with the mailed report copy. As always, if you have any questions or would like to discuss the results, don't hesitate to contact me.

Sincerely,


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. Martin Dudek

Report Date: 1/27/2012

John Milner Associates

Material Received: 1/3/2012

Sample Data	Measured Radiocarbon Age	$^{13}\text{C}/^{12}\text{C}$ Ratio	Conventional Radiocarbon Age(*)
Beta - 313229	116.8 +/- 0.3 pMC	-24.5 o/oo	116.7 +/- 0.3 pMC

SAMPLE : Upton Chamber #1 Cat. 30

ANALYSIS : RadiometricPLUS-Standard delivery

MATERIAL/PRETREATMENT : (wood): acid/alkali/acid

COMMENT: The reported result indicates an age of post 0 BP and has been reported as a % of the modern reference standard, indicating the material was living about the last 60 years or so ("pMC" = percent modern carbon).

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the ^{14}C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby ^{14}C 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 $^{13}\text{C}/^{12}\text{C}$ ratios (delta ^{13}C) 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 ^{13}C . On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta ^{13}C , 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.

Appendix VII –

**Optically Stimulated Luminescence
Sampling by Dr. Frederick W. Martin
and Analysis by the USGS Luminescence
Laboratory**

SOIL SAMPLING DURING REPAIR OF THE UPTON STONE CHAMBER

c/fwm/NEsites/upton/OSL/narrative.rtf

This narrative record is written by Dr. Frederick W. Martin at 50 Village Ave, Dedham MA 02026 on Oct 26, 2011, using his fieldbook pages 1754-1764, digital camera images #71-140, and a summary of these images PIClist.xlr. The aim was to get soil samples from behind the lowest stones in the wall of the chamber by a technique suitable for dating the soil by optically stimulated luminescence. Samples so obtained are to be sent to the US Geological Survey lab in Boulder CO, for a determination of the time since they last saw daylight. Present were Dr. David Stewart-Smith (his degree is in anthropology) and Mr. Peter Wiggin, as stonemasons under contract to repair the chamber for public safety reasons, Brendan Strickland as an assistant to them, Marty Dudek from Milner Associates with Massachusetts Historical Commission archaeological permit #3276, and myself (a semi-retired physicist), as well as visitors from time to time, including Barbara Burke and Cathy Taylor of the Historical Commission of the Town of Upton MA, which voted financial support for permitting OSL dating during its regular monthly meeting of October 18..

Tuesday, October 25: OSL sampling work at the Upton Stone Chamber (N 42deg 10min 32.8 sec, W 71deg 35min 54.4sec, NAD27 CONUS) began at 8:14 on October 25, 2011, when I arrived to find the 3-ton stone lintel restrained by a waistline belt and chain fall pulling toward the tree located over the back chamber. It was further resting on two stringers placed between cribs of 8x8 timbers built inside and outside of the chamber. Its right end rested on the right wall, the upper courses of the left wall were already removed, and Dr. David Stewart-Smith was disassembling the lower 3 courses of stonework. DSS stated that most of the soil behind the already removed courses was brown and included many stones, indicating that it was backfill from a previous repair. He further stated that no one other than himself could work under the lintel, because his insurance policy does not allow them.

A procedure was developed whereby DSS selected locations and drove the sampling tube, PW took a near and a far picture of each sampling, and FWM received and secured each sample. A red plastic cap was put on the end of the steel pipe sample tube by DSS immediately as he withdrew it from a hole, and the description of location given by DSS was recorded by FWM. FWM then put the assembly under a rubber raincoat, and (1) unscrewed the 6" sample tube from the reducing coupling to the 24" long driving pipe (2) tested for soil at the driving end (3) added a red plastic cap at the driving end (4) added a numbered label to the tube, (5) rolled the tube up inside a light-tight black plastic bag, and (6) sealed the bag with a numbered label. If the tube was less than half full, it was discarded as a failed sample; if it was more than half but not full, newspaper was pushed into the driving end of the tube to keep the sample from mixing during transit.

The sample tube was 1 1/4" nominal blacked steel pipe from local Republic Plumbing Supply, with an inside diameter of 1 3/8"; the red plastic end caps with inside diameter 1 5/8" were #030520 from Stockcap in Arnold MO, available by direct Internet purchase, and the light-tight black plastic bags were Delta Safe-T bags for photographic paper, available retail from BH Photo in New York City.

Samples #1 - #6: DSS stated that bleached oxidized soil (also known as subsoil) exists above the third course, and down at least to the level of the joint between 2nd and 3rd courses. He drove sample #1 horizontally into the region behind the removed 3rd course, above a stone of the 2nd course labelled "b" in Fig. 1-far.png. This stone is located about 24" into the tunnel from the exterior face defined by the final placement of the lintel and columns. Later samples were placed in sequence in a roughly vertical line at this depth into the tunnel.

Photo 1-near shows that sample #1 is being taken about 24" behind the face of the wall, since the length of the driving pipe is 24". He drove sample #2 down at an angle behind the second course, as shown in 2-near, reaching a distance about 18" behind the face, as shown in 2-far. Only one bulk sample of soil was collected (in a 1-quart double-seal plastic bag) for these two samples, and labelled #2.

Stone b in the second course was then removed, and he drove sample #3 horizontally at the bottom of the second course as shown in 3-near, to a verbally stated depth of 3 feet. At the same level he drove a "deeper" sample #4 starting at a verbally stated 1 meter from the face. Again only one bag of soil was collected, labelled #4.

Sample #5 was driven behind stone d of the first course, as shown in 5-far. Stone d was verbally estimated as 18" wide by 24" deep x 10" high, and the sample was recorded as 2 1/2 feet behind the wall

surface. It has its own bag of soil.. DSS stated that there is a fine grain gravel with pebbles behind the first course, which does not look like a backfill (from repairs).

Sample #6 was driven vertically downward in a space beside stone d as shown in 6-near, at a location verbally stated to be 18" from the face of the wall, and at the base of the 1st course. No depth was recorded. It will also have to use #5 as a reference bag of soil. Another attempt to reach a lower level (see image 100 for near, 104 for far) was made, but it failed due to hitting something - presumably still lower footings - at 4" depth under the wall, resulting in specimens which did not fill the sample tube.

No further samples were obtained this day, but the large stone (labelled d in the .png images) was removed, and stone c fell into the gap so created when its prop was disturbed, a situation shown in image 112. Stone d rested on a "big flat stone" which was photographed between a and c, as best shown in image 111 where the end of d is still observable as well. The big flat stone appears wet because water was encountered. PW said that when he pulled out a tree root, there was a flow of clear water, as "a spring from below".. To establish a good foundation, the gravelly soil was removed over the big flat stone, and carried out in buckets, where it was used to fill the test pit no longer needed at that time. During this activity, MD picked a 3" x 1" x 1/4" weathered sliver of wood out of the gravel. DSS said the gravel came "from the bottom two courses". Because the big flat stone extends to the face of the wall, the wood could be a sliver of the floor known to have been placed in the chamber, rather than a fragment buried behind the walls when they were built.

Wednesday, October 26: On October 26, 2011 at 7:46am when I arrived, the lintel was restrained by a midline belt as before, but resting on a single 8x8 stringer at the center, and on the stone wall at the left. Using the belt, they pulled the lintel toward the chamber dome, forming a close fit (varying from touching to maybe 1" gap) with the next roof slab to its rear. DSS stated that the joint between these slabs was formed by battering the edge, and then abrading it, so that the edges matched. Both the roof slab and the lintel were relieved some 3 inches, as if to support a covering stone above this joint.

At this point FWM and MD attempted to obtain a geological sample from below the test pit previously dug by MD (images 118, 124), who stated that he had previously found a gravel layer sterile of human artifacts overlaying a clay deposit. This failed due to the wet condition of the soil which fell out of the tube.

Samples #7 to #10: Meanwhile the masons had removed the upper courses from the right pillar (image 125), and then began sampling in the right chamber wall. Sample #7 was successful, at the back end of the previous repair, at a level behind the top remaining course. However no depth was recorded, although a bulk sample was collected. An attempt at the middle of the previous repair, through a hole at the bottom of the 3rd course (image 128,129) failed to collect. Likewise an attempt at the middle of the repair, at the level of "the fourth course from the top" (images 130,131) failed to collect. Possibly stones larger than 1 5/8" diameter in the backfill, placed during a previous repair, blocked the end of the collecting pipe. Finally sample #8 was obtained near the front face, at the same level of the 4th course from the top (remaining) course. This sample only filled 1/3 of the collecting tube length, but was saved nevertheless. No bulk sample was collected. DSS spent a total of 11 minutes on this activity, conducted under the lintel stone which remained unsupported by the right wall. It was desired to finish placement of the lintel by noon, when advancing rain was expected. He had earlier suggested that sampling could better be conducted through cracks in the wall when the roof was securely resting on the walls.

FWM and MD returned to trying to get a geological sample from the previously excavated test pit. Image 135 shows the relation of the test pit to the chamber entrance, and image 134 shows the pit cleared of gravel, with a 4" diameter hole bored at its bottom by MD using a coring tool. This hole filled in a few minutes with water from the surrounding water table. Its bottom was measured to be 29" from the ground surface, and the sampling pipe was driven in from this level. Sample #9 was obtained by driving the tube below this level. It filled to 4" long in spite of the wet conditions, and has its own bulk collection. Later after two more attempts (image 137) sample #10 was obtained by driving the pipe in at an angle to the vertical. The top of the driving pipe went to 8" below ground level, and the hole was measured to be 37" deep. Another bulk sample was obtained by MD.

Meanwhile the masons had built up the right wall, and placed a hydraulic jack under the 8x8 stringer (image 136), so that the lintel could be slowly lowered onto the right wall. After this was done DSS looked up at the hole behind the lintel and noticed a 3/4" diameter bore hole in a two-foot rock

resting over the left wall, the first tooling mark ever seen at the chamber. Image 138, taken from below, clearly shows the nature of this bore hole, and image 139 shows the 2-foot rock and the lintel. Image 140 shows a similar drill hole in the base course of the wall extending to the left of the chamber, one of 3 pointed out by MD. These 3/4" drill holes were typical of the 1850's according to MD and DSS. DSS thinks that the several 2-foot diameter rocks over the left tunnel wall were added in the 19th century. MD mentioned that a barn is thought to have existed to the left of the chamber, and that records show that a wealthy citizen who built a brick house in 1820 operated a tannery to the right of the chamber. In his previous test pits MD found two butchered cattle bones in the excavation squares near the chamber, which may have come from the tannery. Also a newspaper record from 1880 states that there was a second chamber to the rear, which collapsed and was filled with earth in 1870. Possibly an ancient chamber was used by the tannery for disposal of liquid waste, accounting for the careful ancient stonework of the lintel (and the careful corbelling of its dome) combined with the relatively coarse 19th century alteration of its roof.

POSITION AND WEIGHT OF SAMPLES COLLECTED AT THE UPTON STONE CHAMBER

c/fwm/NEsites/upton/OSL/table.xlr

F. W. Martin

10/27/11

Sample number	location data			OSL tube			Bulk sample		rank	remarks
	H (a) (courses)	D (b) (inch)	L (c) (inch)	wall	aim	c (e) (in)	weight (grams) gross net	wt (grams) gross		
1	2.2	24	24	se	h		849 359	use #2	3	near back of wall, H too large?
2	1.5	18	24	se	h		872 382	742	2	closest to back of wall; but loamy
3	1.0	33	24	se	h		767 277	use #4	4	D too large?
4	1.0	39	24	se	h		720 230	714	5	D too large?
5	0.5	30	24	se	h		752 262	691	1	H low, but D more than #2; gravelly
6	0.0	18	24	se	v		639 149	use #5?	6	low wt and poor bulk
7	4	NA	36?	nw	h		692 202	503	7	may be into a repair
8	1	NA	18?	nw	h	4	559 69	use #7?	8	very low wt, no bulk
9		32(d)			v	2	696 206	use #10		wet
10		34(d)			v	1	749 259	409		wet
empty tube, caps, and bag							490 0			

a) H is the height of the sample above the chamber floor, measured in courses of stonework, with 0 indicating floor level and 1 the top of the first course.

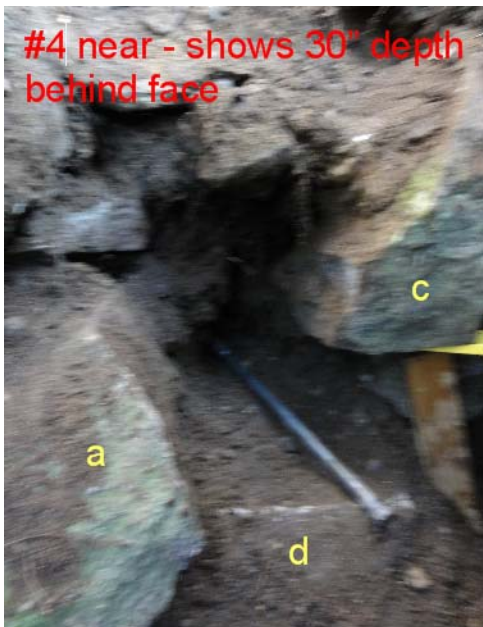
The courses were not measured, but are around 10 inches high

b) D is the estimated depth of the sample behind the wall surface, in a direction perpendicular to the plane of the wall.

c) L is the length from the point where the sampling pipe was driven in to the front of the chamber, taken as a vertical plane defined by the final front surface of the lintel and its pillars.

d) for the comparison sample, the location of the test pit can be seen in image #135, and D is the depth below ground level

e) c is the approximate length of the void in the 6-inch-long sample tube, filled with newspaper to avoid mixing in transit

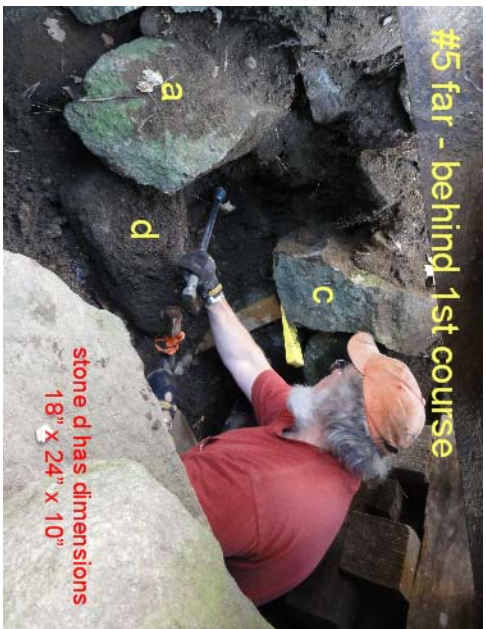




#6 far - 18" behind face at base of 1st course



#5 near - behind 1st course



#5 far - behind 1st course

stone d has dimensions
18" x 24" x 10"



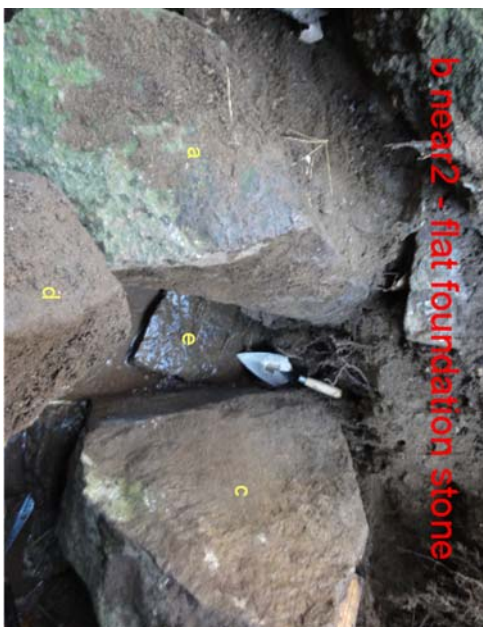
b near 1 - flat base stone
from above



b near - trowel points to big flat
stone located below



#6 near- 18" behind face
at base of 1st course



b near 2 - flat foundation stone

Image log for OSL Sampling at Upton Stone Chamber Oct 25-26, 2011 F. W. Martin

camera session #	OSL disk # image #	hour	min	description
Oct. 25, 2011				
1	1	71	8	14 #1 - start behind 3rd course
	1	72	8	14 #1 - 24" behind 3rd course
	2	73	8	26 #2 near - start behind 2nd course
	2	74	8	27 #2 far - behind 2nd course
	3	75	8	33 #3 far - begin at lower edge of 2nd course
	3	76	8	35 #3 middle - driving at lower edge of 2nd course
camera dial was misset				
7, 8	4 77, 78	8	38	#4 near - shows 30" depth behind wall face
9, 10, 11	4 79, 80, 81	8	38	#4 far - shows deeper hole, maybe 42" behind face
12, 13, 14	5 82, 83, 84	8	52	5f - start behind 1st course
15, 16, 17	5 85, 86, 87	8	53	#5 far - behind 1st course
18, 19, 20	5 88, 89, 90	8	53	#5 near - behind 1st course
21, 22	6 91, 92	9	0	#6 near - 18" behind face at base of 1st course
23, 24, 25	6 93, 94, 95	9	0	#6 far - vertical 18" behind face at base of 1st course
26, 27, 28, 29	96,97,98,99	9	1	crib in entrance, shows void at left pillar
30 to 33	100 to 103	9	8	near - failed - hit footings 4" down, collect only 2" soil
34 to 38	104 to 108	9	8	far - failed slant attempt
camera dial set to "easy"				
39	109	9	24	view into chamber, shows right pillar before repair
40	110	9	56	flat base stone
41	111	9	57	flat base stone close up
42	112	9	57	flat base stone distant
43	113	11	10	wood fragment from soil
44	114	11	23	another (poor) view into chamber

Oct. 26, 2011

	1		115	7	46	lintel in place - camera facing sw
	2		116	7	47	lintel in place - camera facing sw, closer
	3		117	7	49	lintel in place - view from chamber roof
4 to 9		118 to 123		8	33, 34	fwm driving pipe in archaeological test pit
	10		124	8	35	closeup of driven pipe
	11		125	8	39	view into chamber, with old pillar removed
	12	7	126	8	43	#7 near - at back of old repair, behind top course
	13	7	127	8	43	#7 far - useless photo
	14		128	8	50	near- bottom of 3rd course at middle - failed sample
	15		129	8	50	far- bottom of 3rd course at middle - failed sample
	16		130	8	53	near - at 4th course from top - failed sample
	17		131	8	53	far - at 4th course from top- failed sample
	18	8	132	8	54	#8 near - 4th course (from top) at rear of lintel
	19	8	133	8	54	#8 far - 4th course (from top) at rear of lintel
						#8 is 1/3 tube, with newspaper stuffing at driving end
	20	9	134	9	38	#9 near - hole in test pit starts 29" below surface
	21	9	135	9	39	#9 far - test pit and chamber, dudek and stewart-smith
	22		136	9	55	lowering lintel onto repaired right pillar - Wiggin
	23		137	9	56	far - at test pit, dudek - failed sample
	24		138	10	18	closeup of 3/4" bore hole in top rock from inside chamber
	25		139	10	21	view showing lintel and top rock from outside
	26		140	10	22	similar drill hole in base course of adjacent wall
	10					#10 had no pictures, select from other pics of test pit it was a good sample on 3rd try; 5" long in 6" tube bottom of hole 37" below surface level



DSC00070



DSC00071



DSC00072



DSC00073



DSC00074



DSC00075



DSC00076



DSC00077



DSC00078



DSC00079



DSC00080



DSC00081



DSC00082



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DSC00099



DSC00100



DSC00101



DSC00102



DSC00103



DSC00104



DSC00140



Optically Stimulated Luminescence (OSL) data and ages from an archeological non-destructive field investigation at the stone chamber in the town of Upton, Massachusetts

Final Project Report Submitted to Dr. Fredrick W. Martin and Massachusetts Historical Commission

This report is informal and has not been reviewed or approved by the Department of the Interior (DOI) or the U.S. Geological Survey (USGS). Interpretations are solely the authorship of Shannon Mahan and do not reflect an official policy or position by the USGS. Results from data were passed through quality control procedures but this does not absolutely guarantee that there are not errors in the final data transcriptions.

Accessible on May 19, 2012

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Luminescence Dating Explanation, Data, Results, and Discussion

EXPLANATION OF TECHNIQUE:

Most minerals react to ionizing radiation by essentially gaining energy at the electron level, which accumulates through time if that energy is not released (as light) by some outside stimuli (sunlight or intense heat over 200 °C). Thus, sediment grains can record their exposure history to ionizing radiation, which can then be “read” in the laboratory and used as a clock. This procedure is referred to as luminescence geochronology, the goal of which is to establish the timing of the burial of mineral grains in sedimentary deposits (*Duller, 2008*).

Luminescence dating is based on solid-state dosimetric properties of natural mineral grains. Minerals react to ionizing radiation, which is generated by radioactive isotopes found in minor quantities in most terrestrial sediments and by cosmic radiation. Specifically, ionizing radiation creates charge pairs/carriers (e-, h+) in mineral crystals. The charge carriers are mobile within the crystals, but can become localized, or trapped, at lattice defects and held there over geologically significant time scales. Over time, the number of segregated, or trapped, charge carriers builds up in a way that can be described by a saturating exponential function.

If the mineral grains were transported at night, in turbid fluvial conditions, or were generally considered to be deposited in massive, sudden discharge events (i.e. debris flows, colluvium, floods, proximal glacial melting, etc.), luminescence dating may produce depositional ages that are too old because the luminescence clock was not reset to “zero” prior to burial. Exposure to heat, light, or high pressures can release charge carriers from trapping sites (detrapping) and permit recombination, during which light is emitted from the mineral grains. This detrapping resets the system within the mineral grains.

In terrestrial environments, exposure to sunlight during sediment transport resets the clock and it is also why a luminescence age is considered to be a burial age. In the laboratory, sediment is stimulated to emit light, which is measured. The sediment is stimulated by exposure to light of specific wavelengths (optically stimulated luminescence, OSL) or heat (thermoluminescence, TL) in a prescribed manner. The intensity of emitted light measured in the laboratory is proportional to the trapped charge population, which is proportional to the total absorbed radiation dose (D_e) that the sedimentary deposit experienced, and that relation is proportional to the time elapsed since burial (*Duller, 2008*). The simplest form of the OSL age equation is:

$$t_{OSL} = \frac{D_e}{D'}$$

where

t_{OSL} = age

D_e = total absorbed radiation dose,

D' = natural environmental dose rate.

The rationale for using luminescence to put an age to the Upton Stone Chamber construction is that sediments within the top few centimeters of a stable surface will get brought to the surface through bioturbation and thereby bleached during normal geological processes. Bleaching is a process that is curtailed by placement of a rock on the surface. Only the top grains are expected to be fully bleached, but the application of any luminescence dating should yield the age of the retaining rock wall of a passage or at least the bottom or floor of the rock emplacement (*Feathers and Sheikh, 2009*).

DATA: Includes field sampling protocol, descriptions of elemental concentrations for dose rate, **“raw” values for equivalent dose**, and sample preparation methodology.

Field sampling and protocol:

The aim of this project is to obtain and document the sampling of sediment taken from behind the rock walls during the masonry reconstruction of the Upton Chamber in Massachusetts. The procedure prescribed by the US Geological Survey for obtaining samples suitable for dating by optically stimulated luminescence (OSL) was used. The contractor had to dig out behind the walls in order to stabilize them, and after OSL samples were taken and other in-situ studies completed, masonry reconstruction took place (*Fredrick Martin, written communication, 2011*).

The Upton Chamber is an important stone structure of unknown provenance, and obtaining a date for it based on established scientific geochronological methods is an important issue, especially in light of claims that this chamber represents pre-Columbian or pre-European construction of the original feature. The Upton Chamber is located within the USGS Milford MA quadrangle map and can be found at N 42° 10' 32.8"/W 71° 35' 54.4', NAD27 CONUS (*Fredrick Martin, written communication, 2011; Figure 1*). Field sampling commenced on October 25, 2011 with the OSL sampling directed by Dr. Fredrick Martin but actually taken by Dr. David Stewart-Smith (*Figure 2*). This report will present the final data and ages for Sample #5, which was deemed as having the best chance for unbiased dating out of the ten samples collected. The archaeological sample is expected to come from the bottom of a narrow trench, about 4' deep x 1' wide x 2' long (122 cm x 30.5 cm x 61 cm), dug behind a stone retaining wall which forms the entrance passageway of the ancient stone chamber.. The other nine samples have been archived (*Fredrick Martin, written communication, 2011*).

Source geology for the stone wall was determined to be granite and mafic rocks of Cretaceous age (*Robinson and Kapo, 2003*). According to Robinson and Kapo (2003), this correlates with the surficial geology of the area and the rocks are not exotics brought in by glaciers. This was confirmed by a close-up of the stones in the wall during some of the sampling. The granite rocks and cobbles were distinct from the soil or organic-rich detritus layers (*Figure 3*). Exact details of the OSL sampling may be obtained from Dr. Martin's field notes narrative (*written communication, 2011*).

Steel pipes were used as sample containers and sampling was completed in the daytime but care was taken to limit exposure of the tube ends to light while capping. A bulk sample of the sediment and cobbles of rock of the same material in the wall were collected at each OSL sample site for dose rate calculation purposes. No modern sample was collected.

Determining the Dose Rate (D_R) from elemental concentrations of the sediment and rocks:

Water content of the sediment samples was measured as 17% in the field and determined to be at most 23% of saturation moisture by lab measurements. In other words, the most the sediment could hold in terms of water saturation is 23% of the sample weight. This is a common percentage for sandy sediment with little clay or silt. I calculated the dose rate in terms of the measured field moisture at 17% water moisture as my best estimate of the water budget of the sediment year-round (this means an annual average of 17% water). I assumed that precipitation was evenly spaced throughout the year, without distinct “dry” or “rainy” seasons with total precipitation ranging from 40”-50” (102-127 cm) per year (*CoCoRaHS, written communication, accessed May 2012*).

Most ionizing radiation in the sediment that gives rise to the luminescence phenomenon is from the decay of isotopes in the uranium and thorium decay chains and the radioactive potassium (^{40}K) element. The dose rate was obtained using elemental concentrations (K, U, Th, and Rb) as determined from Gamma Spectrometry following the procedures described from Snyder and Duvall (2003).

The gamma-ray spectrometer: The gamma spec provides the isotopic discrimination of gamma rays; correspondingly, beta and alpha dose rates may be estimated. In the laboratory, the bulk sample was counted in a high-resolution gamma spectrometer fitted with a germanium detector. Measured elemental concentrations, associated dose rates, and cosmic ray contributions are presented in the *Appendix* and *Table 1*. Cosmic-ray dose rate data was estimated for each sample as a function of depth, elevation above sea level, and geomagnetic latitude (*Prescott and Hutton, 1994; 1988*).

The bulk sample was dried, homogenized by gentle disaggregation, weighed, sealed in plastic planchets having a diameter of 15.2 cm by 3.8 cm (some modification from *Murray et al., 1987*), and then immediately placed in a gamma-ray spectrometer for counting of the gamma rays during 10 hours. Samples were then stored for a minimum of twenty-one days to allow radon to achieve radioactive equilibrium, and the measurements were repeated. The fraction of radon emanation was estimated from the difference of these two spectrometer measurements. A sealed/unsealed ratio of <1.10 is not considered to represent significant radon escape under laboratory conditions. These count rates are accurate for calculating dose rates. Alpha and beta contributions to the dose rate were corrected for grain-size attenuation (*Aitken, 1985*).

Determining the Equivalent Dose (D_E)-in the dark lab:

The steel tube was only opened under “safe light” (sodium vapor lighting) conditions in the luminescence laboratory once it was received. After discarding about 2 cm from the opened end, the entire volume of the

middle of the tube (the other end was also discarded) was treated with 4N HCl, 35% hydrogen peroxide, and sieved to collect coarse grained fractions (with fractions between 90-250 μm or 170 to 80 mesh). The samples were leached in 4N HCl (10% HCl) for 24 hours (to dissolve any post-depositional carbonate coatings), 35% H_2O_2 for 24 hours (to dissolve the organic and soil carbonates), and 10% HF for 20 minutes (to dissolve surface impurities such as iron oxides from the quartz grains). The coarser grained size (180-250 μm) quartz fractions were separated from the feldspars and any heavy minerals using a Franz magnetic separator and heavy liquids (lithium sodium polytungstate or LST) ($\rho=2.58 \text{ g cm}^{-3}$ and ($\rho=2.67 \text{ g cm}^{-3}$). To remove feldspars and to isolate pure quartz from the selected sand fraction, we centrifuged the sand sequentially in a heavy liquid called Lithium Sodium Tungstate (LST). The float from density 2.67 was subjected to a 50% solution of HF acid for 40 minutes while in an ultrasonic bath. After pouring off the HF solution, we put the sample in 6N HCl for five minutes (still in the ultrasonic bath) and finally re-sieved to winnow out broken feldspar grains.

Steel target discs were dabbed with a small circle silica spray (1mm, known as a “1-mm mask”) and a single grain thick layer of these refined quartz grains was dispersed onto steel discs. Approximately 50 to 150 grains were used for each disc. These discs were then loaded onto a carousel, ready for luminescence analyses. 40 aliquots were measured for the luminescence equivalent dose; ideally between 40 and 50 aliquots would be measured per sample (if possible) to ensure the most reliable statistical trends (*Rodnight, 2008*). However, due to no signal on about one-third of the aliquots (13 aliquots), in reality this meant that only 14 to 28 aliquots were used in the final data analyses. The “raw data values” from each population in equivalent dose values in the appendix data section (at the end of this report).

Blue-light OSL was done on fine sand-size quartz separates using single aliquot regeneration (SAR) protocols (*see Tables 2 and 3*). Light stimulation of the quartz was achieved using a RISØ TL-DA-15 TM reader with an array of blue light emitting diodes (LEDs centered at 470 nm or 15 MW/cm²). Detection optics were comprised of Hoya 2×U340 and Schott BG-39 filters coupled to an EMI 9635 QA Photomultiplier tube. β radiation was applied using a 25 mCi ⁹⁰Sr/⁹⁰Y in-built source (*see Table 2 for summary details*).

The main SAR parameters included use of the 40 second blue-diode wash step of Murray and Wintle (2003) at the same temperature as the preheat temperature and the preferred component of SAR dating (i.e. the ‘fast’ component, *Murray and Wintle, 2000; Wintle and Murray, 2006*), a signal usually released in the first 0.8 seconds of a typical blue diode stimulation. SAR was used because a dating precision of ~ 10% (sometimes better) can be attained routinely with multigrain SAR quartz methods (*Murray and Olley, 2002*) when applied to eolian sand. With SAR, each aliquot yields a distinct equivalent dose value, and thus a distinct age estimate.

The choice of preheating temperature for each sample was based on preliminary tests and the experiences of others with samples of similar age and lithology. All sample aliquots were run at 200 °C for ten seconds, depending on the initial estimate of age. Several quality-control criteria were employed to reject OSL signals and resultant SAR equivalent dose values. Data rejection criteria were similar to those in common practice (*Wintle*

and Murray, 2006) and growth curve data was fit to a linear trend using continuous wave OSL (CW-OSL) (*Table 2; Figures 4A and 4B, 5A and 5B, and 6A and 6B*).

The growth of the luminescence with increasing dose was represented well by a simple linear function and illustrates the generally reliable behavior of the quartz samples for the SAR protocol. We accepted data having 'recycle' ratios within 10% of 1.0 and 'recuperation' ratios (*Aitken, 1998*) within 2% of zero when recuperation was >20% of the normalized 'natural' signal (L_x/T_x ratio), and test-dose-signal errors were <10%. We forced dose-response curves through the origin. Dose recovery and preheat plateau tests were performed to ensure that the sediments were responsive to optical techniques and that the proper preheat temperatures were used in producing the equivalent dose values.

RESULTS (Includes analyses of data, graphs, figures, and tables):

1. Partial bleaching or dispersion of the equivalent dose analyses and preferred statistical methods. The dispersion on the equivalent doses obtained in the sample (Upton #5) do show skewness (distortion or bias or not having equal properties above and below the mean), which is normal for samples which have had a shallow fluvial or alluvial origin or many generations of depositional cycles with extensive bioturbation within the sediment (*Duller, 2008*) (*Figure 7*). There are two types of models for dealing with high skewness; both strive to retain the most appropriate measure of equivalent dose. The main choice is between a measure of central tendency (for samples without large partial bleaching or bioturbation problems) or the minimum age model that tries to capture the younger part of the distribution, or samples without very obvious partial bleaching or bioturbation results) (*Galbraith et 1999, Galbraith 2005*). Measures of central tendency are preferred when both skewness (balance) and overdispersion (scatter) are deemed low. Since the dispersion and skewness are generally high for these samples I used the minimum age model to calculate the equivalent doses and thus the ages (*Table 1; Figures 7 and 8*). Further details of the Minimum Age Model can be found in Arnold et al, 2007, particularly the supplemental data. *Figure 8* also shows blue and yellow colored bars; these represent two populations of equivalent dose and will be discussed in more detail below.

Radial plots are also included for these samples (*Figures 7 and 8*). Reading and understanding radial plots require a bit of practice, but the radial plots allow a more refined plotting of each data point with its associated precision; any radius passing through the origin represents a line of constant dose and the precision of the measurement increases from left to right (*Vermeesch, 2008*). When attempting to understand radial plots it is important to know these six parameters:

1. Partial bleach in sample aliquots is identified as those aliquots or dots ABOVE the blue space or bar. The blue bar is simply the two sigma (95% confidence level) average (mean) of all equivalent doses or aliquots that were run.

2. The aliquots or equivalent doses used to calculate your OSL ages are those analyses (shown as dots) that are contained within either of the colored bars.
3. There are three axes that are important: On the LEFT is the two (2) sigma error which the filled lines or bars originate from (going to both above (+2) and below (-2) a zero) and this is determined by both the values of the measurement and the measurement errors.
4. On the RIGHT is the measured Grays (Gy) of the equivalent doses. The units in the scale are usually arbitrary and can be changed by the operator to make the axis more appealing or understandable (i.e. space by a count of five, don't include decimals, etc.).
5. At the BOTTOM is a measure of the error attached to each measurement (i.e. 12.5 ± 1 will be plotted much differently than 12.5 ± 2) and is plotted according to the accuracy of the error to the measurement. The smaller proportion errors put the associated measurement closer to the right of the plot and the less accurate errors (defined as a larger percentage of the measurement) put the number closer to the left of the plot. The precision of the entire set is then derived from the reproducibility of the measurements.
6. The blue bar simply "gathers" together those points that cluster around a probable set of equivalent doses that came from only fully bleached quartz grains (bleached prior to being covered by the rock). Those grains above the blue bar represent varying degrees of bleaching that were not fully effective and the grains below are most likely bioturbated (i.e. ants, soil heaving, etc.) in varying degrees. The average equivalent dose used in determining the ages was taken from the blue colored bar area. As an example, in Figure 7, the lowest equivalent dose values centered at 1.35 Gy, which was close to the minimum age model determined 1.24 Gy.

2. Strength of the luminescence signal from Sample #5. In many samples of quartz, three main components have been observed and are informally called the "fast", "medium", and "slow" components (*Bailey et al., 1997*). The fast component of OSL is usually required for accurate analyses and reliable age determination, unless one wishes to engage in time-consuming efforts to de-couple the growth curve components. The initial part of the signal in these samples was observed to have the fast component and thus de-coupling was not needed (*Figure 5A and 5B*). However, fully one-third of the aliquot samples either had a very dim signal or no signal at all (*Figure 4A and 4B*). The dim signal was not unexpected; after all the sediment could have been covered by the rocks at any time in the past, but it was estimated, before actual OSL measurements were carried out, not to have been more than one thousand to five hundred years ago. *More than likely the dim signal was simply measuring a modern component of grains or grains with no luminescence.* Because the dose rate was moderate (around 3 to 4 Gy/ka) a signal would have developed rather quickly; in this case that was an unexpected bonus. The data then did not suffer from signals that were barely above background or were insensitive to stimulation and measurement.

Any data that returned an equivalent dose between 0.1 to 0.2 Gray was assumed to be modern or bioturbated modern (that is drawn in from the edges or otherwise newly exposed) or simply the background signal in the photomultiplier tube during the interaction of the phosphor and the LED's (the grains themselves not producing any signals). There was no modern sample to compare signals with, but in other studies of young archeological artifacts, any data that did not return an equivalent dose of greater than 0.1-0.3 Gy was later found to be modern or bioturbated modern (that is drawn in from the edges or otherwise newly exposed). This allows the reader and the scientist to conclude that the modern processes are working as assumed and that grains that were exposed to sunlight (literally yesterday) return no signal and thus would not bias the results from those grains that had been gaining signal when covered with the rocks or sediment.

3. Dose rate heterogeneities and comparisons between techniques. This is a definite uncertainty in the dose rate data. The sediment is assumed at the time of sampling to be derived solely from the bedrock and to suffer no disequilibrium in the uranium decay chain throughout the lifetime of the luminescence being measured. Only one technique was used to detect the elemental concentrations (gamma spectrometry), and by measuring both original and storage sealed gamma rays from the packaged sample, disequilibrium does appear to be small to non-existent.

Because the pervasive rock was the granite or metamorphosed granite, both of which could contain large crystals of potassium feldspar, there is a strong probability that microdosimetry may have occurred to and within some of the grains. That is, a grain of quartz lying next to a grain of feldspar may have been "dosed" more than a quartz grain lying next to a biotite, another quartz, or other heavy mineral (such as hornblende or augite). This probability was not pursued in much detail because there was only one sample from the site that was analyzed and no reasonable comparison could be made of differing sample locations within the wall (*see Appendix and Figures 4, 5, and 6*). It would, however, look very similar to a partial bleaching problem (i.e. aliquots or grains with a larger measured equivalent dose than about 80% of the other measured equivalent dose values).

One other potential cause for concern could be that no in-situ dose rate data was taken, but the alternatives (leaving a copper capsule buried for several months or digging deeper and wider holes for a large probe) would not have left the site as intact as did taking smaller, representative samples.

Radioactive disequilibrium was not assessed by looking at the differences in the isotopes measured for uranium and thorium (for example, using differing techniques that may measure varied isotopes of the uranium-thorium decay series). However, based on previous studies in similar rock type and our timed gamma spectrometry tests, the author does not believe any significant disequilibrium exists.

4. Severity of the bioturbation. As discussed earlier, the radial plots do not seem to show extensive bioturbation (i.e. equivalent doses that fall below the colored bars). One way to test this (in future samplings) would be to take one sample from beneath the center of a rock as well as a sample from the edge of the rock to determine horizontal turbation; in other words whether modern grains would have been brought in under the rocks

through normal geomorphic processes of soil swell and shrink, biologic agents like ants, small mammals, or from other anthropogenic activities. *Table 1* shows the data from both samples and indicates that there is no difference in the measured equivalent doses.

5. The probable age of Upton Sample #5 is as follows:

The age associated with Upton Sample #5 is 363 years (± 16 years) or 1664-1632 A.D in calendar terms (calculated from 2011 A.D.) or 393 years (± 26 years) between 1644-1592 A.D., depending on how the data is graphed and shifted. The age from the same Upton Sample #5, when some of the higher equivalent dose population is included, is 490 (± 25 years) or 1546-1496 A.D in calendar years or 554 years (± 35 years) or 1422-1492 A.D. in calendar years. There are no calibration curves or adjustments that need to be made as there would be with radiocarbon ages. Luminescence is not an isotopic decay method and quotes to calendar years by default.

There were groups of outliers in the equivalent dose (*see Appendix "raw values"*), as shown in the radial plots for each site (*Figures 7 and 8*) and Upton Sample #5 had some aliquots that were thrown out before radial plotting (*see Appendix*). The ages come from two populations of equivalent doses; one at 1664-1592 A.D. and one at 1546-1422 A.D. (*Table 1, both methods used for the range*). The uncertainty in the ages is one sigma (68% confidence level), errors include both random and systematic errors, and the ages were rounded up to the nearest tens in the text to facilitate easy discussion. The ages should be considered to start from the year 2011; the year of sample collection (i.e. if we went back to sample five years from now the ages would be five years older than the ages obtained in 2011). I will discuss the implications of these ages below.

DISCUSSION (includes interpretation and recommendations for further work):

There are five results I would like to summarize my conclusions to: equivalent dose heterogeneities and partial bleaching, strength of the OSL signal, dose rate heterogeneities, implication of the severity of any bioturbation, and the range of ages as measured from the luminescence.

1. Evaluation of the equivalent dose analyses. The quartz grains had the "fast" component of OSL, there were some grains that returned a signal that I consider to be either modern or background (0.0 to 0.2 Gy), and statistical analyses of the scatter in the equivalent doses show clear signs of partial bleaching that could be separated from the rest of the grain sediment populations (the larger doses of 15, 20, and 26 Gy). However the introduction of modern grains deep within the sediment profile (bioturbation) is not a common problem at this site. Plotting of the equivalent doses show scatter above the radial plot two-sigma bar that points to partial bleaching tendencies but there was also a clear grouping of equivalent dose populations that were not related to partial bleaching; enough to conclude that an anthropogenic influenced signal is present. *However the presence and complications of beta microdosimetry are more than possible and so the most conservative estimate of the equivalent dose population should be used to avoid overestimating the true age.* These points strongly suggest that the age model the author used (Minimum Age Model) will return the most reliable and reproducible

amalgamation of equivalent dose analyses until such time as a five or more samples from the same site have been analyzed.

2. Strength of the luminescence signal from the samples. The quartz had a beautifully clear and strong signal and was sensitive to the blue light stimulation. There was absolutely no problem with the strength of the signal, unless the grain was modern or had no luminescence. This was due to the moderately high dose rate that creates luminescence in a very short time. In spite of the young age of the sites I got enough precise data to return reliable and accurate ages. A failure rate of 35% is considered to be acceptable in this case, especially when the failure rate was mostly that there was simply no signal to measure and not a failure of the sample to pass protocols. The lack of signal could have been due to grains that would never emit any luminescence because they did not have the proper mineral characteristics or simply due to those very young grains that had not “grown in” any luminescence.

3. Dose rate heterogeneities and comparisons between techniques. There were no in-situ methods taken for dose rate data, and so I must caution that this is a major concern in the dosimetry because of the unknown uniformity of the geological source of the rocks at the sites. There was no radioactive equilibrium detected within the gamma spectrometry lab (samples measured before and after a time-delay), so this factor would seem to be negligible. I also discount any possibility of measuring grains that had simply decomposed in place from the parent rock and lain at the surface. I would have seen much higher equivalent doses and I would have seen much more scatter in the range of the equivalent doses. The dose rates as calculated from the elemental concentrations are accurate and well reflect the amount of ionizing radiation the grains would have been subjected to after the rock was placed over them. The biggest concern, iterated from above, is that that microdosimetry may have occurred to and within some of the grains. This would look, to varying degrees, like partial bleaching which is why I recommend the lowest equivalent dose population until such time as the variation in other samples from the site have been tested and a more detailed geological survey is done of the rock in the wall.

4. Severity of the bioturbation. There was no test of bioturbation taken; such as taking one sample from the center and one from the edge of rock to determine the degree of horizontal turbation (modern grains brought in under and around the rocks). I do not believe that one test would completely rule out the significance of horizontal turbation disrupting the results, but it at least would show that it is not a critical component to factor into the age of the sediment beneath the stone wall. I would recommend at some time this simple test be done, and it can be done at any part of the wall at any place.

5. The ages of the sediment beneath the rock. Based on the data that I measured, and in the strictest sense of the data, the sampled layers beneath the rock mean only that that particular rock was emplaced there at the calculated age that has been assigned to the sediment beneath or behind the rock. It is entirely possible that placement of the other rocks in the walls could be younger, but it is also possible that they could be older. If we look critically at the data, it looks as though the one population is about a hundred years older than another, but it

could also mean that we sampled older rock-building at that site. The errors on the equivalent dose measurements are about 4 to 5 percent (at one sigma). In general, these errors are fantastically small and much better than I expected to get without running the samples to another 100 aliquots and taking even more time to measure.

I realize that these ages represent the first concrete chronology at this site, which is why I have attached so much data and graphical presentations to this report. I want there to be no doubt that I tried to look into almost every possibility that I could. I did measure aliquots or groups of grains that were higher than 1-2 Gy (from 3 to 6.5 Gy, also 15 to 25 Gy) but the aliquots that were higher than 6 Gy were almost certainly a product of not being fully “zeroed” or bleached before being buried (whether naturally or not) under the rocks. I still have not decided whether the grains that measured from 3-6 Gy really reflect the true time of burial or are a result of some other radiation dosimetry processes that should (and can) be further explored. Could these grains have come instead from earlier occupations of the site? We can’t rule that possibility out, but the data does tell us that the MINIMUM age of the wall rock emplacement is: Upton Sample #5 is either between 1664 A.D. and 1632 A.D, or (using another method to calculate the equivalent doses) is between 1644 and 1592 A.D. The age from the same Upton Sample #5, when some of the questionable higher equivalent dose population is included, is either between 1546 A.D. and 1496 A.D or between 1492 A.D. and 1422 A.D. in calendar years, which *could* make the site pre-Columbian.

In conclusion, I (SAM) inject some pure speculation and philosophy as I complete this report. What was happening during these time periods in this area? I have no idea. Are the ages plausible? Ask the historians and archeologists, I believe the ages I have measured represent the best luminescence dating I can give. Does having younger than expected ages make these sites any interesting or valued? No. Should further OSL samples be analyzed? Yes.

I cannot say that there wasn’t some sort of pre-stone wall structure at this site that was then torn away or re-worked by the builders of the more current structures. It’s a plausible scenario that the latest workers did follow some sort of pre-made form or structure when constructing the features. We may never know for sure, but we do know this sort of “path of least resistance or pre-form” has happened at other sites and cultures (*no specific references*). Upton is listed as originally the home of the Nipmuc, was settled by Europeans in 1728, officially incorporated in 1735, and now has a total land area of 21.7 square miles (56 km²) (*Wikipedia, accessed May 6, 2012*). Perhaps it is not too much of a stretch to suppose early European settlers added to, enlarged, or modified aspects of structures that were there previous to them. I leave this part of the analyses to other scientists.

Recommendations for future work:

1). I believe (for reasons outlined throughout the results and discussion) that at least four other samples should be dated using OSL (giving a minimum statistical n=5) from this site. These samples would provide the basic structure in solidly defining the age of the site and also be of great value for the accuracy and precision of this reported age range to be able to systematically date the samples from this one site in great detail. It would

involve analyzing OSL samples taken from varying depths around a particular feature or structure or concentrated around one part of the wall so that we could have some understanding of periods of occupation, the variation of the dosimetry, and whether assumptions about very old and modern analogs hold up well in to intensely dated sites.

2). Transfer some grains from the luminescence aliquot disc to a scanning electron microscope (SEM) stub to assess mineralogical content and see what the probability of microdosimetry really is. Alternatively, making a thin section of the sediment (it can be done to loose material and not just rocks) and having an experienced geologist or mineralogist make a point count of the different minerals would produce the same result, depending on the quality of the geologist. Would this help elucidate the scatter in the equivalent dose? Definitely, but it is relatively expensive to get these measurements although at this point perhaps work could be obtained with contacts through other government agencies. I include it to show that I know that the microdosimetry question was not fully explored in my experiments.

3). I recommend that a modern sample be taken from somewhere near the site and also that either a horizontal or vertical subsampling take place (from 0 to 5 cm in some sort of large incremental scale). These tests would answer any questions about whether the site processes for a modern sample carries essentially a “zero dose” (0.1-0.3 Gy), whether bioturbation is a common problem in the sediments at the site, whether the possibility of slow sedimentation rates exist, and if microdosimetry plays a substantial role in the modern analog.

4). I wanted to date the grains using a more modern technique of single-grain dating. Because the USGS lab will not have this capability until the summer of 2012, I tried to gain access to equipment at Los Alamos National Labs, a sister agency (Dept. of Energy) to the Dept. of Interior. However, due to a forest fire and equipment and lab relocations this did not happen. I kept spare material from Upton #5 and will try again sometime in the future to obtain single-grain analyses. I do not anticipate the ages from this analysis will be markedly different than those reported here, but the precision in the errors will improve and I feel it is worthwhile to explore this avenue of investigation.

5). Have a geologist complete a “survey” of the rock wall. What types of rocks are in the wall? Are the rocks uniformly placed? Is the sediment derived from the erosion of the rocks or are there any exotics to the wall? In general outline the source geology and implications of placements as this will either confirm (or not) some assumptions that I had to make about the dose rates.

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Figure 1 Stone circle sample site

Figure 2 Picture of sample site and sampling protocol

Figure 3 Close-up of rock from the wall

Figure 4a and 4b Growth and decay curve sample with no signal

Figure 5a and 5b Growth and decay curve of sub-optimal signal

Figure 6a and 6b Growth and decay curve of optimal signal

Figure 7 Radial plot of all acceptable values 28 (39)

Figure 8 Radial plot of lowest equivalent dose population 14 (28)

Table 1 Quartz OSL data and ages

Table 2 SAR protocol

Table 3 OSL machine and measurement parameters

Appendix-supplemental data



Figure 1. View of the stone wall “chamber” in Upton, Massachusetts that was sampled for OSL dating (First three photo figures provided by Dr. Fredrick Martin).



Figure 2. Rock #5 sampling site, with steel sample tube being driven in by Dr. David Stewart-Smith. Sample #5 was driven behind stone D of the first course and this was the sample submitted for OSL.



Figure 3. Rock showing foliation and crystalline growth typically of granite, granodiorite, or metamorphosed intrusives (including granite). This was the best picture of a fresh exposure, since the surface of the rocks in the majority of other photos is weathered and stained green by organic growth.

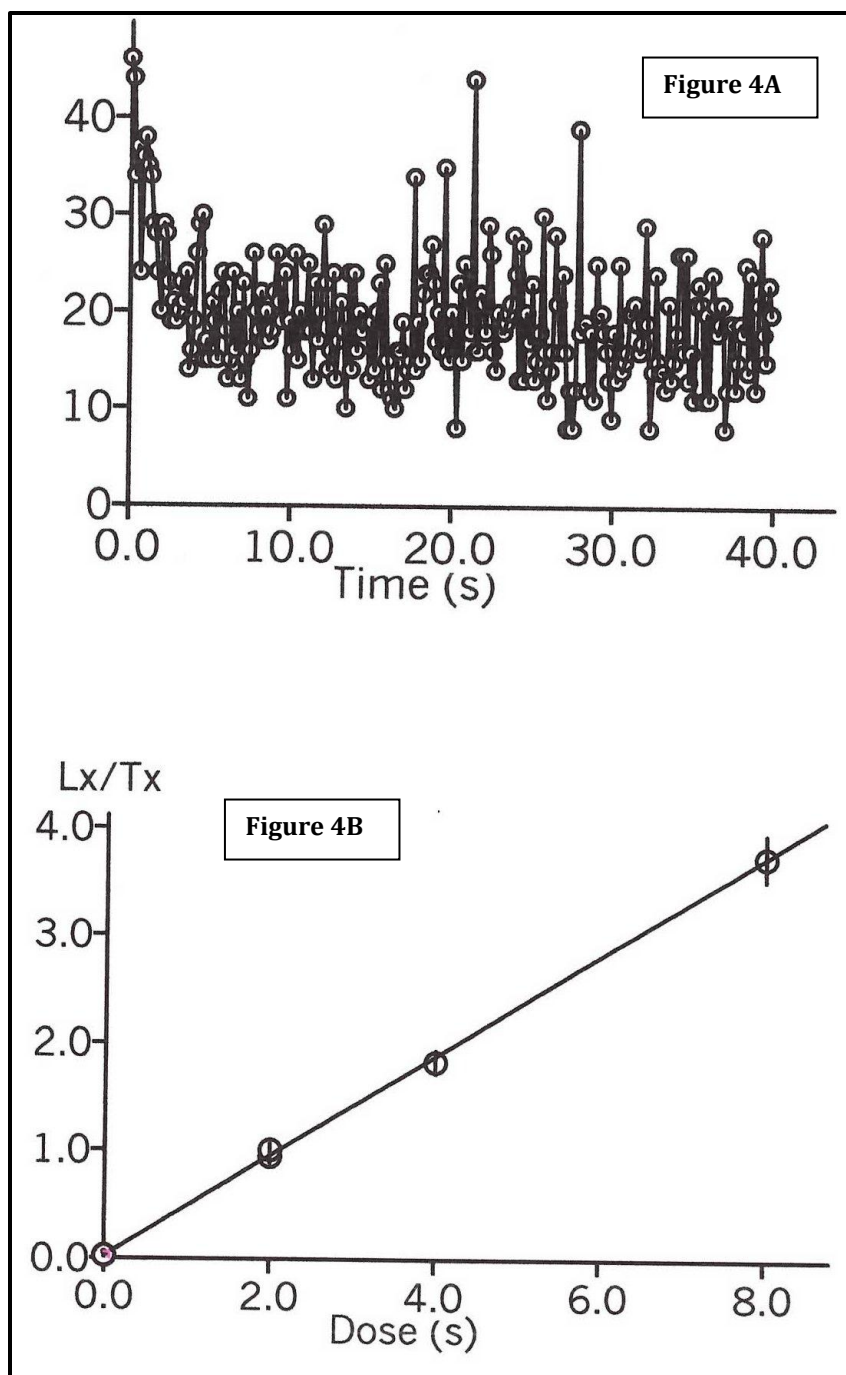


Figure 4A. An OSL decay curve for Upton Sample #5 showing the quartz signal as measured with blue-light wavelength emitting diodes. A sharp decay is seen after 1 to 2 seconds of stimulation indicating access from a fast component of OSL but the signal is essentially nonexistent (at background counts of 29-35 photons/sec) and shows the low end of a modern signal. Figure 4B. Upton Sample #5 growth curve, with the natural (red lines) so low as to not generate a reading above a bleach or "zero". The x-axis is the equivalent dose measured in Grays (source calibration is 0.087 Gy/sec and shown circles are obtained at 2 Gy, 4 Gy, 8 Gy). The y-axis shows the luminescence response over the test dose response (L_x/T_x or unitless normalized OSL sensitivity measurements). Regeneration proceeded "optimally", with a recycle within 7% of the first measurement (two clustered circles close to the 2.0 x-axis mark).

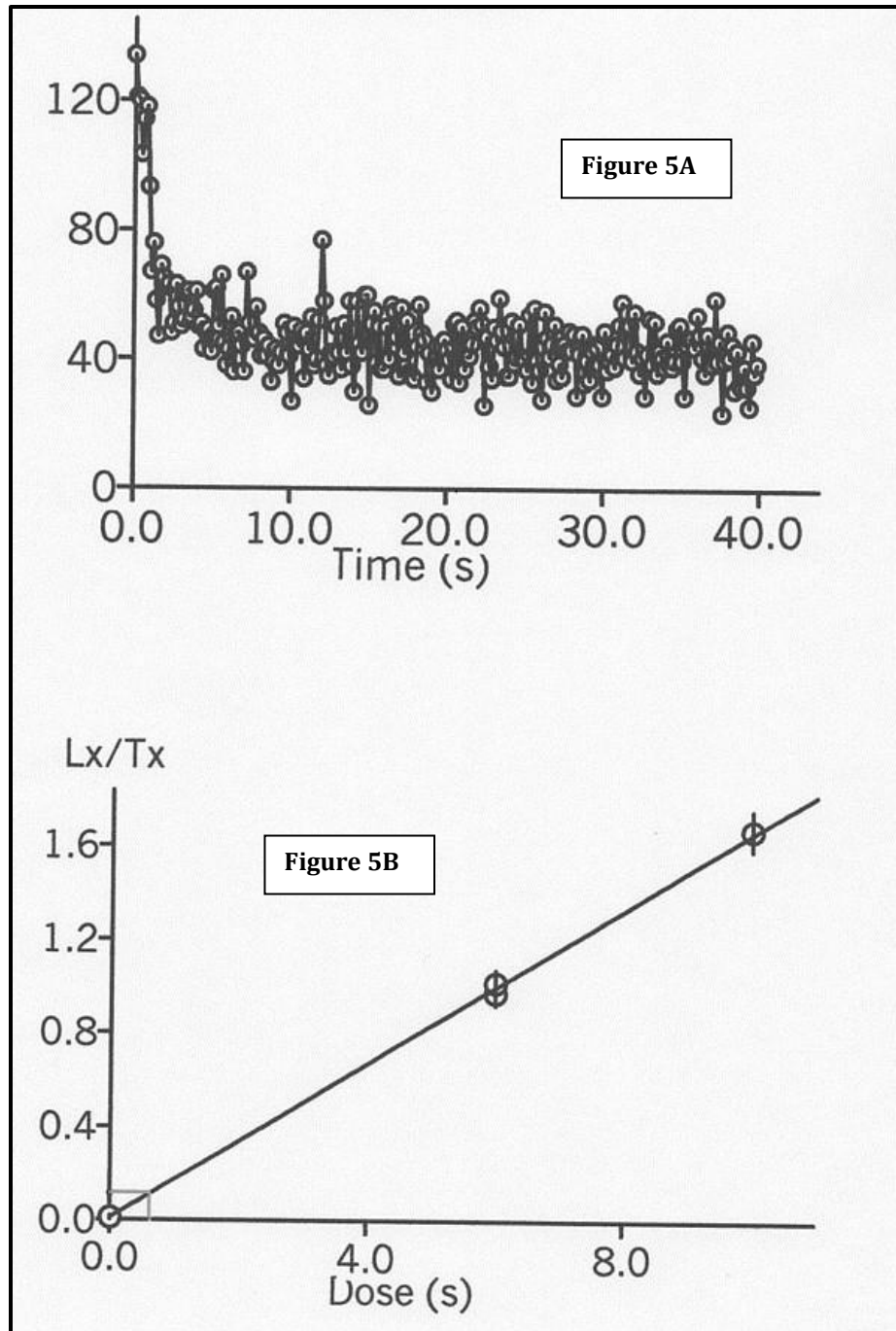


Figure 5A. An OSL decay curve for Upton Sample #5 showing the quartz signal as measured with blue-light wavelength emitting diodes. A sharp decay is seen after 1 to 2 seconds of stimulation indicating access from a fast component of OSL but the signal is much weaker or “dim” (about 120 photons/sec) and shows lowest equivalent dose population found in the sample. Figure 5B. Upton Sample #5 growth curve, with the natural (red lines) so low that they barely register above the 0.0 (gray box that intersects the linear growth line). The x-axis is the equivalent dose measured in Grays (source calibration is 0.087 Gy/sec and shown circles are obtained at 5 Gy and 10 Gy). The y-axis shows the luminescence response over the test dose response (L_x/T_x or unitless normalized OSL sensitivity measurements). The natural hits the line at 0.8 Gy.

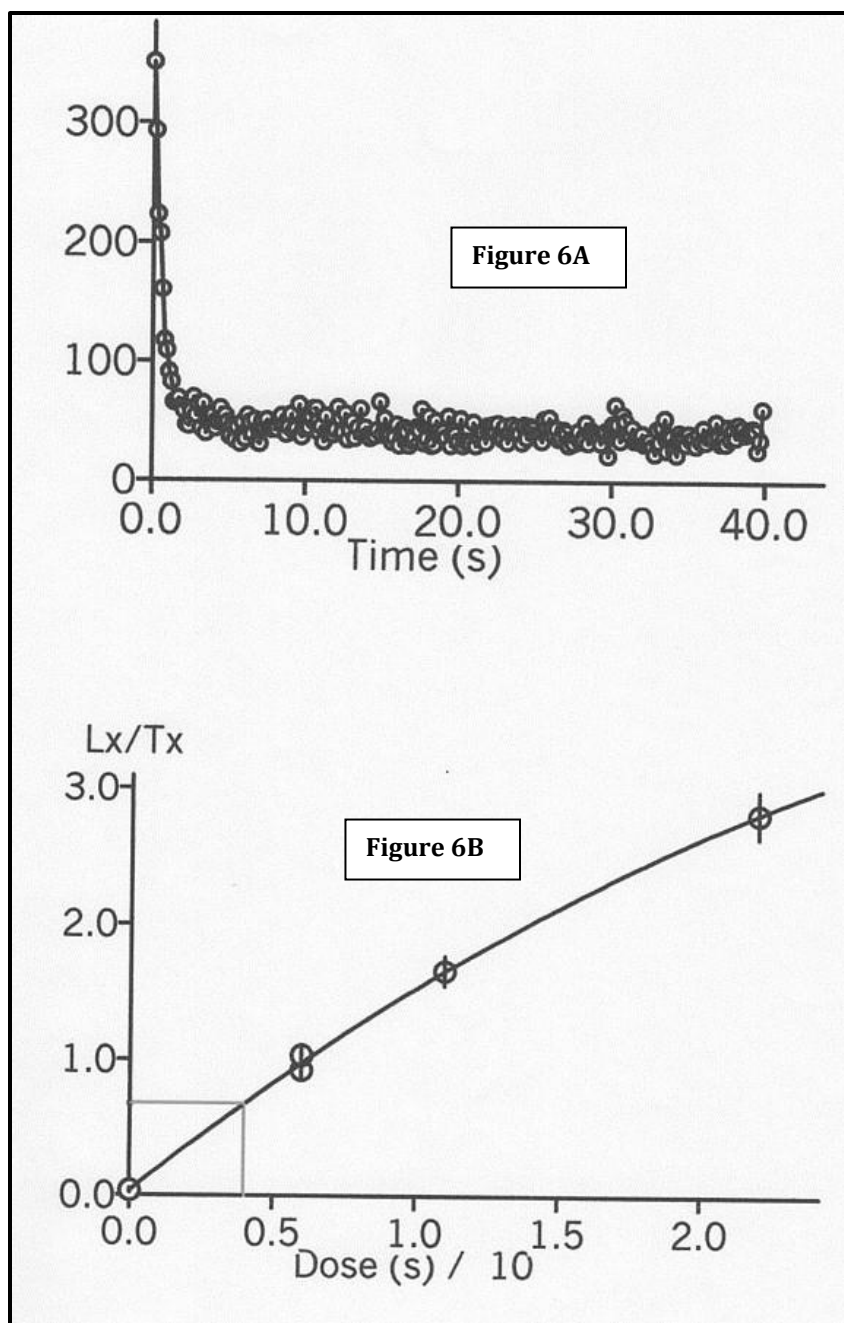


Figure 6A. An OSL decay curve for Upton Sample #5 showing the quartz signal as measured with blue-light wavelength emitting diodes. The x-axis is time of measurement in seconds (s) and the y-axis is photon counts/second over the course of the 40 second measurement period (here a little over 300 photons/sec at the start of the LED's stimulation). A sharp decay is seen after 1 to 2 seconds of stimulation indicating access from a fast component of OSL. The OSL equivalent dose data is taken from the initial part of the first 0.5 sec. and the background adjustment is taken from the last second of the 40 second measurement. Figure 6B. Upton Sample #5 growth curve, with the natural (red lines) plotted on the Lx/Tx axis below 1.0. The x-axis is the equivalent dose measured in Grays (source calibration is 0.087 Gy/sec and shown circles are obtained at 6 Gy, 12 Gy, 24 Gy. The natural hits the linear line at about 4.0 Gy for this particular aliquot. The bleach (zero) is shown at the junction of the axes. The y-axis shows the luminescence response over the test dose response (Lx/Tx or unitless normalized OSL sensitivity measurements).

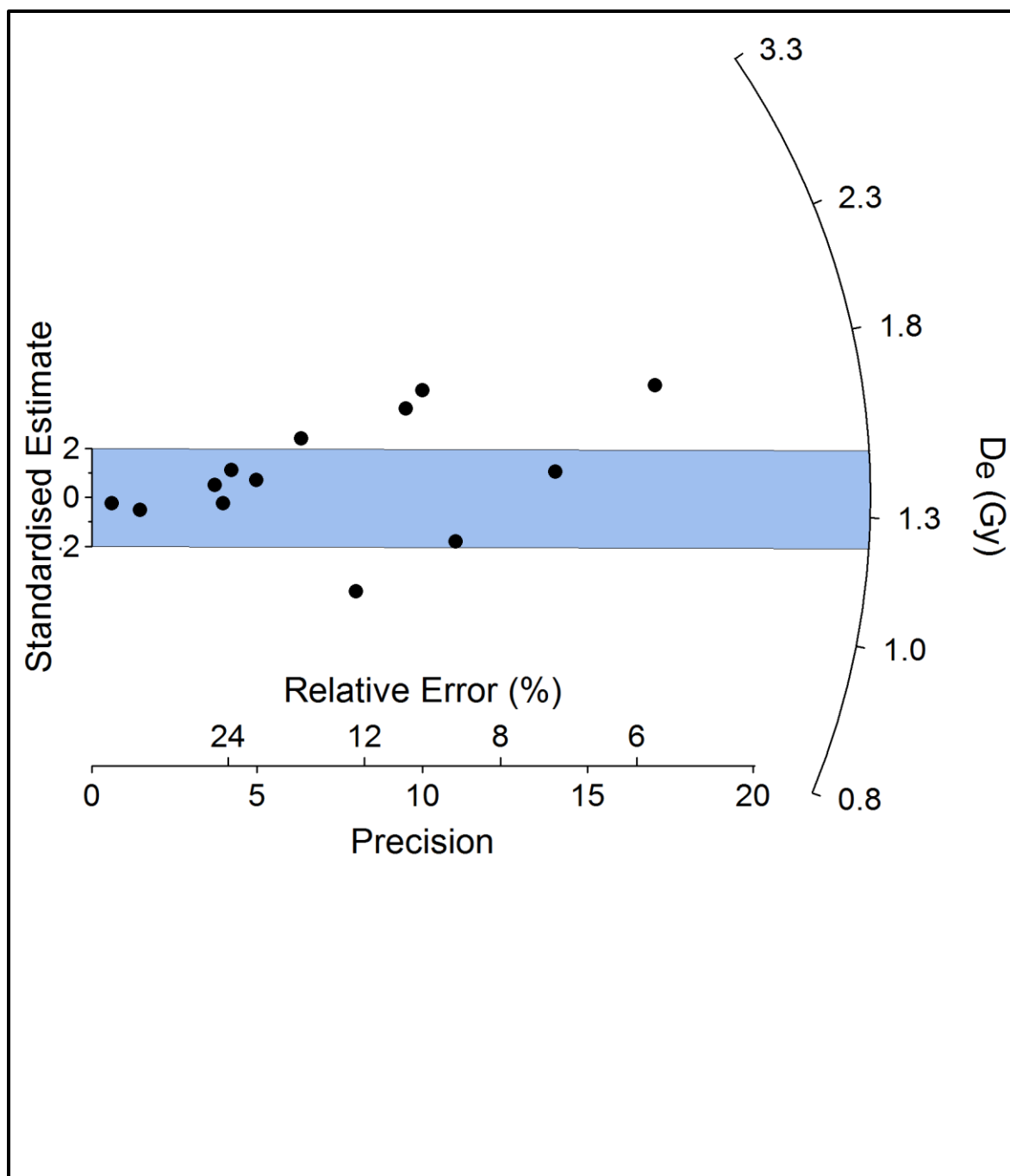


Figure 7. Radial plot graphical analyses for Upton, MA that allows visualization of equivalent dose distributions, where focus is drawn to the best-known results (*Wallinga, 2002*). The number of aliquots = 14 (39) or really = 14 (26) acceptable (i.e. with a signal) have been used. The population plotted here is taken from the Appendix values De#1 (*see Appendix*). Note that there is a slight dispersion (above the blue bar; one below) but this could be due to the fact that there are large errors associated with most of the measurements (about 20%). There were also some equivalent doses of the same value and error and thus fourteen dots may not be visible. Four aliquots had very high equivalent dose measurements (1.7-2.0 Gy) that fell outside of the two sigma blue bar and one aliquot is below the blue bar. The mean here is 1.35 Gy.

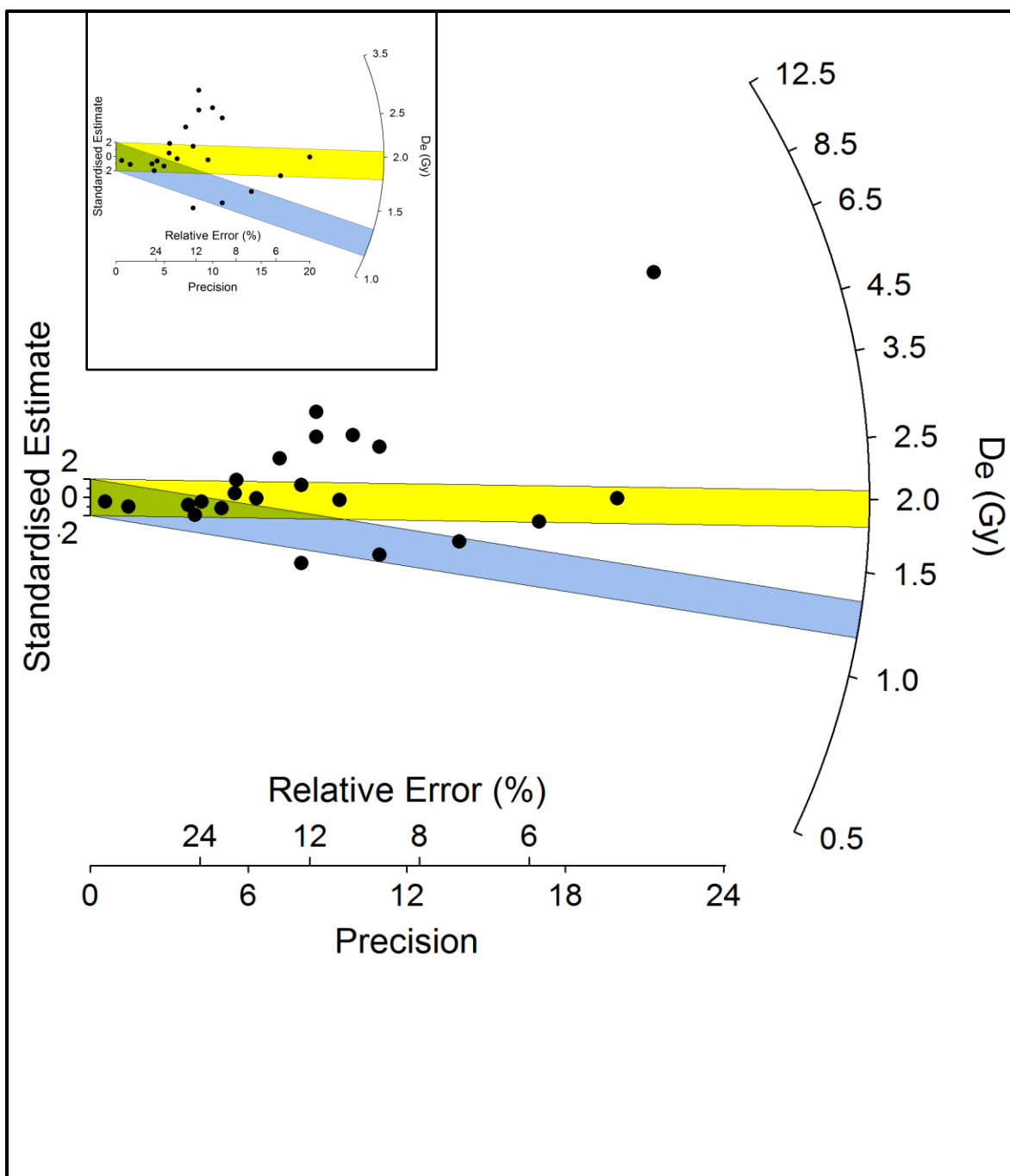


Figure 8. Radial plot graphical analyses for Upton, MA showing the number of aliquots = 16 (39) or really 16 (26) acceptable (i.e. with a signal) have been used. The populations plotted here are taken from the Appendix values De#1 and De#2 (*see Appendix*). De#1 is still the blue bar and De#2 is the yellow bar. One aliquot had a higher equivalent dose measurement with a more precise error (6.4 ± 0.03 Gy) making it fall well outside of the two sigma yellow bar. Taking this outlier away does not change the structure of the graph in any way (thumbnail above). The other larger equivalent doses have less precise errors, making a cluster just above the yellow bar. There were also some equivalent doses of the same value and error and thus sixteen dots may not be visible. The mean here is 1.90 Gy for the yellow bar and 1.35 Gy for the blue bar.

TABLE 1: Quartz OSL Data and Ages from Upton Stone Chamber, Massachusetts									
Sample information	% Water content ^a	K (%) ^b	U (ppm) ^b	Th (ppm) ^b	Cosmic dose ^c additions (Gy/ka)	Total Dose Rate (Gy/ka)	Equivalent Dose (Gy)	n ^d	Age (yrs) ^e
Upton #5	17 (23)	2.40 ± 0.04	2.34 ± 0.14	11.2 ± 0.40	0.19 ± 0.01	3.43 ± 0.08	1.24 ± 0.05	14 (26)	363 ± 16.0
<i>lowest equivalent dose population</i>			-	-	-	-	1.35 ± 0.07 ^f	14 (26)	393 ± 25.6 ^f
Upton #5	17 (23)	-	-	-	-	-	1.68 ± 0.08	16 (26)	490 ± 24.5
<i>medial equivalent dose population</i>			-	-	-	-	1.90 ± 0.10 ^f	16 (26)	554 ± 34.9 ^f
^a Field moisture, with figures in parentheses indicating the complete sample saturation %. Ages calculated using approximately 75% of saturation values.									
^b Analyses obtained using laboratory Gamma Spectrometry (high resolution Ge detector).									
^c Cosmic doses and attenuation with depth were calculated using the methods of Prescott and Hutton (1994). See text for details.									
^d Number of replicated equivalent dose (De) estimates used to calculate the equivalent dose. Figures in parentheses indicate total number of measurements included in calculating the represented equivalent dose and age. All aliquots passed methodology tests. 35% of the aliquots returned no signal.									
^e Dose rate and age for fine-grained 250-180 microns quartz sand. Linear fit used on equivalent dose, errors to one sigma, minimum age model.									
^f Dose rate and age for fine-grained 250-180 microns quartz sand. Linear fit used on equivalent dose, errors to one sigma, radial plot mean.									

TABLE 2: Luminescence parameters used in preparation and analyses of samples for quartz OSL

Measurement parameters:

Machine	Automated Risø TL/luminescence-DA-15
Mineral; grain size:	quartz: 250-180 μm
Stimulation source:	blue LED diodes, emission centered on 470 nm
Power delivered to aliquot:	14 mW/cm ² (90% power)
Duration of stimulation:	40 seconds
Final signal level:	2% of initial
Photomultiplier:	Thorn-EMI 9235Q
Aliquot temperature:	125 °C
Detection filters:	two Hoya U340 filters
Normalization:	none
Preheat:	200 °C (samples <5 ka) for 10 secs
Delay before measurement:	120 sec
Equivalent dose evaluation:	single aliquot regeneration (<i>Murray and Wintle, 2000, 2003</i>)
Background evaluation:	black body counts <29 ct/sec, BG counts <27 ct/sec
Alpha effectiveness:	n/a
Dose-rate evaluation:	high-resolution gamma spectrometry
Dose rate range:	3.43 Gy/ka (Grays per thousand years) moderate range
Water content:	17% of full saturation (about 75% of the time it is moist or wet)
Cosmic-ray contribution:	5.5% of total dose rate

Table 3. Single Aliquot Regeneration Protocol for Optical Dating.

1. Preheat (200 °C) for 10 seconds (preheat range is specific to Upton Stone Chamber samples)
2. OSL stimulation with blue light (470 nm) at 125 °C for 40 seconds (L_n)
3. Test dose beta irradiation
4. Cut heat (same temp as preheat) for 0 sec
5. OSL stimulation with blue light (470 nm) at 125 °C for 40 seconds (T_n)
6. Beta irradiation of regeneration dose
7. Preheat (200 °C) for 10 seconds
8. OSL stimulation with blue light (470 nm) at 125 °C for 40 seconds (L_x)
9. Test dose beta irradiation
10. Cut heat (same temp as preheat) for 0 sec
11. OSL stimulation with blue light (470 nm) at 125 °C for 40 seconds (T_x)
12. Repeat Steps 6-11 with further regeneration doses

APPENDIX (SUPPLEMENTAL DATA)

Raw Equivalent Dose Values

DE (#1)	error	DE (#2)	error	DE (#3)	error	DE (#4)	error
0.8	1.3	6.4	0.3	15.2	1.9	0.1	0.1
0.8	0.1	6.0	0.7	20.1	1.8	0.0	0.1
0.8	0.1	4.3	0.5	25.9	4.3	0.0	0.1
0.9	0.6	4.0	0.4	3 (26)		0.1	0.1
1.1	0.1	3.6	0.5	20.4 ave		0.1	0.1
1.2	0.3	3.3	0.3	nul radial		0.2	0.2
1.4	0.1	2.8	0.5			0.1	0.1
1.5	0.4	2.4	0.3			0.1	0.1
1.5	0.3	2.2	0.4			0.0	0.1
1.7	0.1	9 (26)				0.0	0.2
1.7	0.4	3.9 ave (this set only)				0.0	0.1
1.9	0.3	1.9 radial (combines first 2 sets)				0.0	0.1
1.9	0.2	3.81 minimum age model (this set only)				0.1	0.1
2.0	0.1					0.2	0.2
14 (26)						no signal	
1.40 ave							
1.35 radial							
1.24 minimum age model							

			Peak Energy (keV)	Net Counts in Peak		Times	PPM (U&Th) or % (K-40)		
			Peak 1	Peak	Error	Count (s)	results -bkg	±	Error (%)
sample ID	Isotope	Element							
UptonStoneChamber	K-40	K	1460.81	3775.37	64.76	38750.7	2.4 %	0.04 %	1.7 %
11/27/2011	Pb-212	Th	238.63	4735.4	76.26	38750.7	10.73 ppm	0.18 ppm	1.7 %
New England	Ac-228	Th	911.2	915.03	46.6	38750.7	11.57 ppm	0.62 ppm	5.4 %
	Ra-226	U	186.21	657.34	73.09	38750.7	2.05 ppm	0.27 ppm	13.2 %
	Pb-214	U	351.92	2123	37.68	38750.7	2.49 ppm	0.05 ppm	2 %
	Bi-214	U	609.31	1551.29	53.94	38750.7	2.49 ppm	0.09 ppm	3.6 %

Gamma Spectrometry (Ge detector) values for sediment collected at Upton Stone Chambers archeological site. These values are used in the determination of a dose rate.

From: [Fred W. Martin](#)
To: [Shannon A Mahan](#)
Cc: [Cathy Taylor](#); [Marty Dudek](#); [Ted Ballard](#)
Subject: Upton sample processing
Date: Thursday, June 21, 2012 11:27:43 PM

Ms Shannon Mahan, Research Geologist
USGS Luminescence Dating Lab
Denver Colorado

Hello Shannon:

Thank you for discussing the Upton Chamber report by telephone today. Here are my written questions Q1-Q4.

I am worried by the peak of 13 aliquots with no signal. It seems there must be two groups in the data, and it is very hard to understand how this can happen when there are supposed to be 40 samples from a uniform source, with 200 quartz grains in each sample. Somehow the mixture becomes non-uniform.

Q1: could it be background subtraction? You said you could check the background level for the 40 samples and provide a list of the data.. In the measurement of light emission, do the 13 "dead" aliquots have a higher background than the others?

Q2: Is the emitting substance a mixture, from which the 27 good aliquots have mostly the same "dead" grains as the 13, with only a few emitting grains? In other words, could the average aliquot have 199 "dead" grains and only one emitter? With 40 samples and a mean near 1 emitting grain, it would not be statistically unreasonable to get 13 samples with 0 emitting grains.

Without the textbook promised by our library, I think I have puzzled out the calibration. The light emitted after beta dosage must be proportional to the number g of "live" grains and the number n of emitting centers per grain, which itself is proportional to the beta-ray dose. Thus the light emitted after beta dosage measures g . The calibration of g determined in this way can then be used to find the original density of centers, call it n_0 , caused by natural radiation. A consequence of this model when $g = 1$ would be weak emission after beta dosage.

Q3: is the absolute quantity of light T_x emitted after beta dosage low for Upton sample #5 compared to other typical samples in the laboratory? In other words, is there any experimental support for only a few emitters per aliquot in the 27 active aliquots of sample #5?

In today's phone call, you provided some details that I can't find in the report about the centrifuge process on page 5. There is apparently a third type of grains, not quartz and not feldspar, which has a density very close to quartz. This makes it more likely that a mixture could have a high fraction of the third type of grains as theorized above. .

I think it is important archaeologically to know whether the 13 aliquots have quartz or another material on them. It is conceptually possible that there are an awful lot of modern quartz grains washed down behind the retaining walls by seepage and rain, which grains emit no OSL light. On the other hand according to the above ideas they might be a centrifuge effect, consisting of grains which are not quartz. You proved that they are not feldspar by subjecting them to infrared light.

Q4: can you run some other test to determine what the grains on one of the 13 "dead" aliquots do consist of? I am familiar with proton-induced X-ray tests which are good for polished minerals, so I would think they would work for 0.2 mm mineral grains as well. We might be able to get a free PIXE test at Connecticut College. Maybe you have access to other tests such as ordinary x-rays or scanning electron microscopes that can excite the characteristic X-rays of the grains and compare them to

quartz. If you can walk down the hall to an SEM, by all means do so. Most scanning electron microscopes are fitted out to look at electron-induced X rays, and to hold fairly large samples.

I continue to be worried that the sample is properly separated into quartz grains, with no modern component of quartz grains, and that the gap between 0.3 and 0.8 gray is caused by some instrumental or processing error, such as a mistaken exposure of a batch of 13 aliquots to room light. If the gap repeats in future samples, perhaps it is caused by a very large modern component of grains. If that gap goes away and the low counts are retained, the age moves toward 1700 AD.

Sincerely

Frederick W. Martin

Appendix VIII –
Upton Chamber Remote Sensing Project
2011
by David Gutbrod

Upton Chamber

Prepared for the Upton Historic Commission January 2012

Remote Sensing by David Gutbrod



Gutbrod 2011 400 Megahertz (MHz) antenna and survey wheel

UPTON CHAMBER REMOTE SENSING PROJECT 2011

This project was initiated by the Upton Historical Commission in conjunction with the archaeological investigation that was performed at the town owned land at 18 Elm St., Upton, Ma. This report is solely focused on the remote sensing and primarily the Ground Penetrating Radar that followed the archaeology and restoration of the Chamber stone entrance. It is meant to contribute to the knowledge base of the Chamber and its history.

The historic background and documentation of the archaeology completed before the entrance reconstruction of the Upton Chamber can be found in the report filed by John Milner & Associates (Dudek 2011-2012) including all archaeological excavation documents and records.

The conclusions and recommendations are an essential piece of the heritage management of the Upton Chamber. At the request of the Upton Historic Commission, the author has included the guidelines for preservation and management of this historic resource as it is outlined by the international community, in particular ICOMOS (International Council On Monuments and Sites). While this may be beyond the typical GPR project this recommended approach is necessary to address the unique nature of this resource and the diversity of the participating stakeholders.

The Town Historical Commission retained the services of David Gutbrod independently and any errors or omissions are solely his responsibility and does not reflect upon the previous archaeological survey as conducted by JMA (John Milner Associates).

The author would like to acknowledge the expertise and recommendations of Martin Dudek, without whose interest and foresight this project would not have been completed. In addition, Dr. Meg Watters, who not only assisted me with technical questions and operations, but was instrumental in the overall data collection. Also, over the Christmas holidays Kent Schneider assisted with the visualization by importing the data into GPR Slice Software allowing for comparison to the RADAN GPR Software.

Finally, I would like to thank Cathy Taylor for her kind and consistent manner that helped foster, nourish and complete this project.

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*GPR Slice software designed by Dean Goodman submitted by K. Schneider (graphics added by author).

**Satellite photos and internet photos are individually marked with web address and company.

Project Theory, Goals and Parameters

1. Theory of GPR & Magnetometry

Ground Penetrating Radar sends radar waves in distinct pulses from a surface antenna into the ground and measures the time and strength in the return reflection by a receiving antenna. The Relative Permittivity or dielectric constant of different materials can then change the velocity of the wave as it hits individual materials. The greater the contrast in this measurement, results in the greater the resolution in the data. When the travel times of energy pulses are measured and their velocity through the ground is known, depth can be measured to produce a three-dimensional data set (Conyers and Luscius 1996).

In recent years, advancement in visualization software has increased the uses and understanding of the radar data (Fisher, S., R. Stewart & H. Jol. 1994, Goodman, D. 1996, Watters 2011). These advancements have made it possible to target future ground archaeology for specific areas, and increase the knowledge of buried features before actual excavation.

Magnetometry is a prospecting method that maps local variations of the earth's magnetic field in the near-surface. It is a passive method of remote sensing since it utilizes the earth's magnetic field rather than generating its own artificial energy wave such as GPR and resistivity. (Kvamme 2006)

- 1) Fired artifacts can produce detectable anomalies such as ceramic vessels.
- 2) Accumulations of topsoil associated with constructed features can cause positive anomalies.
- 3) Intensive firing can create pronounced anomalies (hearth or burning episode).
- 4) The removal of magnetically enriched topsoil can produce negative anomalies.
- 5) Imported stone can be more or less magnetic than surrounding soil, introducing significant anomalies in either case.
- 6) Iron and ferrous compounds produce strong anomalies readily detected by Magnetometry.

Equipment The Ground Penetrating Radar equipment used was the SIR3000 unit with Survey wheel made by GSSI Inc. It was used with a 400 MHz antenna which reaches a depth of about 3 meters or just

under 10 feet. Also, as an added measure of detail and to have additional data in the grid above the chamber a deeper penetrating antenna, the 200 MHz was used. This was beyond the scope of the projected work and estimate; however it offered the comparison to the primary 400 MHz data set and insured a deeper penetration.

The Magnetometry was collected using a Geometrics G-858 gradiometer. This equipment utilizes the characteristics of cesium gas and uses a counter which measures teslas per root Hertz. This can have a sensitivity as low as .00005 nt/ $\sqrt{\text{Hz}}$ (.5 picoTesla per root Hertz)(Smith, K. 1997).

Location and Soil The Upton Chamber, as it has been named (also called Upton Cave), is located in Upton, MA. At the following coordinates (42°10'33.05"N 71°35'52.26"W). It is located in the southern section of Worcester County. It is just to the east of the Mill Pond and the property borders Elm St. The soil description is available at Web Soil Survey (WSS). The USDA provides soil data and information produced by the National Cooperative Soil Survey. It is operated by the USDA Natural Resources Conservation Service (NRCS). The Upton property contains Canton fine sandy loam, 8 to 15 percent slopes, and 15 to 35 percent slopes, extremely stony, also smaller percentages of Charlton and Hinkley soils. Nearby properties in addition to these soils exhibit Swansea muck as well as Scarboro and Walpole soils, 0 to 3 percent slopes. Available Water Storage (0-100cm): 8.14 cm. What is relevant to the GPR is the choice of the dielectric value of the soil (also relative permittivity). These can vary and a value of 12.0 f/m (farads per meter) was used.

Units It should be noted that most remote sensing project grids are set in meters and the equipment made by the manufacturers reflect this preference. However, due to the previous work performed in the English system at the Upton property, including site maps and an archaeological excavation (1955), and at the request of the clients, the decision to stay consistent slightly outweighed the obvious advantages of the metric system.

Project goals and parameters Given the interest in the Upton chamber over the last century, and the recent acquisition of the property, a long-range management plan can be a useful tool for the town and historic commission. It is the hope that this project contributes toward this plan. One facet of this plan would be the inventory of all known data about the property. This could include maps, previous research, ongoing research, and recent technological innovations toward understanding the resources that are within the property and nearby landscape.

One method for combining this information is to input data that is geographically related into software such as ArcGIS or Geographic Information System. This can allow older data to be compared with recent data in a spatial reference system to enhance future research and clarify the information already gathered. Though it is beyond the scope of this project, The Ground Penetrating Radar and Magnetometry Project, it has been the concept during the research phase, data collection phase, and reporting phase to have this eventual goal.

The research goals for utilizing remote sensing in particular stem from the property stakeholder's intention to learn more about its resources. This coupled with the fact that archaeology and ground truthing is both expensive and destructive. While salvage archaeology may be the option of last resort as is often the case, the advantage of remote sensing is that it leaves no footprint on the landscape. Ground disturbance methods in archaeology are unmatched in comparison and they cannot be replaced but the downside is that the method can only be done once. In other words, archaeology can destroy the actual resource that is trying to be learned from and investigated. This is especially noticed when future science and technology produces new techniques for the archaeologist.

Remote sensing is one way to further the goal of understanding the resource without degrading and or altering its value.

Ground Penetrating Radar is one method of remote sensing that can report back certain material signatures and characteristics of the ground beneath the surface. With the existence of the Chamber and questions surrounding the interior walls, such as a buried tunnel, it may be possible to understand the extent of buried walls and other possible buried features with GPR. There have been mysteries and folk lore mentioning further tunneling and stone structures (Hopper; Daily News 1990) that may be located with the 400 MHz antenna and subsequent data visualization.

Therefore, the grid (systematic placement of transect lines) was placed over the top of the Chamber and extended to the property borders and up to the former marsh and shrub area. While SIR3000 is the primary tool for this project, it has been reported (Clay 2001; Kvamme 2003) that multiple methods of remote sensing can capture what characteristics are missed by only using one technique. Therefore, a magnetometer (more specifically a cesium vapor gradient magnetometer) was chosen to compliment the data from the GPR.

Methodology

Grid layout began with the use of a Topcon 2B total survey station for the accurate layout of the survey grid. Using Elm St. as an anchor point the total station mapped out a 300 ft base line. The survey equipment is essential for maintaining 90° angles and equivalent distances.



Fig 2

GPR grid for 400 MHz antenna (Fig. 2)

The constraints of the grid size were based on several parameters. The property width (north-south) and the driveway limited data collection to 140 ft. at its widest extent. The property has previously had fill added to the west area which is drawn as swamp in the Pearson Map blue print (Pearson nd. 1928-1973). This begins at the 300 ft. mark and arcs toward the chamber in a north easterly direction. The change in elevation results in a rounded hill edge which has presently some coverage of tall grasses and small shrubbery above the former area marked swamp in the Pearson Map.

The former house foundation which is seen in the satellite image taken in the spring of 2008 (Fig. 3) is the constraint on the lower east section of the grid. Both the GPR and Magnetometer data would be flooded with readings from the debris of the former house which would offset the sensitivity settings needed for the rest of the survey area.

Therefore, the former house area was abutted to but not included in the above grid layout. Finally, the large maple tree and the rectangle which encompasses the declining angled path toward the Chamber is presently covered with a pile of cut stones, sifted archaeological soil, and shrubbery not conducive to taking GPR data. The result of all of these parameters is the grid that is laid out above in (Fig 2).

Transects of three feet were measured and marked rope was stretched the entire length of the grid to enable one and a half foot measured lines for the GPR and Magnetometer. The 400 MHz antenna was used over the largest extant of the grid. While the 200 MHz was used over just the 30 X 45 ft. square that included the Chamber, the Magnetometer was run the full length of the central portion of the grid using the dimensions 30 ft. X 140 ft.

These choices were based on the layout of the land, the constraints of pulling the large 200 MHz antenna, and the focus of the project. The constraints were also the project cost and scope presented in the initial GPR proposal. It was determined in the final days of preparation, which if time allowed, a 200 MHz antenna would possibly offer additional data and the size of the grid used would have to be select.

This determination was based on the input by several outside consultants which the Upton Historic Commission has retained for further review of the data presented in this project. For further information, contact the Town of Upton Historic Commission in regards to additional reporting and data not included in this report.

This recommendation and request to utilize the 200 MHz antenna added to the tasks of data collection thus, the size of the grid needed to be smaller and target the highest priority in order to make it possible to complete the project within the designed timeframe. Here, it was determined that the general area around the top of the Chamber would be the first priority. Because the radar equipment must make contact with the surface of the ground, the stone wall, sharp decline surrounding the entrance, and the lower flooded area could not be included. Therefore, at no time was data collected inside the chamber.



Fig. 3

GPR grid for 400 MHz antenna (Fig. 3)



Fig 4

Grid Layout for Magnetometry (Fig. 4)

THE DATA

Three parts 1. GPR using 200MHz 2. GPR using 400 MHz 3. Magnetometry

Part 1

Starting with the 200 MHz antenna, the grid as seen in figure 3 was designed with 3 ft. transects. The antenna itself is close to three feet wide. The pattern walked is a zigzag design and the data using the SIR 3000, is graphically shown in the field monitor and before processing in a grey scale format using RADAN software. The raw data has been included in digital form and is not included in the visual portion of this report.



Fig 5

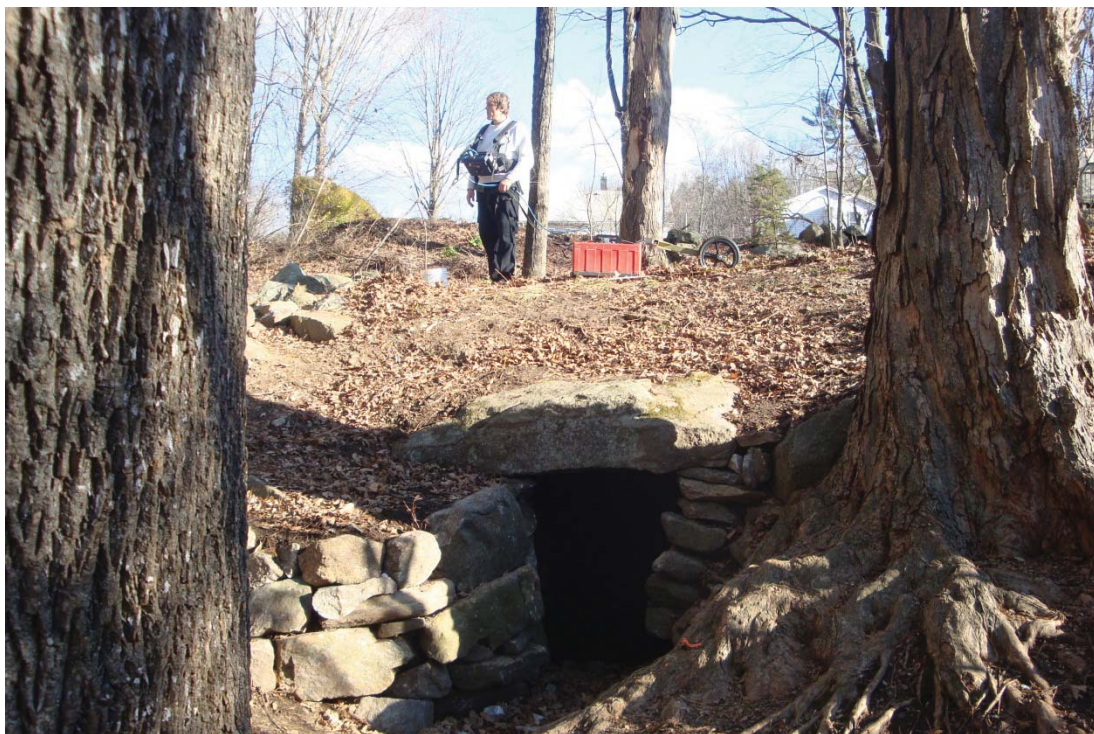


Fig 6

Fig. 5 facing north & Fig. 6 facing east with larger 200 MHz antenna above Chamber.

The signal or pulse from the 200 MHz reaches deeper depths but does not have the resolution of the 400 MHz antenna. After processing with RADAN software, the initial 2-d image can show the preliminary anomalies in the soil (Goodman, D. & Y. Nishimura 1993; Bevan, B., & J. Kenyon 1975).

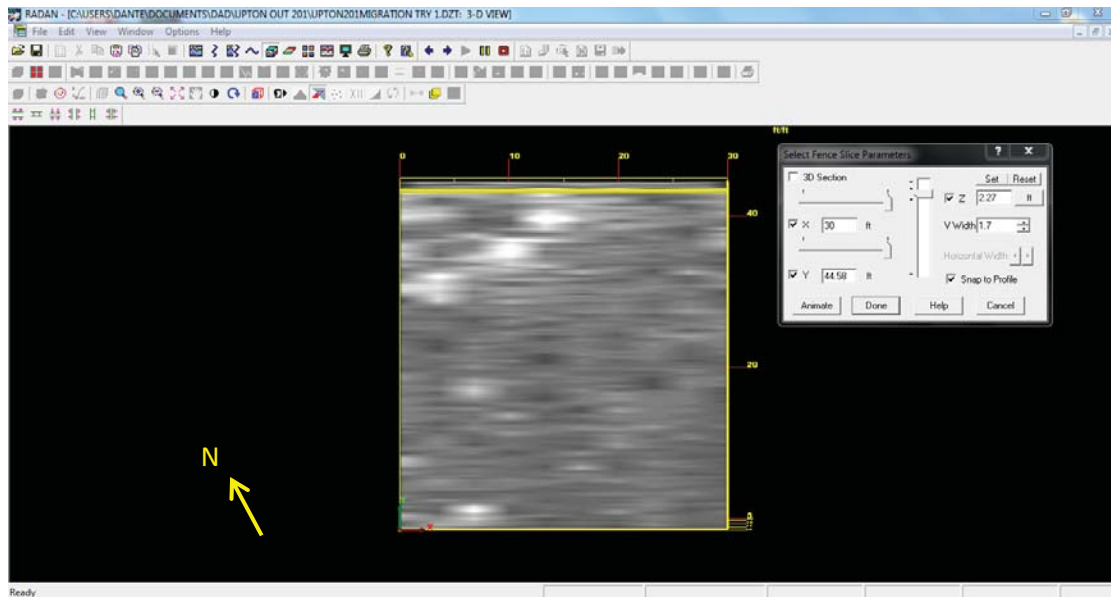


Fig 7

Planar view of 200MHz depth represented 1.5 to 2.5 ft. (RADAN Software)

The light grey and white areas are highlighting the greatest difference in the measurements of the two-way travel time as it is collected by the receiving antenna. The depth conversion between 1.5 and 2.5ft in Fig. 7 begins to show the difference in the dielectric in the north-west corner, (the Chamber location), and the rest of the collection grid. If this same slice is made into a 3-D visualization, the relative depth and relationship to the full data set is seen (Fig. 8). This has been converted into the software GPR Slice designed by Dean Goodman and was submitted by Kent Schneider.

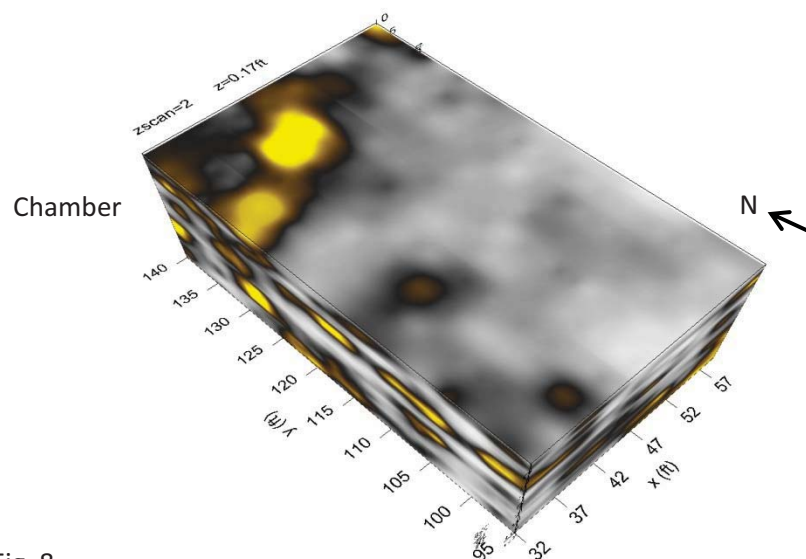


Fig. 8

As the depth is increased the next image shows a slice of the data also calculated in nanoseconds or the recording of the two-way travel time. Here, in Fig. 9, the depth of 4-5ft shows the contrast of the chamber walls with surrounding soil and the beginning of an anomaly south of the Chamber location.

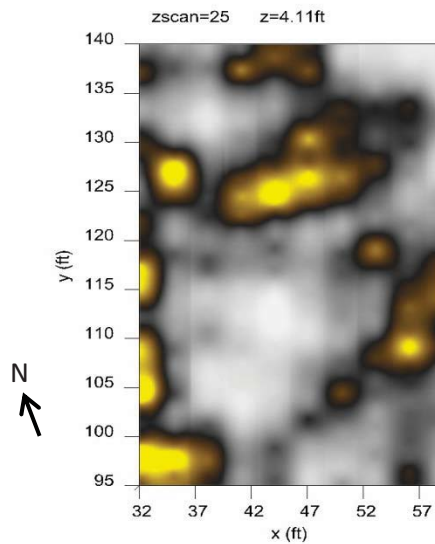


Fig 9

Planar view of 4-5 ft. collected with 200 MHz antenna

Finally, at 10-11 ft. the data slice produces these outputs Fig 10 and Fig 11 in planar view.

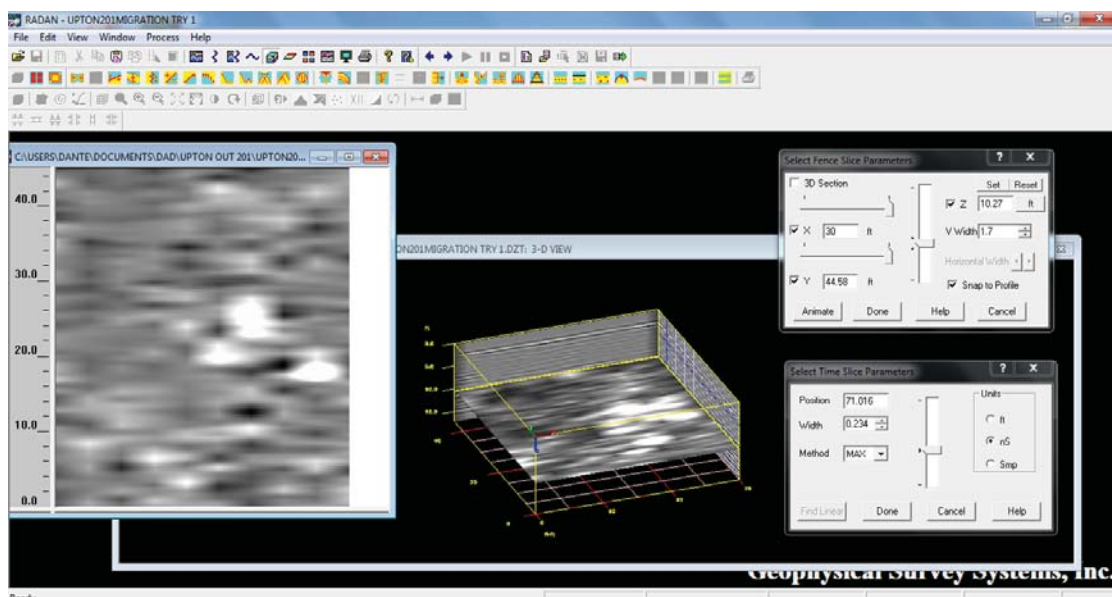
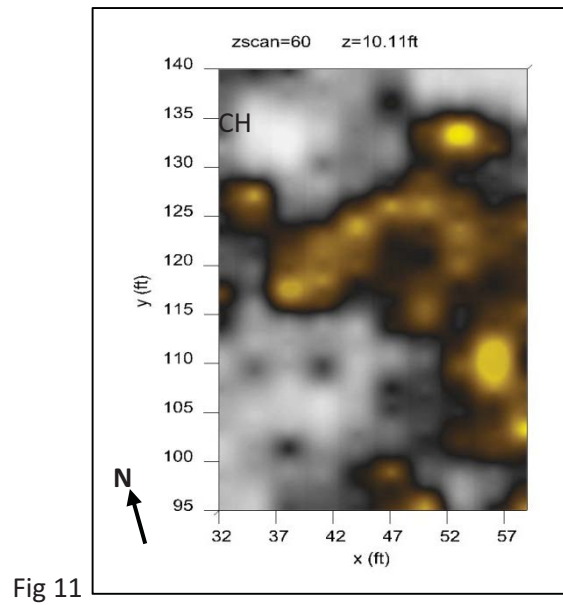


Fig 10



Depth represented 10-11 ft. Approximate Chamber location CH.

The depth slice at 10 – 11 ft. has highlighted another area where the Relative Dielectric Permittivity is different than the surrounding area and changing the two-way travel time back to the receiving antenna.

It could be noted here that water has a very high Dielectric of 81 (also termed Relative Permittivity) and because the depth is at 10-11ft., it is suggested that this could be a saturated soil area or a signal for bedrock. There was no signal difference of this area in the first 9 ft. of depth slices and no change from the surrounding area to suggest that the material changes occurred before that depth. Any fill on top or disruption of the soil above this area would have had a specific signature to offset it from the nearby soil material. This would lead to the conclusion that the material composition that is highlighted at 10ft. by the 200 MHz is natural and has been undisturbed. The question of bedrock or glacial till is of interest here. The bedrock in the area is of lower quality meaning it tends to shatter and break apart randomly rather than to fracture in a specified line. Also, it has poor access for quarrying in contrast to glacial rock deposited on the site at or near the surface (Smith, A. 2011). At a depth of 10 ft. this would make bedrock removal difficult at best and not as desirable for construction use, which leads to the likelihood of these anomalies being natural glacial till deposit with high moisture content. If any human disturbance and or influence were to be suggested at this depth more soil signatures would be needed. This however would be increasingly deep for quarrying since the east side of the grid is at the base of a hillside rise in the topography on the surface.

Part 2

Shifting to the 400 MHz antenna data, the grid size is much larger, and because the antenna size makes it possible, the transect width was then reduced to 1.5 ft. (18 inches). The resolution of the data and depth slices becomes easily recognized in comparison to the 200 MHz visualization examples. The following 3-D image slices are also available on the accompanying Upton Data Disc in more detail. The surface slice is represented with consecutive deeper snapshots, with the vertical walls representing the raw GPR data.

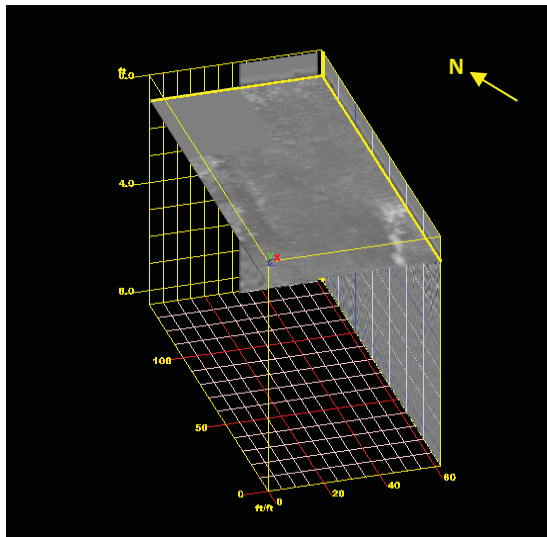


Fig 12.

Depth Represented 1.0 ft. – 2.0 ft.

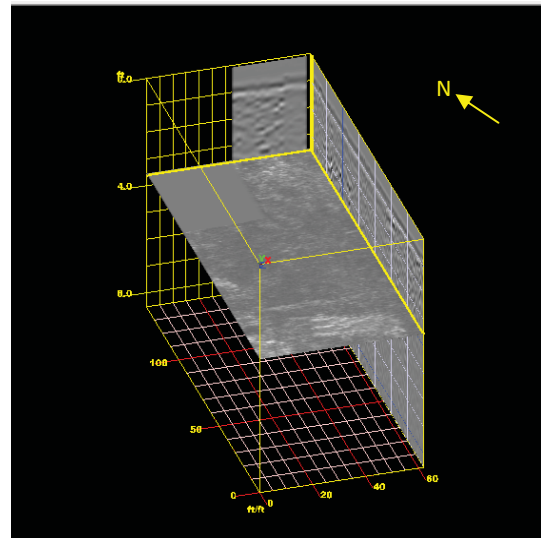


Fig 13.

Depth Represented 3.0 ft. – 4.0 ft.

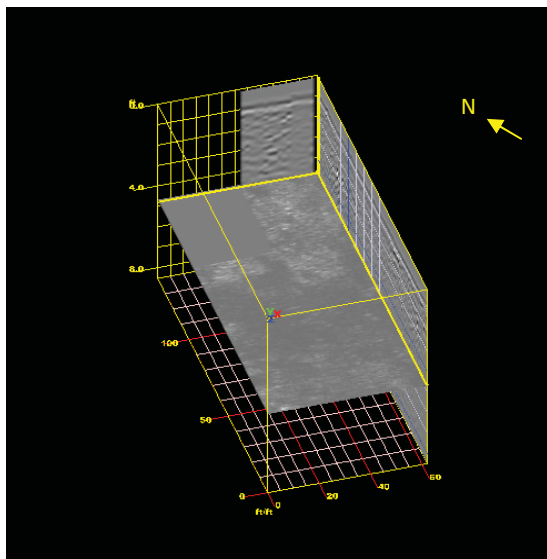


Fig 14.

Depth Represented 4.8 ft. – 5.5 ft.

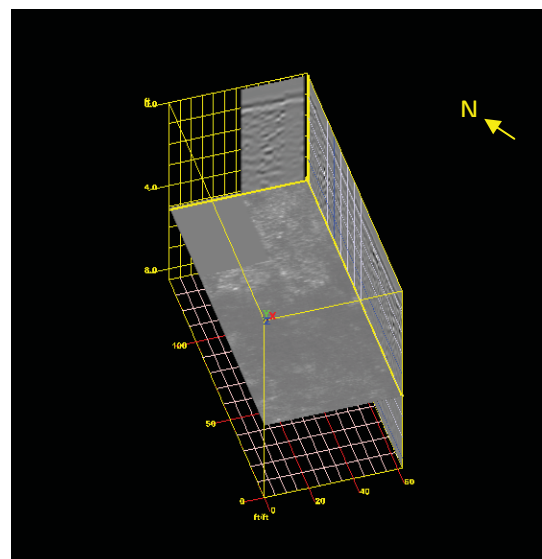
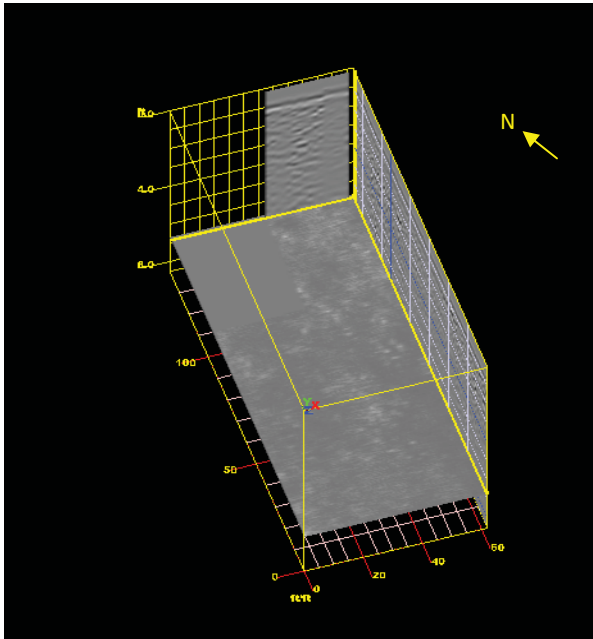


Fig 15.

Depth Represented 5.0 ft. – 6.0 ft.

Fig 16. Max Depth Represented 8.0 ft. – 9.0 ft.



The application of the 400 MHz antenna results in the maximum depth of 8-9 Ft. The resolution however, allows for clearer observation of the anomalies in the ground and even possible shapes. For example, the southern section of the grid in Fig. 13 (also Fig 17) which is displaying a depth of 3.0 ft. to 4.0 ft. appears to reveal a linear feature made of three equally spaced pipe-like structures. Applying what we know is the back of the former house site, and the ideal depth for water piping in freezing zones, it leads to the conclusion that these are part of the house drainage design. These may represent water pipes or buried septic leaching field PVC drainage pipes.

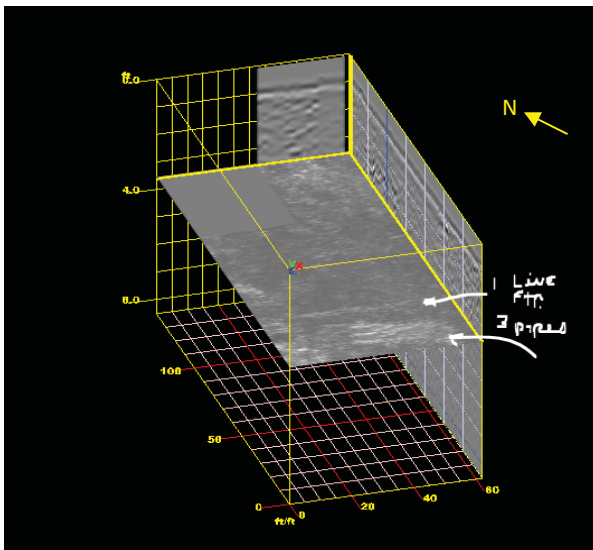


Fig. 17 Three linear features equally spaced 3-4 ft. depth

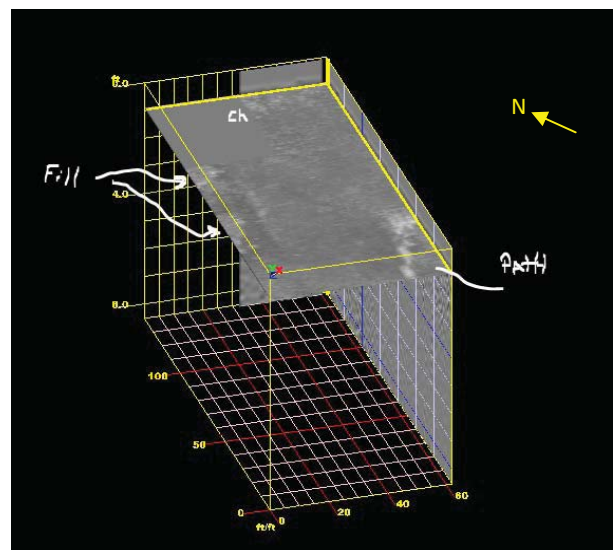
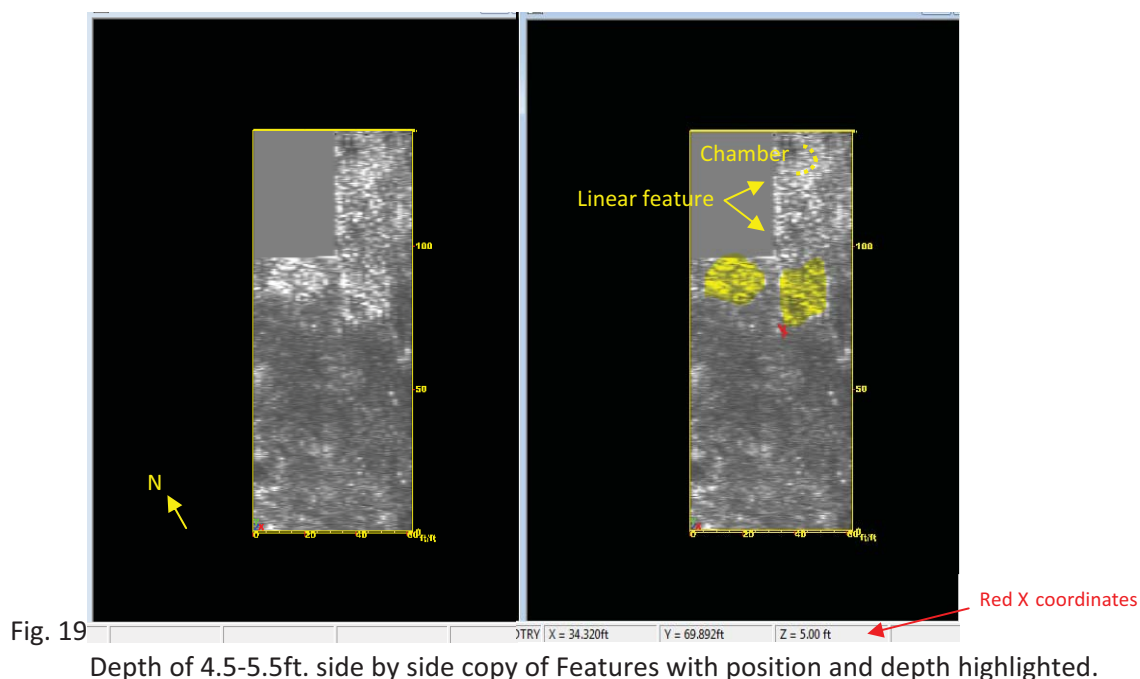


Fig. 18 Top of grid showing worn path and cement as well as possible fill areas on hillside. The chamber entrance location is marked (CH).

Fig. 14 and Fig. 15 are capturing a rectangular anomaly in the 4.8 ft. to 6.0 ft. depth. The feature may have a quadrangular edge possibly outlining a wall of the soil where stone was removed or alternately where stone was positioned. The size of each linear contrast is approximately 16.5 ft. on the three most visible sides. In each case, the Ground Penetrating Radar is recording a different signature of the highlighted material versus the surrounding material. Secondly, it disappears after the 6.5 ft. mark and this may be a result of attenuation and signal refraction and/or scattering (Watters, M. 2007). In Fig. 19, the same data is viewed in a planar or top-view with an adjusted value for the gain resulting in a higher contrast.

This depth holds the greatest potential for discovery of a buried wall or other stonework. The two areas highlighted in Fig. 19 are approximately 15-17 ft. on edge. The data along the edge of the transect running along the uncollected northwest grid corner appears to hold a linear feature and could possibly be a buried wall.



The depth of this feature is more specific than the Chamber, which exhibits a noticeable reflection in the first foot of depth recording slices. The Chamber in addition is visible in subsequent depths due to partial signal reflections from stone, partly traces getting through the stone ceiling, and finally partial radar measurements coming into contact with the water in the Chamber floor which is at a depth of 10-12 ft. from the ground surface above (See Conyers, Lawrence B. 2004 for moisture effects in GPR data).

Rather, the feature that appears in Fig 14, Fig. 15, and Fig. 19 with rectangular edge may have a human origin or influence and further investigation would be needed for decisive conclusions. The visual aspect is limited in these snapshots, for further investigations please refer to Data Disc RADAN Movie files.

Part 3

The final data collection performed for use in remote sensing discovery is the Magnetometry Data.

Please refer to the grid layout in Fig. 4 and the Project Theory of Magnetometry on page 5 for this section.

Magnetometer data does not allow for depth calculations but the display has several processing options and choices for visualization. The software package MagMap 2000 designed by GEOMETRICS is the first consolidation of the data where errors are detected and removed, and the data can be seen in visual form. The grid layout is matched with the data and odd numbered transects are flipped for processing. The following screen shot Fig. 20 displays the first look of the magnetic properties of the soil.

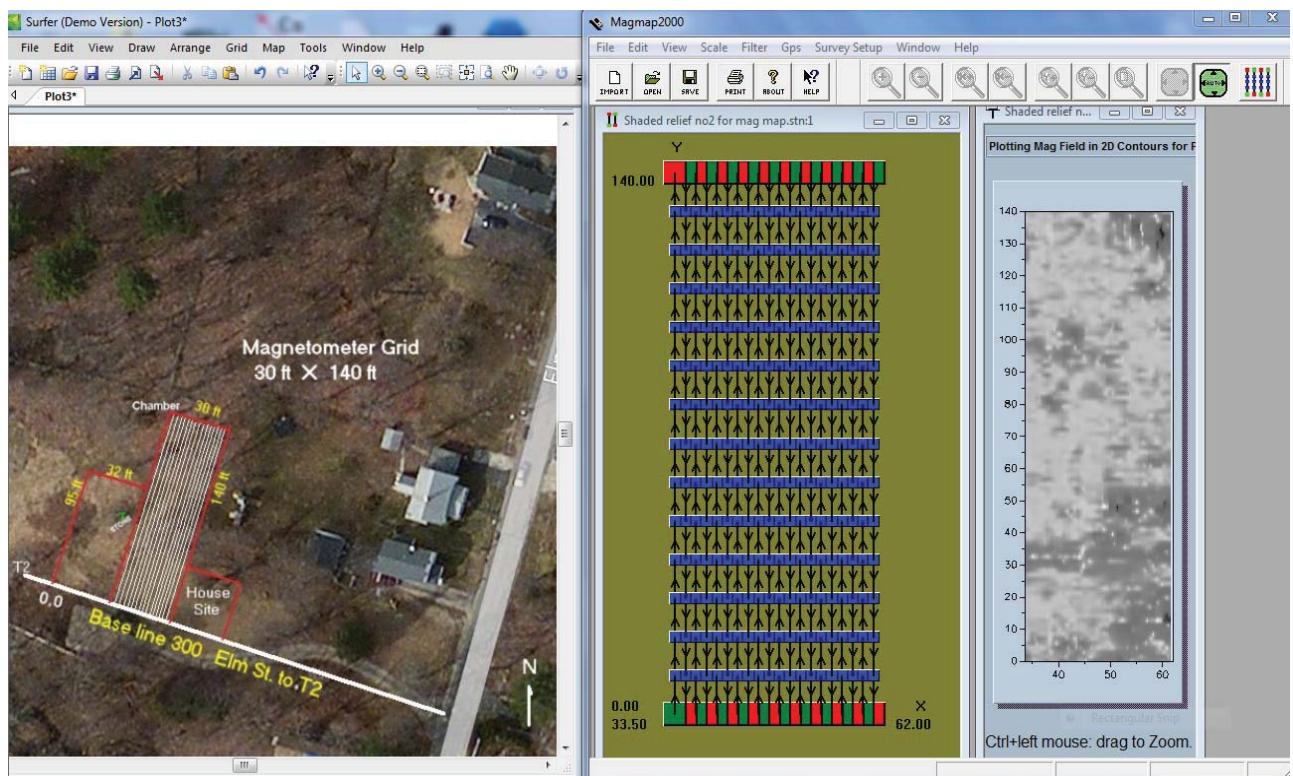


Fig 20.

Initial Grid

MagMap Grid

Grey-scale Data

The dark areas in the Grey-Scale Data are noted for higher readings from the gradient cesium sensors. This is the result of the sensors having a change in the magnetic field measurement or in the case of the gradient the largest change in the material composition of the soil. The lower right or the back side of the house exhibits most of the higher readings. The possibility of an iron or ceramic pipe exiting the house is highly likely. The long pipe that runs linearly at the 30 ft. mark may also be a drainage pipe or similar structure.

In the upper north east corner, during the pre-walk of the site, revealed a small modern ball of concrete mix with a foot of rebar imbedded into it. This was removed out of the grid, but the possibility remains that more existed. There were no more visible (Iron rebar) reinforcement bar pieces seen. Also, the rear of the chamber has higher readings than the surrounding soil which may be influenced by the spike in the data from the dark black display. If we view the data with several other methods, the size and location become clearer.

In Fig 21,

We have the simple black and white grid to the left with the highest values shown with black contour lines where large inclines in contour lines, detail pronounced inclines in the data collected.

The second representation in color designates areas or contours within a range of the data values. Each range is given a different shade and contour. These readings can highlight regions in the data that stand out. This method directs the interpretation toward the anomalies in the soil. This is the most basic of the models in that it highlights the extremes. However, as we see in the following models the use of a greater range of color employed with smaller data value separation can highlight more subtle changes in the data.

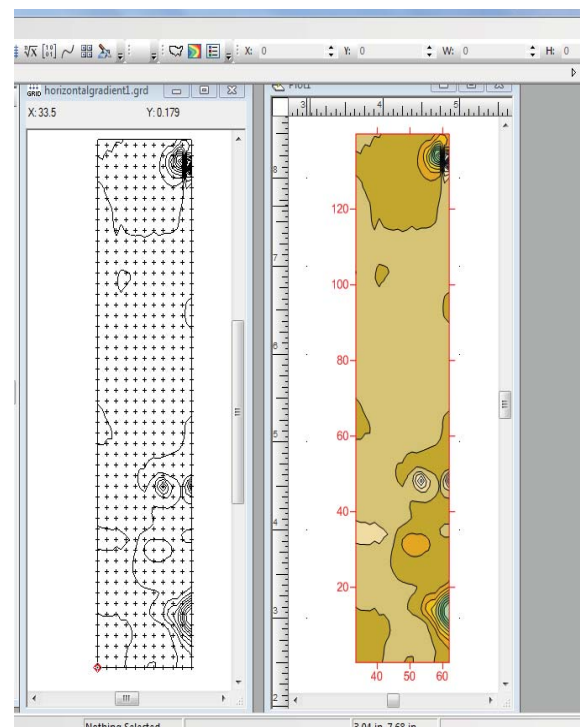


Fig 21. Data Comparison

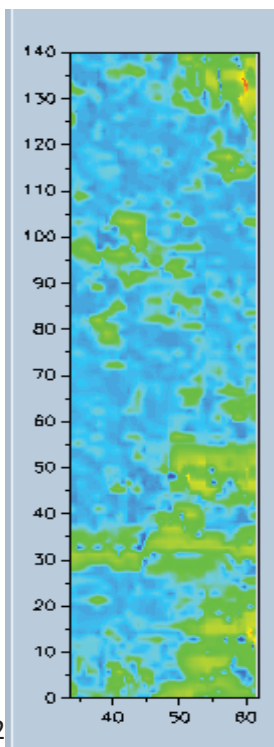


Fig. 22

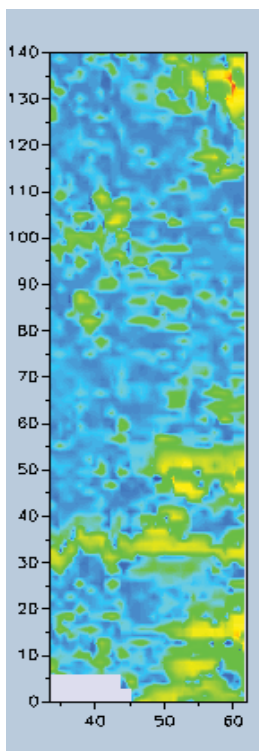


Fig. 23

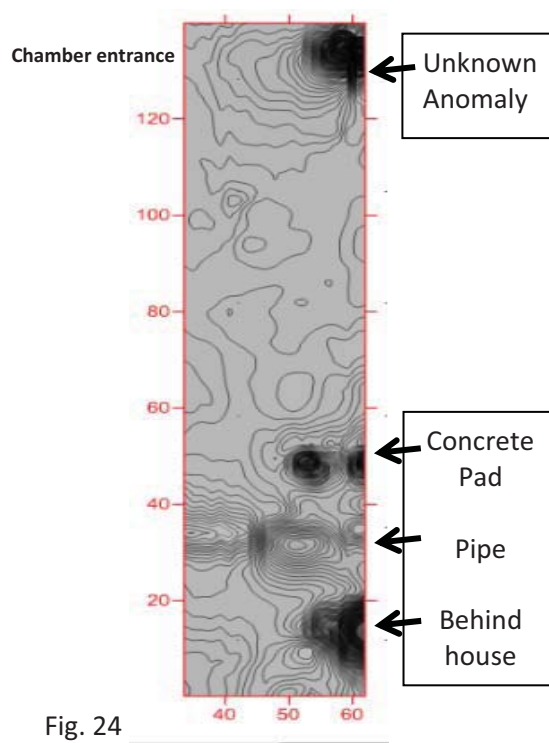


Fig. 24

In the three figures (Fig22-24) all representing the same grid, the common elements that are graphically highlighted show the most notable features as, the adjacent house area and the upper north east corner. The rear of the house may have either iron pipe or ceramic pipe running east-west at or near the 30 ft. grid mark. The two areas on either side of the linear feature would seem to line up with a surface gravel cement area near the 45 ft. mark and underneath the path which is highlighted in the GPR sensing section.

Fig 23 is an attempt to align the linear feature (pipe shape) to see if an offset would either reveal other notable shapes or call attention to a shift in the data of several feet along the first several transects. In either case, the effect is successful but minimal on the rest of the grid.

The dilemma around the upper corner is what the effect of perhaps a medium size rebar or modern ferrous compound has on the rest of the nearby data. It is not clear if the area directly behind the Chamber has a continuous higher reading or if it is the side effect of this large spike in the data. To review and reiterate, a surface rebar was found loose on the surface during branch cleanup. However, after closer examination no further modern artifacts were noticed.

The small pile of stones on the surface in the area of this high reading would seem to match the data in location. Any further opinions would be just conjecture. The elements of remote sensing are to utilize the existing technologies for efficient location and material characteristics. The nature of absolutes can only be found with the actual excavation by archaeology.

Upton Chamber

Satellite Imagery

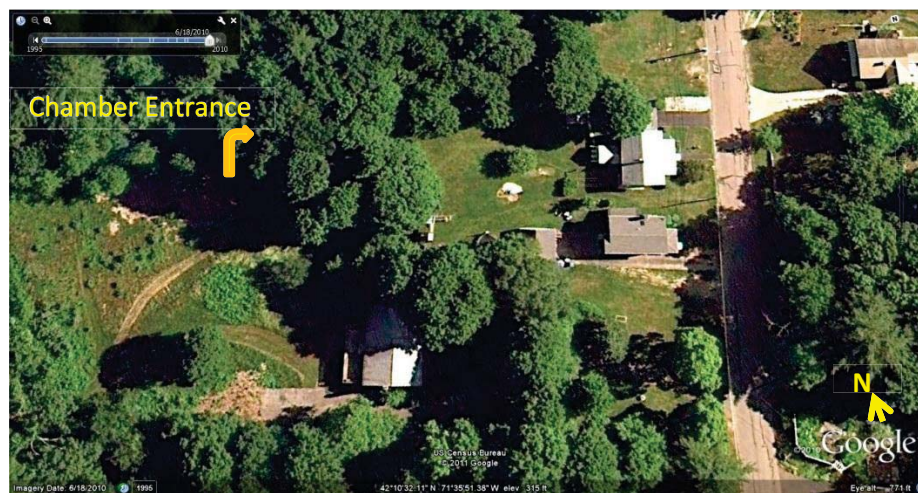


Fig. 25 4/9/2008 USGS Maps using Google software (Image Sat1)

Fig. 26 6/18/2010 USGS Maps using Google software (Image Sat2)

In these satellite photos (Sat1,Sat2), we can see the changes in the landscape and the local uses in just two years. The house that was razed (2010/11) is centered with several cars parked alongside. The changes in utilization of this parcel can also be seen in the pathways in the left of the image or to the west side of the house property. While seasonal information can also yield unique perspectives, the human induced changes are evident here, and in the 2011 satellite images (Below; Sat 4) will show land clearing, new pathways and new ownership. The following image (Sat3) was taken at a similar spring-season time as in the above 2008 photo (Sat1). This early spring image taken March 28, 1995 can be used for comparison over a sixteen year period.



Fig. 27 3/1995 USGS survey (Google software) (Image Sat.3)

The center shows the extent seen in the more recent photos. Very apparent is the offset of the house from Elm Street in comparison to nearby residences and the proximity to the Mill Pond showing the important relationship with the marsh and water to the west. Also, pathways and worn areas appear to

differ from the later photos. Here, in this close-up of the same satellite photo there appears to be a vegetation edge or tree line heading directly north (see yellow arrow.) This may have a correlation to the 400MHz GPR Data where the swath and angle line up with the anomalies in white Fig. 28

3/1995 USGS survey (Google software) (Image Sat.3 zoom-in)

Fig. 28



Dotted line represents GPR grid location

GPR 400 MHz 2.5 ft. -3.5 ft.

The dotted line represents the grid for the 400 MHz GPR reading on the right in Fig. 28. The north east corner in the satellite photo from 1995 appears to have a surface feature that runs along the same axis as the northeast corner of the GPR Data. The data represents a depth of 2.5 ft. – 3.5 ft. Possible connections might be the root masses growing and decaying over a period of time and the redirection of the water table from this growth and

decay. It runs close to the back of the Chamber Wall but shows little structural evidence. While any conclusions are beyond the GPR data as it is presented, there is little to suggest a link in the 400 MHz data to the deepest part of the Chamber (x=40, y=135) and tunneling (x=45-50, y=135).

Finally, the most recent photo (Image Sat4) illustrates the impact of recent uses of the land. Most notably the house has been taken down.



Fig. 29 (Image Sat4, 4- 2011 Bing Software)

The topsoil shows areas where disturbance and redistributed soil has covered previous pathways. New worn marks are evident in different areas as compared to earlier photos. The worn pathways are no longer evident. Many of these changes are obvious to those that frequent the site. Individuals can recall the recent removal of the house and can remember the swamp or lower elevation on the west of the property before fill was added. These are memories freshly etched into the record.

It may be, that in the more distant colonial past, individuals would have readily recalled past uses of the landscape in a similar way. Local townspeople might have been readily available to relay a story or an experience with the stone walls and structure. The recent changes may have come at a more rapid pace as we see in these images. Yet it would lead one to conclude that changes over the decades were in both vegetation and human impact, natural and man induced.

We can use remote sensing to capture changes in the landscape. Here photos taken at different times of the year, several years apart, are able to highlight major impacts on the local landscape. For future research, the recording of these changes will both clarify and assist researchers in the site interpretation and management. How we see the landscape can be enhanced by different perspectives.



Fig. 30 Aerial Photo Nov. 4, 1938. Location of Mill Pond and tree line near Chamber Property prior to backyard fill episode (yellow).

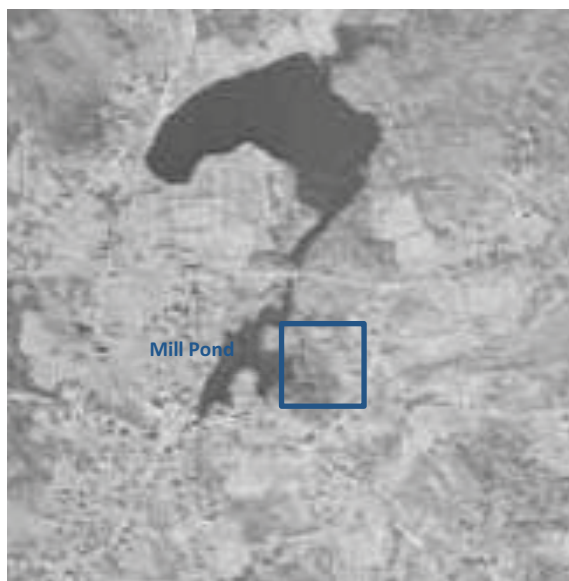


Fig. 31 Nov. 4, 1938 Aerial USGS

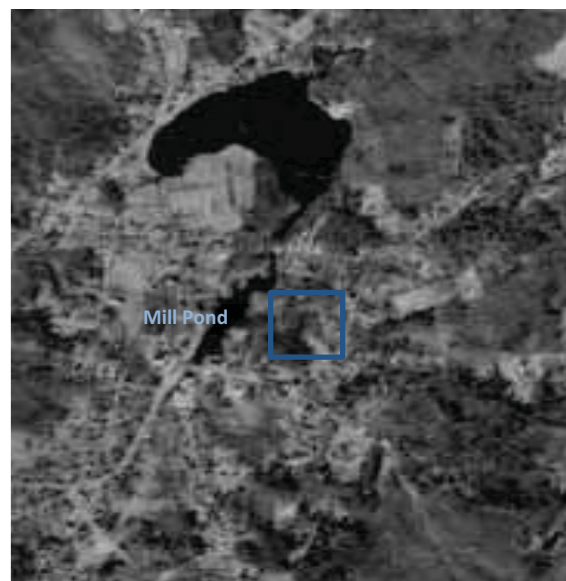


Fig. 32 Dec. 1, 1967 Aerial USGS

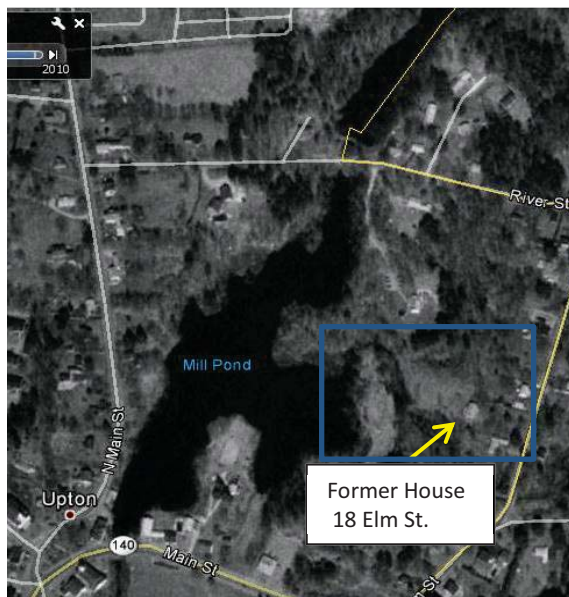


Fig. 33 1995 Satellite USGS



Fig. 34 2008 Satellite USGS

Note the changes in the Mill Pond, the vegetation and wetland aspects in the comparison of these aerial photos and satellite photos. The extent of the wetland into the present backyard can be seen by evaluating the Nov. 4, 1938 aerial photo in Fig. 31. The darker shade of growth is cleared in the 1995 photo (Fig. 33).

This would coincide with the fill brought in to extend the backyard and block the range of wetlands in the decades between 1967 and 1995.

In the 2008 photo, growth has resumed with increased tree cover, pollen in the water and vegetation effecting the open area and Mill Pond. Trees may have replaced wetland plants.

The change in the wetlands may have had an adverse effect on the water table by redistributing the flow. This would account for the increase in water into the Chamber and the trapping of water around the general Chamber area.

*all four figures are aligned with north facing top of page.

By recording and comparing these perspectives researchers can identify and interpret the built environment, and the natural environment, and how it relates to the landscape over time. By understanding and conserving the landscape stakeholders in the Upton chamber preserve the cultural values. Building these values engages and creates a community.

What are values?

They are the characteristics of place, the qualities of a landscape the understanding of an object. Such as how an object was made and how it was used. Values change over time and are related to ideology. They reflect cultural, scientific, economic thinking, and they reflect the time in which they are formulated. They can be subjective and contextual and can depend upon opinions. Any place or object can have multiple values, held with differing scales of conviction, as interpreted by different people. They can be tangible like stone or intangible as in the presence of light, particular memories, or a special ambiance. They might inspire spiritual or social functions or have aesthetic qualities which help invigorate artistic creativity (Burra Charter 1979).

Upton Chamber

Photo comparisons showing rock slide, vegetation change, and top soil deposition

Part 1 Seven Year Comparison



<http://strangene.com/ancient/upton.3.jpg> (Photo Ch1)

Nov/16/08 <http://stoneruins.cellarwalls.com/#15.3> (Photo Ch2)

9/20/2011 Gutbrod (Photo Ch3) Fig. 37

2003-2005 (Fig. 35)

C W Pittman (Fig. 36)

The change of the opening of the Upton, Chamber as compared with these three photographs is evident. The most obvious movement is of the large boulder in the 2003 photo (1) where it was originally on the hillside left. It then moves slightly downward in this 2008 photo (2). By the most recent photo (3), it has taken a commanding location at the front of the chamber. The angle of the top lintel is more difficult to ascertain whether its angle has shifted down during the period due to water seepage and rock movement. Or, the tree growth is forcing the right side to shift up to create more space for growing roots. Note the surface change in small tree growth and brush in Photo 1 to a small plant ground cover in Photo 3. Spot clearing of the site since the town purchased the land was done in the last year and perhaps increased foot traffic as well as seasonal growth would account for some of these changes. Finally, this side by side method would be useful over the entire photographic period of the site.

Part 2 Sixty-Five Year Comparison

Here, we have photographs spanning **65 years**. The wall changes are seen on both sides as well as on top of the entrance lintel. The photo from 1946 shows a large boulder on top of the lintel that has fallen and been moved by the middle photo (See arrow A).



Goodwin, W.B. (1946) (Photo Ch4)

1950 Photo sub. by C. Taylor 2011 (Photo Ch5)

Present Restoration Nov. 2011 Gutbrod (Photo Ch6)

The long stone (see arrow B), and behind the stadia rod in the middle photo, is the same stone in all three photos above (Chamber Photo 1, 2, 3) that is projecting out. It doesn't appear to have been under the lintel, but was a buttress for the stone behind which supported the lintel. The two "twin" stones above this long stone (above arrow B) are also no longer in the framework by 1950.

While we are not sure if the well-dressed woman is standing in or near water, the drainage continues to be an issue concerning both the movement of the stone and the safety of the walls. In just a 24 hour period of pumping the chamber to facilitate archaeological recovery before restoration could take place, the water had changed to a silty wash. This is attributed to new channels of water seepage between the stones and bringing the soil from higher elevation and above and behind the stonework into the chamber floor. A more detailed study of the effects of water drainage should be addressed before changing the water flow or drainage.

Conclusion and Recommendation

The following quote was written in to the Burra Charter 1979. The Charter has been adopted by the International Council of Monuments and Sites (ICOMOS).

Why conserve?

Places of cultural significance enrich people's lives, often providing a deep and inspirational sense of connection to community and landscape, to the past and to lived experiences. They are historical records, that are important as tangible expressions of identity and experience. Places of cultural significance reflect the diversity of our communities, telling us about who we are and the past that has formed us and the landscape. They are irreplaceable and precious. These places of cultural significance must be conserved for present and future generations.

The Burra Charter advocates a cautious approach to change: do as much as necessary to care for the place and to make it useable, but otherwise change it as little as possible so that its cultural significance is retained.

In the next section, the International preservation community has developed a guideline which the author does not attempt to improve upon and should be the basis for every future consideration for the property at 18 Elm St.

The following articles are the most relevant to the Upton Chamber Property.

Adapted from The Burra Charter 1979, revised 1999.

Article 1. Definitions

- 1.1 **Place** means site, area, land, landscape, building or other work, group of buildings or other works, and may include components, contents, spaces and views. This may include memorials, trees, gardens, and parks, places of historical events, urban areas, towns, industrial places, archaeological sites and spiritual places.
- 1.2 **Cultural significance** means aesthetic, historic, scientific, social or spiritual value for past, present or future generations. Cultural significance is embodied in the *place* itself, its *fabric*, *setting*, *use*, *associations*, *meanings*, records, *related places* and *related objects*. Places may have a range of values for different individuals or groups. The term cultural significance is synonymous with heritage significance and cultural heritage value. Cultural significance may change as a result of the continuing history of the place. Understanding of cultural significance may change as a result of new information.
- 1.3 **Fabric** means all the physical material of the *place* including components, fixtures, contents, and objects. Fabric includes building interiors and subsurface remains, as well as excavated material. Fabric may define spaces and these may be important elements of the significance of the place.
- 1.4 **Conservation** means all the processes of looking after a *place* so as to retain its *cultural significance*.
- 1.5 **Maintenance** means the continuous protective care of the *fabric* and *setting* of a *place*, and is to be distinguished from repair. Repair involves restoration or reconstruction.

- 1.6 **Preservation** means maintaining the *fabric* of a *place* in its existing state and retarding deterioration.
- 1.7 **Restoration** means returning the existing fabric of a place to a known earlier state by removing accretions or by reassembling existing components without the introduction of new material.
- 1.8 **Reconstruction** means returning a place to a known earlier state and is distinguished from restoration by the introduction of new material into the fabric.
- 1.9 **Adaptation** means modifying a *place* to suit the existing use or a proposed use.
- 1.10 **Use** means the functions of a place, as well as the activities and practices that may occur at the place.
- 1.11 **Compatible** use means a use which respects the *cultural significance* of a *place*. Such a use involves no, or minimal, impact on cultural significance.
- 1.12 **Setting** means the area around a *place*, which may include the visual catchment.
- 1.13 **Related place** means a place that contributes to the *cultural significance* of another place.
- 1.14 **Related object** means an object that contributes to the *cultural significance* of a *place* but is not at the place.
- 1.15 **Associations** mean the special connections that exist between people and a *place*. Associations may include social or spiritual values and cultural responsibilities for a place.
- 1.16 **Meanings** denote what a *place* signifies, indicates, evokes or expresses. Meanings generally relate to intangible aspects such as symbolic qualities and memories.
- 1.17 **Interpretation** means all the ways of presenting the *cultural significance* of a *place*.

Article 2. Conservation and management

- 2.1 Places of cultural significance should be conserved.
- 2.2 The aim of conservation is to retain the cultural significance of a place.
- 2.3 Conservation is an integral part of good management of places of cultural significance.
- 2.4 Places of cultural significance should be safeguarded and not put at risk or left in a vulnerable state.

Article 3. Cautious approach

- 3.1 Conservation is based on a respect for the existing fabric, use, associations and meanings. It requires a cautious approach of changing as much as necessary but as little as possible. The traces of additions, alterations and earlier treatments to the *Fabric* of a place are evidence of its history and uses which may be part of its significance. Conservation action should assist and not impede their understanding.
- 3.2 Changes to a place should not distort the physical or other evidence it provides, nor be based on conjecture.

Article 4. Knowledge, skills and techniques

- 4.1 Conservation should make use of all the knowledge, skills and disciplines which can contribute to the study and care

of the place.

4.2 Traditional techniques and materials are preferred for the conservation of significant fabric. In some circumstances modern techniques and materials which offer substantial conservation benefits may be appropriate. The use of modern materials and techniques must be supported by firm scientific evidence or by a body of experience.

Article 5. Values

5.1 Conservation of a place should identify and take into consideration all aspects of cultural and natural significance without unwarranted emphasis on any one value at the expense of others.

Article 6. Burra Charter process

6.1 The cultural significance of a place and other issues affecting its future are best understood by a sequence of collecting and analyzing information before making decisions. Understanding cultural significance comes first, then development of policy and finally management of the place in accordance with the policy.

6.2 The policy for managing a place must be based on an understanding of its cultural significance.

Article 7. Use

7.1 Where the use of a place is of cultural significance it should be retained.

7.2 A place should have a compatible use. The policy should identify a use or combination of uses or constraints on uses that retain the cultural significance of the place. New use of a place should involve minimal change, to significant fabric and use; should respect associations and meanings; and where appropriate should provide for continuation of practices which contribute to the cultural significance of the place.

Article 8. Setting

Conservation requires the retention of an appropriate visual setting and other relationships that contribute to the cultural significance of the place. New construction, demolition, intrusions or other changes which would adversely affect the setting or relationships are not appropriate. Aspects of the visual setting may include use, siting, bulk, form, scale, character, color, texture and materials. Other relationships, such as historical connections, may contribute to interpretation, appreciation, enjoyment or experience of the place.

Article 9. Location

9.1 The physical location of a place is part of its cultural significance. A building, work or other component of a place should remain in its historical location. Relocation is generally unacceptable unless this is the sole practical means of ensuring its survival.

Article 10. Contents

Contents, fixtures and objects which contribute to the cultural significance of a place should be retained at that place. Their removal is unacceptable unless it is: the sole means of ensuring their security and preservation; on a temporary basis for treatment or exhibition; for cultural reasons; for health and safety; or to protect the place. Such contents, fixtures and objects should be returned where circumstances permit and it is culturally appropriate.

Article 11. Related places and objects

The contribution which related places and related objects make to the cultural significance of the place should be retained.

Article 12. Participation

Conservation, interpretation and management of a place should provide for the participation of people for whom the place has special associations and meanings, or who have social, spiritual or other cultural responsibilities for the place.

Article 13. Co-existence of cultural values

Co-existence of cultural values should be recognized, respected and encouraged, especially in cases where they conflict.

Article 14. Conservation processes

Conservation may, according to circumstance, include the processes of: retention or reintroduction of a use; retention of associations and meanings; maintenance, preservation, restoration, reconstruction, adaptation and interpretation; and will commonly include a combination of more than one of these.

There may be circumstances where no action is required to achieve conservation.

Article 15. Change

15.1 Change may be necessary to retain cultural significance, but is undesirable where it reduces cultural significance.

The amount of change to a place should be guided by the cultural significance of the place and its appropriate interpretation. When change is being considered, a range of options should be explored to seek the option which minimizes the reduction of cultural significance.

15.2 Changes which reduce cultural significance should be reversible, and be reversed when circumstances permit.

Reversible changes should be considered temporary. Non-reversible change should only be used as a last resort and should not prevent future conservation action.

15.3 Demolition of significant fabric of a place is generally not acceptable. However, in some cases minor demolition may be appropriate as part of conservation. Removed significant fabric should be reinstated when circumstances permit.

15.4 The contributions of all aspects of cultural significance of a place should be respected. If a place includes fabric, uses, associations or meanings of different periods, or different aspects of cultural significance, emphasizing or interpreting one

period or aspect at the expense of another can only be justified when what is left out, removed or diminished is of slight cultural significance and that which is emphasized or interpreted is of much greater cultural significance.

(Adapted from The Burra Charter 1979, revised 1999).

The basic building blocks put forth above by the International Council on Monuments and Sites should be the backbone for all future decisions regarding The Chamber Property at 18 Elm St.

Articles 3, 11, and 13 should be especially noted.

First, Article 11 is relevant to the Upton Property because of the relationship proposed in several earlier studies regarding Pratt Hill. Also, the relationship that the property has with the nearby walls and archaeology in the neighboring property is noteworthy. These resources contribute significance to the Upton Chamber.

Second, Article 13 creates a pragmatic and fair acceptance of the difference of opinion. Conflicting values should be respected and encouraged.

Finally, Article 3 relates to the treatment of new data or evidence of the history and uses of the Upton Chamber. “Conservation action should assist and not impede the understanding” of the evidence. Yet, changes to a place should “not distort the physical or other evidence it provides, **nor be based on conjecture**”.

This is especially relevant to the remote sensing data as it is used to interpret the subsurface of the surrounding Chamber area. How to proceed with the GPR data and the anomalies it produced can be both fascinating and contentious. The further investigation using traditional archaeological methods will ultimately deplete the resource which is being studied. Chasing a feature may reveal information about the history but it may also undermine the meaning of place for many of its shareholders. Mystery and landscape has been integrated into the Chamber history and any future disruption of the ground should be carefully weighed with this in mind.

Having described these details, the following would all be possible avenues for future research.

Pursuing a Data Repository

As the data for this property has expanded, the organization and method of accessing the data is an essential component for the Heritage Management of the Property at 18 Elm St. The data consists of a century of research,

photographs, and archaeological reports. How this is stored and the associations that are created by decisions of storage can influence future research and management. The digital copies of all possible data are the initial step. Possibly creating a website or town link to this information in order to be discussed among specialists, town members and interested parties for planning. Some documents may be sensitive and should be treated with this in mind.

One vision for this organization of data would be the construction of a GIS layered map. This would allow for future researchers to compare the archaeological data with the town's topographical and water table map layers. Older maps can be digitized to the correct coordinate system and used for comparison purposes. The location of previously dug excavation units from 1955 and the recent 2011 examination could also be included. This could allow for spatial 3-d understanding of the data and lead to more informed decisions for future research.

Remote Sensing Beyond the Property Line

One intriguing result of the remote sensing project is the question of: What lies beyond? The property to the north and on the other side of the exposed stone wall that became the constraint to the north for the Data Grid's during GPR collection could answer several questions concerning the Chamber. Such as, what is the relationship of the exposed stone walls? How and when were they constructed? Is there more evidence of a colonial era structure or barn on the neighboring property?

The relatively recent and somewhat artificial property line should not be a barrier for research. Since the question of pre-European contact and even earlier land use has been suggested, this line would seem to be an artificial obstacle to be looked beyond for future research.

Depth of Features

Once "Ground Truthing" is the agreed method for continuing research and it is the consensus among all interested stakeholders, the initial recommendation would be to establish "real" depth values. This could be done in a number of ways. However, the pipe feature behind the former house site would be the least destructive for the conservation of the historic resources and give a reasonable depth conversion to be used through the GPR data.

Magnetometry anomaly

The high data reading in the north east corner east of the Chamber and beyond the extent of the "beehive" is very possibly a modern artifact that is made of iron. The spike in the data is very local in nature and was associated with other surface rebar. It would require an archaeological permit since it is disturbing the landscape and all decisions,

methods, and rationale would be essential components for the application for a permit as is outlined in Massachusetts General Laws. One of the results would be to clarify the readings around this element (x=60, y=135).

Since there is much interest in this area behind the Chamber, including several theories suggested to the author, the additional remote sensing techniques of resistivity and conductivity may enlighten research as to its characteristics. However, the data may be washed out, if this “high point” is not explored first. Therefore it is recommended that the identification of this near surface anomaly be inspected before any further remote sensing techniques are used in the northeast corner of the grid.

The readings are also suggesting an interesting peak at x=42, y=104. This coordinate is just north of the rectangular feature highlighted in Fig. 19. It may be as simple as a modern iron artifact or as enlightening as a potential buried ceramic artifact. This conjecture peaks interest but has no merit without further investigation.

Magnetometry has highlighted what is shown but also has given information on what soil signatures are absent. The significance of the low signal coming from the area above the rectangular feature highlighted in the GPR data at 4.5-6.0 ft. (Fig. 19) seems to suggest that this is not a modern structure that used nails or any iron in its formation. This would eliminate a former water well or outbuilding/shed foundation.

GPR Anomalies

1). Reasons for undertaking new exploration (Williams, T. 2005).

Knowledge, support conservation, participation and attraction

Academic gain.

Improved quality and depth of interpretations.

Gained support through additional knowledge and excitement and growing sense of value.

Site stability and water runoff management.

Active participation leading to a sense of ownership and discovery process.

2). Opposing reasons for continuing exploration.

Does research increase value?

Will results diminish the sense of place?

Future generations with better technology.

Native American and other collective beliefs in the disruption of soil and rock.

Cost.

The importance of these discussion points cannot be overemphasized. With multiple views on the management, interpretation, and land-use of the property at 18 Elm St., all voices should be heard before any site disturbance is initiated.

If further excavation is determined to be the best plan of action, the following areas for excavation could be the most productive given the GPR anomalies put forth in the data.

- 1) Depth conversion by finding the depth of the linear feature at y=30 feet running east to west behind the house. This offers the least disturbance with the most accurate depth calculation for the following recommendations (Fig. 13, 17, 20, 24). It is believed to be associated with the house and not of historic value. The result will then clarify the depth readings for the entire GPR grid.
- 2) A 3 X 12 ft. (1 X 4 meter) trench covering the area highlighted in Fig. 19. The spatial objective being the potential wall running along the transect from x=32 and y=105 to y= 120.
- 3) A second trench to also capture the feature (highlighted in yellow in Fig. 19) at x= 32 and y=75 to y=85.

Management 5 and 10 year plan

Consider a long range plan for the future of the site. This would include research, maintenance, monitoring and public outreach. This can be extensively detailed or started with a simple outline. Some issues to consider.

1. Understanding the path of rain runoff. The adverse effects of the wetlands being filled in. The utilization of aerial photos and satellite imagery gives evidence for the major changes in water runoff routes as well as how this has affected water levels within the Chamber. To insure further water damage does not undermine the integrity of the structure, a complete study of the cubic rainfall and soil storage should be considered from Elm St. to the western edge of the property.
2. Interpretive display for chamber entrance before and after. Utilizing the photos included, so the changes to the entrance can be readily understood by visitors.
3. Consultation with various interpretations and experts to represent all interested parties.
4. Creation of a site website. This can be a location for data as well as public outreach for education and research.
5. Future research directions.

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Appendix 1

Settings for the Ground Penetrating Radar Equipment SIR 3000 for Repeatability and Data Processing.

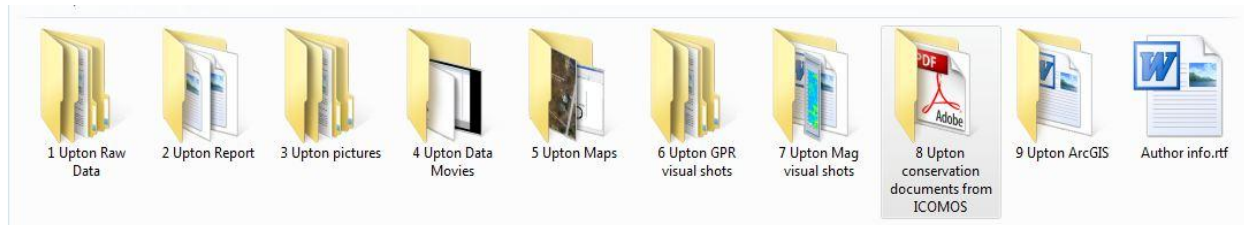
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☐  PLAYBACK		
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☐ FORMAT (bits) 16		
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☐ RATE 100		
☐ SCN/UNIT 18.00		
☐  GAIN		
☐ AUTO		
☐ POINTS 3		
☐ GP1 (dB) -10		
☐ GP2 (dB) 15		
☐ GP3 (dB) 25		
☐		
☐		
☐  POSITION		
☐ AUTO		
☐ OFFSET 25.00		
☐ SURFACE (%) 7.00		
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☐ HP_IIR 100		
☐ LP_FIR 0		
☐ HP_FIR 0		
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☐ BGR_RMV 0		
	☐  PLAYBACK	
	☐  SCAN	
	☐ DIEL 12.00	
	☐ SURFACE (%) 10.00	
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	☐ LP_FIR 0	
	☐ HP_FIR 0	
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	☐ AGC OFF	
		☐  SYSTEM
		☐  UNITS
		☐ DEPTH foot
		☐ DISTANCE foot
		☐ VSCALE depth
		☐  SETUP
		☐ RECALL
		☐ SAVE
		☐  PATH
		☐ NEW
		☐  BACKLIGHT
		☐ LEVEL 4
		☐  DATE/TIME
		☐ DATE
		☐ TIME
		☐  BATTERY
		☐ STATUS
		☐  LANGUAGE
		☐ ENGLISH
		☐  VERSION
		☐ SHOW
	☐  OUTPUT	
	☐  DISPLAY	
	☐ LINE	
	☐ C_TABLE 4	
	☐ C_XFORM 2	
	☐ GAIN (dB) 0	
	☐  TRANSFER	
	☐ PC	
	☐ FLASH	
	☐ HD	
	☐ DELETE	

Appendix U2

UPTON CHAMBER

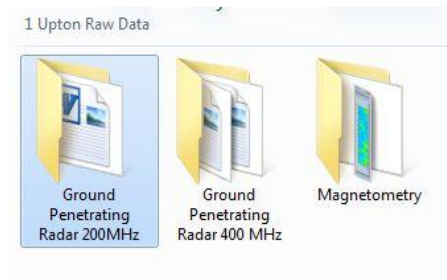
Remote Sensing Data Disc

File folders

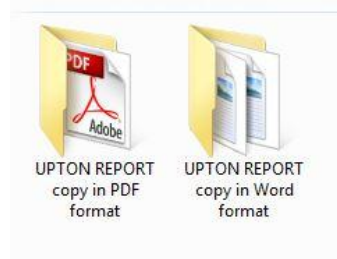


Contents of Folders

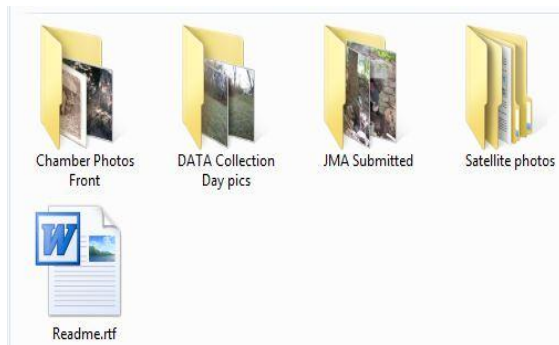
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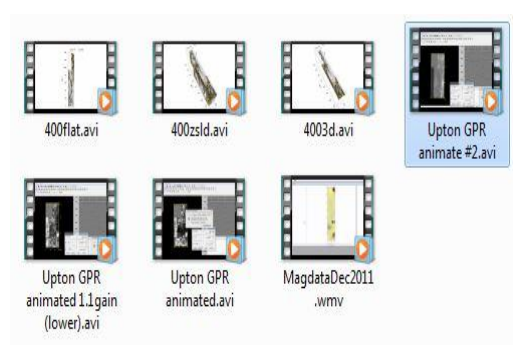
Folder 2 Upton Report



Folder 3 Upton Pictures

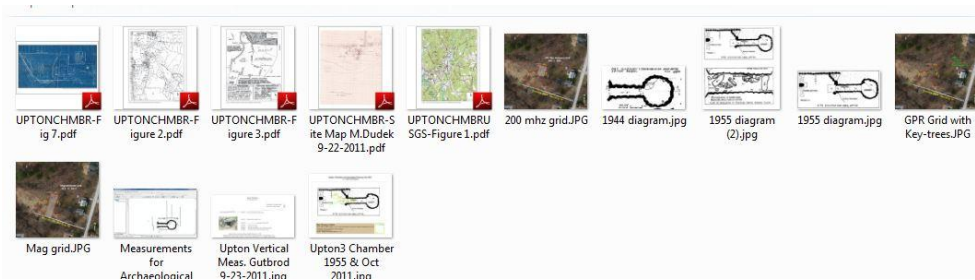


Folder 4 Upton Data Movies

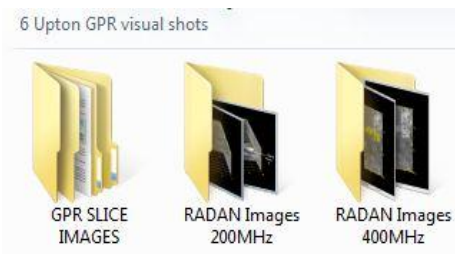


Appendix U2

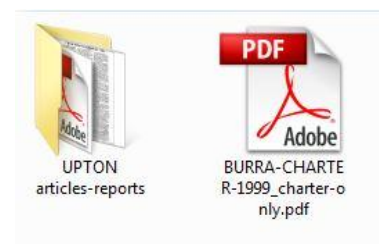
Folder 5 Maps



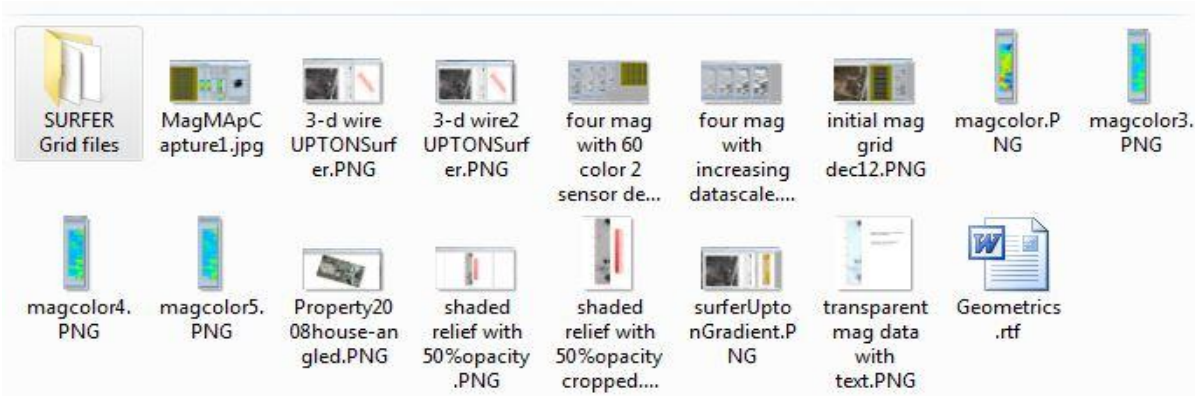
Folder 6 GPR visual shots



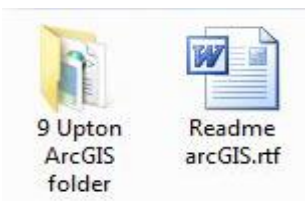
Folder 8 Upton Conservation docs



Folder 7 Upton Magnetometry Visual



Folder 9 Upton ArcGIS



Overlay of Chamber archaeology 1955 with 2011 pits added
on top of Pearson blueprints With 400 MHz data at 4.5 -5.5 ft

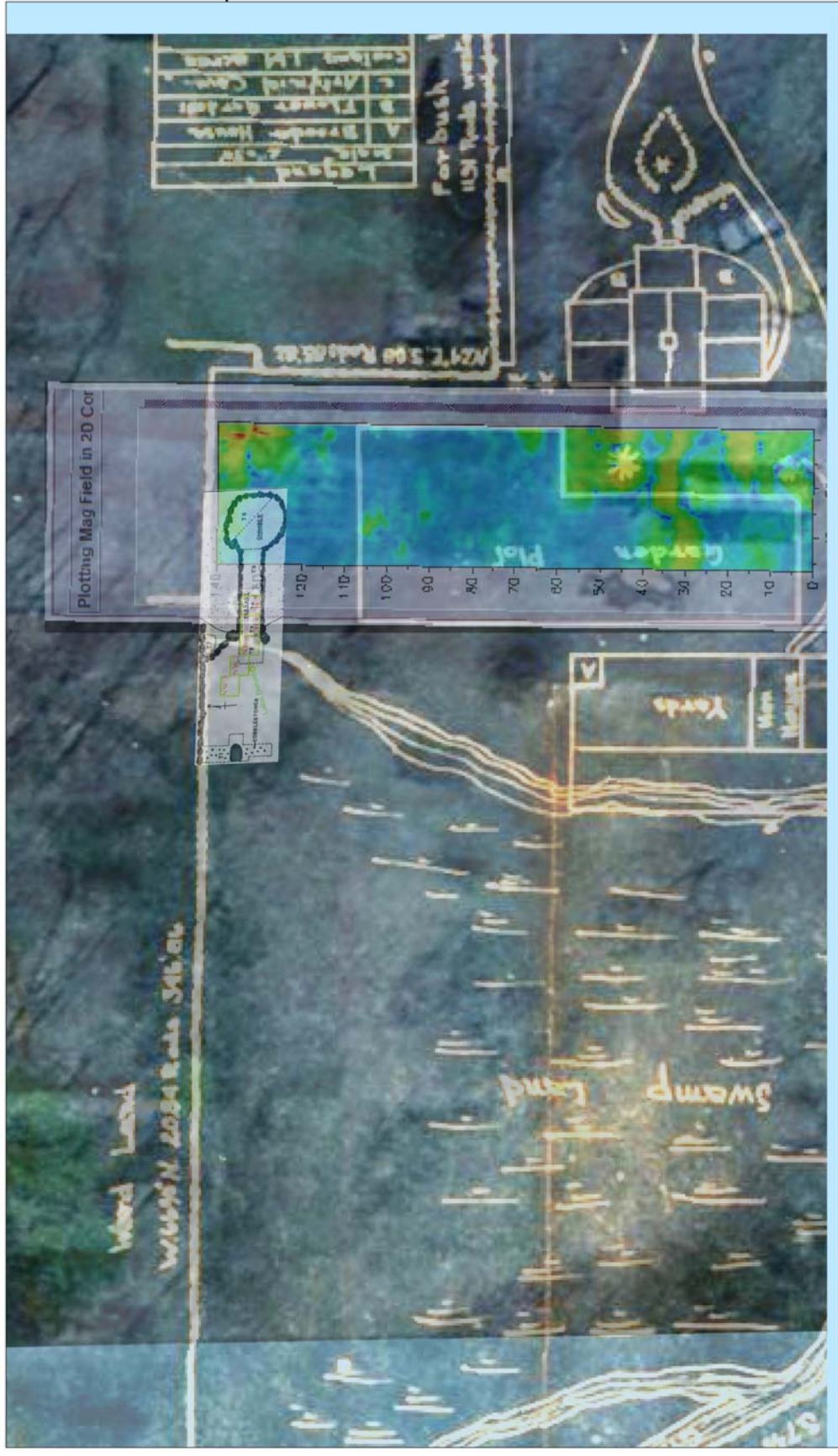


Upton chamber Remote Sensing Project 2011

Pearson blueprint (no date) of property at 18 Elm St. Upton, Ma.
John Milner Associates Archaeological site (Green) 2011
David Kelly 1955 Archaeological site map
2011 GPR data slice of 4.5-5.5 ft depth

David Gutbrod 2011

Overlay of Chamber archaeology 1955 with 2011 pits added
on top of Pearson blueprints With Magnetometry Data high values in yellow



Upton chamber Remote Sensing Project 2011

Pearson blueprint (no date) of property at 18 Elm St. Upton, Ma.
John Milner Associates Archaeological site (Green) 2011
David Kelly 1955 Archaeological site map
2011 GPR data slice of 4.5-5.5 ft depth

David Gutbrod 2011