

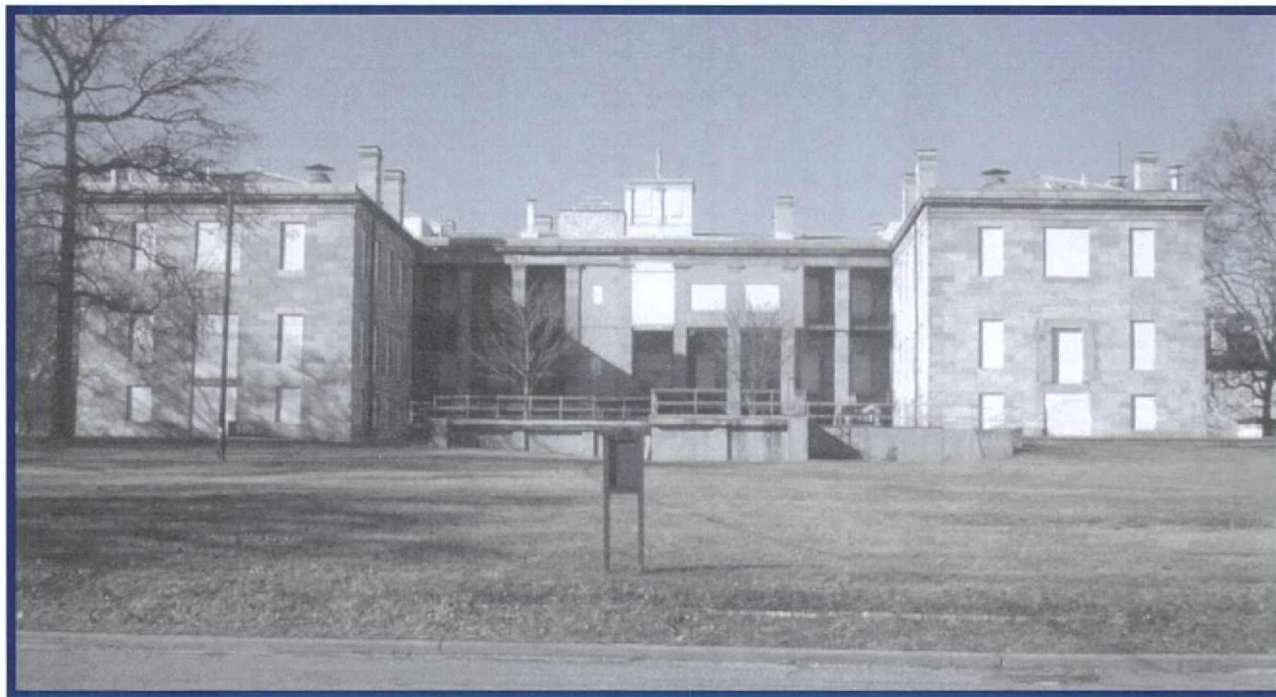
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1997

Ground-Penetrating Radar Evaluation



**Navy-Retained Section
(former) Brooklyn Navy Yard
Brooklyn, New York**

Geismar, Joan H.



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Naval Facilities Engineering Command
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Ground-penetrating Radar Evaluation

for

Navy-Retained Section (former) Brooklyn Navy Yard
Brooklyn, New York

July 1997

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Executive Summary

Archaeological field research was conducted during July 1997 at the former cemetery portion of the Navy-retained section of the former Brooklyn Navy Yard. Figure 1 (NAVSTA Brooklyn), shows the general vicinity of the project area. This research consisted of a ground-penetrating radar (GPR) test and ground proofing its results, with the intention of examining the ability of GPR to assess the subsurface characteristics of the project area.

The GPR test identified numerous subsurface anomalies. Five areas that GPR purported to contain individual or multiple anomalies, were ground proofed using a combination of mechanized soil removal and hand excavation. A possibly intact human skeleton and numerous filled shaft features were identified during ground proofing. These shaft features were devoid of intact skeletons but contained fragmentary pieces of human bone and evidence of decaying and disturbed coffins. Limited quantities of human bone were recovered from each excavation area. (The possibly intact human skeleton was encountered at a surprising, shallow elevation and was not accompanied by a noticeable shaft feature; this feature was observed and protected, but not excavated.)

Ground proofing established that GPR is capable of locating possibly intact skeletons and shaft features, but can not necessarily distinguish between the two. It also established that burials are likely to be closer to the ground surface than previously thought.

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1 Introduction

The former cemetery (hereafter referred to as the project area) is located along the eastern edge of the Navy-retained section of the former Brooklyn Navy Yard (the Navy Yard) in the Wallabout section of Brooklyn. The project area is low lying and level and is presently covered with a playing field. It is bounded to the west by a brick wall, an embankment, and a road, to the north by an embankment, a road and a former gas station, to the east by a fence and Kent Avenue, and to the south by a fence and a structure (Figure 1).

Documentary research identified the possibility of burials remaining in the project area despite a 1926 contractor's report stating that all burials had been removed. Since ground-penetrating radar has been helpful at identifying burials at historic cemetery's across the northeast, it was decided to evaluate its utility in the project area.

The present research consisted of a ground-penetrating radar (GPR) test and ground proofing its results, with the intention of examining the ability of GPR to assess the subsurface characteristics of the project area.

2 Methodology

2.1 GPR Test

Four transect lines were established for this test (Figure 2, GPR Evaluation and Ground Proofing). These lines were based on a grid with a datum point (origin point) located 26.5 feet east of the southern termination of the brick wall that defines the western edge of the project area. This wall is present on a 1936 map of the project area which shows a series of 24 piers running along its western edge. These 24 piers were checked in the field to confirm that the present wall is the one depicted in this map. A more recently constructed brick wall continues to the south.

The grid was oriented approximately 10 degrees east of magnetic north (grid north), and laid out using a hand compass and fiberglass tapes. A stake was left at the datum point to facilitate re-establishing this grid in the future if necessary. The four GPR transect lines were designated A1, A2, B1, and B2 (Figure 2). The A1 line originated at a point 10 feet north of datum and extended to a point 300 feet north of datum. The A2 line originated at the point 20/20 (20 feet east and 20 feet north) and ran grid north 280 feet. The B1 line originated at the point 0/80 and ran grid east 180 feet perpendicular to A1 and A2. The B2 line originated at the point 0/100 and ran grid east 180 feet perpendicular to A1 and A2. Surveyor's shiners sprayed with yellow paint were hammered into the ground at 20 foot intervals along these lines.

Ground-penetrating radar scans were performed along transect lines with a 500 megahertz (MHZ) antenna. Transects A1 and B2 were also scanned with a 100 MHZ antenna. Since the GPR

equipment proved successful in characterizing portions of the site, no other geophysical techniques were applied.

GPR equipment used in this test was manufactured by Geophysical Survey Systems, Inc., of North Salem, NH. Data were plotted on a PR-8300 profiling recorder. The 500 MHZ antenna was operated with a 50 nanosecond (ns) window; the 100 MHZ antenna was operated with a 200 ns window.

2.2 Ground Proofing

Ground proofing consisted of the excavation of trenches in areas where GPR anomalies were identified. Trenches were excavated through mechanized soil removal and hand excavation. A small earth moving machine, a Bobcat, with a 18 inch wide, toothed bucket on a backhoe arm was used for mechanized soil removal. An archaeologist observed all mechanized soil removal. Hand excavation involved some or all of the following equipment - shovels, trowels, hand picks, and whisk brooms, depending upon the soil type and sensitivity of the situation. The location of each trench was established based on the GPR test grid using a hand compass and fiberglass tapes.

All features were photographed and drawn by hand. Soil matrices, inclusions, and Munsell soil colors were noted and documented on drawings. All measurements were recorded in feet. Trench coordinates were recorded in relation to the site datum in the southwest corner of the project area. Depth measurements were recorded from the ground surface. A small number of soil samples were collected for future analysis if necessary. To facilitate artifact identification, on three occasions soils were screened through 1/4" hardware cloth. The few collected artifacts were placed in labeled plastic bags.

3 Chronology of Fieldwork

During the month of July 1997 four days were spent in the field. The field crew consisted of archaeologists, a GPR technician with a background in geology, a faunal specialist, and a Bobcat operator.

Monday July 7, 1997

Established survey grid and conducted GPR test.

Prior to beginning the GPR test a surveying grid was established at the project area. The GPR unit was calibrated and the antenna performance evaluated. Approximately 5 hours were spent conducting the GPR test. Approximately 10,000 square feet were surveyed using GPR.

Tuesday July 8 through Saturday July 12, 1997

Assessed GPR printouts and developed ground proofing strategy.

The GPR printouts were examined for anomalies or groups of anomalies. A ground proofing strategy was developed to verify the ability of GPR to characterize the subsurface features of the project area.

Monday July 14, 1997

Began ground proofing.

Laid out trench locations. Opened Trenches 1, 3, and 4 (Figure 2). Filled shaft features were identified in Trenches 1 and 3; a possibly intact human skeleton was identified in the north and west walls of Trench 4. Some of the Trench 4 backdirt was screened to search for human bone. This trench was backfilled at the end of the day to stabilize human remains located in the walls of the trench. A small test unit was excavated by hand into the bottom of Trench 1 to examine the sites' deeper stratigraphy. Notable features were documented by photograph and through drawings. A reassessment of GPR results was made based on these findings.

Tuesday July 15, 1997

Continued ground proofing.

Opened Trenches 2 and 5 (Figure 2). A small test unit was opened by hand in Trench 5 to investigate the possibility of an intact burial to determine if GPR could identify this kind of feature. Notable features were documented by photograph and through drawings.

Wednesday July 16, 1997

Completed ground proofing.

Expanded Trench 5. Excavated a test unit by hand in Trench 2 to investigate a shaft feature. Notable features were documented by photograph and through drawings. The Bobcat filled all trenches and the test area was cleaned up.

4 Results

4.1 GPR Test

Depending upon the frequency of the antenna used, different penetration depths were attained. The maximum penetration depth of the 500 MHZ antenna was approximately 5 feet below ground surface due in part to the clay-rich fill which impeded the GPR pulses. The maximum penetration depth of the 100 MHZ antenna was approximately 8 feet below grade. The signal was abruptly cut off below 8 feet possibly due to saline groundwater or the presence of clay-rich bottom muds in the former tidal creeks documented on historic maps for this area.

Prior to ground proofing, only five anomalies or groups of anomalies were identified in the test area. Based on documentary evidence it had been assumed that a 1 to 2 foot layer of fill postdating the removal of the cemetery, covered much of the project area. Anomalies lying within the upper 1 to 2 feet of fill were assumed to be cobbles or reflections from a buried sprinkler system or other relatively recent disturbance.

After ground proofing encountered a shallow possibly intact human skeleton, the GPR printouts were reassessed for more shallow point targets. This reassessment led to the discovery of a series of additional anomalies with very similar reflections to that of the possibly intact skeleton.

4.2 Ground Proofing

Five trenches were excavated in the project area. Figure 2 shows the location of the trenches in relation to GPR transects and the boundaries of the project area. Each trench was excavated using mechanized soil removal and augmented by hand excavation. Table 1 (Summary of Ground Proofing), provides a brief summary of the findings in each trench as well as its location, size, orientation, and deepest excavated depth. The following sections provide a more detailed description of each trench.

4.2.1 Trench 1

The first and northern most trench, Trench 1, was excavated in arbitrary 1 foot levels by the Bobcat. A very large rock measuring approximately 3 feet by 1.5 feet, was encountered at a depth of three feet about two feet south of the northern edge of the trench. While this large rock surely returned a strong signal to the GPR system, it was encountered at a depth in which evidence of substantial soil disturbance was also identified.

The upper one foot of the trench consisted of a layer of dark brown silty sand fill with numerous small pebbles and gravel, and occasional recent historic artifacts such as asphalt, glass, coal, shell, and ceramics. The second soil level consisted of two feet of very well-sorted and banded yellow brown

sand. This sand deposit was dramatically disturbed by what appeared to be two or more soil removal and filling episodes. Only two small areas of the naturally deposited sand layer remained visible in the east wall profile (Figure 3, Trench 1 - East Wall Profile). The fill material consisted of mottled, very compact, dark yellow brown to strong brown sandy clay with pockets of almost pure brown clay. From 3 to 4.5 feet below ground surface a naturally deposited layer of brown clay was encountered followed by a deposit of strong brown glacial till comprised of compact gravelly sand from 4.5 feet to 6 feet, the lowest depth of the trench.

The east wall profile revealed that two rectangular shafts had intruded upon the naturally deposited sand layer. These shaft features were associated with the former cemetery or the reported removal of the burials. The entire west wall of Trench 1 showed fill to a depth of about 3 feet below the ground surface, where the layer of brown clay began. The relationship between the fill observed in the west wall and the shafts in the east wall is unclear.

A small test unit was excavated by hand close to the northern edge of the trench. This test unit was intended to assess the deeper stratigraphy of the area. The soils removed from this unit were screened, but no artifacts were recovered.

4.2.2 Trench 2

This trench was excavated to define in plan view the shape and extent of the northern most shaft feature visible in the east wall profile of Trench 1. It was oriented perpendicular to Trench 1 and extended eastward from approximately Trench 1's midpoint. Approximately 12 inches of fill were removed from Trench 2 by the Bobcat.

Using hand tools, the trench was carefully cleaned revealing the plan of additional shaft features (Figure 4, Trench 2 - Plan View). The original shaft feature encountered in the east wall of Trench 1 extended further east than the eastern edge of Trench 2. This shaft feature also made a right angle turn northward. A second shaft feature was exposed to the south, it continued into the southern and eastern walls of the trench. At two locations, fragmented human bone was found protruding from the surface of the fill material (Figure 4). Another piece of human bone was uncovered and collected during surface scraping.

A small test unit, measuring roughly 1.5 by 2 feet, was excavated into the southwestern corner of the northern shaft feature to explore its contents (Figure 4 and Figure 5, Trench 2 Test Unit - Profile and Plan View). This test unit straddled the apparently sterile sands to the south of the feature, and the fill material of the shaft itself. This test unit was excavated to the bottom of the fill material, the top of the brown clay deposit. The screening of soils from this test unit led to the recovery of a few historic artifacts from the fill material. No artifacts were recovered from the sandy material. At the bottom of the unit, a dark stain apparently oriented west-east, with associated decaying wood and an old nail was encountered (Figure 5). This stain has been interpreted as the remains of the bottom of a coffin. A human bone fragment was visible in the north wall profile of this test unit.

4.2.3 Trench 3

Trench 3, located 50 feet south of Trench 1, was excavated by the Bobcat in arbitrary 1 foot levels to a depth of 3.5 feet. The top 10 inches of this trench were comprised of dark brown silty sand fill containing pebbles, cobbles, and occasional historic artifacts such as brick, shell, and glass. The remainder of the trench contained a natural deposit of well sorted, banded, water-deposited sands.

After excavation the trench walls were carefully cleaned using trowels. A series of 4 or 5 shaft features were exposed in the east wall profile (Figure 6, Trench 3 - East Wall Profile). The western edge of these features had been truncated by the Bobcat since they were not noticed during excavation, and did not extend into the west wall profile. Badly decomposed human bone was identified at the bottom of the northern most of these shaft features (Figure 6). The east wall of the trench was drawn and photographed. A soil sample of the fill material lying above the decomposed human bone was collected.

4.2.4 Trench 4

This was the southern most trench, located 90 feet south of Trench 1. It was excavated to investigate an anomaly tentatively interpreted as a soil interface, a plane along which the soil properties changed, located 3 feet below ground surface. After the western half of this trench had been excavated to a depth of 40 inches by the Bobcat, a concentration of bone material was noted in the northern and western wall profiles of the trench at a depth of between 15 and 19 inches below ground surface (Figure 7, Trench 4 - Plan View and Profile). Closer inspection revealed that it was a possibly intact human skeleton.

What was identified as a human radius and an ulna were observed in the western wall. Unidentified bone, a possible broken innominate, foot bones, and possible coffin nails were observed in the northern wall. All bone material was found within the upper dark yellow brown silty sand layer. A second soil level of lighter brown sands began at a depth of 19 inches below ground surface. No observable soil change or shaft feature was present around the layer of human bone. The compact fill layer encountered in the other trenches was noticeably absent in this trench.

A black plastic coated copper power line was severed during soil removal in this trench. This power line was visible in the north wall profile at a depth of 13 inches below ground surface, just above the bone layer. Hand excavation determined that the introduction of this power line did not impact the buried bone material.

A sample of the backdirt removed from Trench 4 was then screened to recover any bone which may have been dislodged during mechanized soil removal. A number of human foot or hand bones and other unidentified bone material was recovered during this process. In addition, two toe bones, which seemed likely to fall from the trench wall, were removed from the north wall profile.

Trench 4 was backfilled after documenting the skeletal material by photograph and field sketch. It was hoped that immediate backfilling would help stabilize this possibly intact skeleton. If intact, this skeleton would likely be oriented with the skull just beyond the northwest corner of the trench and the body extending to the east from that point. This possibly intact human skeleton was encountered at a surprisingly shallow elevation and was not accompanied by a noticeable shaft feature; this feature was observed and protected, but not excavated.

4.2.5 Trench 5

This trench was excavated to examine an anomaly that appeared similar on the GPR printouts to that generated by the shallow, possibly intact, human skeleton encountered in Trench 4. Only the upper 12 inches of fill were removed by the Bobcat.

Surface cleaning using shovels and trowels revealed the outline of a decayed wooden coffin (Figure 8, Trench 5 - Plan View). Careful cleaning and scraping gradually exposed the northern, western and southern edges of the coffin. Coffin hardware, consisting of both nails and metal molding was recovered at the eastern edge, though the stain of the coffin outline had faded in this area (Figure 8). The exposed coffin outline measured roughly 2 feet by 5.5 feet and was oriented west - east.

A test unit measuring 1.5 feet by 2 feet, was excavated within this outline to explore the possibility of an intact burial (Figure 8). The western edge of this test unit was placed 14 inches east of the west edge of the outline. Careful soil scraping within and around this unit recovered coffin hardware and fragmentary human bone. Soil in this test unit was very compact and difficult to excavate. To facilitate the test the Bobcat was used to excavate beyond the western end of the coffin outline. This revealed that the decomposing bottom of a coffin had been encountered in the trench, that there was no intact burial present, and that the shaft of another burial was located to the west (Figure 9, Trench 5 - East and West Wall Profiles). An organic stain covered the bottom of the former burial.

5 Conclusions

A number of anomalies identified on the GPR printouts were examined through ground proofing. Most anomalies were identified as refilled shaft features containing highly compact clayey fill excavated into well sorted sands. One anomaly was a possibly intact human skeleton. The anomaly caused by the skeletal material in Trench 4 was very similar to the anomaly caused by the shaft feature investigated in Trench 5 where coffin remains were found but no burial.

Ground proofing established that GPR is capable of locating possibly intact skeletons and shaft features, but can not necessarily distinguish between the two. It also established that burials are likely to be closer to the ground surface than previously thought.

Table 1
Summary of Ground Proofing

Trench	Coords of sw corner (x/y), orientation, dimensions, max depth	Description
1	8/269, N/S, 5' x 10', 6.5'	Excavated through series of GPR anomalies. Encountered a very large cobble at depth of 3'. Wall profiles indicated that substantial earth removal and filling took place in this area.
2	12/272.5, E/W, 4' x 9', 3'	Excavated to expose in plan view a possible burial shaft visible in east wall of Trench 1.
3	15/200, N/S, 5' x 18', 4'	Excavated through series of shallow anomalies. Encountered 4 or 5 shaft features and a small pocket of fragmentary decomposing human bone.
4	0/180, E/W, 5' x 8', 3.3'	Excavated to investigate a possible soil interface. A possibly intact human skeleton was encountered at a shallow depth in this trench.
5	12/238, E/W, 4' x 14', 2.8'	Excavated to investigate a similar anomaly to the one generated by the skeletal material in Trench 4. Encountered shaft features, decomposed coffin remains, but only fragmentary skeletal remains.

NAVSTA Brooklyn

Brooklyn
Navy Yard





Former
Cemetery

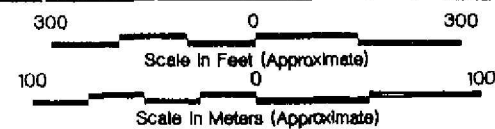
19th Avenue

Queens
Expressway

Flushing Avenue

Flushing Avenue

- | | | | |
|---|--------------------|---|---------------------------|
|  | Existing Buildings |  | Former Cemetery (Approx.) |
|  | Pavement |  | Property Boundary |



Source: NYC Redevelopment Plan, 1996.

Figure 1



GPR Evaluation and Ground Proofing

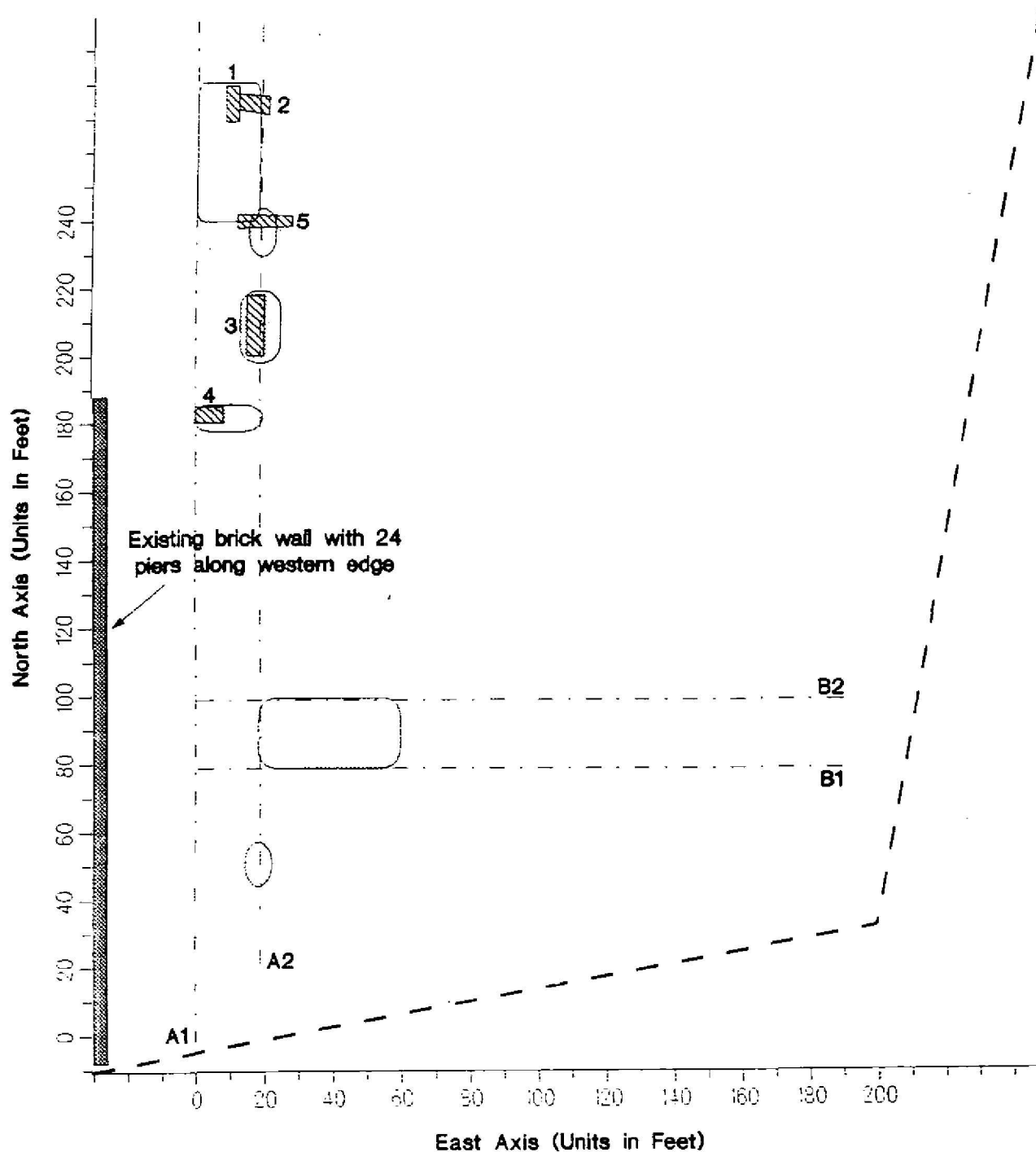
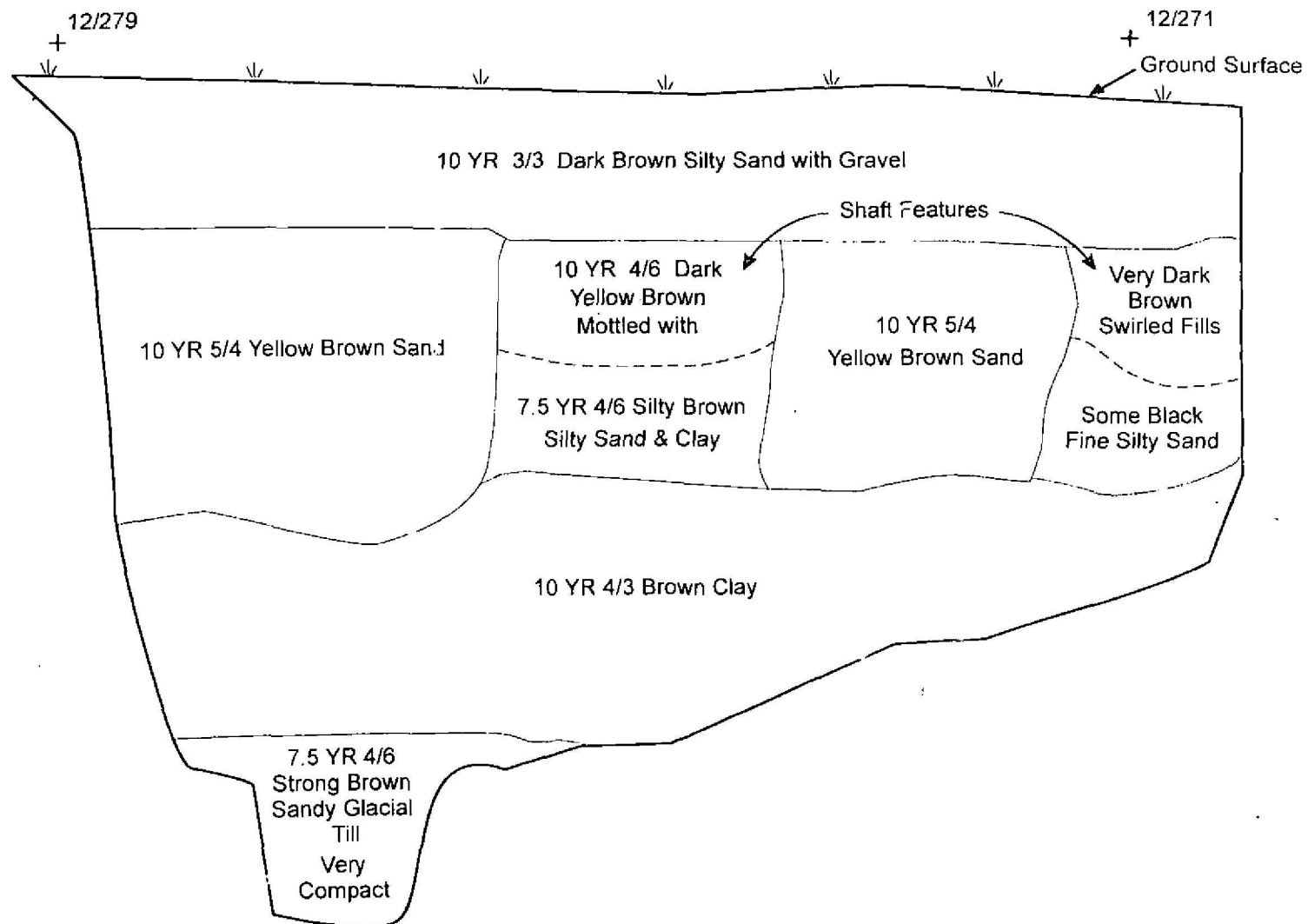


Figure 2

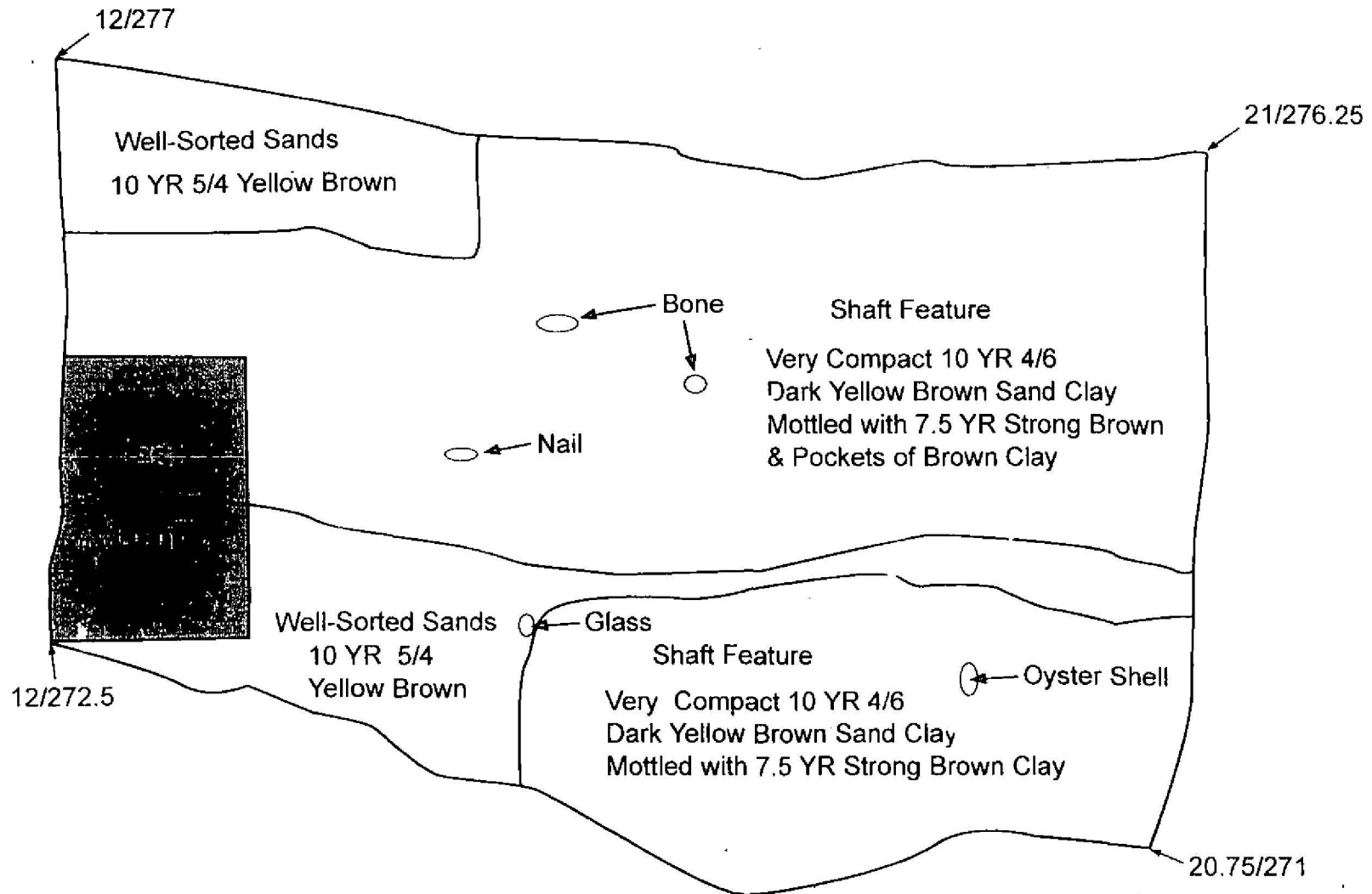
Trench 1 - East Wall Profile



1 0 1
Scale in Feet

Figure 3

Trench 2 - Plan View

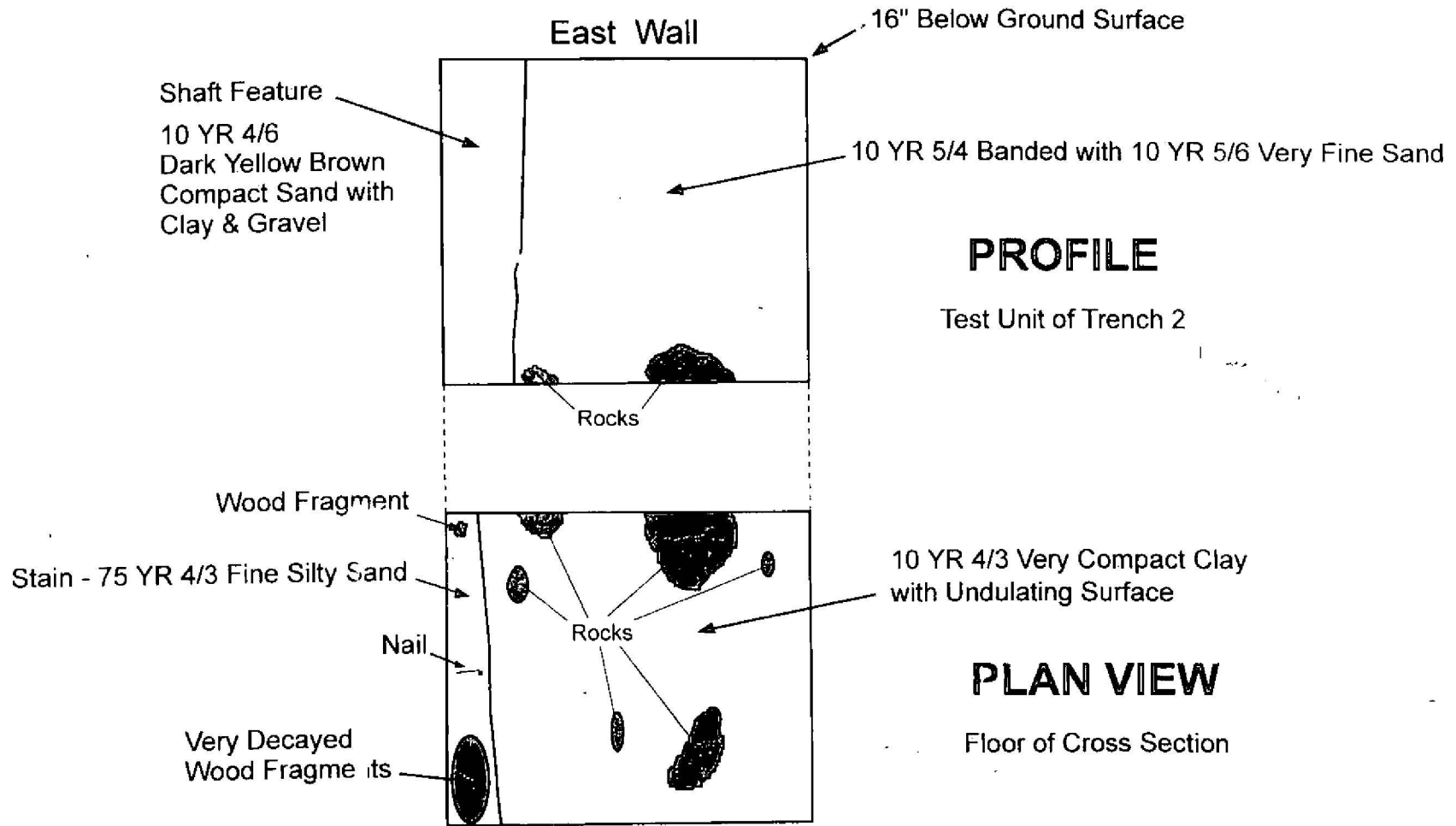


1 0 1
Scale in Feet

Figure 4



Trench 2 Test Unit - Profile and Plan View

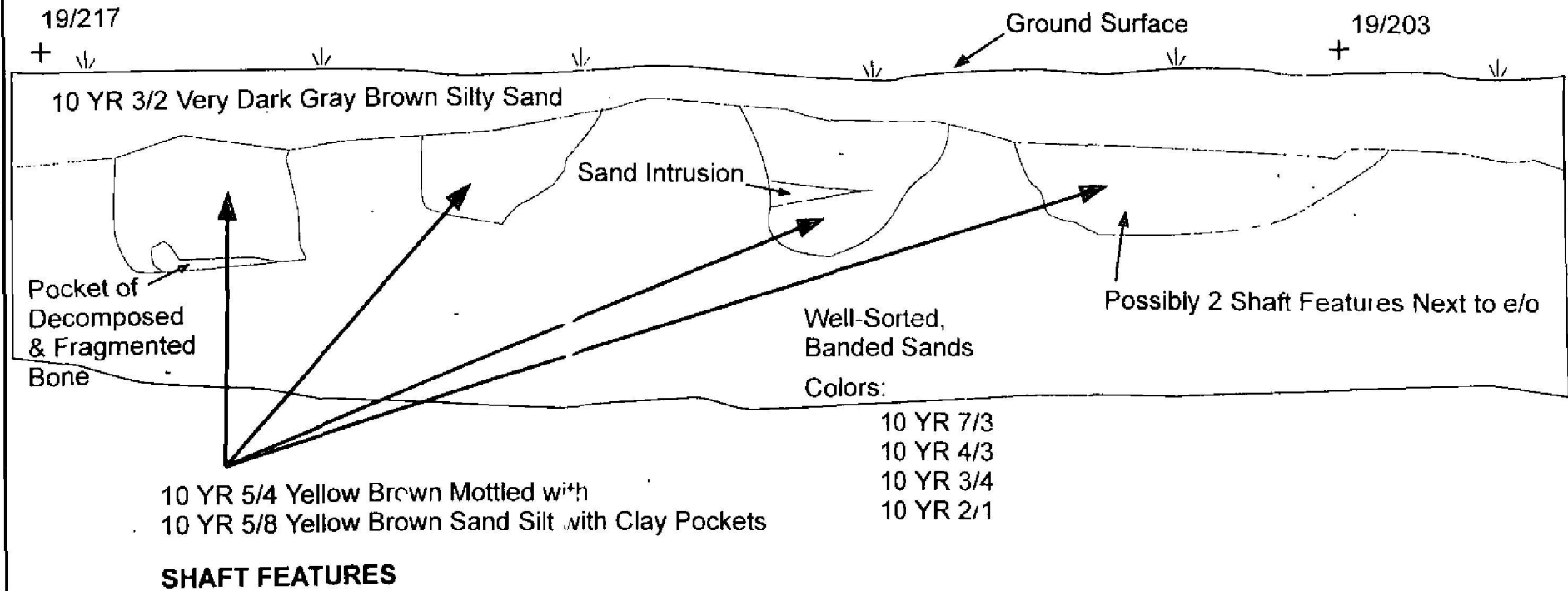


1 0 1
Scale in Feet



Figure 5

Trench 3 - East Wall Profile



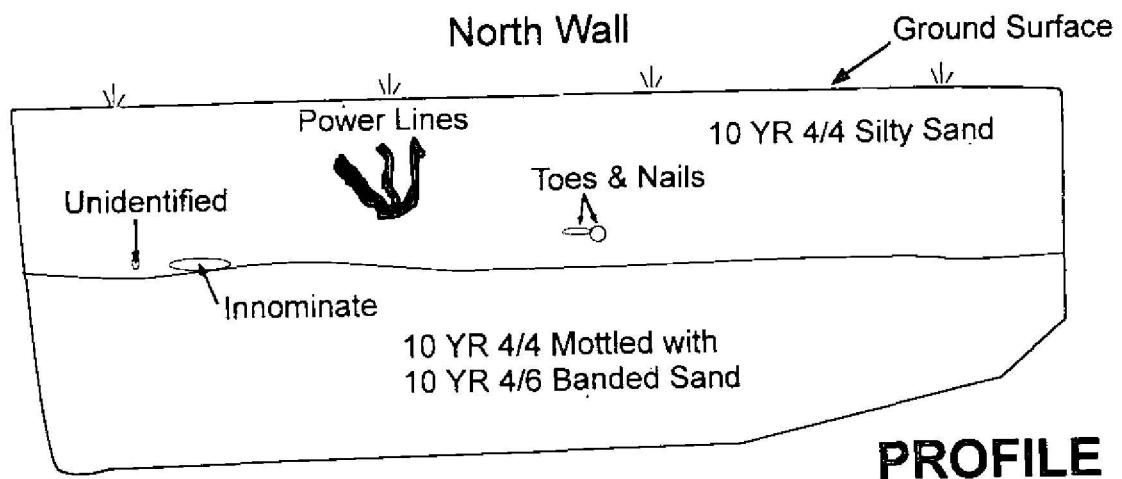
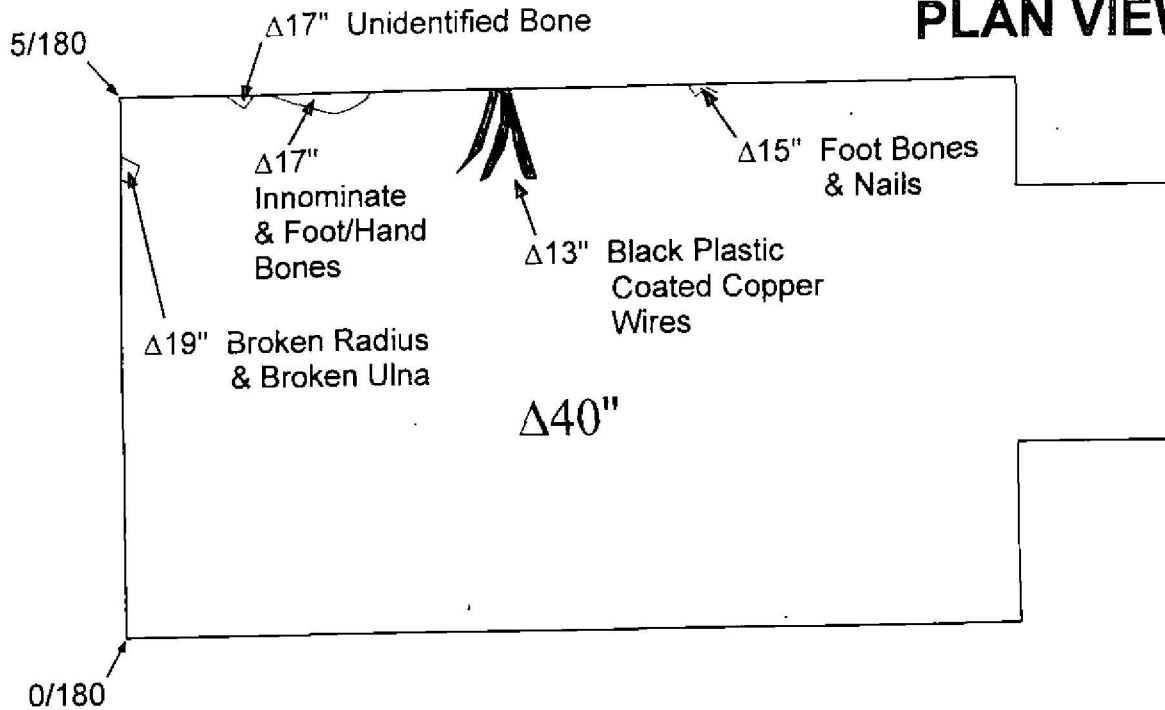
1 0 1
Scale in Feet

Figure 6



Trench 4 - Plan View and Profile

PLAN VIEW



PROFILE

Δ Depth Below Ground Surface

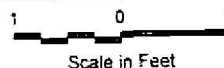
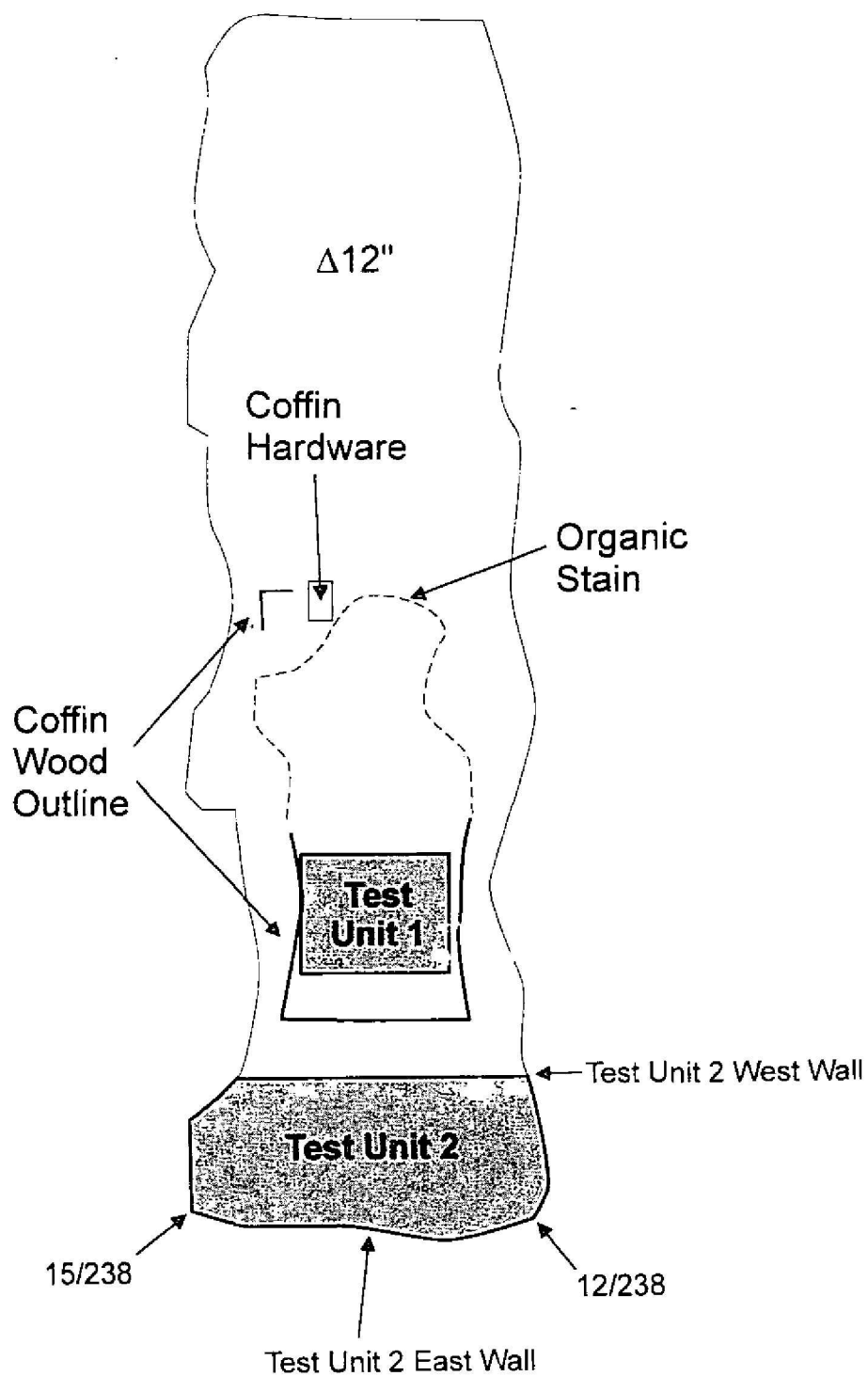


Figure 7



Trench 5 - Plan View



Δ Depth Below Ground Surface

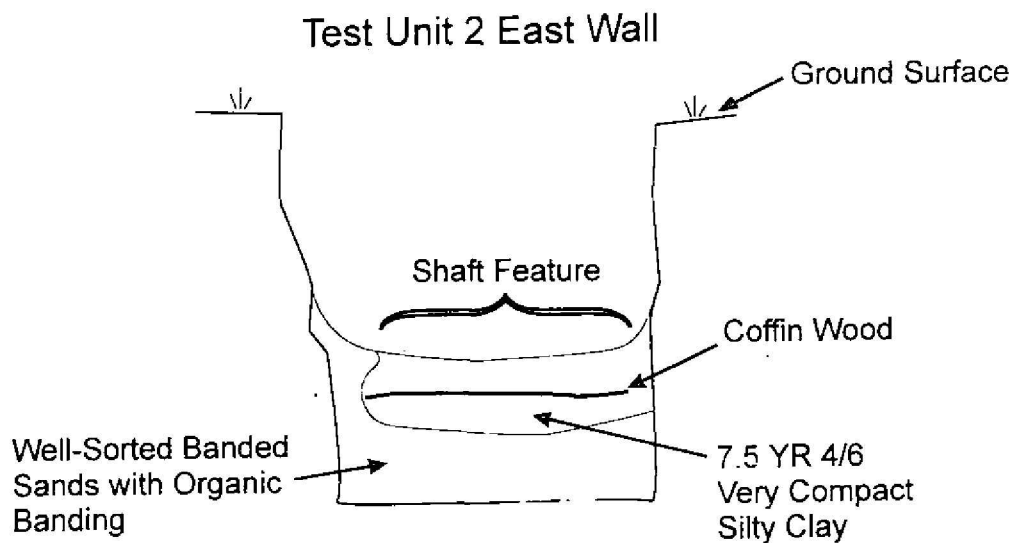
1 0 1

Scale in Feet



Figure 8

Trench 5 - East and West Wall Profiles



Test Unit 2 West Wall

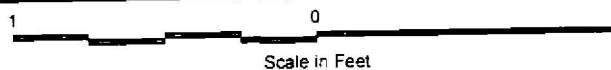
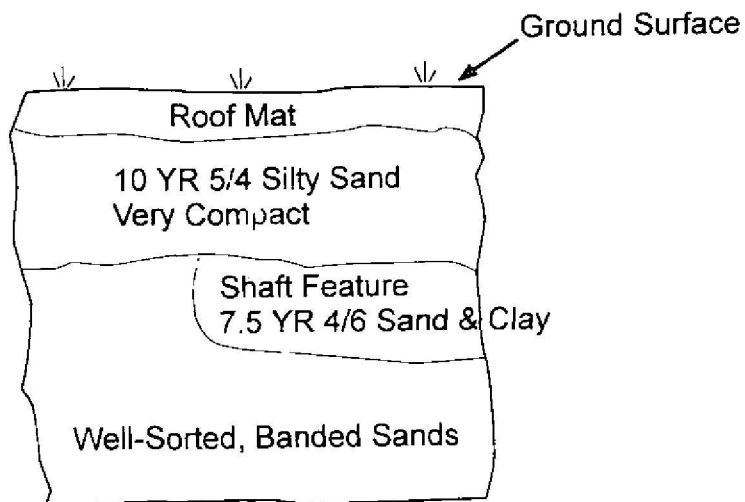


Figure 9