The Reconstruction of Foley Square, Monitoring and Testing, 1994 to 2003 (Selected Data)

Bogardus/McCullough Shot Tower 63 Centre Street, 1908

Prepared by Joan H. Geismar, Joan H. Geismar, Ph.D., LLC
with
Joseph Schuldenrein, Ph.D., Geoarcheological Research Associates, Inc.
July 2014

To: Amanda Sutphin, Director of Archaeology
New York Landmarks Preservation Commission
Re: The Reconstruction of Foley Square, Monitoring and Testing, 1994 to 2003 (Selected Data)
Date: July 11, 2014

Based on its location within the African Burial Ground and Commons Historical District[1] and a 1993 1a archaeological assessment,[2] archaeological monitoring and testing was associated with the "Reconstruction of Foley Square," a New York City Parks (Parks) project located at the heart of Manhattan's Civic Center (Figures 1 and 2). This document is intended to briefly report on noteworthy archaeological activity that occurred between 1994 and 1999 and a 2003 mitigation.

Initially, the field protocol established by Parks in consultation with the New York City Landmarks Preservation Commission (Landmarks) was to monitor all construction excavation below 6 feet (1.8 m). Basically, this applied to introduction of most if not all the park's new infrastructure, that is, catch basins, sewers, some water mains, and a new fountain, and any miscellaneous deep excavations. However, the protocol was partially revised in August 1998, when excavations on the west side of the park proved to be situated directly above a subway tunnel constructed in 1904. Therefore, Landmarks agreed to a proposed alteration to the protocol that eliminated the requirement for monitoring in this area.[3]

In summary, monitoring did not reveal any archaeological issues (sidewalk vaults on Duane Street, which might have proved significant, were only partially exposed and not impacted by the construction). Moreover, the backyards of two former house lots flagged for archaeological testing were quickly found to be deeply disturbed, eliminating any chance of finding any archaeological features (however, as discussed below, one of the yards became the site of an alternative archaeological mitigation). Ultimately, three issues were addressed through archaeology. These included monitoring two soil borings to recover information about site formation and conducting field testing to locate the remains of a historical structure, the Bogardus/McCullough Shot Tower.

One of the soil borings, which was intended to collect subsurface data for a proposed water tunnel, was located in Hamill Park on the east side of Centre Street; the other, in Thomas Paine Park on the west side of the street, was drilled specifically to collect soil samples as an archaeological mitigation. The writer collected soil samples for analysis by Joseph Schuldenrein of Geogarcheological Research, Inc. (GRA, Inc.; see Appendix B for what proved to be invaluable findings). Both borings were situated in former swampland associated with the adjacent, long-filled Collect Pond found north of Worth Street.

In addition to the two monitored soil borings, the third archaeological issue concerned testing for the remains the aforementioned historic structure: James McCullough's mid-19th-

[1] Archaeological Sensitivity Study, African Burial Ground and the Commons Historic District, Borough of Manhattan, City of New York, New York. August 1993. New York City Landmarks Preservation Commission.
[2] Geismar, Joan H., 1993, Reconstruction of Foley Square, Historical and Archaeological Resources Report. Prepared for the City of New York Parks & Recreation through CLRR Coe Lee Robinson Roesch, Inc. N.Y. December 1993.
[3] Landmarks accepted a petition to eliminate monitoring excavations within the footprint of the subway tunnel, a revision to the protocol that did not please the construction company paid extra when archaeologists were on site.

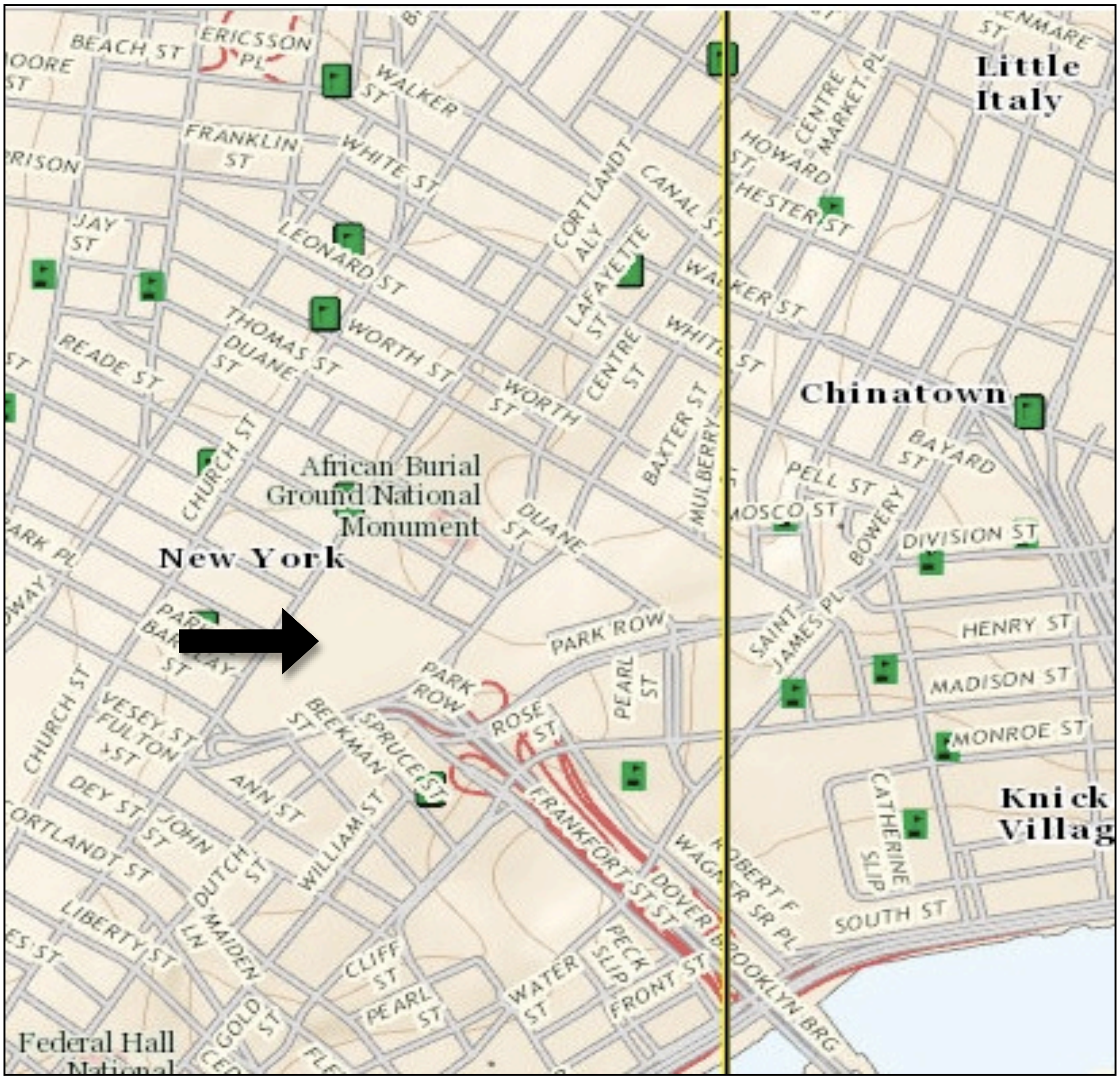

Figure 1. Site Location. Detail of USGS Jersey City and Brooklyn Quadrangles with the site location indicated by an arrow. (USGS Online)

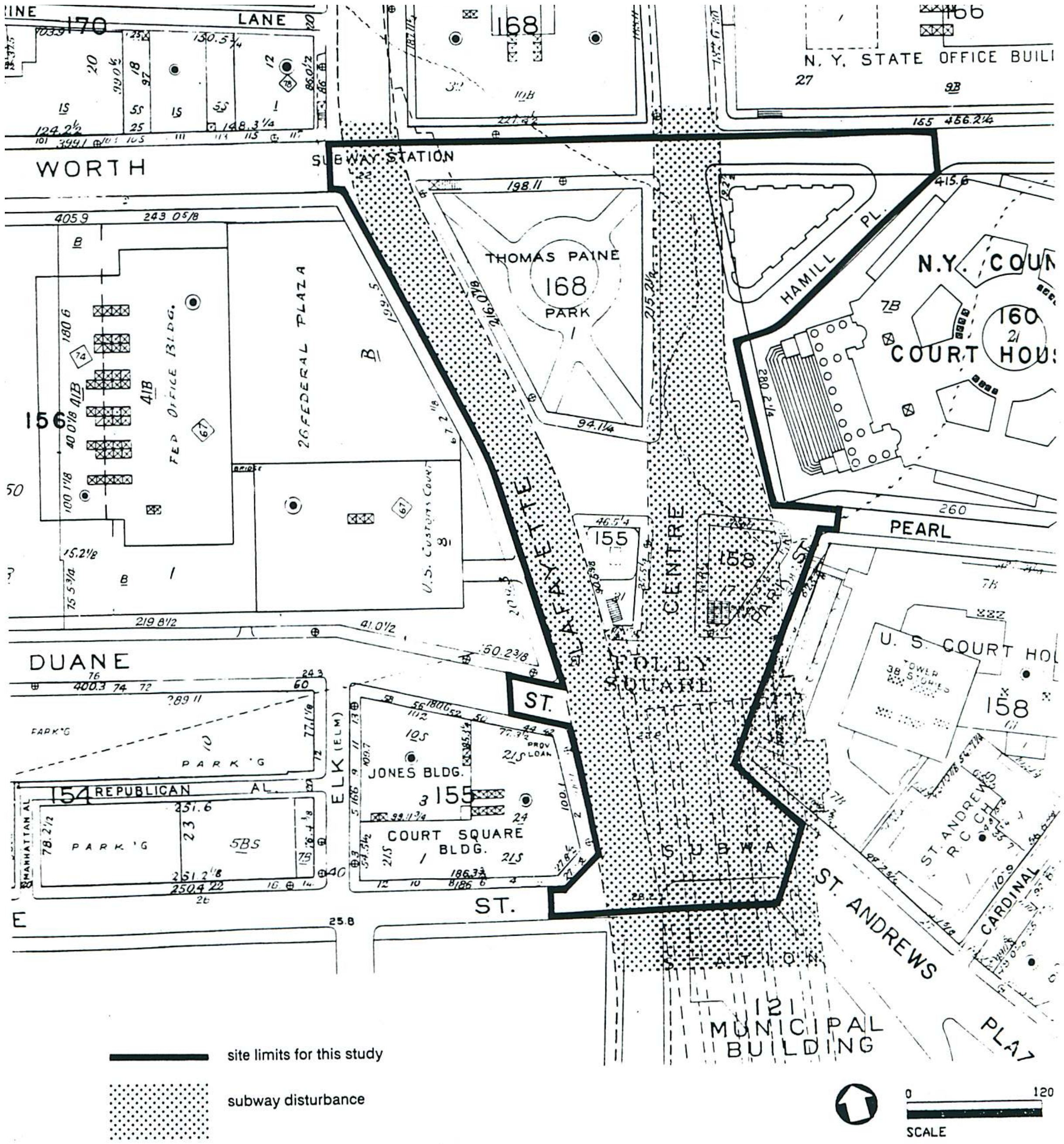

Figure 2. Study Area (Geismar 1993)

century shot tower, a component of his Colwell Lead Company located on Centre Street. James Bogardus, the 19th-century "cast-iron king"[4] whose manufactory was nearby, designed this tower for James McCullough. Designated the Bogardus/McCullough Shot Tower in the project's1a archaeological assessment, with its massive brick foundation and its innovative cast iron infrastructure and brick curtain wall (the forerunner to the skyscraper), it stood within what is now Thomas Paine Park for more than half a century (see Figures 4 and 5).[5] It is the two archaeological monitored soil borings and the search for shot tower foundation that are reported on here.

<u>The Hamill Park Soil Boring</u>

In March 1994, as mentioned above, a deep soil boring located in Hamill park was drilled to obtain subsurface information related to a proposed water tunnel. The upper 37 feet (11.3 m) of the boring were archaeologically monitored to determine just how far below the current ground surface would there be evidence for the historically documented former swamp. Or, to put it another way, just how much fill material was introduced to eliminate the swamp and create the current terrain?

The two-day monitoring effort indicated that approximately 20 feet (6.1 m) of fill obliterated evidence of what had been an intermittent swamp associated with the Collect Pond, an interior body of fresh water once located mainly north of Worth Street. While the observed core samples did not typically include significant cultural material, a thin, 3-inch long by ¾-inch wide strip of leather extracted from a soil sample that documented a one foot thick swamp level could possibly be an artifact from one of the tanning operations that once operated near the pond and its associated swamps but, of course, this is speculative. However, it was definitively established that a deeply-buried swamp deposit remains as evidence of the area's past landscape (see Figure 3, the archaeological monitoring log kept for this undertaking).

<u>The Bogardus/McCullough Shot Tower</u>

In September 1994, that is, six months after the soil boring was monitored in Hamill Park, an attempt was made to locate the foundation of the Bogardus/McCullough shot tower in Thomas Paine Park. There were maps to guide the exploration as (for example, Perris 1857; Figure 4), but an exact location was not known.

The shot tower, a Centre Street feature of McCullough's Colwell Lead Company complex (Figure 5), stood on Block 168 from August 1855 until it was razed in the spring of 1908 (see Figure 6 for an image taken during its demolition). According to accounts in the *New York Times*, the eleven story tower was an "old downtown landmark."[6] An 1881 article indicates that molten lead (a mixture of pig iron and arsenic) was poured into sieves or colanders from the great height of 200 feet (61.0 m) where it went spinning into water below, the spinning making it spherical, the water solidifying its shape (a description of this process and the conditions at the

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[4] For a comprehensive study of Bogardus and his work, see Gayle, Carole and Margo Gayle,1991. *Cast-Iron Architecture in America: The Significance of James Bogardus*. Norton Books for Architects & Designers.

[5] In addition, it should be noted that a faunal grab sample identified by Dr. Sophia Perdikaris entirely comprised animal bones.

[6] e.g.,Charles H. McCullough, a lead manufacturer…*NY Times*, April 23, 1909. NY Times on-line. http://query.nytimes.com/mem/archive-free/pdf?res=9F0CE6D8153EE733A25750C2A9629C946897D6CF

Figure 3.

HAMILL PARK ARCHAEOLOGICAL SOIL BORING LOG MARCH 28, 1994

Day started with rain. Heavy storms predicted; alternated large and small cones

Depth in feet	Soil Description	Remarks
Surface	Concrete	Overlay
1 – 3	7.5 in Bentonite (introduced) 11 in – fill; asphalt, gravel, etc.	No cultural material (glass, ceramics, etc.) noted
2 – 5	3.5 in Bentonite (introduced) same fill as above – gravel, asphalt, etc.	Same as above
5 – 7	6 in. of fill in core with very watered down Bentonite	Slag, clinkers, etc.; no artifactual material
7 – 9	c. 6 in. fill in sample as above with some ash & sand	
9 – 11	(Larger spoon) c. 4 – 5 in. (core empty); reddish/brown soil	Charcoal line c. 2 in. into core; stones, brick frags, mortar, 2+ glass frags, charcoal layer
11 – 13	c. 5 in. sample; reddish/brown, medium to coarse sand	large brick frag.
13 – 15	c. 1 ft. sample; reddish/ brown medium to coarse sand	Brick frags, tiny glass frag, clam shell, stones;
15 – 17	c. 10 in. sample; reddish/ brown medium to coarse sand	Brick frags, clinkers;
17 – 19	Coarse material; denser, finer & darker; with petroleum odor; reddish sand	Clinkers & brick in reddish sand; dark level bottom 10 in., a finer dark sand; small shell frags (change c. 18 ft.); no cultural material
19 – 21	2 ft. sample; top ft. again reddish/brown coarse to medium sand; bottom ft. a denser siltier material with wood frags; glacial till after 21 ft.; therefore, c. 20 ft. of fill, then swamp level	Copper slag; petroleum odor; darker, denser material; many wood frags; rock & wood frags in cone; **leather strip c. ¾ in. wide by 3 in. long.** Swamp level c. 20 ft. to 21 ft.; casing introduced
21 – 23	Stones; virtually no sample	[glacial till begins @ c 21 ft.]
23 – 25	Top ft. stones; bottom ft. medium to coarse sand with stones, pebbles; Reddish/brown sand, but browner than fill above	No artifacts; erratic in sand; fine sands
25 – 27	Glacial till (pebbles, boulder, coarse sand); reddish/brown	No artifactual material
27 – 29	Almost no sample; rocks & driller's clay	No artifactual material; no soil
29 – 31	Small sample (c. 3 - 5 in); stones, brown sand; till	Appears to be c. 10 ft of till under small swamp level

HAMILL PARK ARCHAEOLOGICAL SOIL BORING LOGS MARCH 29, 1994

Rain

Depth in feet	Soil Description	Remarks
31 – 33	Small sample recovered; few cobble frags, stones; glacial till continues	Drilling difficult indicative of very coarse material; large cobbles, etc. Nose cone
33 – 35	Medium to coarse gravels with cobbles, rotten rock (decomposed); red arkose sandstone [identified by driller], some gneiss; glacial till	clogged with cobble frags; drilling still difficult; smaller spoon from 33 feet; poorly sorted gravels (much the same as
35 – 37	Medium to coarse gravel with cobbles, rotten rock, glacial tills; drilling halted due to heavy rains	above). Smaller spoon, difficult drilling (cobbles). Glacial deposition; rocks well rounded; troweled through spoon material

Note: at 33 to 37 ft. each core recovered a c.12 to 15 in. sample. Drilling to continue to c. 600 ft. BGS but monitoring for archaeological purposes not necessary.

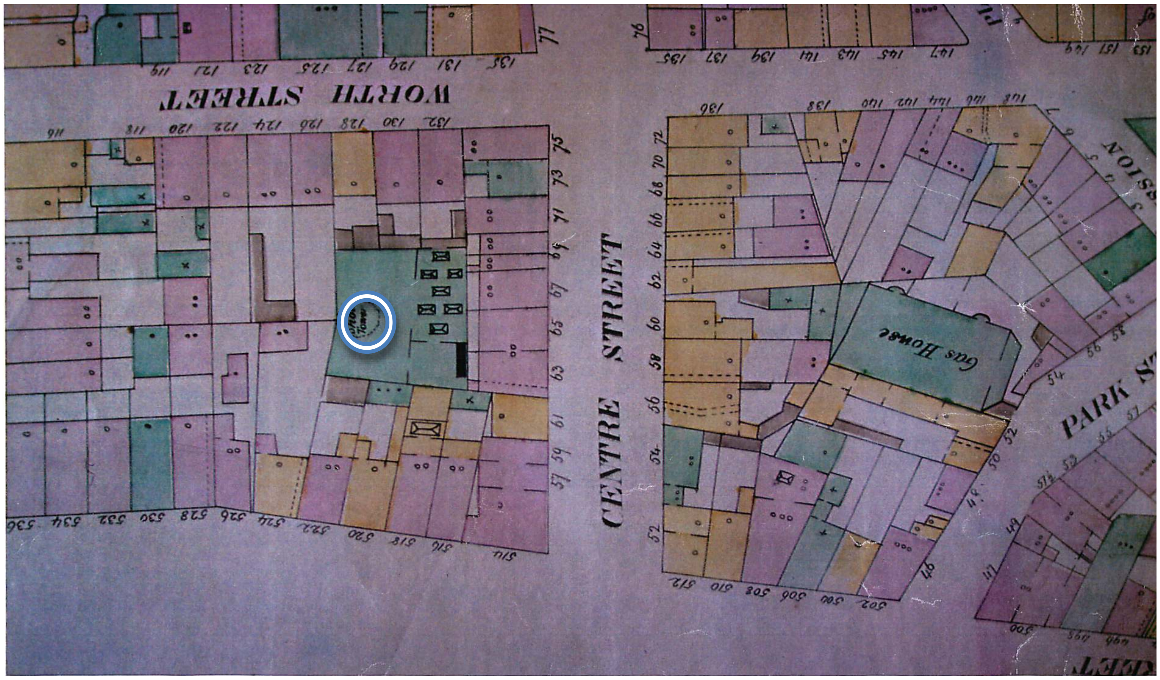

Figure 4. Bogardus/McCullough Shot Tower (within white circle) on Block 168, now Thomas Paine Park. (Perris 1857, Plate 14, detail)

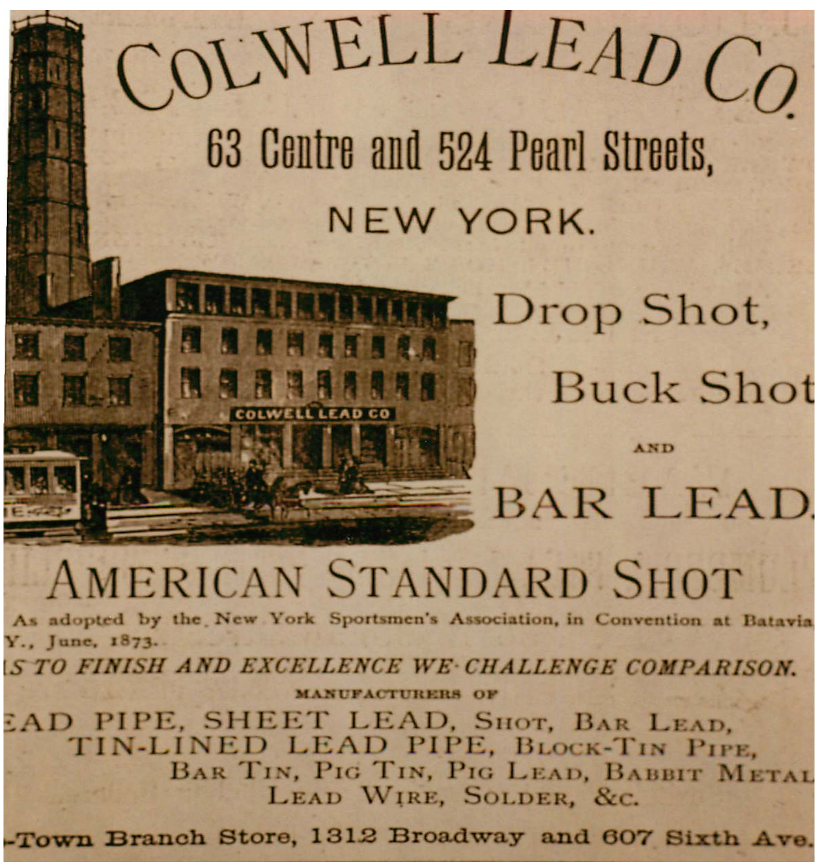

Figure 5. An ad for the Colwell Lead Company showing the Bogardus/McCullough shot tower (far left, rear). (*NYC Directory* 1855)

Figure 6. The Bogardus/McCullough shot tower (63 Centre Street) during demolition in 1908 (New York Views, Local History Room, New York Public Library).

Bogardus/McCullough Shot Tower are presented in this *New York Times* article).[7] In1905, the McCullough family sold the shot tower and lead manufactory; by the time the tower was demolished in 1908, the property had changed hands at least twice. [8]

Fieldwork comprised hand excavating six test trenches of various configurations ("T" and "L" shapes), lengths (3.0 to 17.0 feet [0.91 to 5.2 m] in segments), and depths (2.0 to 5.5 feet [0.61 to 1.7 m]). Their locations were governed by map data (including the aforementioned 1857 Perris Atlas [see Figure 4]) and the presence of venerable Plane trees that necessitated avoidance. The trench dimensions and configurations reflected ground conditions and subsurface findings (these included wall fragments, paving stones, brick and macadam layers, and voids). While three days of fieldwork were allotted for testing, only two were actually needed. The six hand excavated trenches documented tree roots, a great deal of fill, mainly comprising building rubble (undoubtedly from demolished houses and commercial buildings once located on the block), and, in at least one trench, a cache of discarded paving stones (see Figures 7 and 8). No evidence of the shot tower's massive brick foundation (4.5 feet [1.4 m] thick and 18 feet [5.5 m] deep)[9] was found.

As noted in the "draft report" letter to Marcha Johnson, the Foley Square Project Manager for Parks, the hard packed soil, demolition debris, and tree roots made testing quite laborious. Consequently the depths reached, which, as mentioned, did not exceed 5.5 feet (1.7 m) below the ground surface (BGS), apparently did not go beyond the demolition debris and other fill material. The fact that we did not reach the level of the shot tower's foundation was indicated by the lack of lead in the excavated soil. This was determined by an interested member of the New York City Health Department who, given the former use of the site as a lead manufactory and shot tower, was concerned for out safety and voluntarily tested samples of the excavated soil. As indicated in the letter to Ms. Johnson, he reported "markedly low lead levels" of 160 parts per million (PPM) whereas lead levels in the vicinity of a facility using lead typically would measure from the high 1000s to the low 10,000s PPM (see Appendix A below).

With the Plane trees a major consideration, it was impossible to employ heavy equipment to explore the depths that might have revealed the shot tower foundation. That said, it certainly may remain under the demolition debris and other fill material that underlies Thomas Paine Park. Any future deep excavations in the vicinity of the tower's documented location (see Figure 11 and the graphic in Appendix A) should be mindful of the archaeological potential for this feature.

<u>The Thomas Paine Park Soil Boring</u>

In 1999, after years of intermittent monitoring of construction activities, and lacking the ability to fully test for the shot tower foundation, Parks accepted a proposal for an alternate mitigation. This entailed drilling a single soil boring to collect samples of the swamp deposit

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[7] A Visit to a Shot-Tower, How Pig Lead and Arsenic are Converted into Shining Shot, Dropping Molten Lead 200 feet–the Deafening Noise of a Silvery Shower–Description of the Men at their Interesting Work." *NY Times* November 13, 1881. (NY Times on-line http://query.nytimes.com/mem/archive-free/pdf?res=9D00E1DF113EE433A25750C1A9679D94609FD7CF)

[8] "THE REAL ESTATE FIELD: Deal on Centre and New Elm Streets" *NY Times* March 5, 1905. (NY Times on-line: http://query.nytimes.com/gst/abstract.html?res=9C04E5DA133AE733A2575AC0A9659C946497D6CF).

[9] e.g., Kahn, David M., Bogardus, Fire, and the Iron Tower. *Journal of the Society of Architectural Historians,* Vol. 35, No. 3:186.

Figure 7. Test trench 1 (TT1) after excavation (view is west). A tree root lies atop a brick wall fragment with additional debris nearby. (Geismar 4-19-94)

Figure 8. Test trench 4 (TT4). A shallow stone wall runs along the left side of the trench and a brick wall fragment is in evidence under the tree root. (Geismar 9-20-94)

expected to be found in Thomas Paine Park much as it was found in Hamill Park five years earlier. The selected site was the contiguous backyards of former house lots at 516 and 518 Pearl Street where monitoring had indicated that no viable domestic backyard features remained.

On April 14, 1999, continuous sampling was carried out to a depth of 32 feet (9.8 m) below grade. Once again, at least 20 feet (6.1 m) of fill were documented followed by a possible 4-foot (1.3 m) transition zone. At 25 feet (7.6 m) BGS, 2 feet (0.61 m) of swamp deposit was encountered (see Figure 9; see also Figure 10 for the soil boring log kept by the archaeologists). As mentioned earlier, soil samples were collected for Dr. Joseph Schuldenrein's analysis.

Figure 9. Deposit recovered from boring B1 at a depth 24-26 feet (7.3-7.9 m) is being measured in the sampling spoon before transfer to glass collection jars. The lower part of the sample [left) is peat. (Geismar 4-14-99)

In his 2003 report, Dr. Schuldenrein describes the objective of the analysis, or study, as the means "…to reconstruct the environments and history of the buried landscape at the site of former backyards 516 and 518 Pearl Street...[as]…the dated sediments might provide information on the evolution and sequence of environments that gave rise to the Collect Pond, a key feature of the early colonial landscape of Lower Manhattan." He goes on to say,

> "A central objective of the geoarcheological study was to develop a timeline that linked sediments to events leading up to and post-dating the emergence of New York's prehistoric shoreline. Radiocarbon dates were obtained from undisturbed organic horizons that dated a continuous 5000 year sequence related to Holocene shoreline evolution."

The report synthesizes what has been learned to date about the environmental history of the general project area. Clearly, his objectives were more than adequately met:

> "Geoarcheological investigations at Foley Square/B-1 produced a wealth of information bearing on the last 5,000 years of landscape history of Lower Manhattan. Field observations coupled with historic accounts and geological records facilitated a reconstruction of events in the project area."

Dr. Schuldenrein's detailed study, which includes methods and findings as well as extensive comparative data, is presented in Appendix B.

Figure 10.

THOMAS PAINE PARK SOIL BORING (B1) APRIL 14, 1999
Day started with good weather; started work at 1:45pm, ended 5:45pm
Augered to each sample depth after sample collection; auger used as casing.
140 lb hammer – Tri State Drilling.

Depth in feet	Soil Description	Remarks
Top	Ground Surface	
0 – 4	Dark humus? With stones and brick	Fill
4 – 6	Sand, gravel, brick frags	Fill
6 – 8	Cement frag at c. 7.5 ft. – reddish/ brown sand with stones and brick	Fill
8 – 10	Reddish/brown sand with stones and brick	Fill
10 – 12	Reddish/brown sand with stones and brick	Fill
12 – 14	Resistance encountered, cleaned out with auger	Consolidated material 12-13.5 ft.
13.5 – 15.5	No sample obtained	
15.5 – 17	3 in. of soil at top, brick; 8.5 in. – stand stone frags	
17 – 19	Refusal at 17 ft. drilled to proceed	
18 – 20	Sand, stone, brick frags	Fill below 20 ft. possibly natural
20 – 22	Red sand & gravel – wet	Possibly natural
22 – 24	Sand with silt, organic fibers??	
24 – 26	10.5 in. of red sand, c. 6 in. peat, 1.5 in. silt layer, peat 12.5 in. to bottom	Peat deposit identified at c. 25 ft. BGS
26 – 28	9.5 in. of peat over gray silt (thick) to bottom	Interface c. 27 ft. BGS
28 – 30	Gray silt continues to 29.5 ft.; becomes red fine sand with some silt and organics	
30 – 32	Silty red/gray sand grading into brown/red fine sand with silt some mica, to end of boring	Truncated at 32 ft. BGS

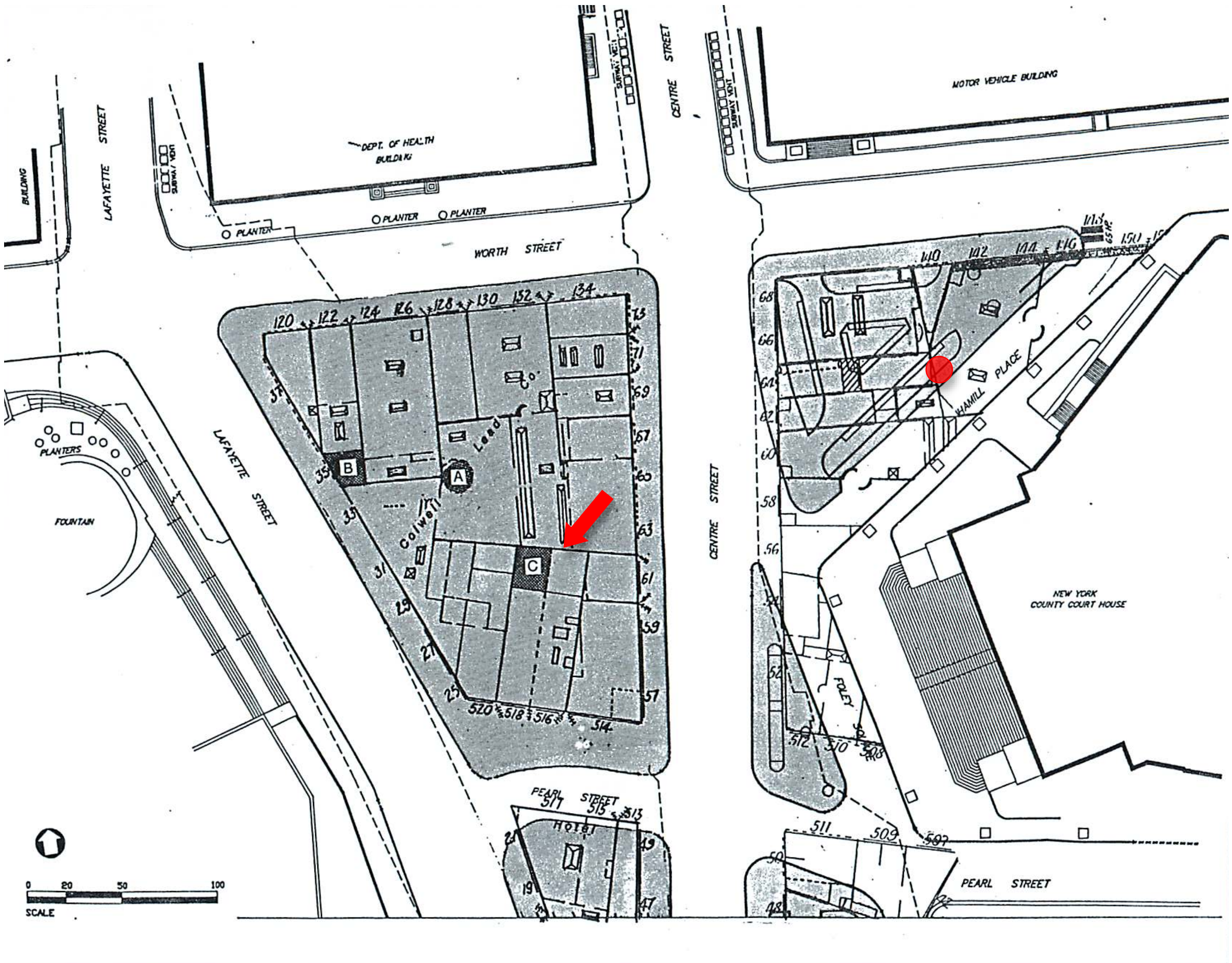
Continuous sampling documented approximately 20 ft. (6.1 m) of fill above a 4-ft. (1.6-m) transition zone (?) followed by a 2-ft. (0.61 m) peat deposit with a thin (1.5 in. [0.04 m]) silt layer (soil samples of the peat and silt were collected for analysis; see Appendix B); this was followed by 2 ft. 6 in. (0.7630 m) of gray silt, then a red/gray sand that graded to a brown/red fine sand with some organics and silt. The boring terminated at 32 ft. (9.8 m) BGS.

To summarize, approximately five years of intermittent archaeological monitoring and minimal testing were carried out during the Reconstruction of Foley Square, a Parks' project located within the African Burial Ground Commons and Historic District. The effort was guided by the findings of the project's 1993 1a archaeological study and a field protocol established in consultation with Landmarks. The archaeological study had established that both Thomas Paine Park on the west side of Centre Street, the main focus of the reconstruction, and Hamill Park on the east side of the street, comprised intermittent swampland prior to becoming subject to 19th century domestic and commercial development. The backyards of two house lots and the site of the mid-19th century Bogardus/McCullough Shot Tower were among the identified archaeological concerns. During the course of the project, the opportunity to monitor and, ultimately collect, soil boring data to reconstruct site formation and understand environmental issues, became a focus of the investigation, and, indeed, mitigation.

The two backyard areas, where it was hoped that 19th-century sanitary features, such as privy pits and/or water cisterns might remain, proved to be unproductive. Also, because testing for the Bogardus/McCullough Shot Tower required hand excavation to avoid damage to established park trees, heavy equipment could not be used in testing. This made it impossible to test beyond the fill encountered throughout the test trenches. Moreover, testing did not reach levels with lead concentrations typically associated with lead production. It is assumed, therefore, that the shot tower's foundation, known to be a massive brick construction, may remain under the demolition debris and fill.

Ultimately, in light of the inability to adequately test for the shot tower foundation, an alternative mitigation was carried out. With the approval of Parks and Landmarks, soil samples were collected from a dedicated soil boring with the objective of studying site formation and reconstructing the environmental history of the project site and area. The study, undertaken by Dr. Joseph Schuldenrein of Geoarcheological Research, Inc., succeeded in shedding light on the last 5,000 years of Lower Manhattan's" landscape history."

As noted previously, this report in its entirety is presented in Appendix B. It is a report that makes an invaluable contribution to understanding the past environment of the project site in particular and Lower Manhattan in general.



A Bogardus/McCullough shot tower location

B 122 Worth Street (former backyard)

C 518 Pearl Street (former backyard), location of the Thomas Paine Park soil boring (B1)

Hamill Park soil boring site (approximate)

Figure 11. Identified Areas of Archaeological Concern/Testing/Mitigation (based on Geismar 1993 Figure 39)

APPENDIX A:
Letter (Draft Report) to Marcha Johnson, Parks, November 14, 1994

Joan H. Geismar, Ph.D.
Archaeologist

40 East 83rd Street
New York, New York
10028
(212) 734-6512
(212) 650-1521 Fax

November 14, 1994

Ms. Marcha Johnson, Project Manager
Foley Square Reconstruction Project
NYC Department of Parks and Recreation
The Olmstead Center/Flushing Meadow Park
Flushing, NY 11368

Re: Archaeological Field Testing, Thomas Paine Park,
Foley Square (McCullough/Bogardus Shot Tower Foundation)
September 19 - 20, 1994

Dear Marcha:

This letter, which is accompanied by photos,*is being submitted as a draft report on field testing at Thomas Paine Park undertaken on September 19 and 20, 1994. Field work was carried out by a field crew of four under the direction of the writer. At the request of Parks, the purpose of testing was to locate the foundation of the McCullough/Bogardus Shot Tower, the major architectural component of a mid-19th century lead shot manufactory and foundry that once stood on the site (the tower was erected in 1855 and demolished in 1908). The history and significance of this mid-19th century structure is presented in a Historical and Archaeological Resources Report prepared for Parks through Coe Lee Robinson Roesch (now CLR Designs, Inc.) in December 1993 (Geismar 1993). The text that concerns the shot tower has been extracted from the report and appended to this letter.

When testing was first discussed, the foundation was being considered an historical/architectural/archaeological feature that might be incorporated into the park's design. However, for numerous reasons, this consideration was abandoned during the design phase. Testing then became solely an attempt to verify historic documentation and to record the dimensions and condition of the tower's foundation. A maximum of three days was planned to achieve these goals.

The uneven ground surface in the vicinity of the tower's documented location suggested that the foundation might be found close to the surface. As it turned out, this was not the case, and the six hand-dug test trenches of various sizes (3 to 6 ft. long [segments, one totaling 17.5 ft.] and depths of 2 to 5 1/2 ft.) opened at the site did not reveal any evidence of the tower feature (see attached draft graphic).

* Note: these prints are no longer available; 35mm slides document the fieldwork

Indeed, with the exception of aligned, dry-laid, worked stone blocks atop a low brick foundation in one trench at a depth of about 2.5 ft. (TT4), laborious testing in extremely hard packed soil mostly revealed large concentrations of building debris and fill material.

A major concern during testing was the effect of excavation on established plane trees located in the vicinity of the proposed tower site as documented on 19th century maps. Excavation proceeded entirely by hand and every effort was made to prevent root damage. Had the tower foundation been close to the surface, the hand excavation undertaken on the site would have answered the questions guiding the field work. However, the dense concentration of building rubble, replete with voids caused by fragments of tumbled brick walls, large unidentified pieces of concrete, and stones, that was encountered in at least one test trench (TT1) indicated that the tower foundation was deeply buried. It should be mentioned that the tower's location based on 19th century maps was confirmed by Parks surveyors who established what is believed to be the center of the tower and four points on its outside perimeter. These were marked with yellow plastic stakes.

While the hard-packed soil made excavation extremely difficult, it became apparent that the variable depths reached in Test Trenches 1 and 4 (up to 5 or 5 1/2 ft. in parts of the former and 3 to 3 1/2 in the latter), presumably located within, near, and along the edge of the tower, did not extend down to the foundation. Soil samples from TT4 voluntarily collected by Richard Jaw of the New York Department of Health, located across the street from the park on Worth Street, appear to confirm this assessment. They revealed markedly low lead levels (160 parts per million [PPM]; (Jaw 1994:personal communication). Mr. Jaw indicated that lead levels in the vicinity of a facility using lead typically would measure from the high 1000s to the low 10,000s PPM [Jaw 1994:personal communication]).

Parks personnel kindly provided temporary fencing to protect the site (as well as some field equipment). On the night of September 19, this fence was sealed and road markers and large metal waste containers were placed in the open trenches. On the second day, it became apparent that a backhoe was needed to proceed with testing, and that this would undoubtedly cause irreparable damage to the roots of established trees. Consequently, testing was halted on the evening of September 20. After consultation with Parks, three of us returned on Thursday, September 22, to backfill open trenches and spread grass seed. Only in one area, along the western edge of TT1 where it bordered a cement walkway, did it appear that settling might create a problem. This was where building debris was most concentrated and where voids had been stabilized by soil and grass prior to testing.

The stakes used to mark the proposed parameters and center of the shot tower were driven flush with the ground to mark its location but eliminate any hazard to park users. Eleven pounds of grass seed were spread over the area after filling and leveling.

Photographs were taken during the two days of testing, although the shade caused by the trees did not make for good pictures [see Figures -- and -- in text].

Although no evidence of the shot tower was found, it seems likely that it remains below tested levels (building rubble often extends 5 to 6 ft. below the surface on urban sites). Since the park's proposed design at this writing will not adversely affect this potential feature, and since continued testing might damage established trees, no further testing for this feature is recommended. However, should construction excavation extend beyond 5 ft. in the vicinity of the shot tower site, it is recommended that an archaeologist be on hand to record the foundation should it be encountered.

Sincerely,

Joan H. Geismar, Ph.D.
Attachments

The Bogardus/McCullough Shot Tower (extracted from Geismar 1993: 52-58; text only)

The ownership and occupation history of 63-65 Centre Street is detailed in Appendix A. Of concern here is the tenancy of James McCullough, an iron founder who sublet part of the property from Abraham Bassford in 1855. Bassford had acquired a twenty-one year sublease from Patrick Cougan on the day Cougan received a lease from the Lorillard family in 1844 (see Appendix A). Cougan does not appear on tax records, but Bassford is listed at 63-65 Centre Street through 1865. He is described as a founder on the lease (LD 448 1844:534), but was for a time a pianoforte manufacturer (his factory is noted on the 1853 Perris Insurance atlas). He became a billiard table maker, and is listed at other .addresses as well as 63-65 Centre Street in city directories (e.g., NYC Directories and NYC Business Directories 1850-1860).

McCullough is first documented as a producer of shot and lead in 1849. In that year he is listed in the New York Business Directory as the president of the "Spring Valley Shot and Lead Company" with an address at 159 Front Street. Since no shot tower is known at this address, it may merely have been a New York City office for the company. McCullough remained at this Front Street address until 1853. Other founders are also listed at this address, but shot manufacture is not mentioned after 1850.

Soon after subletting part of the Centre Street property, McCullough proceeded to erect a 175-ft. cast iron tower to manufacture lead shot on Lot 29. The architect and builder of the tower was James Bogardus whose factory at the time was on the northeast corner of the intersection of Duane and Centre Streets (Bannister 1956:13), just a block or so south of the shot-tower site (Figure 26). Bogardus was not the first to produce cast iron facades, nor was he the only one in New York to do so. But "his work appeared at a moment when the state of technology, need, and taste combined to favor its acceptance and exploitation" (Bannister 1956:16). His fire and shot towers are among his greatest achievements.

Bogardus's factory, built in 1848, was an excellent advertisement for his product and aroused local and international interest (Bannister 1956:13-14). The building stood for only a decade, the victim of the widening of Duane Street in 1859. It was dismantled and stored, perhaps to prove the claim that not only did cast iron supply the greatest strength with the least material, but also cast-iron fronts "could be taken down, removed, and put up again in a short time" (New York Evening Post 1849 cited in Bannister 1956:13). Unfortunately, the building was never re-erected.

McCullough’s shot tower was not the first one built in New York City (the first, 110 ft. highand of stone, was erected in 1821 on the East River between 53rd and 54th Streets [Stokes V 1922: 1618]) nor was it the only one (he built one in 1856 on Beekman Street for Tatham & Bros. that was 210 ft. high [Stokes V 1922:1865; Kahn 1976:186]). However, it was the first to use cast iron as its structural element, and it proved that structures of this type could be built on former marshland using this material.[11] It was also the first to use a masonry curtain wall and a free standing skeletal iron frame, a forerunner of the skyscraper in America (Kahn 1976: 186). (Margo Gayle, the leading expert on cast iron construction in New York City, and the author of a forthcoming book on Bogardus, kindly provided information and sources regarding Bogardus and the tower.)

Bogardus recognized that a cast iron framework would make it possible to build towers, at first fire towers (for sighting fires), then shot towers, where they could not be built before. His two New York City shot towers "stood on small, marshy plots which would have admitted neither the ground-level circumferences nor the tremendous weight of a traditional masonry shot tower" (Kahn 1976:200).

There are no plans for the McCullough shot tower (Gayle 1993: personal communication), and dimensions in the literature vary; only its shape (octagonal), the nature of its brick curtain wall, and its height (175 ft.) are constants. Stokes, based on information from a former superintendent of the tower, notes that its width at the base was 24 ft. and at the top 12 ft. (V 1922: 1862). Carl Condit, in American Building Art: the 19th Century, says its outside base dimension was 25 ft. 6 in., its outside top diameter 15 ft. 6 in., its brick curtain wall 12 in. thick, its foundation 18 ft. deep, and its foundation walls 4 ft. 6 in. thick (1960:282 fn). Turpin Bannister, writing in 1956, gave the same measurements with only one variation: the outside base dimension was only 25 ft., "about half the usual dimension" (1957:13). To make this possible, Bogardus had "used eight cast-iron corner posts, tied together at the eight interior platform levels by horizontal cast-iron members... the sides of this cage were then enclosed with 12-in.-thick panels of brick supported entirely by the framework" (Bannister 1957:13).*

Prior to subleasing part of the 63-65 Centre Street property, McCullough had run into financial trouble that led to a State Supreme Court trial in 1851, four years before building the Centre street tower (Barbour 1853:103-107). His continuing difficulties apparently caused him to move his operation out of the city, but it did not daunt him. He built another shot factory and tower in 1860 on land he leased in Stapleton on Staten Island. Construction of this 200-ft. brick tower was well documented in local newspapers and treated as quite a wonder; this Staten Island tower stood until 1898 (Geismar 1991:52-55).

*Bannister (Bannister, Turpin C., Bogardus Revisited Part II: the Iron Towers, *Journal of the Society of Architectural Historians*, Dec. 1957, Vol. XV 4:12-22)incorrectly asserts that the shot tower site was "exactly in the middle of the former Collect Pond ...” (1957:13). While the site was on marshland, the pond did not reach this part of the study area.

His New York tower, which stood on the property subsequently leased or owned by several lead companies (see Appendix A), out lasted it by ten years. In 1870, when it was operated by the New York Lead Company, twenty-three men were employed who worked twelve months of the year and were paid a total of $15,000 in wages; in that year it produced 1,500,000 pounds of lead shot worth $126,000 (1870 Federal Census Products of Industry).

The tower was demolished in 1908,* soon after the premises were vacated by the Colwell Lead Company (see Figure 32[Figure 6 this document]). It was the last of its kind to stand in the city (the Tatham & Brothers tower had been demolished the year before [Stokes V 1922:1865]).[10] It seems likely that the foundation of this structure still exists on the 63-65 Centre Street lot on Block 168 (see Archaeological Resources).

A word about shot production seems in order. The following is a brief description of the shot making process:

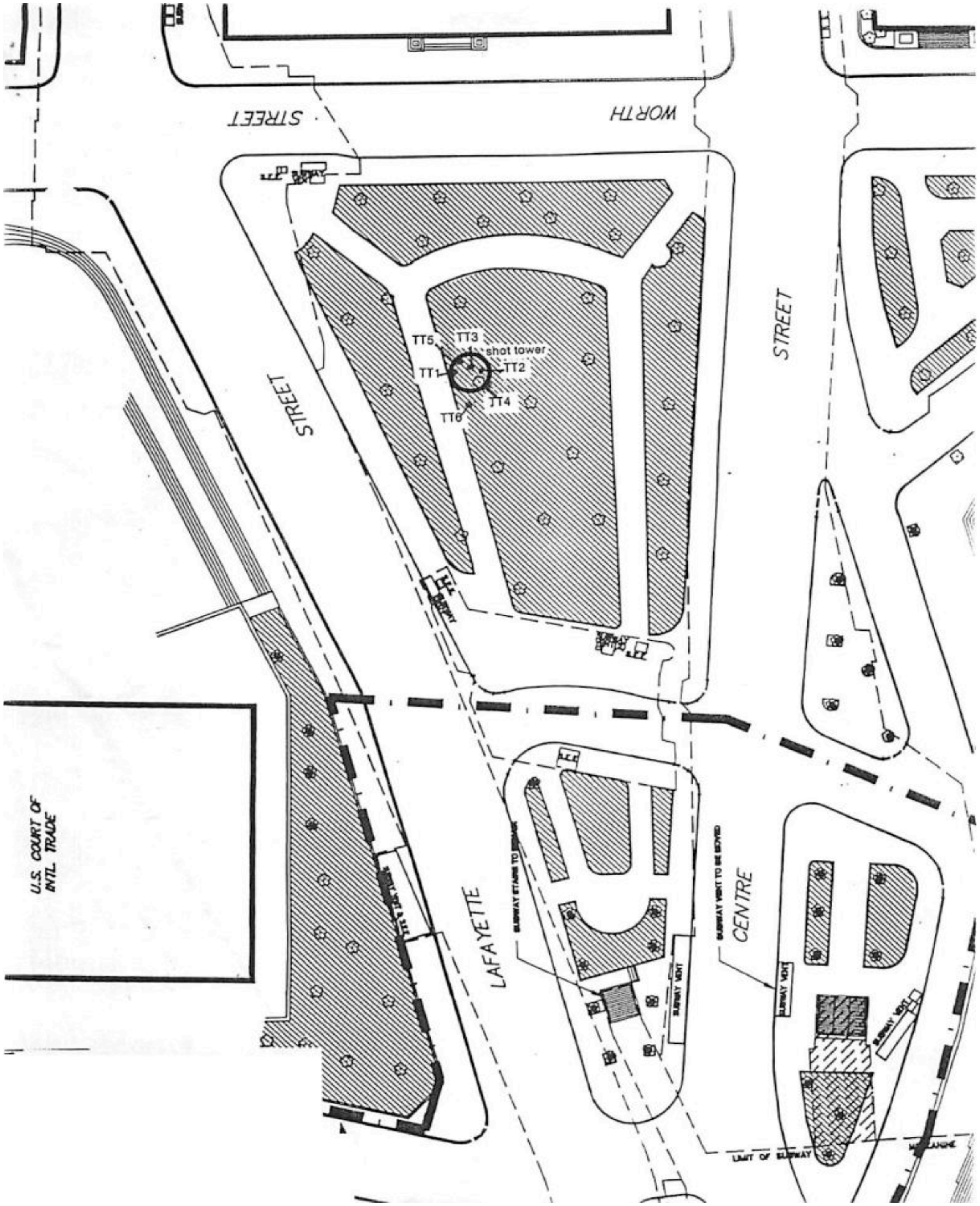
> Shot is produced by dropping melted lead through a sieve, or drop pan, which is situated at the top of the tower, to a tank of water at its base, the falling lead in its descent assuming a spherical form. The largest shot produced this way is .20 in. in diameter and is dropped about 200 feet. Subsequent to this operation a polish is produced by rotating the shot in barrels along with graphite (Steinmeyer 1955:22).[11]

An article in an 1865 edition of Frank Leslie's Illustrated Newspaper (December 16, 1865:204) offers a more detailed description of the shot-making process. It also has a beautiful sectional view of what is identified as the McCullough Shot Tower, but is in fact more likely to be the structure erected by the Tatham & Brothers.

*Bannister (ibid.)is again mistaken when he says that demolition of the tower was due to construction of the IRT subway which passes "directly under the site of the tower" (1957:18 fn 99). The IRT was opened in 1904, four years before the tower was razed. It passes near, but not under, the site of the tower which appears to have remained undeveloped [prior to becoming a park] (see Figure 31[in Geismar 1993]).

[10] Stokes, I. N. P., *The Iconography of Manhattan Island* 1915-1928. Vols. 1-6. Robert H. Dodd, New York. 1967 Arno Press Reprint.

[11] Steinmeyer, Harry G., 1955. The Stapleton Shot Tower. *The Staten Island Historian.* Vol. XIV. Staten Island Historical Society.



Foley Square Reconstruction
TT1-6 Locations
9/19/94 and 9/20/94

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APPENDIX B:

A Geoarcheological Assessment of the Buried Landscape at the
Foley Square Reconstruction Area, New York, New York
by
Joseph Schuldenrein, Ph.D., Geoarcheological Research Associates, Inc.
2003

A Geoarcheological Assessment of the Buried Landscape at the Foley Square Reconstruction area, New York, New York

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July 18, 2003

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Objectives

The following study has been undertaken to reconstruct the environments and history of the buried landscape at the site of former backyards 516 and 518 Pearl Street. The project area is in the southern portion of Thomas Paine Park within the Foley Square Reconstruction area (Figure 1). Research was initiated when archeologists emplaced a boring (B-1) through the substrate and identified evidence of intact stream and marsh deposits beneath 24 feet (7.2 m) of historic fill and debris. The sensitivity of the area is underscored by its proximity to archeologically significant locations, most prominently the African American Burial Ground, but also the MCC Tunnel at the Five Points locality, and a recently excavated 19th century well site at Worth Street (Figure 2). Geoarcheological analysis involved examination of sediments at Boring B-1, on the property circumscribed by Pearl Street (south), Center Street (east), Worth Street (north), and Lafayette Street (west). Preliminary observation of sediments showed that the chronology of events immediately preceding the historic occupation of the Foley Square vicinity could be assembled by dating the undisturbed organic horizons underlying the historic fill. An assessment of the dated sediments might provide information on the evolution and sequence of environments that gave rise to the Collect Pond, a key feature of the early colonial landscape of Lower Manhattan.

Previous subsurface investigations in the area identified deposits indicative of complex landform changes over the course of late glacial and post-glacial times. Sequences indicate the presence of ice-related features (i.e. pro-glacial lake beds, deltas, glacial kames and outwash trains) and post-glacial landscape elements including ancient stream channels, ponded basins, and buried soils. Overlying stratigraphies preserve evidence for large scale historic relandscaping. The old Collect or Fresh Water Pond was a landmark of Dutch and British settlement of Lower Manhattan. In the 18th and early 19th centuries the Collect was associated with the development of the tanning industry (Geismar 1993; Yamin et al. 1995a, 1995b).

Historic maps suggest that the western margins of the Collect and its southern sub-basin, "The Little Collect", abutted Lafayette Street and that the sill separating these two former bodies of water immediately underlies Worth Street (Geismar 1993: Figure 8; Yamin et al. 1995a: Figure 12), at the approximate location of the project area. Most recent mapping indicates that the major Pearl Street tanneries were to the east (Yamin et al. 1995a: Figure 12), but the presence of additional processing centers could not be precluded.

A central objective of the geoarcheological study was to develop a timeline that linked sediments to events leading up to and post-dating the emergence of New York's prehistoric shoreline. Radiocarbon dates were obtained from undisturbed organic horizons that dated a continuous 5000 year sequence related to Holocene shoreline evolution.

Methods and Procedures

The boring was excavated on April 14, 1999 by Dr. Joan Geismar. Sediments were cored using a machine mounted split spoon augur that extracted 1 1/2" diameter samples. Specimens were recovered and described in the field and then placed in sample jars for formal sedimentological identifications at the facilities of Geoarcheology Research Associates (GRA). Excavation of the boring extended to a depth of 32 feet (9.7 m) beneath ground surface. Initial field inspections disclosed the interface between historic fill and undisturbed sands and peats at 24-26 feet (c. 7.6 m) below ground surface. Absolute elevations at ground surface were 16-17 feet (5 m) AMSL.

Archeological field descriptions noted an uppermost massive fill dominated by brick and cement rubble in a reddish coarse sand (5YR 4/4) to sandy gravel matrix. Larger debris included brick fragments and flaggy rubble derived from 19th century building and construction activity. Water table was encountered at 20 feet (6 m) below surface. From 20 to 26 feet (6.1-7.9 m) the consistence of the historic fill changed and included red sands and gravels interbedded with silt lenses and more diffuse intrusions of cultural debris. The disconformity between the lower fill and a series of stratified red and brown sands, peats (10YR 2/1), and grey silts (2.5Y 6/1) marks the separation of the historic and near shore to estuarine landscape. The latter sediment complex was of obvious sub-tidal origin. On closer inspection these represented cyclical shoreline accretion stages and short term fluctuations along the land margins.

Sediments below the base of the historic fills—between 24 and 32 feet (7.3-9.7 m)--were described in the laboratory after fresh ped faces were exposed from the core specimens. Observations were made of Munsell color; texture; structure; consistence; and horizon boundary. Stratigraphic terminology and criteria are per the most recent guidelines set forth in the International Stratigraphic Guide (Salvador 1994). *Geo-stratigraphic units* were used for defining discrete depositions. Geo-strata established how sediments were laid down by natural agency, in this case primarily by water and near shore wave action; the uppermost sediments were modified by extensive landscape reworking ("fill"). Soil terminologies were not used in this study because formal soils were not recognized in the core. Soils are typically used to determine the type and extent of weathering (or sediment transformation) in place (with variants of "A-B-C" profiles). They typically mark surfaces of stability in which prehistoric or early historic topographies could be reconstructed. The geo-strata provide the most appropriate baseline for organizing the B-1 sequences because most of the sediment bodies were representative of rapid and/or episodic accumulation. This applies to the historic fill as well as to the near shore and estuarine deposits. While no formal soils were recognized in Boring B-1 a stable surface (and soil) was preserved at the nearby Worth Street site (Figure 2) and its significance for the regional chronology is discussed subsequently.

Four (4) organic sediment samples were taken from sand-peat-silt complexes for radiometric dating. Two peat samples were dated by standard radiometric procedures.

Single samples from the gray silts and red-brown sands required AMS dating because of low carbon contents. While bulk sediments are less than ideal for radiocarbon dating because of potential contamination and taphonomic concerns, the refinement of AMS dating techniques coupled with recognition of the source of potentially datable sediment has enhanced the utility of the method (Martin and Johnson 1995; Taylor 1997). Humic acid dates represent the Apparent Mean Residence Time (AMRT) for organic material that has decomposed (Matthews 1985; Scharpenseel and Schiffman 1977). The material processed provides an order of magnitude age for environmental events and buried surfaces. In this study, both conventional [^{14}C] and calibrated [cal yr B.P.] radiocarbon ages are reported (Stuiver et al. 1998) as appropriate (Appendix 1).

This account begins with a brief background of the Late Quaternary geoarcheology of Lower Manhattan. It proceeds with a description of the stratigraphy of borehole B-1 at Foley Square, followed by the results of radiocarbon dating. A limited reconstruction of depositional environments is then presented. Results of the Foley Square investigations are subsequently integrated with the emerging subsurface chronologies and reconstructions of Lower Manhattan. Finally, a comprehensive statement on landscape history and archeological potential is proposed.

Late Quaternary Landscapes of Lower Manhattan

The prehistoric potential in the vicinity of Foley Square is of considerable interest to archeologists, because of its unique estuarine setting and the proven sensitivity of brackish environments for aboriginal and historic sites in the Northeast and Middle Atlantic areas (Schuldenrein, 1994.; Thorbahn and Cox 1988). Across Lower Manhattan, however, remnants of glacial features, principally steep sided hills called kames, that chronicle the latest (Woodfordian) advance, have resulted in the estuarine record's being preserved in select locations only. More significantly, Euroamerican landscaping and industrial-age development have irreparably destroyed native natural contours, landforms, and drainage nets. Thus, the surface elevations in the vicinity of Foley Square, currently 15-35 feet (4.5-10.5 m) above Mean Sea Level (MSL) (Geismar 1993: Figure 9), represent cumulative buildups of historic debris and redeposited landfill. Fortunately, 18th, 19th and early 20th century geographers' and geologists' accounts provide considerable information on "pre-fill" colonial-era terrain and stratigraphy (Cozzens 1843; Gratacap 1909; Reeds 1930; Schuberth 1968). These accounts facilitate interpretations of natural landscapes. The most critical pre-industrial age feature in the project area was the Collect Pond, the main interior impoundment of Lower Manhattan (Andrews 1893; Neville 1994). Several reconstructions of the Collect's location have been attempted (Geismar (1993; Yamin et al. 1995a) and its general setting with respect to the 18th century landscape is shown in Figures 3 and 4. No single depiction of the Collect can be considered completely accurate, since the margins of the pond varied with respect to seasonal and yearly discharge from its feeder springs and surface runoff; historic survey error is also critical in assessing the precision of the feature's placement for the various historic maps.

In the vicinity of the project area, subsurface archeological explorations have largely concentrated on historic sites, such that the relationships between aboriginal occupations, natural surfaces, and the changing shoreline of Lower Manhattan have not been documented in any detail (although see Skinner 1942). While researchers have postulated that the water levels of the New York City vicinity may have risen by as much as 45 feet (14 m) over the last 6000 years (Newman et al. 1969; Schuldenrein 2003), there is, to date, no direct association between prehistoric remains and the submerged shoreline of Lower Manhattan. The earliest historic shorelines recorded to date are those of the 17th century (Rothschild and Pickman 1990). A recent compilation of radiocarbon dates spanning a broad range of on-shore and offshore deposits in the vicinity of New York Harbor has shown that sediments on the order of 15-20 feet (5 meters) below sea level are generally less than 5000 years old, although considerably older (i.e. Late Pleistocene) lake beds are preserved at around these depths in the Hackensack Meadowlands to the west (Thieme 2000: Table 1; Thieme 2003).

Regional Geology and Late Quaternary Stratigraphy

Accounts of the surface and immediate subsurface geology of Lower Manhattan are numerous, but one of the more comprehensive is that of Newman et al. (1969) who developed a depositional chronology for the Hudson Estuary. Their model mapped the general sequence as consisting of bedrock (typically gneiss and schist) at depths of 200 feet (60 m) BMSL. Bedrock is overlain by what has been referred to as limited "bodies of till" and/or similarly thin distributions of varved lake (lacustrine) sediments between 125-200 feet (38-60 m) BMSL (see also Reeds 1930). The local pro-glacial lakes included Hudson, Albany, and Flushing as well as Hackensack and Bayonne to the immediate west (Stanford 1997; Stanford and Harper 1991; Stone et al. 2002); lake Bayonne apparently extended around the tip of Manhattan Island beyond the East River (Stone et al. 2002: Map I; see also Schuldenrein 2003). Above depths of 100-125 feet (30-38 m) BMSL are more extensive sands and gravels that represent erosional deposits of the post-lakes period. These deposits signify a major fluvial episode associated with terminal and post-glacial meltwaters (after 13,000 B.P.). These sediments immediately underlie the Holocene marine deposits of the transgression along the Hudson Estuary.

Transgressive sediments are generally found above 130 feet BMSL and contain distinctive organic silts and peats. These will extend to within several feet of contemporary sea level. It is emphasized that the organic silts and peats are typically interdigited with coarser sands, since they represent oscillations in the transgression of sea level. The sands are derived from glacial meltwaters and fluvial beds that were constantly reworked during Holocene oscillations along the shoreline. Thus, depending on location, the sands-peat-organic complexes represent cyclical depositions, often tens of meters deep. These deposits are of most immediate concern for contemporary geoarcheological research, since their uppermost thicknesses register the interface between the oldest natural surfaces and the initial cultural (prehistoric and historic) occupations. Deposits above sea-level typically consist of urban fills that account for elevation ranges across Lower Manhattan of 10-20 feet AMSL (3-6 m).

The "bedrock-lake bed-fluvial sand-estuarine silt-urban fill" sequence is generalized at best. Considerable variability can be expected even within the substrate of Lower Manhattan. Such factors as iso-eustasy ("post-glacial uplift"), fluvial dynamics, and the glacial topography have modified local landscapes and the composition and distributions of sediments underlying them. As discussed further on, estuarine deposits are often not encountered over the course of geoarcheological deep testing below sea-level because the remnants of terrestrial glacial features (kames, terraces, and outwash trains) extend many meters below sea level, depending on the original configuration of glacial topography at the margins of the Harbor Hills moraine, which marked the terminal Woodfordian advance (Sirkin 1967, 1986).

The bedrock geology of Lower Manhattan has been extensively researched, and depths to the basement complex were mapped as early as the mid-nineteenth century (Cozzens 1843). In Lower Manhattan micaceous schists of the Manhattan Formation are encountered 80-330 ft. (25-100 m) below surface (Schuberth 1968; Newman et al. 1969), well over 50 ft. (15 m) beneath the lowermost depths reached in Foley Square/borehole B-1.

Early geographers and geologists were aware of the extent and thickness of the local unconsolidated glacial deposits (Cozzens 1843; Hobbs 1905). Sediment complexes were mapped variously as "Diluvium" or "Drift" and were not typically differentiated by outwash (stream derived) or till (glacial front) facies. Surface sediments have been formally mapped on a large scale, most recently in a compilation of the Hudson River Quadrangle (4°x6°) by Fullerton et al. (1992). Quaternary deposits in Lower Manhattan were classified either as "lake, ice-contact, and outwash sands" or "sand to clay till (ground moraine)", thus establishing the complex glacial landform configuration at the ice front. At the close of the Pleistocene (18,000-12,000 B.P.) glacial lakes Hudson-Albany and Hackensack-Bayonne merged near lower Manhattan, leaving distinct varve sequences at lower elevations (Newman et al. 1969; Schuldenrein 2003; Schuberth 1968; Stanford 1997; Stone et al. 2002); local exposures are rarely preserved because of post-glacial erosion, scouring and effects of upwarping. Schuberth (1968: 188) calls attention to surface glacial features, specifically "low and relatively steep-sided hills of sand and gravel called kames" north and west of New York City that are accumulations of rock debris carried in by glacial activity. As discussed below, the kames were the prominent hills that hemmed in the Collect Pond prior to extensive leveling activities in the mid-19th century.

Geotechnical Explorations at Foley Square and Vicinity

Boring and subsurface exploration in the Foley Square project area have been undertaken several times over the past 150 years in conjunction with construction programs in Lower Manhattan. Gratacap (1909:36-40) has summarized some of the earliest historic logs, describing two stratigraphic sections that extended up to 100 ft. (30 m). The first (near Centre Street) consisted of upper levels of "made ground" (land fill) underlain by black muds, blue clays, and gravel and rocks". The second (at Broadway and Cedar) featured 8 feet (2.5 m) of land-fill atop fine sands and "running sands". Gratacap (1909: 40) correctly attributes deposition of the finer materials (sands, muds, clays) to the action of running water, while coarser components--gravelly sands and rock--represent resorted glacial drift. In retrospect, it would appear that the uppermost muds and clays beneath the fills represent either terminal glacial lake sediments or the onset of Holocene estuary formation, probably the latter based on current topo-stratigraphies and radiocarbon dates (Schuldenrein 2003; Stone et al. 2002). The Gratacap (1909) accounts of upper profiles correspond to intact estuarine sequences assembled for upstream locations (see Newman et al. 1969). As noted, much of the evidence for near shore sedimentation and stabilization of the Manhattan shoreline (around 5000 B.P.) has been destroyed by twentieth century grading activities.

Three (3) sets of more recent geotechnical core logs are available for scrutiny. Two of these are from Foley Square and one is from the structural probing associated with the Worth Street project (200-600 feet west of the project area; Figure 2). Results of each are presented in turn.

In an earlier phase of the Foley Square project Geismar (1993: Table 1 and Figure 9) reviewed a series of more than forty (40) bore logs from 1914 to 1937, during construction of the Court House. Some of these borings in the vicinity of Boring B-1—those reaching depths in excess of 30 m (100 ft.)—are shown in Figure 5. While the logs suggest considerable variability in the substrate, much of this is in the upper 17 feet (5 m) and represents episodic, highly localized land filling. Most significantly, the descriptions suggest that land fill extends to in excess of 20 ft. (6 m). Underlying sediments are dominantly "gravels and sands" and various grades of sorted sands, typically gray to red in color.

A second series of forty eight (48) borings was undertaken in preparation for construction of the Foley Square Courthouse Annex in 1971 (Gruzen 1971). These spanned the square block bounded by Cardinal Hayes Place, Park Row, Pearl Street and Duane Street (Figures 1 and 2). Descriptions for this series are slightly more detailed than those presented for the Court House and identify several facies changes between 20 and 27 ft. (6-8 m), and specifically within the red-brown sediments generally considered to be of alluvial origin in the older logs. Depth of land fill is extremely variable, ranging between 3 and 13 ft. (1-4 m). It is noted that surface elevations in the area are on the order of 14.5 ft. (4.4 m) such that fills extend just barely to elevations of ±0 ft. (0 m) AMSL, effectively to sea level depths.

For the Worth Street project, Mueser Rutledge (2001: Figure B-1) excavated eleven (11) borings generally around the perimeter of the site (Schuldenrein 2002). These verify that typical profiles are capped by 20 feet (6.1 m) of fill above 60-90 feet (18-27.3 m) of sand. Coarser gravelly-sand deposits were only identified at depths >90 ft. (27.3 m) on the northern edge of the site (along Catherine Lane; see Figure 2).

While the coring logs are of assistance, it is cautioned that their gross scale of observation limits their utility for interpretations of Quaternary sedimentation, landscape history and chronology. At best, the bore sections present only a broad measure of vertical resolution delimiting the most rudimentary breaks in sediment type.

The extensive landscaping in the vicinity of Foley Square has removed much of the Holocene and potential archeological horizons. Fine scale stratigraphic breaks that may preserve sedimentary evidence for land use between the prehistoric through early Euro-American agricultural and industrial periods are missing and cannot be identified in boring logs. The MCC Tunnel is one of the only examples of a site that preserved a well dated historic through prehistoric age sequence (Yamin et al. 1995a).

It is nevertheless possible to disclose the following sedimentary trends in the local stratigraphic column:

- Red brown sands intercalated with brick and rubble debris are pervasive in the upper 20 ft. of sediment underlying most of the streets;
- These sands (originally reworked alluvium and/or glacial outwash) represent episodes of yard landscaping and filling that began in the 17th and 18th centuries and became more systematic and intensive in the 19th and 20th centuries;
- Beneath the historic sands or laterally isolated from them there are isolated basin peats, silts and sands documenting the Collect Pond and attendant early historic swamp and marsh basins;
- At depths approaching sea-level (0 ft. AMSL) sandy-rubble fill sequences are underlain by late Quaternary stream ("alluvial or fluvial"), lake margin ("deltaic"), or glacial ("till") deposits that are brown-tan in color and are often bedded and stratified;
- At select locations the lateral continuity of the glacial deposits is disrupted by finer grained peats and estuarine deposits indicative of Holocene sea-level changes (i.e. still stands and transgressive pulses).

Historic Geography

The footprint of Foley Square straddles a pre-industrial age landscape that was significantly different from that of today. An early account describes the immediate landscape as featuring a central pond (the Collect) surrounded by high hills and bordered by a marsh (Lispenard Meadows) (Gratacap 1909: 52). As discussed, most of the 18th and 19th century maps depict the hilly terrain surrounding the Collect (Figures 3 and 4), although dimensions and locations of the landforms vary between sources. However, all sources indicate that the B-1 core penetrates terrain that was swampy and marshy well into historic times.

Figure 6 depicts the pre-industrial age landscape superimposed on the contemporary street grid of Lower Manhattan. The reconstruction was developed from the earliest historic maps, supplemented by field observations by the author at the Worth Street and the MCC Tunnel sites (Figure 2). It is instructive for guiding interpretations of the subsurface stratigraphy of the general project area.

As shown, three (3) prominent landforms fashioned the physiography of the area. These include two glacial kames and the 18th century Collect Pond. Kames are glacial features, typically low and relatively steep-sided hills of stratified sands and gravels that were laid down along the lower Hudson Valley during the terminal glacial (Woodfordian) advance, ca. 14,000 B.P. Both kames appear as extensive hills in the Viele (1874) map of the late 19th century. Figure 6 shows that the northernmost kame once extended eastward to the Worth St. site (see also Figures 3 and 4). This feature was named Kalkhoek Promontory by the Dutch (Neville 1995). The southern kame—historically known as Catimuts Hill (Gratacap 1909)—may have delimited the southern limits of the Collect.

Kalkhoek Promontory was a massive feature extending at least 1200 feet (364 m) north-northeast and spanning 1000 feet (303 m) east-west. The 18th century maps show it as an extensive interfluve, perhaps consisting of two north-facing lobes (Figure 4). Gratacap (1909: 30) describes it as "….a hill whose substratum forms the down grade to Broadway toward Canal Street, rose at Franklin Street and declined towards the still obvious hollow of Centre Street, commanding the Collect Pond and the inconspicuous city to the south." The landform was so prominent that as late as 1772, Broadway terminated at Duane Street and the kame itself was identified as "… a noble hill covered with fine fruit trees known as Rutger's Orchard. The ground was much higher then than now" (Brown 1913: 283). Figure 4 shows that in 1793 it was mapped as being 100 feet high. By the mid-19th century the kame may have been partially razed, since an 1843 account notes that it was only 25-30 feet (7.5-9.1 m) above street level. That account suggests that the "built landscapes" of this part of Lower Manhattan had not yet been elevated to present levels—15-20 ft. (4.5-6.1 m) AMSL (Cantwell and Wall 2001: Chapter 13).

Figure 6 shows that the foot of the southern kame extended westward to Broadway. It was known as Potters Hill in some accounts (Figure 4). The landform is also described as an extremely steep "…. high hill known as Catimuts Hill (probably an Indian name) to the Fresh Water brook that ran from

Collect Pond to the East River" [probably the Eastern Outlet in Figure 6] (Gratacap 1909: 60-61). The prominence of Catimuts Hill cannot be overestimated. The Viele (1874) map shows that it was traversed by Park Row and lower Chatham Street from whence it descended steeply to City Hall Park (Figure 6). The Commons were situated on the southeast segment of the landscape (Brown 1913). Catimuts Hill may once have been part of a continuous glacial feature that merged with the northern outcrop; only Reade and Duane streets were part of the lower lying terrain separating Kalkhoek Promontory and Catimuts Hill. It is certainly possible that Dutch-era landscaping resulted in the leveling of discontinuous segments of the elevated terrain.

The third prominent and defunct feature of the early historic landscape was the Collect Pond. The Collect emerged from a residual glacial drainage line and was probably a former tributary to the Holocene Hudson trench. Early colonial accounts alluded to the Collect as the largest of a series of bog-like ponds, surrounded by hills (read kames), that spanned the lower portions of the [Manhattan] island (Brown 1913; Cozzens 1843; Gratacap 1909). Figure 4 underscores the extent of poorly drained swamps and impoundments covering the terrain north and east of the kames; these may have been part of a continuous basin in the latter Holocene. The historic Collect was approximately 10 acres in extent and waters extended to depths in excess of 50 feet (15 m) (Andrews 1893). The pond was fed by numerous natural springs. In the early 1700's the Collect was heavily stocked with fish and served as a skating pond during the winter. Shortly thereafter, the Collect Pond became the central processing station for a burgeoning tanning industry that had continued to migrate progressively northward from the tip of Manhattan. The Pearl Street tanneries were the most prominent during the 18th century and utilized the Collect Pond and its ancillary effluents (i.e., Eastern Outlet) for hide processing, possibly draining the springs and influents that supplied fresh water to the local basin (Rothschild 1990; Neville 1995; Geismar 1993; Yamin et al. 1995a). The earliest plot of the tanyards in the vicinity of the Collect Pond was the Maerschalck map of 1754 that traces a line of buildings parallel to the north bank of the presumed Eastern Outlet.

The Pearl Street facilities were optimal for tanning because hide processing requires the use of both flowing and standing water. Both were available at the Collect, since it was a spring-fed pond. Quiescent pools were utilized for the construction of vats in which liming and curing solutions required submergence in solution vats for weeks at a time.

Historic accounts of the early days of the tanning industry verify the logistic preference of artisans for tidal margins. Springs, salt marshes, streams, and tidal zones collectively provided advantages for completion of separate stages of the tanning process. Such locales also afforded strong wind currents which would dissipate the foul odors generated from the process (Tomlinson 1854). When the natural tidal margins fell victim to urbanization or pollution (partially because of over-utilization by the tanners), the industry migrated to locales offering the optimal mix of hydrographic resources formerly available at shoreline margins. A number of accounts verify that there was a trend for the tanning yards to move northward on Manhattan Island in search of necessary swamp basins and running water for hide processing (Neville 1995).

By the early 19th century, the delicate balance between supplies of fresh spring water and more saline tidal waters had apparently shifted irrevocably and the tanners abandoned the Pearl Street complex. In 1805 the Collect was entirely covered over, after a debate was raised as to whether a canal should be left running through it. By this time, the pond had become a foul smelling, stagnant pool in which rubbish and especially animal carcasses and hides were discarded. New Yorkers began to fill in the Collect with earth from the construction of City Hall's foundation (Cozzens 1843). Once filled in, the former pond became the site of the prison referred to as the Tombs.

The historic utilization of the Collect has critical implications for the availability of fresh water in historic lower Manhattan. Sources of fresh water in lower Manhattan were rare, as documented in the earliest historic accounts. Gratacap (1909: 53), citing these accounts, noted that in 1690 there were about a dozen public wells and that the water was of poor quality. The Maerschalck map (1754) illustrates the emergence of the Eastern Outlet as a funnel draining the eastern divide of Manhattan Island. Its evolution was apparently linked to the general lowering of the water tables by the drainage of Lispenard's Meadow (1733) north of Kalkhoek Promontory and the localized rechanneling of the Outlet in conjunction with late 18th century tanning activities (Figure 6). The lowered water table was partially due to the increased dependence on the spring waters by the tanners, but also because of reclamation of the surrounding terrain and attendant drain construction by Anthony Rutgers (see Neville 1995: 68 ff). As a result of water table depression, wells began to proliferate in Lower Manhattan.

In the present landscape reconstruction, the dimensions of the Collect Pond are taken from primary sources and the boring logs (Figure 5). They generally follow the contours of the Viele (1874) map. Significantly, the "Tanning Complex" straddles the sill of the Collect Pond, the high ground separating the sub-basins. The sill would have been the most logical place to dry and process the hides, since it was readily accessible to both sub-basins. The controls afforded by artificial drainage would have enhanced the logistical advantages of this locale. It is assumed that since 1733, when the Collect Pond was originally drained, municipal agencies were sensitive and responsive to the needs of the industrial interests of the city. The benefits of establishing tanning complexes along the southern sill of the Collect Pond was to utilize the intermittent marshes at the margins of the Collect for the construction of the tanning vat networks. Boring B-1 appears to occupy such a setting in the “Little Collect” sub-basin or in the intermittent marshes where the same activities would have taken place (compare Figures 3, 4, and 6).

<u>General Core Stratigraphy</u>

The uppermost 24 ft. (7.2 m) of sediment is a weakly differentiated fill. Field descriptions confirmed that dense concentrations of gravel, brick rubble, cinder, macadam and cement were the dominant larger clastic components of the upper fill (Plate 1). At depths of 8-10 ft. (3 m) a reddish (5YR 4/4) coarse sand to sandy gravel was encountered, suggesting a deep but distinct filling episode (Plate 2). Both components of the fill were designated *Stratum 1*.

Detailed examination and dating of sediments began beneath the lowermost fills at >24 feet (7.2 m) below ground surface. Figure 7 shows that Strata 2 and 3 were contained within the lowermost 8 feet (2.5 m) of the B-1 core [depths of 24-32 feet (7.2-9.7 m)]. Stratigraphic separation was based on chronology and structural and textural changes in unit lithology. Units were also separable by sedimentary processes and origins.

Stratum 2 is 3.2 feet (1.0 m) of a dominantly black (10YR 2/1) accumulation of laminar to fibrous peats (Plate 3) with a thin gray (2.5Y 6/1) silt band at 25 feet (7.6 m). It is disconformably separable from *Stratum 3* by a 1.5 ft. (0.5 m) gray (2.5Y 5/1) peaty-silt (Strata 2/3 interface in Figure 7). The peats are equivalent to the uppermost "organic silts" described by Newman et al. (1969) and McCrone (1966) for upper Hudson estuary, where they attain thicknesses of many tens of feet. Near the mouth of New York Harbor this is a considerably thinner and more localized accumulation (see Newman et al. 1969: Figure 1).

Stratum 3 extends to a depth of > 4 feet (1.2 m) and is a series of reworked red (5YR 4/4) outwash and/or fluviatile sands with two thin bands of fine-medium gray (2.5Y 4/1) organic sands (Plate 4). The limited exposure in the boring precludes detailed observations of sediment structure, which is critical for confirming depositional context. Preliminary indications are that the sands are massive which is consistent with fluvial reworking of glacial source materials in the New York Harbor area (Schuldenrein et al. 2000). The sands are capped by 2 feet (0.6 m) of light brownish gray (2.5 Y6/2) organic silts marking the terminal deposition of the unit.

The composite stratigraphy may be summarized as follows (youngest to oldest), using dates obtained from the cores (see discussion below):

1. **Historic Fill, Overburden (0-24 ft.; 0-7.3 m)**
   18th (?), 19th and 20th century landfill, rubble, and residua of urban habitation (i.e., foundation and construction debris) with at least one discrete episode of landscaping near base of sequence;

2. **Late Holocene Estuarine Peats and Silts (24-27.5 ft.; 7.3-8.3 m)**
   Shoreline peats and muds (<3000 B.P.) of the tidal to sub-tidal flats marking the edges of the meta-stable coastline;

3. **Middle to Late Holocene Near Shore Deposits (27.5->32.0 ft.; 8.3->9.7 m)**

> Nearshore sands marking the latter phases of the transgressive shoreline (3500->4700 B.P.); coarse sands may be reworked fluviatile deposits and/or reworked Woodfordian (glacial) outwash sediments.

Radiocarbon Chronology

The sequence of depositional environments was indexed by four (4) radiocarbon dates, two each from Strata 3 and 2. The dates were in correct stratigraphic positions: oldest to youngest from the base to top of the 8 ft. (2.4 m) segment of the core immediately underlying the historic fill (Table 1). Appendix A presents the report of radiocarbon dating analysis along with the calibration to calendar years. The determinations from the peats of Stratum 2 involved standard radiometric treatments. Smaller organic concentrations in the silts and fine sands of Stratum 3 necessitated accelerator mass spectrometry (AMS) treatments for these specimens. Conventional ages are presented in the core sequence shown in Figure 7.

The radiocarbon determinations show that the interval of peat accumulation (Stratum 2) is bracketed between 2490±60 B.P. (Beta-130394) and 1220±50 B.P. (Beta-130393). The calibration curves place the dates between 2750 and 980 B.P (Appendix A). More dynamic near shore sedimentation (Stratum 3) is dated to between 4630±40 B.P. (Beta-130396) and 3500±50 B.P. (Beta-130395), corresponding to a calibrated age range of 5500-3700 B.P.

Both the corrected and uncorrected radiocarbon dates converge around the transition from active shoreline progradation to the onset of the estuarine environment at this inland location between 3500 and 2500 B.P. That shift is registered stratigraphically by the accretion of peaty silts at depths of 27-28 feet (8.5 m) (Figure 7).

While no evidence for prehistoric habitation was identified in the core, it is significant that the sedimentological evidence of the transition to the Late Holocene Hudson estuary is co-incident with the Late Archaic to Woodland period succession in eastern North America (Funk 1976; 1993). Broader geoarcheological implications of the Foley Square/B-1 sequence are discussed below.

Geoarcheology and Depositional History

The Foley Square core offers a limited window on shoreline developments and the evolution of the estuary along the New York City shoreline. The record begins in the Middle Holocene (after 5000 B.P.) and preserves a continuous 4700 year record of shoreline construction above surfaces that were formerly overridden by glacial features and pro-glacial lake sediments. It is unfortunate that probing did not extend beneath elevations of –15 ft. (-4.5 m) BMSL, since the stratigraphy would have been able to clarify the transition between the late to post-glacial fluvial sand deposition and the emergence of the estuarine environment.

The top of the estuarine sequence is truncated by 19th century historic deposits; earliest historic shore sediments were not identified in the core, although regional evidence indicates that a more extensive exposure at this location may provide such information. To date, the evidence for early Holocene sedimentation in New York Harbor is sparse, and preliminary indications are of extensive erosion during the early post-glacial, following the disappearance of the pro-glacial lake complexes of the Lower Hudson drainage basin (Schuldenrein 1995a; Schuldenrein 2003; Thieme 2000).

The most recent and comprehensive mapping of the Hudson estuarine stratigraphy is that of Stone et al. (2002). While their mapping of the surficial geology did not formally extend into New York State, the subsurface units underlying the shallow channel floor of the Hudson were mapped as tidal marsh and estuarine deposits ("Qm") and those extending onto Manhattan Island were designated glacial Lake Bayonne sediments ("Qrbn") (Stone et al. 2002: Sheet 3, Section C-C'). Boring B-1 actually penetrated sediments of the "Qm" unit beneath the 24 ft. (7.3 m) thick accumulation of historic fills. Stone et al. (2002: 3) note that such sediments are up to 10 ft. (3 m) thick in northern New Jersey, and Schuldenrein (2003: Figure 2) has dated estuarine deposits in excess of 50 ft. (15.5 m) in Jersey City. These data argue that depths to the base of the tidal deposits are locally variable and that the unconformable contact with the Pleistocene sediments is not predictable.

Sediments of Early Holocene (ca. 10,000-6000 B.P.) age are ubiquitously absent in the most recent reconstructions of the late Quaternary history of the lower Hudson drainage (Newman et al. 1969; Schuldenrein 1995b; Stone et al. 2002; Thieme 2000). Significant exceptions come from archeological sites, specifically a complex of Early to Middle Archaic assemblages dated to the interval 9500-7200 B.P. (Ritchie and Funk 1971; Kraft 1977) along the western margins of Staten Island. The unique preservation contexts of these sites is their association with terminal moraine deposits overlooking what were the key streams of the late glacial to early post-glacial periods (Schuldenrein 1995a; Schuldenrein and Thieme 1996). More typically, post-glacial fluvial sedimentation and encroachments of the Early Holocene shoreline would have eroded lower lying settings of this age. Most recently Schuldenrein (2003) obtained a date of 9140±70 B.P. (Beta-17334) from Jersey City at a depth of –55 ft. BMSL (-16.7 m) that may be a relict slackwater feature of Glacial Lake Bayonne.

The subsequent record of estuarine developments is variously preserved and documented along the northeastern shoreline of the United States. It provides a comprehensive picture of paleoecological developments since the Middle Holocene (after 5000 B.P.). Drastic reductions in sea level rise followed the stabilization of base levels along the Atlantic coast. Submergence rates in the Middle Atlantic region were slowed by a factor of 4 subsequent to 5000 B.P. (Newman et al. 1969; Schuldenrein 1995b). In contemporary near shore locations—such as Foley Square-- the slowing of the marine transgression during the Holocene means that the setting would have been transformed from a terrestrial riverine terrace, to an estuary and then to an embayment and finally, in engineered urban environments, to a "built landscape". Estuarine landward advances through time are accompanied by progressive incursions of saline waters and halophytic biomes, with local habitats regulated by topography and physiography. These changes are recorded in subsurface profiles. By dating and identifying the composition of the various subsurface deposits, the timing of these habitat changes can be reconstructed (Schuldenrein 1995b; Young et al. 1992).

After 6000 B.P. there is evidence for broad based changes in the lower Hudson estuary. Both Weiss (1974) and Schuldenrein (1992) have identified mosaics of freshwater and saltwater marshes in organic peat and silt interdigitations that uniformly inundated the lower estuary around 3000 B.P. and have continued to accumulate to the present. At Iona Island, about 40 miles (64 km) north of Foley Square, Newman et al. (1969: Figure 2) mark a stratigraphic transition from the earlier Holocene organic silts to fibrous peats sometime before 2500 B.P., although along the edge of the island peat sedimentation began to accumulate directly over bedrock shortly after 5000 B.P. The chrono-stratigraphic transition to the peat sequence mirrors the succession from stratum 3 to 2 at Foley Square (Figure 7), suggesting a regional depositional change. Weiss (1974) notes that over the past 3000 years a decrease in salinity is a result of freshwater infilling of estuarine embayments throughout the Lower Hudson at a rate in excess of sea level rise. This may reflect trends to increased estuarine and coastal siltation as verified everywhere along the Northeast littoral (Bloom 1983). Climatically, increases in moisture and regional cooling are signaled by expansion of oak-pine-hickory forests after 5000 B.P., a trend verified in the Hudson estuarine pollen cores (Weiss 1974: Figure 3 and Table 2). In the later Holocene, dominant wetland species are noted in marshes fringing estuaries in southern New England as well as the New Jersey Meadowlands between 2500 and 1200 B.P. after which a return to drying is suggested (Thorbahn and Cox 1988; Heusser 1963).

Predicting preservation potential for archeological resources in estuarine settings is difficult since despite a propensity for sites to be located at such favorable ecotonal settings—at the margins of salt water and fresh water resources—the range of post depositional disturbance processes is extensive. Stream erosion as well as near shore wave cutting and siltation are likely to act in concert and separately. Moreover, at Foley Square it is not possible to project the archeological potential on the basis of a single core.

Nevertheless, for comparative purposes it is instructive to compare the depositional history of the estuary in Lower Manhattan with an analogous near shore urban setting in Boston, Massachusetts, at the site of the Boylston Street Fishweir. That sequence is also capped by a (historic) “built environment” in proximity of the contemporary shoreline. The site, known since early in the twentieth century, preserved an array of wooden stakes and brushwork, interpreted to be a prehistoric fishweir used to entrap fish and other marine animals (Johnson 1949). Renewed excavations prompted by development in downtown Boston resulted in a program of extensive radiocarbon dating of fishweir materials (Dincauze 1989) and pollen analysis (Newby et al. 1994) that determined that optimal utilization of the site occurred between 4700 to 3700 B.P. The sequence identified five (5) stratigraphically ordered, local pollen assemblage zones based on a 13 ft. (ca. 4 m) deep core bracketed between basal estuarine sediments dated to 5630±90 B.P. and uppermost silts at 1890±60 B.P. The pollen chronologies, in particular, reflect the transition from the fluvial to estuarine habitat, while recording key Middle to Late Holocene environmental trends (Newby et al. 1994).

Figure 8 is a representation of the sedimentation histories for the Boylston fishweir site and Foley Square. Sedimentation rates are calculated for the interval 5000-1000 B.P. based on sequential radiocarbon dates for each project area. The rates are expressed in terms of net accretion (in cm) per millennium. In general sedimentation rates are 20% higher in the Boylston location. However, both stratigraphies demonstrate a general slowing of deposition with time, although local conditions (including topography, storm events, vegetation covers, near shore siltation) may account for spikes in the curves. Accordingly, the New England sequence shows an increased rate of accumulation between 4000 and 3000 B.P., perhaps attributable to the activation of the weirs by the Archaic fisherman at that time; this period immediately preceded the permanent transformation to a marsh environment (Newby et al. 1994). At Foley Square peak sedimentation occurred between 2000-1000 B.P.

More striking, however, are the co-eval transformations of the estuarine micro-environments. Figure 9 summarizes the key facies changes for both sites along with the dominant environmental changes inferred from depositional regimes and the pollen record from the Boylston site. As shown, increasingly saline incursions accompanied by progressively fining grain sizes (B-1) and cyclic settling sequences (Boylston) mark the passage to the estuarine basins around 3500 B.P. Tidal settings are displaced by more permanent marshes, as near shore sedimentation diminishes in both locations as the dynamism along the coast diminishes. This time frame is co-incident with the hickory forest peak in the New Jersey Meadowlands, interpreted as a period of general drying (Rue and Traverse 1997). Expanding salt marshes began to colonize shorelines for the next millennium (to 2500 B.P.), ultimately producing stabilized tidal zones whose margins oscillated within the pre-Euroamerican shoreline. Wetland species prevailed across the saline marshlands. Large scale erosion initiated during the Industrial Age ultimately displaced shorelines and modified drainage patterns to the extent that shorelines were permanently destabilized and are currently being reclaimed and relandscaped.

Finally, a major source of concern is the source materials that account for the unique reddish hue of the parent sands in historic deposits. The matrix is pervasive in historic fills across Manhattan Island. The present investigations suggest that its origins may be attributable to two sources. First, the preponderance of red brick fragments entrained in the fills will, when weathered, imparts the strong hue to the supporting sandy and silty matrix. As noted in the B-1 core, the most prominent components of the detrital population in Stratum 1 are the large fragments of disaggregated brick (Plate 1) which would have weathered and translocated iron-rich minerals into the surrounding matrix. Second, the pervasiveness of red sands in the Holocene deposits, free of larger clasts, implicates a reddish geological source material. At Hanover Square the source facies was considered to be a beach sand (Rothschild and Pickman 1990; see also Cantwell and Wall 2001: 239). The beach sands were an apparent near-shore facies and immediately underlay the initial (17th century Dutch) Euroamerican occupation. However, the erosional origins of the sands were not identified, and they were considered to be a continuously reworked and older Pleistocene outwash. This description conforms to the sediment descriptions for stratum 3 in Core B-1 (Plate 4 and Figure 7). Recent remapping of local surface geology suggests that proveniences are more directly linked to the sandy loamy/sandy-clay tills of the ground moraine, specifically with the unit mapped as the Rahway Till (Stone et al. 2002). The parent matrix is deeply rubefied (5YR 5/4) and could have been eroded and reworked by fluvial transport in the local drainage catchments. Alternatively, the sands could be derived from saprolite or eroded sandstone bedrock of the Upper Triassic Lockatong and Stockton Formations (Drake et al. 1996), both of which were extensively scoured during three glacial cycles and contributed to the outwash deposits and fluvio-lacustrine sediments that were reworked along the transgressive shoreline.

Synthesis: A Model of Landscape Archeology in Lower Manhattan

Field relations and stratigraphy afford a three dimensional perspective on the landscape history. Collectively, the historic map and the subsurface records help to establish the depositional contexts of the sediments and to explain the stratigraphy in the absence of intact landscape relations.

While the site formation model presented above applies directly to the archeological record at Foley Square, its detailed record of landscape change and occupation has more regional ramifications for understanding the evolving human and physical landscapes of Lower Manhattan. As late as the early 19th century, the local terrain still preserved the contours of the immediate post-glacial period. Moreover, the economic foundations of colonial and early post-colonial New York were, in large measure, fashioned by activities dictated by the intensive utilization of local physical and natural resources. In particular, the Collect Pond stood out as the original boundary between town and country, eventually becoming the hub for New York's thriving tanning industry in the 18th century and ultimately the center of the notorious Five Points neighborhood by the mid-19th century (Yamin 2000).

The native geography of the area has been totally obliterated by development over the past 150 years; at least two periods of large scale land-filling resulted in the near complete leveling of the hills and rises that broke up the flat terrain of Lower Manhattan (Yamin et al. 1995a). However, the geomorphic record of pre-settlement New York City is sealed within the subsurface sediments that typically begin nearly 15-20 ft. below street grade. Additionally, it is possible to reconstruct the landscaping events associated with the initial settlement of a good portion of Lower Manhattan by examining the stratigraphic records of several well researched locales in the vicinity of Foley Square.

Figure 10 is a west-northwest to east-southeast subsurface transect spanning three (3) historic sites whose stratigraphies have been recently investigated. They include the Worth Street site (Schuldenrein 2002), Thomas Paine Park north of Foley Square (this report) and the MCC Tunnel at the site of the old Five Points neighborhood (Yamin et al. 1995a). The transect extends for a distance of 1600 feet. It crosses the undulating terrain that historically extended from the southeast margins of the glacial kame at Kalkhoek Promontory (111 Worth St.), through the southern end of the Collect Pond ("Little Collect"; Thomas Paine Park, boring B-1), and across to the southeastern margins of the Collect at the site of the former tanyards at Five Points (MCC Tunnel). To gain perspective, it is noted that the original landforms that formed the local topography are depicted in Figure 6.

Even today, subsequent to systematic leveling and grading, surface elevations range from 17 feet to 28 feet. Present topographic gradients still reflect landform relations that existed in the past, such that the highest elevations flank the ancient Collect Pond setting (B-1), from the edge of the former Kalkhoek Promontory on the west to the open area that marked the eastern extent of the tannery complex near the location of the Eastern Outlet. The latter funneled the waters of the Collect to the East River. The stratigraphies of these formerly higher landforms (at Worth Street and MCC Tunnel) preserve the massive terminal glacio-deltaic (Woodfordian) deposits on which a Holocene Cambic soil formed (Yamin et al. 1995a; Schuldenrein 2002). This sedimentary suite is not contained in the lowerlying B-1 locality whose basal sequence consists of cyclic, time transgressive accumulations of estuarine silts and reworked near-shore deposits. Ironically, evidence for the Collect Pond's signature organic silts, sands, and slackwater clays is present only at MCC Tunnel, which formed the outer margins of the pond basin, and not in the B-1 section where it would be expected. The absence of historic marsh and/or stream sediments at B-1 can only be explained by the depth of filling at this location. As illustrated in Figure 10, fills here extended beneath sea level, thus securing an unconformable interface between the estuarine silts and the lowermost historic fills. Assuming that the depth of the Collect Pond averaged about 10 feet at its margins—and the B-1 core was probably in the vicinity of the shallower "Little Collect"—Figure 10 indicates that the historic fills extend on the order of 5-10 feet beneath the depths of the original Collect Pond impoundment.

Taken together, five (5) discrete sedimentary deposits (stratiforms) form the stratigraphic columns obtaining across the generalized transect in Lower Manhattan (Figure 10). The generalized sequence may be summarized as follows (oldest to youngest):

- **<u>Upper Historic Fill (Unit 5; 19th to 20th century); 15-20 ft.</u>**
  This is a dense, massive, and heterogeneous fill containing poorly sorted, clast supported rubble. The upper 10 feet were churned by heavy equipment to level surfaces while lower accumulations (<5 feet) are often more variable in composition, containing silts and clays that appear to have been laid down on a lot by lot basis. Source material is often reddish sands, derived from reworked older outwash, dispersed the length of Manhattan's original shoreline. This fill forms a near uniform cap across much of lower Manhattan.

- **<u>Lower Historic fill (Unit 4; 19th century); 4-10 ft.</u>**
  Deposits are thickest and most poorly differentiated in Foley Square/B-1. In general matrices are separable from Upper Historic Fill, because there are visible stratified pockets. Stratification is due to localized erosion and deposition across "natural features" (i.e., ponding in yard depressions). Sediment packages contain admixtures of perishable and inorganic cultural materials extending to the unconformity with underlying stratigraphic units.

- **<u>Collect Pond sediments (Unit 3; 17th-19th century); <4 ft.</u>**
  Confined to MCC Tunnel. Deposit consists of organic, low energy stream sands as well as slackwater clays and silts. Laminar to lenticular bedding is characteristic of seasonally discharged alluvium. Perishable cultural materials (wood from tanning vats, waste products, and faunal remains) are abundant throughout. Sediment not identified in Foley Square/B-1 because of burial by later, massive fill.

- **<u>Estuarine silts, sands and peats (Unit 2; Middle-Late Holocene); 6-10 ft.</u>**
  Recognized only at Foley Square/B-1, these are cyclic sets of near-shore, reworked fluvial sands and organic silts. Nearshore sands grade thinner up the sequence, while silts become thicker and progressively more organic (peats to top). Deposits record progressive shoreline stabilization and emergence of tidal environment between ca. 4600-1200 B.P.

- **<u>Ice contact to fluviatile sands and gravels (Unit 1; Late Pleistocene) capped by Cambic soil (Holocene)</u>**
  At MCC and Worth Street only. Very complex and diverse sequence of steep to sub-horizontally bedded sands and gravels, sometimes interdigited with more massive, unstratified sands. These are ice-front depositions of high energy fluviatile and/or delatic origin that formed at the margins of pro-glacial Lake Hudson and Lake Bayonne. Truncated

> kame terraces are recognized (Worth Street) per morphology and historic geographic accounts. Cambic soil recognized at both Worth Street and MCC Tunnel. Soil is of probable Middle to Late Holocene age.

The highest elevations of the early historic landscape were at Worth Street which formed the edge of the glacial kame known by the Dutch as Kalkhoek Promontory. It was to the west of the Collect Pond. This landform was only one in a series of such steep sided hills of sand and gravel that defined the prominent topography of colonial New York well into the 19th century. Catimuts Hill was a more extensive feature that flanked the Collect Pond to the south. The kame terraces originally flanked former pro-glacial Lake Hudson and Bayonne. With the retreat of the glaciers, the contours of the emerging Hudson Valley system followed those of the existing glacial topography. This topography is reflected in the early colonial period (Dutch and English) maps depicting the historic landform configurations. Subsurface excavations confirmed the dominance of kame features across the Woodfordian glacial margins of Lower Manhattan. This is expressed by the fact that only Foley Square/B-1 records a well stratified record of estuarine sedimentation along the later Holocene shoreline of Manhattan Island. Accordingly, the kames extended to such depths that they effectively blocked the encroachment of the transgressing shoreline. The stratigraphy illustrated in Figure 10 also suggests that the early Holocene Hudson drainage trench cut through the kames, only partially eroding them.

The various sources of geologic, cartographic, informant, and historic data abstracted for this study can be merged with field observations to develop a more comprehensive model of landscape archeology for Lower Manhattan near Five Points. A diachronic construct demonstrating the sequential interaction of landscape evolution, land use, occupation, and site preservation is presented in Figures 11a and 11b. The model structures a six-stage developmental chronology for the last 15,000 years. It is based on the composite stratigraphy generated at the three study locations.

For the late glacial through prehistoric periods (Stages I and II) the ancient geography shows the long term evolution of the alluvial valley that eventually gave rise to the Collect Pond, flanked on both banks by the prehistoric aged Holocene paleosol (at Worth Street and the MCC Tunnel site). For the colonial periods (Stages III and IV), the transect begins at Catimuts Hill, crosses the lower sub-basin of the Collect Pond at B-1 and the MCC Tunnel, and terminates at the Kalkhoek Promontory overlooking Worth Street. This is the optimal projection of landscape features and human settlement prior to large scale relandscaping during the Industrial and Recent Ages (Stages V and VI). Each developmental stage in human and landscape history is considered separately below.

Stage I (Terminal Pleistocene/Holocene: 15,000-10,000 B.P.) underscores the geomorphic dynamism of the Pleistocene to Holocene transition. At this time the ancestral Hudson may have featured a distributary net that migrated southeastward and created the trough that evolved historically into Lispenard's Meadow, the poorly drained fields north of the kames fronting glacial lake Hudson. Both the MCC Tunnel and Worth Street excavations encountered remnants of the deeply stratified and steeply bedded gravels and sands that can only have been derived from meltwater drainage and glacio-deltatic sedimentation. While Early to Middle Archaic period sites could have been located in the vicinity of both locations, the stratigraphy demonstrates that the local fluvial environments were too dynamic to have preserved archeological remains.

Stage II (Middle-Late Holocene: 8000-2000 B.P.) is the earliest period for which geological contexts bearing on archeological site potential is recorded, albeit indirectly. The Cambic paleosol (Worth Street and MCC Tunnel) probably first stabilized over 6000 years ago and was progressively enriched by soil forming processes. Since the paleosol caps a regionally extensive surface, it would have spanned most of the level terrain fronting the channel hemmed in by the kame landforms. The historic breadth of this terrain, the relative narrowness of the channel, the coarseness of the channel fill, and the subdued relief along the floodplain, indicates that a braided stream would have migrated across the valley. The later Holocene channel would have been sub-tidal in its downstream end, in response to the stabilization of near shore environments. In the immediate site vicinity stream migration was confined by the depth of the kame sands which would have blocked Holocene stream flow at depth. The stream was fed by active springs that discharged through the local aquifer. It is possible that considerable prehistoric activity (Middle Archaic-Woodland) would have occurred along the channel banks, especially since the evidence points to enrichment and incremental buildup of the soil and surface for at least 5000 years. No evidence for prehistoric occupation has been reported within the paleosol because of the limited window afforded by the testing efforts at both MCC Tunnel and Worth Street. However, site expectation should be considered high for the soil, where encountered.

By stage III times (A.D. 1650-Dutch settlement), historic maps depict extensive agricultural lands. The Lispenard Meadows functioned as farm, pasture and swamp lands depending on the permeability and composition of the soils (see Castello Plan of 1660; Lyne Plan of 1728). The Worth Street site was part of the Hook Farm at this time. The Collect Pond began to develop, perhaps as a result of delicate hydrological balances related to pre-tannery land use (i.e. overgrazing, destructive farming practices, accelerated erosion) and general aggradation of the alluvial surface. Drainage features were being built at this time in Lispenards Meadow. Indications are that at least two water bodies emerged at that time, both nourished by springs and run-off from the surrounding kames. These would have been the forerunners of the "Collect" and "Little Collect". By the time of Dutch settlement, the southeastern kame had been named Catimuts Hill and the lookout above Worth Street was called Kalkhoek Promontory. The topographic gradients across the transect began to diminish as a result of limited landscaping and the aforementioned sedimentation of the floodplain.

In stage IV (A.D. 1750), the Collect Pond became the central fixture of the economic landscape. The entire expanse between Catimuts Hill and Kalkhoek Promontory was part of the tannery infra-structure centered on the Collect. As discussed elsewhere (Yamin et al. 1995a), the Collect Pond was a swamp that probably was utilized for long-term hide soaking while running waters from the Eastern Outlet (Figure 6) were exploited by the tanners to remove chemicals and rinse the hides. In the vicinity of Foley Square/B-1, the tanners would have had access to the waters on the southwest end of the Collect, which were probably more stagnant (and favored soaking). Extensive debris, animal carcasses and tanyard waste were discarded everywhere along the swamp margins. Processing sheds would also have been built along the sill and the higher ground flanking the Collect and Eastern Outlet.

Stage V (A.D. 1850) registers the abandonment of the tanneries and burial of the Collect and the sub-basins associated with the tannery infra-structure. Extensive grading was the dominant regional activity over the course of this period. The area became an increasingly commercial center as the leather trade (and the tanneries) disappeared. The kames were leveled and differential grading soon created the even surfaces over which streets and sidewalks were built.

The stratigraphy documents a second major phase of land filling after A.D. 1900 (Stage VI: Contemporary), again attendant to the area's transition to its contemporary role as an administrative and legislative center. The excavated fill preserves more diverse artifact assemblages of the latter twentieth century including utility debris and large scale construction rubble. The transformation of the prehistoric environment was completed.

Conclusions

Geoarcheological investigations at Foley Square/B-1 produced a wealth of information bearing on the last 5,000 years of landscape history of Lower Manhattan. Field observations coupled with historic accounts and geological records facilitated a reconstruction of events in the project area. The following are the key findings of this study:

1. The stratigraphic column at Foley Square/B-1 consists of three primary depositional units to a depth of about 32 feet below surface; these include 24 feet of historic fill (Stratum 1); 3-4 feet of estuarine sediment (Stratum 2); and >5 feet of near shore deposits (Stratum 3);

2. Stratum 1 documents massive surface buildups and the large scale relandscaping of Lower Manhattan as it became a major administrative center in the late 19th to early 20th century; the reddish sandy fill is originally derived from near shore glacial deposits transported some distance from the site;

3. Stratum 2 is a sub-tidal deposit of peats and silts indicating stabilization of the New York shoreline between 3500-2500 B.P. as mud flats formed the surfaces of the sub-tidal environments;

4. Stratum 3 is a either a near shore or fluvially reworked sediment representing the latter phases of the Middle Holocene transgressive shoreline (3500->4700 B.P.);

5. There is no evidence for an early Euroamerican shoreline. The depth of historic disturbance extends to 6 feet below sea level;

6. While the exact location of the B-1 core cannot be unequivocally placed, early Euroamerican geographic accounts and maps indicate that it was on the southwest end of the Collect Pond, a central feature of the Dutch, British and early American colonial landscape. It may have straddled the sill dividing the Little Collect and the major Collect. No historic swamp sediments were identified, as they were obliterated by filling activities. The deposits immediately underlying the historic sediment (Stratum 1) are Late Holocene in age, dated to 1220±60 B.P.

7. Foley Square/B-1 is currently the best dated Middle Holocene sequence for Lower Manhattan, registering the evolution of near shore environments between 4700-1000 B.P.

8. Sedimentation rate curves for Foley Square are consistent with those generated elsewhere in the northeastern United States and show analogous environmental changes, especially during the interval 3500-2500 B.P.

9. The stratigraphy and historic geography at Foley Square supplements reconstructions developed at neighboring geomorphological and archeological sites in the vicinity of the old Five Points neighborhood. Such sequences preserve evidence for late glacial and early post-glacial sequences. Foley Square/B-1 provided the only estuarine chronology, a unique context for the area.

10. This study demonstrates that an approach utilizing historic maps and limited subsurface excavation is optimal for reconstructing post-glacial human and landscape histories with unusual clarity and resolution.

References Cited

Andrews, W. L.
1893 *The Bradford Map: The City of New York at the Time of the Granting of the Montgomerie Charter*. De Vinne Press, New York.

Bloom, A. L.
1983 Sea level and coastal changes. In *Late-Quaternary Environments of the United States, the Holocene*, edited by H. E. Wright, pp. 42-51. University of Minnesota Press, Minneapolis.

Brown, H. C.
1913 *Old New York*. Lent & Graff Company, New York.

Cantwell, A.-M. and D. d. Z. Wall
2001 *Unearthing Gotham: the Archaeology of New York City*. Yale University Press, New Haven.

Castello-Plan
1660 Redraft of the Castello Plan, New Amsterdam in 1660, John Wolcott Adams. Map Division, New York Public Library, New York.

Cozzens, J., Issachar
1843 *A Geological History of Manhattan or New York Island Together with a Map of the Island, and a Suite of Sections, Tables, and Columns*. W. E. Dean, New York.

Dincauze, D. F.
1989 Geoarchaeology in New England. *The Review of Archaeology* 10(2):1-4.

Drake, A. A., R. A. Volkert, D. Monteverde, H., G. C. Herman, H. F. Hourghton, R. A. Parker and R. F. Dalton
1996 Bedrock Geologic Map of Northern New Jersey. Miscellaneous Investigations Series ed. U.S. Department of the Interior, U.S. Geological Survey, Reston, Virginia.

Fullerton, D. S., W. D. Sevon, E. H. Muller, S. Judson, R. F. Black, P. W. Wagner, J. H. Hartshorn, W. F. Chapman and W. D. Cowan
1992 Quaternary Map of the Hudson River 4º x 6º Quadrangle, United States and Canada, Map I-1420 (NK-19). Miscellaneous Investigation Series, U.S. Geological Survey, Washington, D.C.

Funk, R. E.
1976 *Recent Contributions to Hudson Valley Prehistory*. Memoir 22. New York State Museum, Albany.
1993 The Upper Susquehanna Sequence and Chronology. In *Archaeological Investigations in the Upper Susquehanna Valley, New York State, Volume 1*, edited by R. E. Funk, pp. 141-213. Persimmon Press, Buffalo.

Geismar, J.
1993 *Reconstruction of Foley Square: Historical and Archaeological Report*. Coe Lee Robinson Roesch, Inc. Report submitted to The City of New York Parks and Recreation.

Gratacap, L. P.
1909 *Geology of the City of New York with Numerous Illustrations and Maps*. 3rd ed. Henry Holt and Company, New York.

Gruzen and Partners
1971 *Boring Log. Foley Square Courthouse Annex, New York, New York. Drawing Nos. 1-3 and 1-6*. Jersey Boring and Drilling Corp. Report submitted to The General Services Administration, New York.

Heusser, C. J.
1963 Pollen Diagrams from Three Former Cedar Bogs in the Hackensack Tidal Marsh, Northeastern New Jersey. *Bulletin of the Torrey Botanical Club* 90:16-28.

Hobbs, W. H.
1905 The Configuration of the Rock Floor of Greater New York. *United States Geographical Survey Bulletin* 270:1-93.

Johnson, F.
1949 The Boylston Street Fishweir II. *Papers of the Robert S. Peabody Foundation for Archaeology* 4(1).

Kraft, H. C.
1977 The Paleo-Indian Sites at Port Mobil, Staten Island. In *Current Perspectives in Northeastern Archaeology: Essays in Honor of William A. Ritchie*, edited by R. E. Funk and C. F. Hayes-III. Research and Transaction of the New York State Archaeological Association Vol 17. New York State Archaeological Association, Albany and Rochester.

Lyne, J.
1728 A Plan of the City of New York from an Actual Survey Made by Jaems Lyne. Orrin and Vanderhoven, New York. New York Public Library, New York.

Maerschalck, F.
1754 Plan of the City of New York from an Actual Survey. Anno Domino MDCCLV by Francis Maerschalck, City Surveyor. Lithographed by G. Hayward for D. T. Valentines Manual. Map Division, New York Public Library.

Martin, C. W. and W. C. Johnson
1995 Variation in Radiocarbon Ages of Soil Organic Matter Fractions from Late Quaternary Buried Soils. *Quaternary Research* 43:232-237.

Matthews, J. A.
1985 Radiocarbon Dating of Surface and Buried Soils: Principles, Problems, and Prospects. In *Geomorphology and Soils*, edited by K. S. Richards, R. R. Arnett and S. Ellis, pp. 269-288. Allen & Unwin, London.

McCrone, A. W.
1966 The Hudson River Estuary: Hydrology, Sediments, and Pollution. *Geography Review* 56:175-189.

Mueser-Rutledge Consulting Engineers
2001 *Worth Street & Foley Square Development, New York, New York*. Mueser Rutledge Consulting Engineers. Report submitted to Forest City Ratner Companies, Brooklyn, New York.

Neville, C. P.
1994 *Overlooking The Collect: Between Topography and Memory in the Landscape of Lower Manhattan.* Unpublished M.A. thesis, Columbia University.

Newby, P., R. S. Webb and T. I. Webb
1994 Pollen and Sediment Records from Walter's Puddle in Central Delaware. In *Paleoenvironmental Studies of the State Route 1 Corridor: Contexts for Prehistoric Settlement, New Castle and Kent Counties, Delaware*, edited by D. C. Kellogg and J. F. Custer, pp. 27-35. Delaware Department of Transportation Archaeology Series No. 114, Dover, Delaware.

Newman, W., D. Thurber, H. Zeiss, A. Rokach and L. Musich
1969 Late Quaternary Geology of the Hudson River Estuary: A Preliminary Report. *Transactions of the New York Academy of Sciences* (31): 548-570.

Reeds, C. A.
1930 *The Geology of New York City and Vicinity*. American Museum of Natural History Guide Leaflet Series 56: 1-36.

Ritchie, W. A. and R. E. Funk
1971 Evidence for Early Archaic occupations on Staten Island. *Pennsylvania Archaeologist* 41(3):45-49.

Rothschild, N. A.
1990 *New York City Neighborhoods: The 18th Century*. Academic Press, Sand Diego.

Rothschild, N. A. and A. Pickman
1990 *The Archaeological Excavations on the Seven Hanover Square Block*. Report submitted to the New York City Landmarks Preservation Commission.

Rue, D. J. and A. Traverse
1997 Pollen Analysis of the Hackensack, New Jersey Meadowlands Tidal Marsh. *Northeastern Geology and Environmental Science* 19:1-16.

Salvador, A. (editor)
1994 *International Stratigraphic Guide: A Guide to Stratigraphic Classification, Terminology, and Procedure*. 2nd ed. The International Union of Geological Sciences and The Geological Society of America, Inc., Boulder.

Scharpenseel, H. W. and H. Schiffman
1977 Radiocarbon Dating of Soils, a Review. *Zeitschrift Pflanzanernaehr Bodenkunde* 140:159-174.

Schuberth, C. J.
1968 *The Geology of New York City and Environs*. The Natural History Press, Garden City, New York.

Schuldenrein, J.
1992 *Geoarchaeology Overview of the Carlstadt Loop, Bergen County, New Jersey*. Geoarcheology Research Associates. Report submitted to 3D/Environmental Services, Inc., Cincinnati.
1994 Alluvial Site Geoarcheology of the Middle Delaware Valley: A Fluvial System Paradigm. *Journal of Middle Atlantic Archaeology* 10:1-21.
1995a *Geoarcheological Observations for the Arthur Kill Factory Outlet Center (AKFOC) Project, Staten Island*. Geoarcheology Research Associates. Report submitted to Hunter Research, Inc., Trenton, New Jersey.
1995b Prehistory and the Changing Holocene Geography of Dogan Point. In *Dogan Point: A Shell Matrix Site in the Lower Hudson Valley*, edited by C. Claassen, pp. 39-63. Occasional Publications in Anthropology No. 14.
2002 *A Geoarcheological Assessment of the Buried Landscape at the Proposed Site of 107-111 Worth Street, New York, New York*. Report prepared for URS Arch Hist ArchitGroup, Florence, NJ.
2003 *Buried Landscaps Along the West Shore of the Lower Hudson River: Geoarchaeological Observations of Core R15-4, Jersey City, New Jersey*. Report submitted to Joan Geismar LLC, New York, NY.

Schuldenrein, J., D. Thieme, M., T. Epperson and M. A. Smith
2000 *A Geomorphological and Archeological Study in Connection with the New York and New Jersey Harbor Navigation Study, Upper and Lower Bay*. Prepared submitted to the U. S. Army Corps of Engineers, New York District.

Schuldenrein, J. and D. M. Thieme
1996 *Staten Island Bridges Program - Modernization and Capacity Enhancement Project. Phase 1B Geomorphological Analysis. Final Report of Field Investigations.* Report submitted to Parsons Brinckerhoff Quade & Douglas, Inc., New York, New York.

Sirkin, L.
1967 Late-Pleistocene pollen stratigraphy of western Long Island and eastern Staten Island, New York. In *Quaternary Paleoecology*, edited by E. J. Cushing and H. E. Wright. Yale University Press, New Haven.

1986 Pleistocene Stratigraphy of Long Island, New York. In *The Wisconsinan Stage of the First Geological District, Eastern New York*, edited by D. H. Cadwell. New York State Museum, Albany.

Skinner, A.
1942 *The Indians of Manhattan Island and Vicinity*. 6th ed. American Museum of Natural History Science Guides No. 41.

Stanford, S. D.
1997 Pliocene-Quaternary Geology of Northern New Jersey - An Overview. In *Pliocene-Quaternary Geology of Northern New Jersey - Guidebook for the 60th Annual Reunion of the Northeastern Friends of the Pleistocene*, edited by S. D. Stanford, Trenton.

Stanford, S. D. and D. P. Harper
1991 Glacial Lakes of the Lower Passaic, Hackensack, and Lower Hudson Valleys, New Jersey and New York. *Northeastern Geology* 13(4):347-363.

Stone, B. D., S. D. Stanford and R. W. White
2002 Surficial Geologic Map of Northern New Jersey. U.S. Geological Survey.

Stuiver, M., P. J. Reimer, E. Bard, J. W. Beck, G. S. Burr, K. A. Hughen, B. Kromer, G. McCormac, J. van der Plicht and M. Spurk
1998 INT-CAL98 radiocarbon age calibration 24000-0 cal BP. *Radiocarbon* 40:1041-1083.

Taylor, R. E.
1997 Radiocarbon Dating. In *Chronometric Dating in Archaeology*, edited by R. E. Taylor and M. J. Aitkin, pp. 65-96. Plenum Press, New York.

Thieme, D. M.
2000 Paleoenvironmental and Archeological Contexts in the New York and New Jersey Harbor Region. Paper presented at the Society of American Archaeology, Philadelphia.

Thorbahn, P. and D. Cox
1988 The Effect of Estuary Formation on Prehistoric Settlement in Southern Rhode Island. In *Holocene Human Ecology in Northeastern North America*, edited by G. Nicholas, pp. 167-184. Plenum Press, New York.

Tomlinson, C.
1854 Leather. In *Cyclopaedia of useful Arts, Mechanical and Chemical Manufactures, Mining, and Engineering*, edited by C. Tomlinson. vol. II. George Virtue & Company, London.

Valentine, D. T.
1863 Map of the City of New York. G. P. Putnam & Co., New York.

Viele, E. L.

1874 *Topographical Atlas of the City of New York Including the annexed Territory. Showing Original Water Courses and Made Land. Prepared under the Director of Egbert L. Viele, Civil and topographical Engineer*. Map Division, New York Public Library, New York.

Weiss, D.
1974 Late Pleistocene stratigraphy and paleoecology of the lower Hudson River estuary. *Geological Society of America Bulletin* 85:1561-1580.

Yamin, R., J. Schuldenrein and M. L. Schleidt-Peñalva
1995a *Archeological and Geoarcheological Investigations Associated with the Construction of the Metropolitan Corrections Center Tunnel Under Pearl Street, Foley Square, New York*. John Milner Associates, Inc. Report submitted to Edwards and Kelcey Engineers, Inc., Morristown, New Jersey and General Services Administration, New York, New York.

Yamin, R., T. Johnson and J. Schuldenrein
1995b Tanning on Pearl Street: Evidence from Historical Archeology and Geomorphology. Paper presented at the 1995 Middle Atlantic Archaeological Conference Annual Meeting, Ocean City, Maryland.

Young, R. S., D. F. Belknap and D. A. Sanger
1992 Geoarchaeology of Johns Bay, Maine. *Geoarchaeology* 7(3):209-249.
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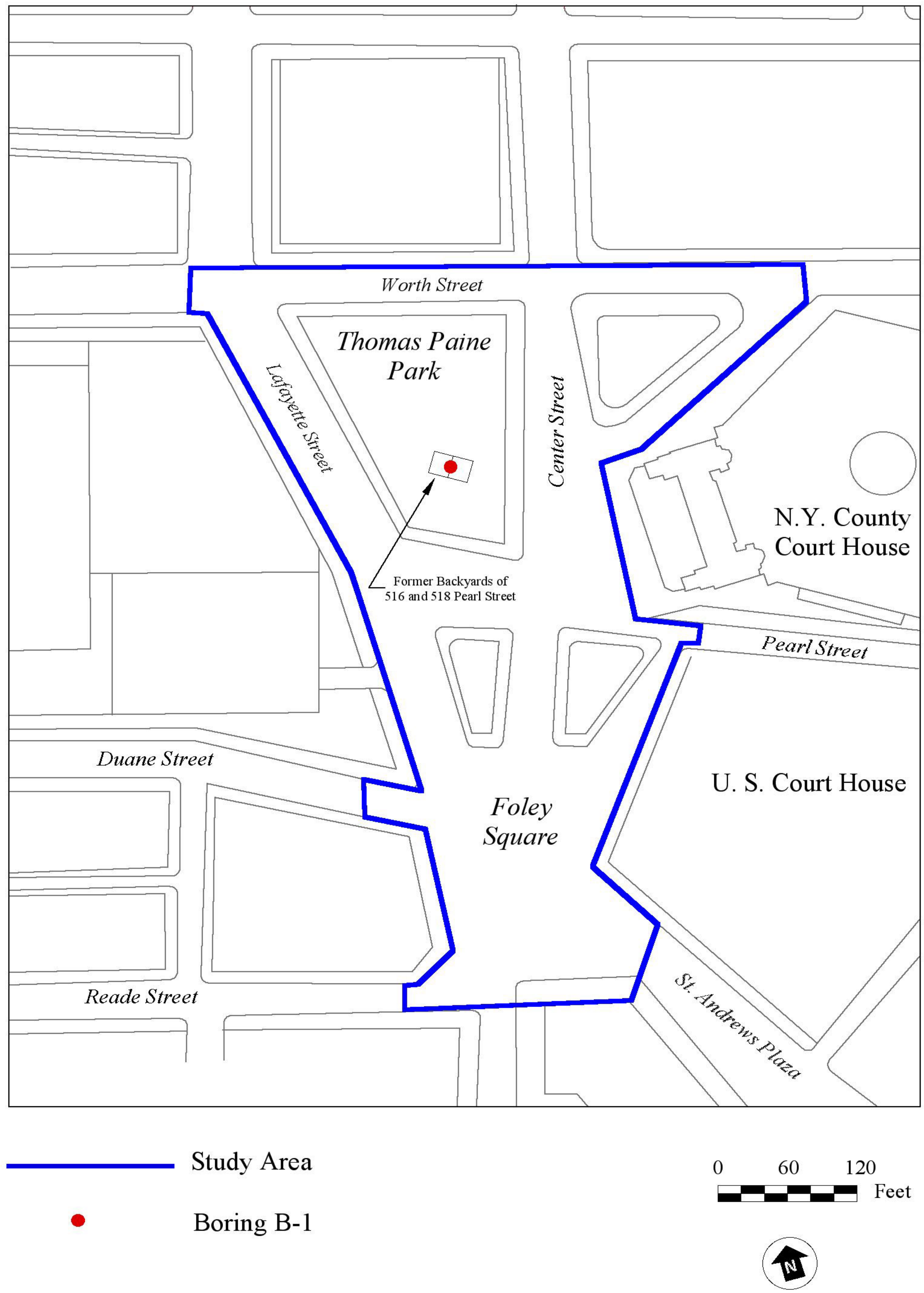


Figure 1: Location of Boring B-1 within the Foley Square Reconstruction Study Area.

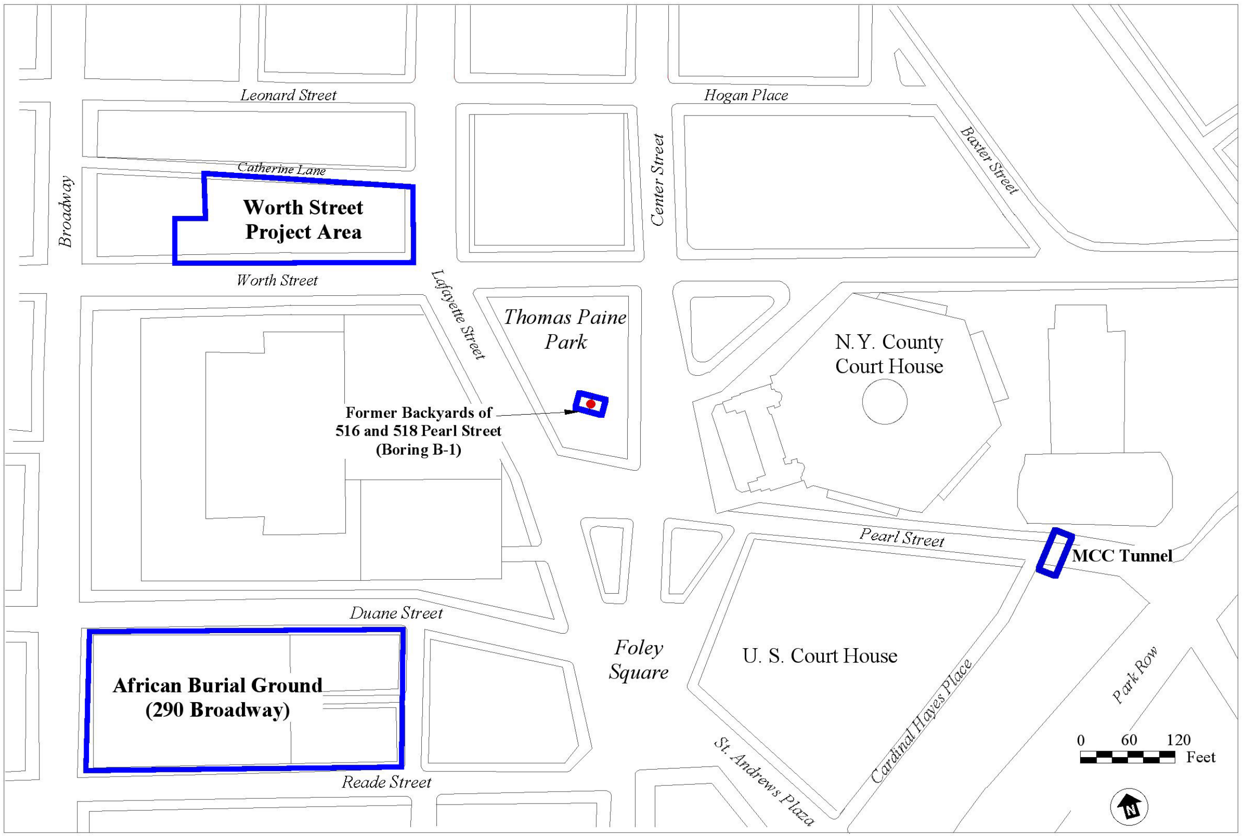


Figure 2: Map of project area and other prominent archeological sites discussed in text.

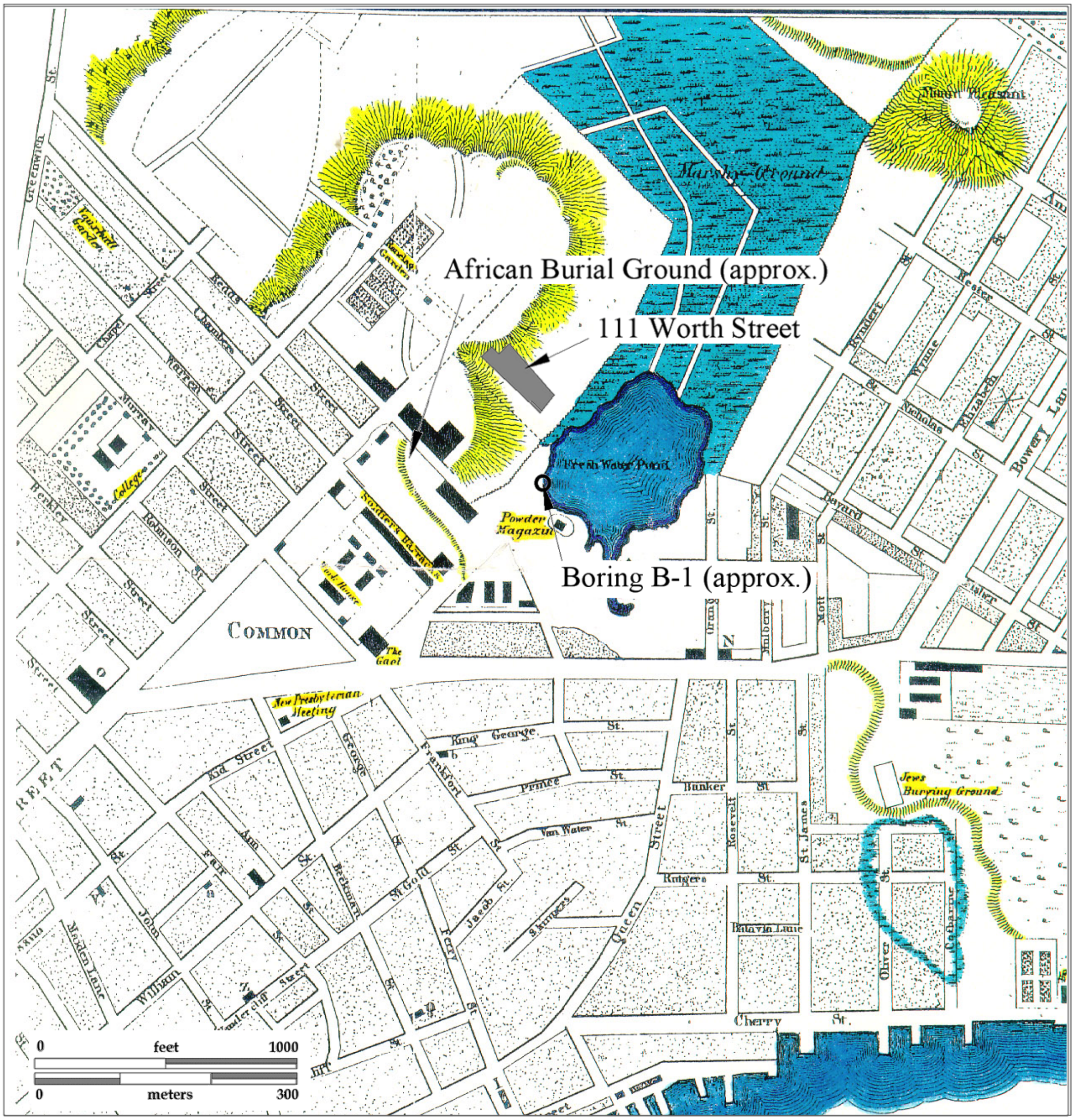


Figure 3: Depiction of Collect Pond and vicinity in the mid-18th century. Worth Street site, the African American Burial Ground and Foley Square boring B-1 are superimposed. Source (Valentine, 1863).

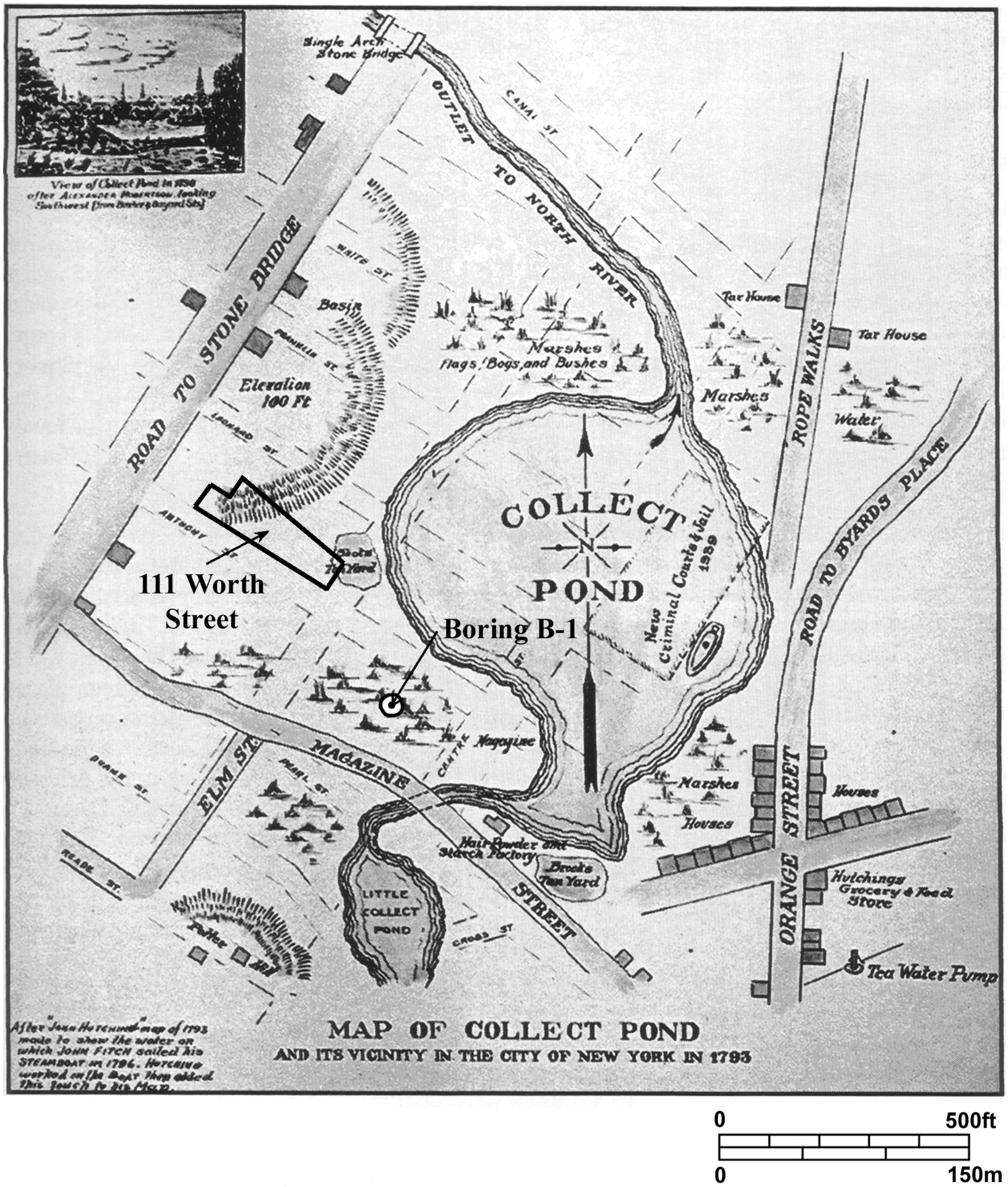


Figure 4: Depiction of Collect Pond and vicinity, 1793. Worth Street site and Foley Square boring B-1 are superimposed. Note division of Collect into primary and secondary ("Little Collect") basins. Source (Hutchings, 1793).

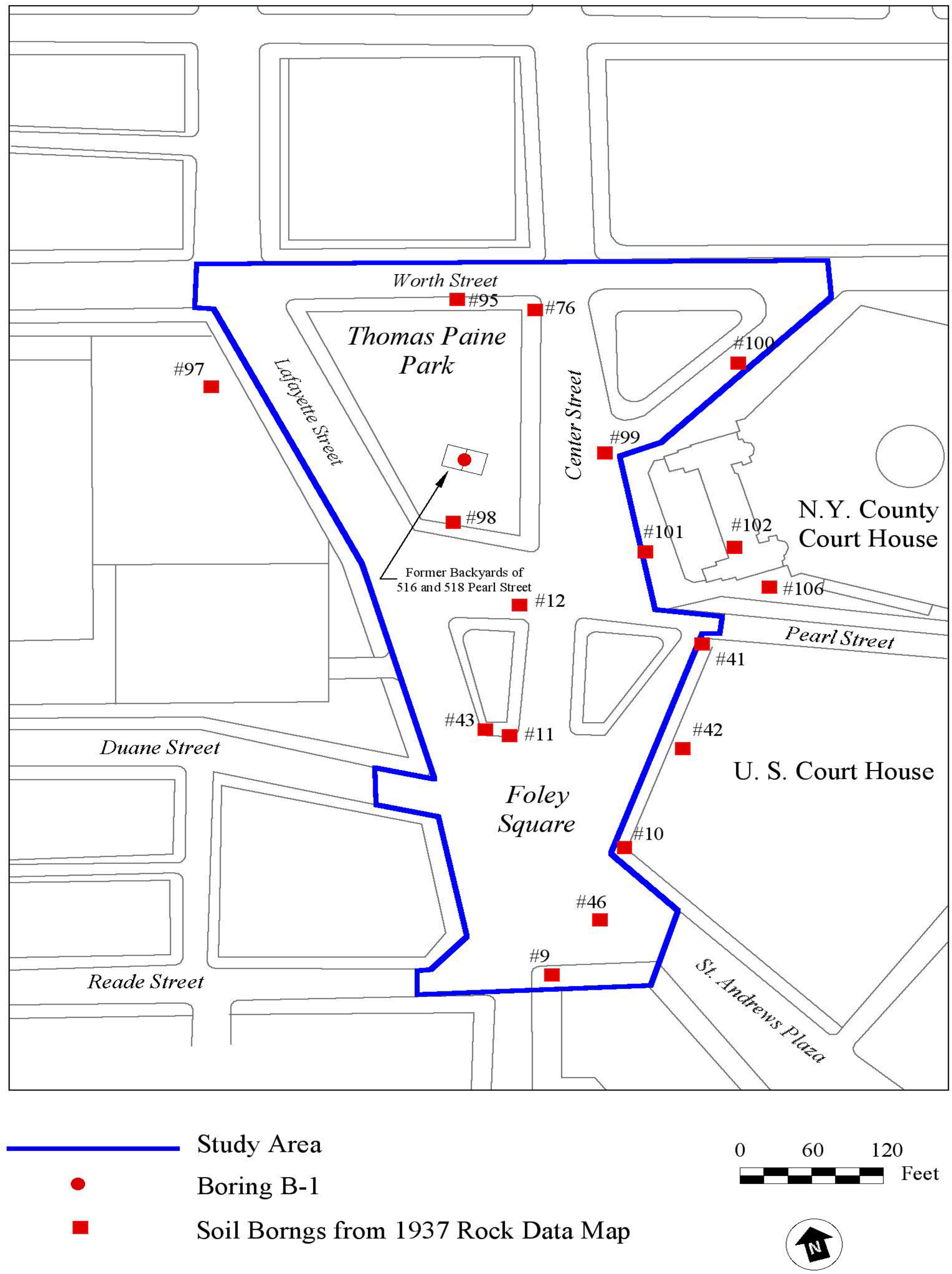


Figure 5: Geo-technical boring logs at Foley Square.

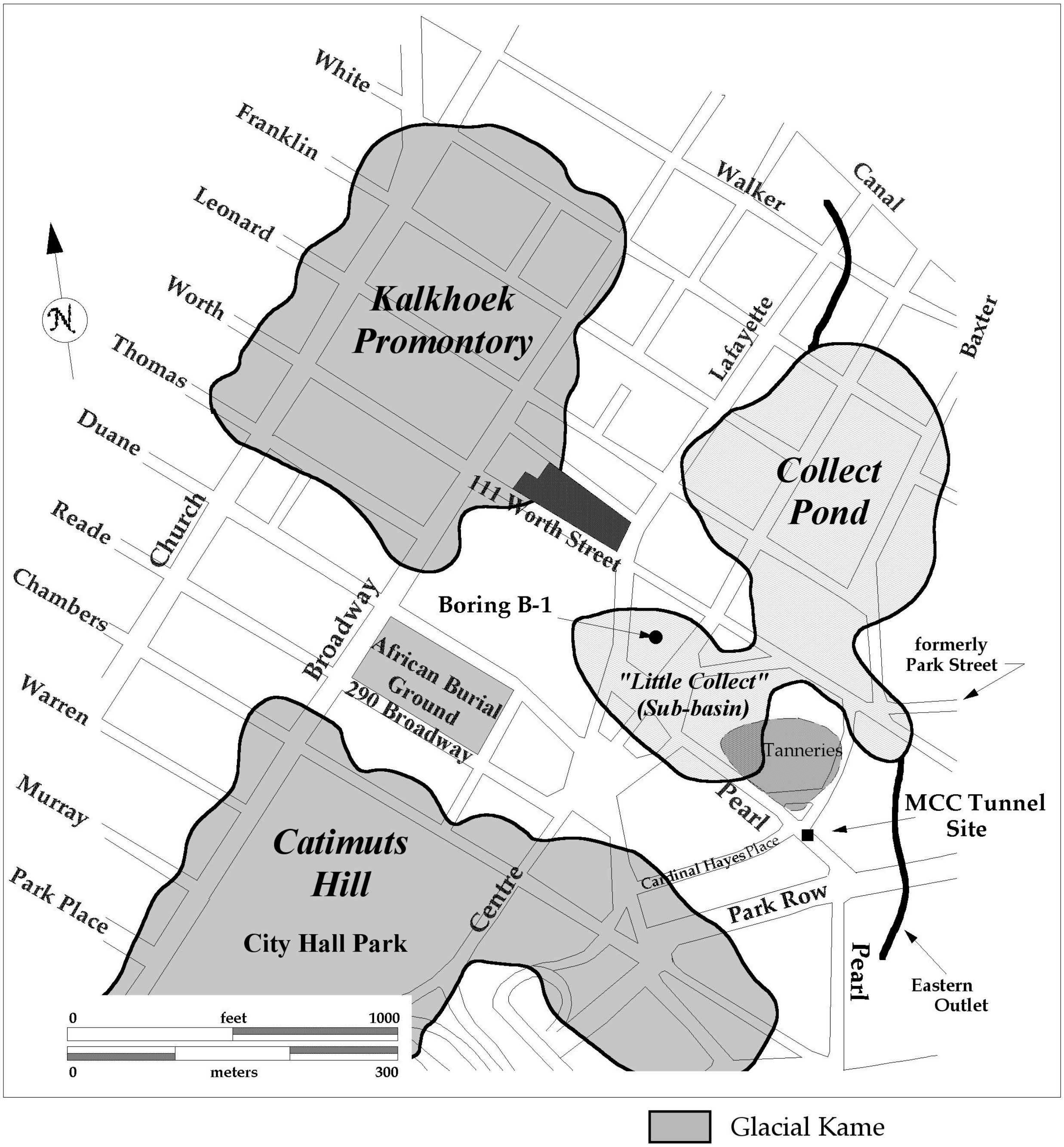


Figure 6: Reconstruction of post-glacial landform distributions superimposed on contemporary street grid of Lower Manhattan. Landform dimensions are approximate and depict maximum projected extents prior to Industrial Age removal (ca. Pre-1850). Early colonial names of landscape features are used. Source (Viele, 1874 and others).

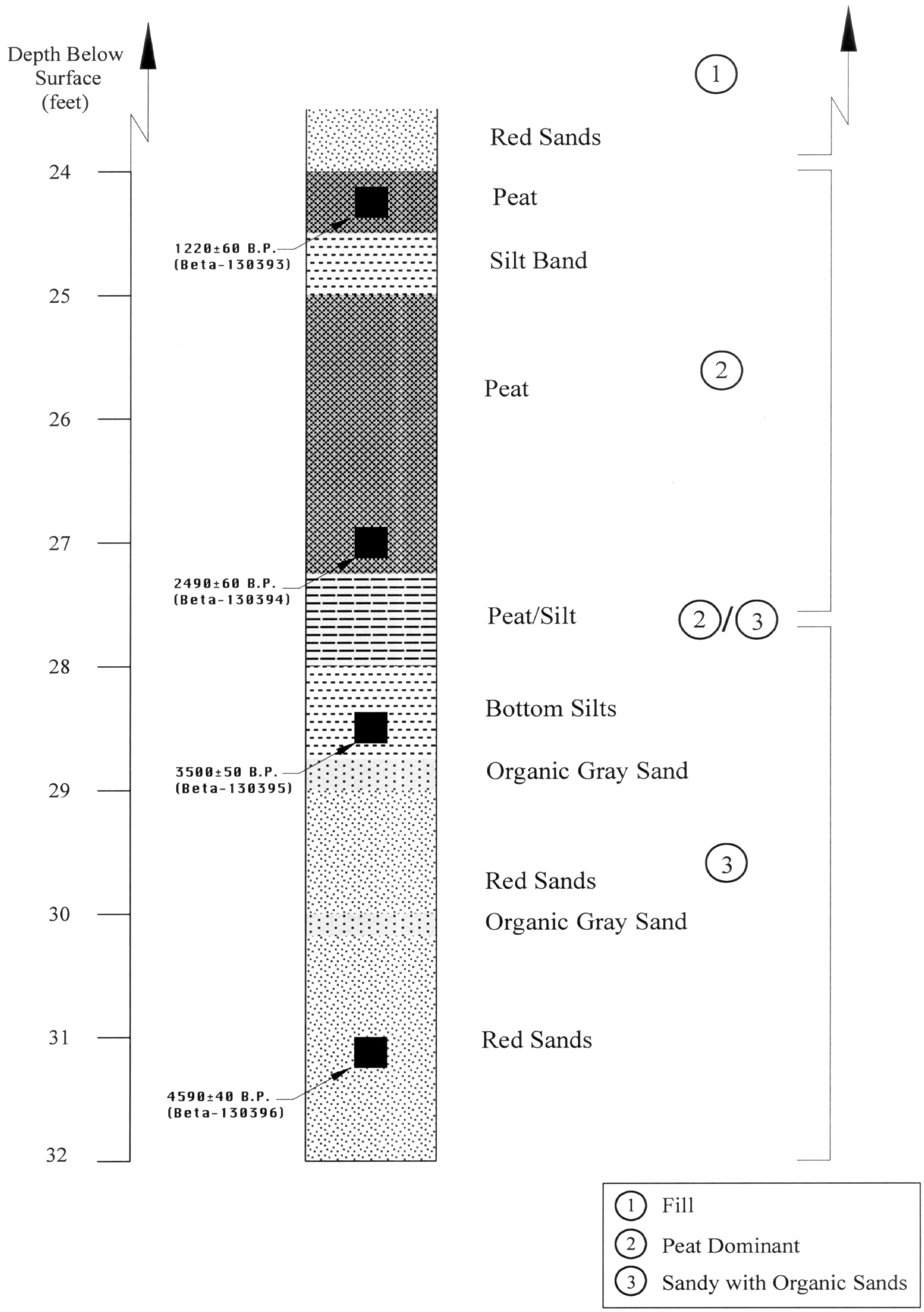
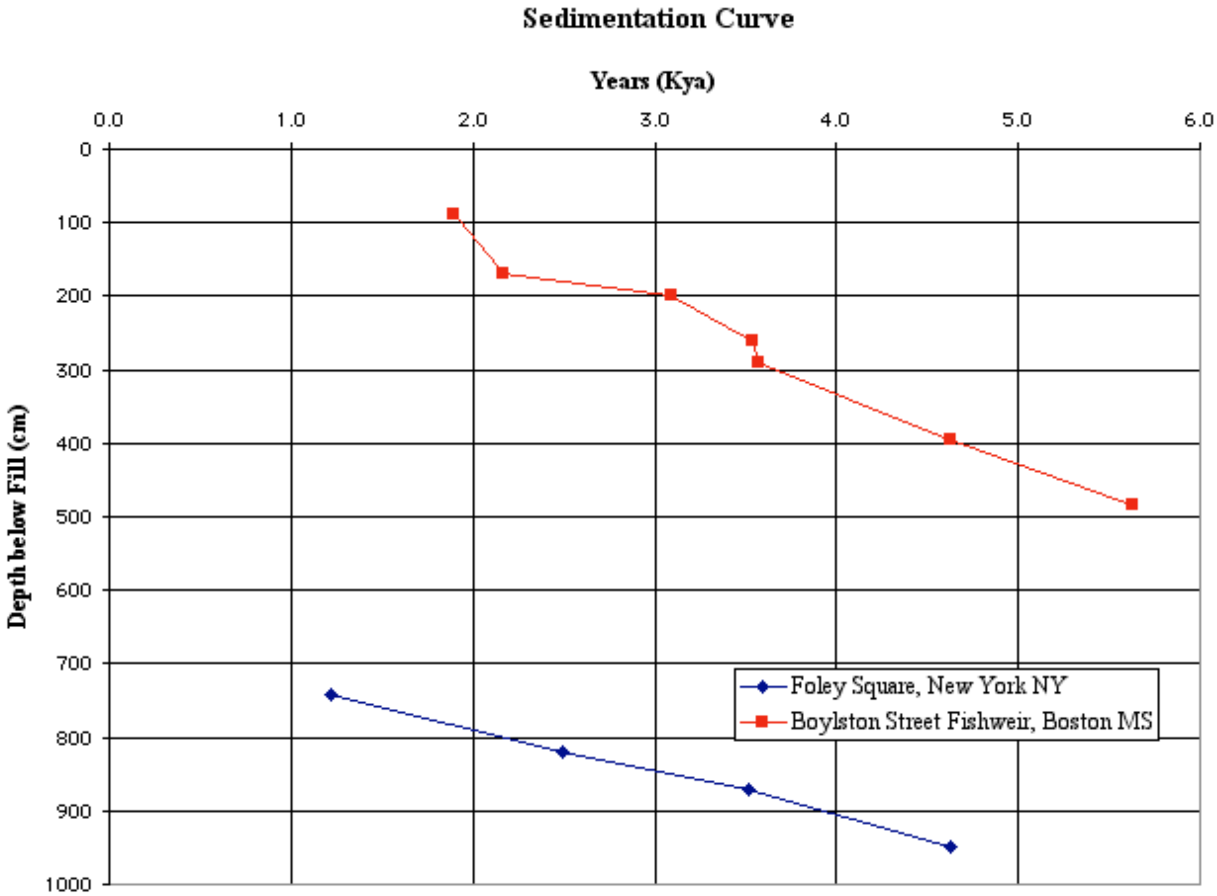


Figure 7: B-1 Stratigraphic column.



Kya	Boylston Street Fishweir, Boston MS (m)	Foley Square Core B-1, New York NY (m)
5-4	0.95	0.75
4-3	1.30	0.60
3-2	0.80	0.55
2-1	0.80	0.65

Figure 8: Holocene sedimentation curves: Foley Square, B-1 (New York City) and Boylston Fishweir (Boston).

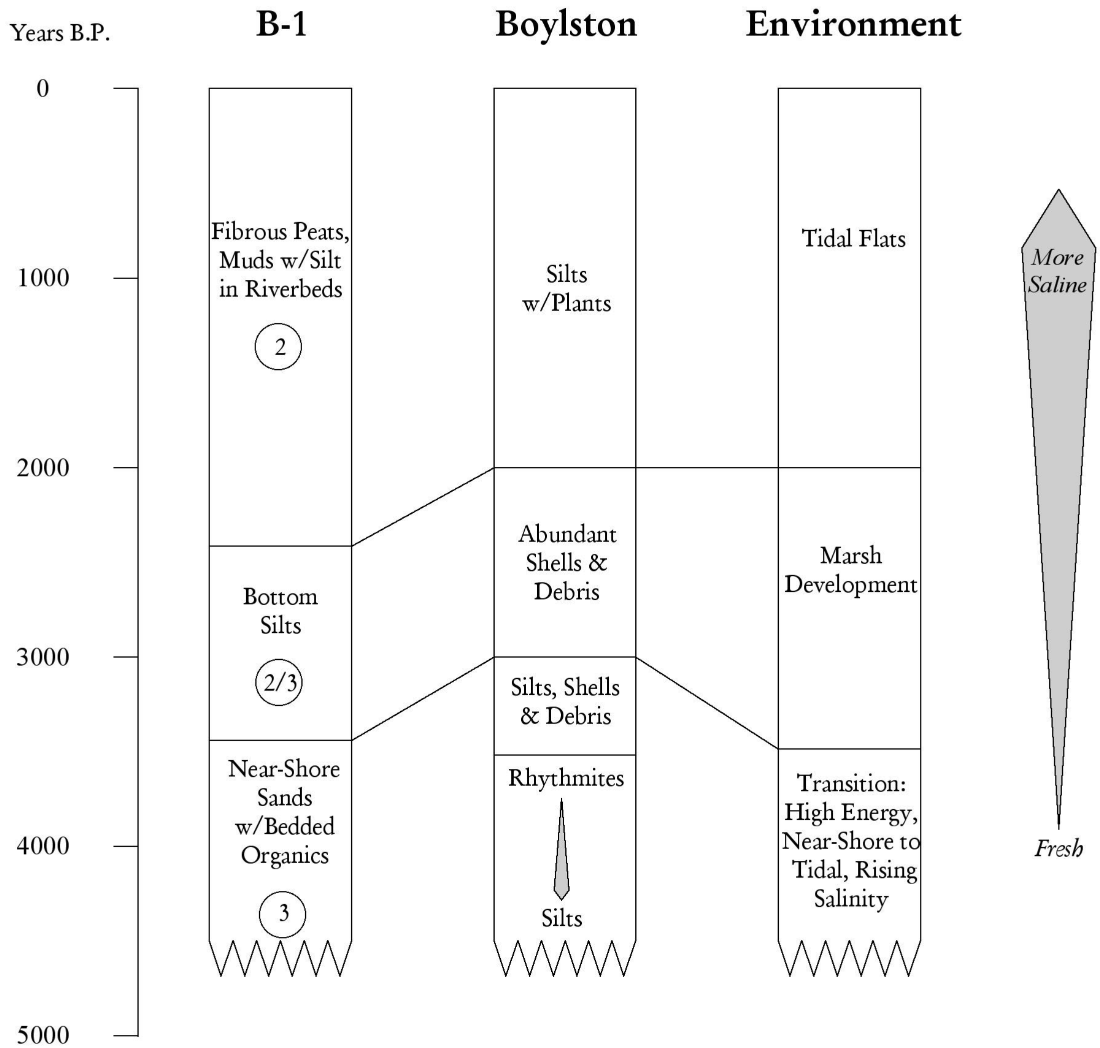


Figure 9: Evolution of Holocene near-shore and tidal environments.

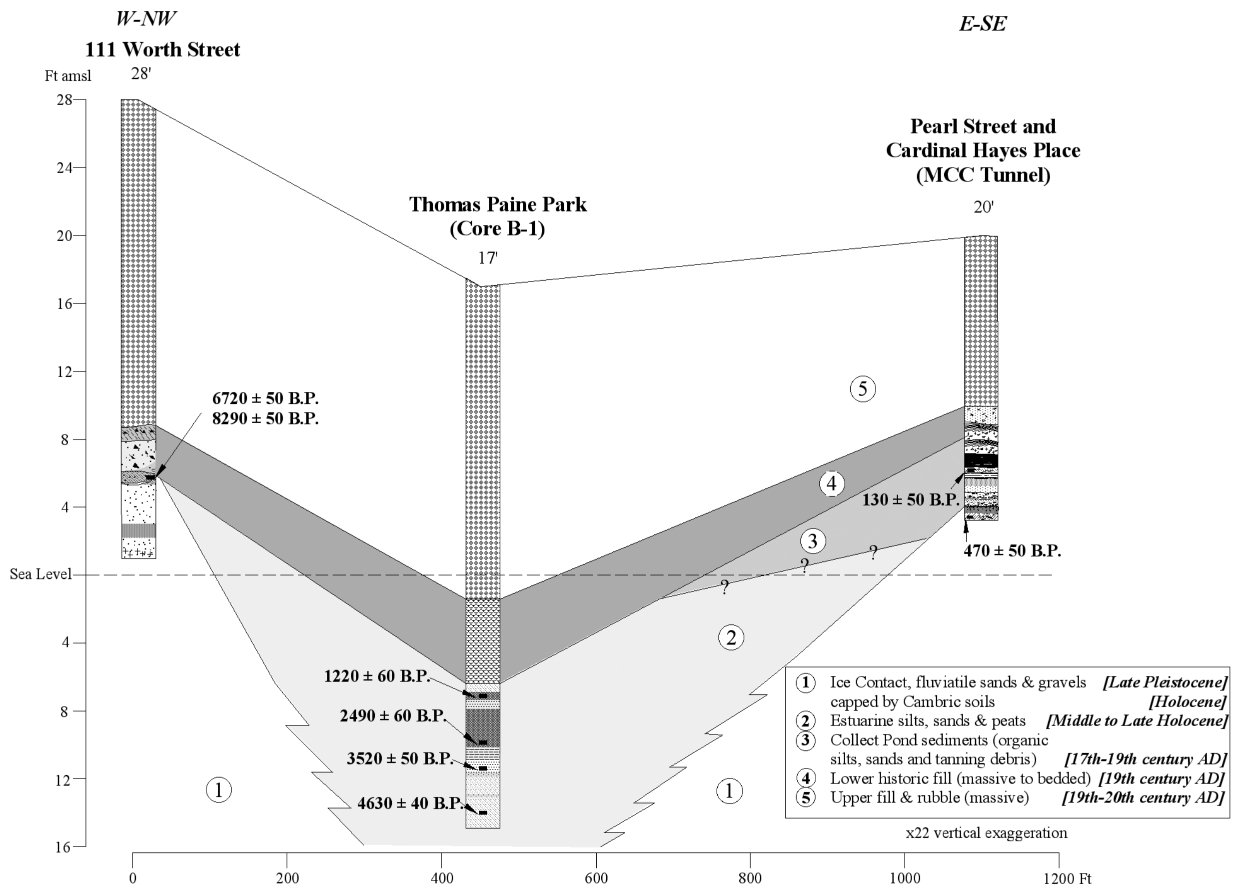


Figure 10: Subsurface stratigraphies at three (3) historic sites in Lower Manhattan.

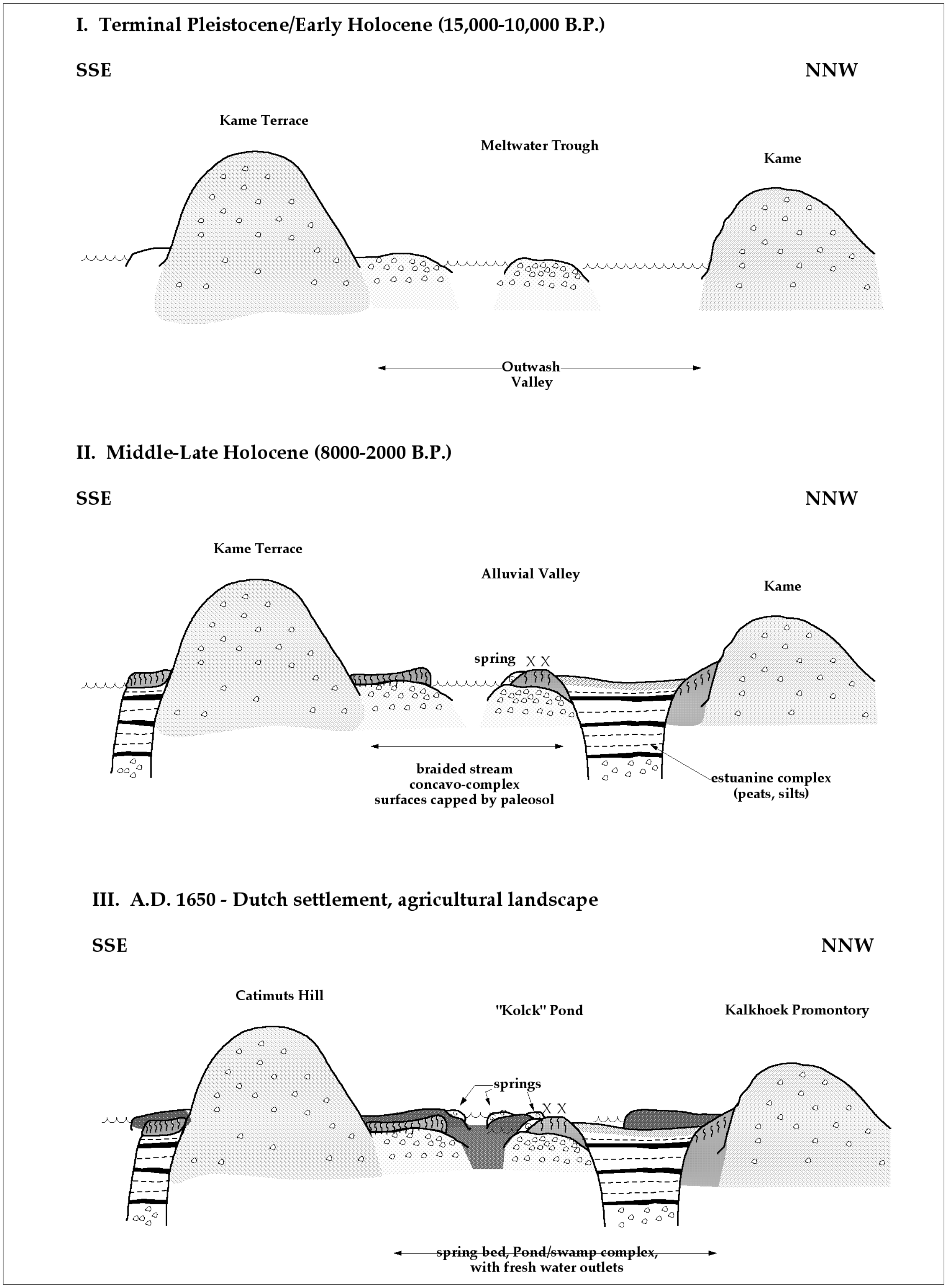


Figure 11A: Diachronic model of land use and occupation, Five Points area (15,000 B.P. - A.D. 1650).

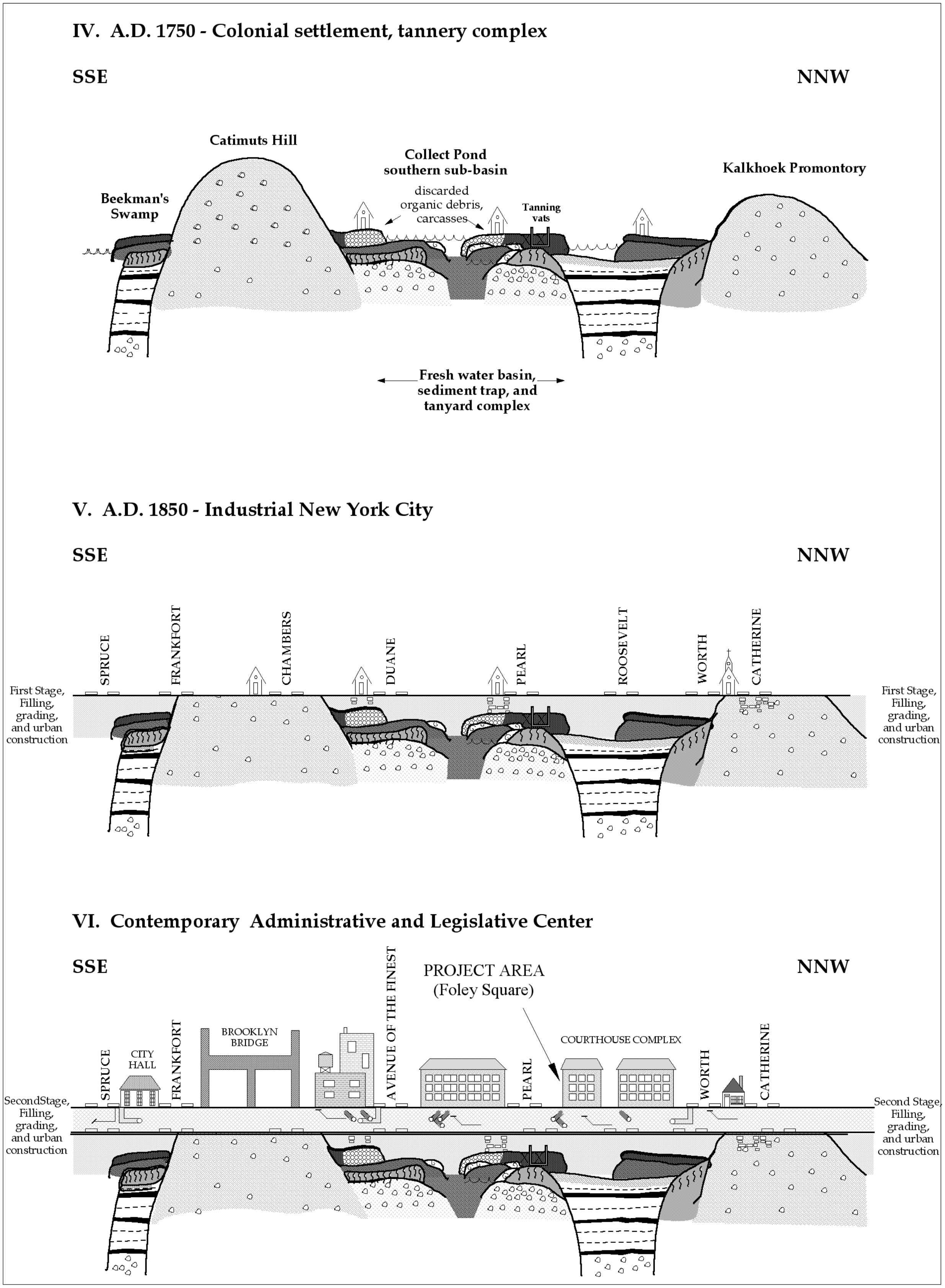


Figure 11B. Diachronic model of land use and occupation, Five Points area (A.D. 1750 - present).

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Plate 2: Reddish sands within lower historic fill (Stratum 1), probably dervived from Wisconsinan outwash deposits and associated with a distinct historic landscaping episode.

Plate 3: Laminar and fibrous peats characteristic of the Late Holocene estuarine deposits (Stratum 2).

Plate 4: Reworked glacial outwash and/or fluviatile red sands of the Middle to Late Holocene near shore deposits (Stratum 3).

Table 1: RADIO CARBON DATES

Beta #	Sample Description	Elevation (feet below surface)	Analysis	C13/C12 Ratio	Conventional C14 Age	Stratum
130393	Top of Peat	24-26	Radiometric	-25.0 o/oo	1220 ± 60 BP	2
130394	Peat/Silt Interface	26-28	Radiometric	-25.0 o/oo	2490 ± 60 BP	2
130395	Gray Silt with Organics	28-30	AMS	-26.5 o/oo	3500 ± 50 BP	3
130396	Red-Brown Find Sand and Silt	30-32	AMS	-27.4 o/oo	4590 ± 40 BP	3