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~~APPENDIX Z~~

SUPPLEMENTAL DOCUMENTARY RESEARCH REPORT

GREENHOUSE CONSULTANTS, INC.

(HISTORICAL & ARCHEOLOGICAL ISSUES)

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SUPPLEMENTAL DOCUMENTARY RESEARCH REPORT

TRUMP CITY PROJECT
MANHATTAN, NEW YORK

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INTRODUCTION

This report presents the results of supplemental documentary research conducted on the Trump City project. This research was requested by Dr. Baugher of the N.Y.C. Landmarks Preservation Commission staff. Three issues were to be addressed: 1) explanation of the process of forging as carried out at the Hamersley Forge, 2) explanation of the bone black making process that subsequently took place there, and 3) further information regarding the location of the original shoreline relative to the project area.

The Trump City project area consists of Block 1171, Lot 1, in Manhattan. It is bounded on the south by 59th Street, on the west by the Hudson River, on the north by 72nd Street, and on the east by the railroad easement currently controlled by Conrail.

THE HAMERSLEY FORGE

Additional documentary research on mid-nineteenth century American iron working has been conducted with the goal of attaining a greater understanding of the Hamersley Forge. This forge, which was located between 59th and 60th Streets, west of Eleventh Avenue in Manhattan, operated between ca. 1840 and ca. 1850.

As specific information on the Hamersley Forge was found to be limited, general primary and secondary sources concerned with mid-nineteenth century iron working were surveyed. Based on the facts concerning the Hamersley Forge that are available to us and a knowledge of the basic general practices, machinery, etc., involved in mid-nineteenth century forging operations, an attempt will be made to postulate the workings and characteristics of the Hamersley Forge.

As noted in the Architectural/Historical Sensitivity Evaluation of the 641 West 59th Street, TV City Project Report (Roberts and Zakalak 1987), the earliest reference to the Hamersley Forge dates to 1840 and consists of the following listing in the 1840-41 Longworth Directory: "Ward & Co. L.B. Forge and Iron Works, 59th at North River." The iron works and Ward's nearby residential address are listed in New York City Directories throughout the 1840's. Wilson's 1850-51 Business Directory of New York City, the earliest such directory to include "Forges" as a business category, lists L.B. Ward's "Hamersley Forge" at the foot of 59th Street, North River. Directories dating between 1851 and 1860 do not list the Forge or ironworks. Records of Property Assessments show that while Ward's property is described as a "factory" in 1845 and a "forge" in 1850, by 1860 it is merely described as "waterfront," with no reference to any industrial usage. One can only therefore conclude that the Hamersley Forge ceased operating some time between 1851 and 1860.

A reconstruction of the operations carried out at the Hamersley Forge is necessarily dependent upon a knowledge of its principal products. The only real clue to the possible range of this forge's production is contained in an early twentieth century source which identifies Lebbeus B. Ward, "the mechanician," as the founder of the Hamersley Forge (Mott 1908:11; Roberts, Zakalak et al. 1987:4-5). From Mott we learn that the Hamersley Forge was the "first establishment in this country fitted with furnaces and steam hammers of sufficient size to manufacture shafts and cranks for steamer and steamboat use" (ibid.). Mott also notes that the "Peacemaker," the famous 12 inch caliber wrought iron gun that was mounted on the U.S.S. Princeton, was forged there (ibid.). Mott also states that at its test "trial on the Potomac River in 1844, it was very successful, but later at a final discharge, it exploded, killing two secretaries of Tyler's cabinet" (ibid.). Investigations regarding the construction of the "Peacemaker," including the quality of the metal employed and its welding were conducted by the Committee on Science and Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the Promotion of the Mechanic Arts. This committee's questions were addressed to "Messrs. Ward & Co." of the Hamersley Forge.

The proceedings and results of the committee's investigations were published in an issue of the Journal of the Franklin Institute. These proceedings comprise the basic source of information specific to the Hamersley Forge. The committee's inquiries were concerned solely with the construction of the "Peacemaker," and provide only a partial picture of the forge's overall operations circa 1844. However, the fact that the Hamersley Forge was selected to manufacture the "Peacemaker" indicates that Mott's description of the Hamersley Forge as an establishment specialized in the production of large scale wrought iron products is accurate (Mott 1908:11). One can therefore assume that the processes described by Ward in his response to inquiries by the Franklin Institute's committee generally characterize operations carried out at the forge, and that these same processes and machinery were used in the forging of most, if not all, the products manufactured there.

A brief discussion of the history and characteristics of iron working in America will facilitate an understanding of the forging operations that were carried out at the Hamersley Forge and those specifically referred to in the abovementioned Franklin Institute report. Iron blast furnaces were introduced in the North American colonies by the mid-1600's. The furnace is the heart of the ironworks, and it was there that iron was made in a simple operation, which remains essentially the same to the present day. Inside the stone furnace, iron ore is heated in burning charcoal until the metal becomes molten, separates from the earth and rock in which it is embedded, and trickles down into the hearth. It collects there and is kept molten until the founder lets it out. To this mixture of charcoal and ore is added a "flux," usually limestone, which helps the liquid iron separate and flow freely from the rock, charcoal, and other impurities. These appear at the hearth as "slag," which, because it is lighter than iron, floats on top of the molten mass, where it can be drawn off before the iron is let out. The molten iron was drawn off from the blast furnace and could be cast into a variety of shapes. The molten iron was often molded into bars or "pigs," which were reheated and hammered to produce wrought iron. Cast iron pigs were also melted down at foundries in cupola furnaces or air furnaces to be then poured into molds.

The iron-master or furnace manager could control the temperature inside the furnace by adjusting the "blast," the oxygen for the burning mixture which is forced at the bottom of the furnace and exhausts through the open stack at the top. The blast is created by a blast machine, originally nothing more than a huge fireplace bellows. Early blast machines were powered by waterwheels. Beginning some time in the 1830's, the blast itself was heated to further increase the efficiency of the furnace (Weitzman 1980:140).

The early forges to which pig iron from furnaces was shipped generally consisted of two hearths: a refinery, or finery, and a chafery. At the finery the pig iron was heated to a semi-molten state, pounded by a massive water-powered hammer, reheated, and then hammered again into anconies, thick bars with bulbous ends. The ancony was one form of bar iron, and its fabrication often marked the final step of production at a forge. Frequently, however, the anconies comprised semi-finished input material for the chafery, where they were heated and hammered again and then cut into various sized bars for sale (Paskoff 1983:7-8).

Until the 1830's ironworks, whether furnaces, forges or bloomeries, remained dependent upon charcoal and waterpower. To determine the best location for an ironworks an entrepreneur needed to assess the availability and proximity of several key factors. Proximity to an ore deposit was to be expected in the case of furnaces, and these were, for the most part, located on or near land that was known for its iron ore content and offered an outlet to a market. Access to sufficient wood for making charcoal and waterpower were essential to an ironworks' operation. Both timber and swiftly moving streams were common enough in eastern North America, and it was only after an ironworks had been in operation for a number of years that the supply of timber became a cause for real concern.

By the 1830's scarcity of charcoal had created a crisis in the American iron industry. American ironworks were lagging behind technologically and the owners of furnaces and forges found it difficult to compete with British producers in the wrought iron market without tariff protection (Lewis 1976:25). The opening of anthracite coal fields in northeastern Pennsylvania circa 1830, however, encouraged the large scale adoption of new smelting and refining technologies. West of the Alleghenies, charcoal continued to be utilized until wood supplies were depleted. The eastern seaboard states had lagged behind in the use of coal principally because the main coal source in the region was anthracite coal, and not the bituminous coal used in England in coked form (Ralph Brill Associates 1979:75). Another important factor determining the location of an ironworks before 1840 was access to inexpensive water transportation, or terrain conducive to road construction. An iron producer needed to ensure that his products could leave the works with minimal expense and risk of loss or damage.

The American iron industry expanded more rapidly in the last three decades of the pre-Civil War era than in the ones preceding. By the end of the antebellum period, American ironmakers had successfully responded to the demands of altered modes of transportation, new manufacturing and building techniques, and improved means of communication. Use of anthracite coal gained favor slowly, but as techniques improved, it gradually became the most widely used fuel in the production of wrought iron. By mid-century, 80 percent of all Pennsylvania wrought iron was made by the cort puddling and rolling process (Lewis 1976:25). The introduction of the puddling process and other methods of refining from the pig iron instead of the ore at forges, bloomeries and rolling mills "was of the greatest importance, as this method of refining iron was destined to supplant all others and to continue in existence until in turn replaced by newer methods of making mild steel for structural purposes" (Depew 1895:322).

The period between 1840 and 1850 was "the most eventful" one in the history of the American iron industry (op. cit.:323). The introduction of improvements in smelting and refining, together with the use of steam-power for propelling the blast in furnaces and various processes at forges, its replacement of water power in operating rolling mills and hammers, in mining coal and ore, and the rapid growth of railroads, produced "a stimulating effect probably never before experienced in a similar degree by any American industry" (ibid.).

Eastern Pennsylvania remained the heart of the American pig and wrought iron industry up to the Civil War. After the 1830's, production of pig and wrought iron along the Atlantic seaboard became increasingly specialized in the fabrication of finished items. In New York state, Albany and Troy became the leading upstate centers for the manufacture of specialized items, and New York City excelled in the production of all sorts of finished cast iron wares. The 1850-51 New York City Business Directory lists thirty-eight foundries, but only three forges.

The responses to questions posed to "Messrs. Ward & Co." which appear in the Franklin Institute's "Report on the Explosion of the Gun on board the Steam Frigate 'Princeton'" indicate that the Hamersley Forge implemented many of the forging processes, techniques and machinery that during its period of operation (ca. 1840-50) represented the newest inventions and improvements in American iron forging. At this time (1843) most American forges were still dependent upon charcoal and water power for their basic operations. These were, for the most part, to be found in rural settings, "more often than not built deep into the backcountry" and were specialized in serving agrarian communities (Weitzman 1980:139). (See Boyer 1931 and Poole 1982 for descriptions of 19th and early 20th century American forges.)

Operations at the Hamersley Forge, on the other hand, depended upon steam power, and its location efficiently met all of its particular requirements. Proximity of both water and overland transportation routes ensured the forge of its supplies of pig iron and fuel (anthracite or bituminous coal) from upstate New York and elsewhere. At the same time, the forge's location heightened its ability to serve what was then the relatively new and growing demand of urban industrial enterprises. Set in a semi-urban area, which was becoming increasingly built up, the Hamersley Forge produced large-scale wrought iron products for steamers and steam ships and probably other forms of products required for structural purposes. The Hamersley Forge represented the type of forge that was required by an age that was witnessing the growth of cities, transportation networks, and manufacturing enterprises of all sorts, accompanied by swelling demands for a variety of both finished goods and industrial or mechanical parts.

The iron used by the Hamersley Forge in the production of the "Peacemaker" was in the form of bars forged "on the Ausable River in Clinton county" and made from ore "from beds in the vicinity of Clintonville" (Jones 1844:207-8). Mr. Ward informs the committee that "a few hundred weight of the iron used on the small end of the gun, in lengthening it out, was puddled by ourselves, on the old plan, with bituminous coal, and without artificial blast, and the whole throughout was manufactured by hammering alone" (op. cit.:209). About half the bars used, which measured "four inches square, and in length about eight and a half feet . . . were trimmed at the end" and the fag ends of the bars used initially were "cut off . . . {and} effectually got rid of" (ibid.).

During the "forty-five and a quarter 'turns,' or day's work . . . expended on the gun from the time of commencement to its completion" the gun was "kept more, or less heated." By attaining a welding heat the faggots (bundles of thirty bars) could be joined by hammering and drawn to form the required shape, thicknesses, and diameters of the gun. The process of heating, welding and shaping is described by Ward as follows:

> These {faggots} were heated and welded together, and, when so done, rounded up, forming a shaft from twenty to twenty-one inches in diameter. Iron was then laid on to enlarge the size, being, for the

> most part, prepared in the form of segments, partly from scraps of our own working, and partly from bars, and made of different thicknesses, to suit the position for which they were intended on the gun. The weight of them must have varied from about two hundred to eight hundred pounds; the heaviest ones being put on the breech on which were laid two tiers, or strata, the one being first welded, and then the other upon the top of it. They were of such length usually that three of the segments reached round the body of the gun (Jones 1844:209).

Mr. Ward also informed the committee that the hammer used in the construction of this piece weighed fifteen thousand pounds, and that "the weight of the gun, before being bored, was twenty-seven thousand pounds" (op. cit.:210).

An example of a large forging cited in an 1865 description of the puddling process provides a fuller picture of the methods used in the manufacture of large wrought iron guns. This account was provided by Mr. Clay of the Mersey Works, Liverpool and concerns the production of a gun similar to the "Peacemaker" in weight and dimensions. It is possible that the gun described in the following description referred to the "Oregon" which was forged at this British works and mounted upon the U.S.S. Princeton with the "Peacemaker."

> It was built in seven distinct layers or slabs, and the forging occupied seven weeks: nor will this time seem unreasonable, when its dimensions and weight are considered. The first operation was to prepare a core of suitable dimensions, and nearly the whole length of the gun. This was done by taking a number of rolled bars, about 6 feet in length, welding them together, and drawing them out till the proper length was attained. A series of V-shaped bars were now packed round the core, the whole mass heated in a reverbatory furnace, and forged under the largest belly-helve hammer. Another series of bars were now packed on, and the mass was heated again and worked perfectly sound. Another longitudinal series of bars were still required over the whole length of the forging, which were added, and the mass now presented a forging about 15 feet in length and 32 inches in diameter, but requiring to be augmented to 44 inches at the breech, tapering down to 27 inches at the muzzle. This was accomplished by two layers of iron placed in such a manner as to resemble hoops laid at right angles to the axis of the mass; and after two more

> heatings, and careful welding, the forging of the gun was completed (Fairbairn 1865:137-8).

The evidence provided by Mott's (1908) description of the Hamersley Forge and by Ward in the above cited Franklin Institute report enables us to piece together a partial picture of its processes and machinery. The size of Ward's property between 1840 and 1850 together with the cartographic evidence suggests that the Forge covered a relatively small area and that its main operations were housed within four buildings. The cartographic evidence and possible lay out logistics of the forge will be discussed below, following an explanation of the forge processes known to have been in use at the Hamersley Forge through the literary evidence cited above, as well as inferential evidence.

The Puddling Process:

The conversion of cast iron pigs, scrap, and gate metal into wrought iron involved a process that was essentially the same at any forge:

> After kindling the fire, the finer's assistant would heap charcoal 12 to 18 inches high in the fireplace for gray metal, or up to 24 inches if white metal were to be worked. When the fire was just right, the finer would insert the ends of two or three pigs into the charcoal fire. The blast was now applied, and as the ends of the pigs in the fire softened, the rest was fed in and new pigs added until there was about 120 pounds of iron in the hearth. The iron was melted not to a fluid state again but just until it reached a pasty consistency. Using a long iron bar, the finer worked the pasty mass into a ball by continually raising and turning it until the iron was uniformly heated. When the finer felt the time was right, the bloom was lifted from the hearth with tongs, swung onto the anvil of a huge hammer, and beaten into a rectangular billet, 5 or 6 inches square and about 16 inches long. The carbon had been brought to the surface of the bloom in the refining fire, and now the hammering would remove this carbon, combined with the cinders, and would lengthen the fibers -- producing a much stronger and different iron than that which had emerged from the blast furnace (Weitzman 1980:170).

One or more fineries of the type described above would have probably formed a part of the equipment at the Hamersley Forge.

The reverbatory, or puddling, furnace was introduced by Cort about 1784 and was first used, with bituminous coal, in the United States in 1816-17 at the Plumsock Rolling Mill in Pennsylvania (Lewis 1976:30). Between 1840 and 1850, the puddling process became increasingly common in America, and accepted as the most effective alternative in iron refining technology. According to one mid-nineteenth century source, "the reverbatory or puddling furnace is, unquestionably, of all arrangements, the best adapted to convert cast iron into bar iron" (Overman 1854:259). The puddling furnace "differs from the forge fire in that the fuel, either coal or coke, does not come in contact with the iron, but is burned, instead, in a fireplace or grate adjacent to but separate from the hearth" (Weitzman 1980:170). The hearth is heated partly by the flame heating the walls of the furnace, but mostly by the intense heat that is reflected or "reverbated" off the roof of the furnace. Two forms of the furnace evolved during the second quarter of the nineteenth century: the single furnace, the older form, which was used at Pittsburgh and generally throughout the states west of the Allegheny Mountains; and the double furnace, commonly built in the Eastern states (Overman 1854:260; Weitzman 1980:171).

Figures 8c and 8d illustrate the double puddling furnace. The puddling furnace at the Hamersley Forge, presumably a double furnace, would have measured approximately 18 by 8 feet with a stack between 30 and 40 feet tall. The stack would have been "erected on a solid foundation of stones" (Overman 1854:261). The following summary of the puddling process, in conjunction with the keyed Figure it refers to, also provides a description of the furnaces' main structural elements:

> {The furnace} consists externally of an oblong casing of iron plates firmly bound together by iron tie-bars, and lined with fire-brick. A is the fire-grate, separated form the body of the furnace E by a bridge over which the heated products of combustion, with a surplus of oxygen, play upon the surface of the molten metal, and effect its conversion, and thence pass to a lofty chimney K, over the top of which is suspended a metal plate, by which the draught can be regulated to a niceity. The body of the furnace E is dish-shaped, and constructed of cast-iron plates, the sides being in some cases hollow blocks, through which a stream of water or air is made to circulate to retard their deterioration by the heat. The free access of air to the under side of the plate forming the bottom, in a similar manner conserves that part. The puddler effects his operations through a door balanced by a lever and weight, so as to open or close with ease. In some furnaces the charge of iron, weighing about 4 cwts. before its introduction into the puddling furnace, is raised to a red heat

in a chamber provided for that purpose between the body of the furnace and the chimney, and in this way both time and fuel are economised. In the furnace the iron is kept in a state of fusion, whilst the workman, called the 'puddler,' by means of a rake or 'rabble,' agitates the metal so as to expose, as far as he is able, the whole of the charge to the action of the oxygen passing over it from the fire. By this means the carbon is oxidised, and the metal is gradually reduced to a granular form, somewhat resembling heaps of boiled rice with the grains greatly enlarged. In this condition of the furnace, the cinder or earthy impurities yield to the intense heat, and flow off from the mass over the bottom in a highly fluid state.

At intervals in the process, portions of oxides of iron, hammer scales, scoriae, and in some cases limestone and common salt, are thrown upon the molten iron, and form a fluid slag, which assists in oxidising the carbon, and removing as silicates, etc., the magnesia, sulphur, and other impurities of the iron.

The iron at this stage is comparatively pure, and quickly becomes capable of agglutination; the puddler then collects the metallic granules or particles with his 'rabble,' and then rolls them together, backwards and forwards, over the hearth, into balls of convenient dimensions (about the size of thirteen-inch shells), when he removes them from the furnace to be subjected to the action of the hammer or mechanical pressure necessary to give to the iron homogeneity and fibre (Fairbairn 1865:105-7; See Figure 8a).

For a detailed description of the materials and modes of construction employed in mid-nineteenth century puddling furnaces, see Overman 1854, pp. 259-79.

Forge Hammers:

Several different types of hammers were used at mid-nineteenth century forges. These included the tilt (or German) forge hammer, the T-hammer (used for hammering slabs for boiler-plate and sheet iron), and the belly-helve hammer (See Weitzman 1980:174-5; Overman 1854:334-41). The Hamersley Forge was apparently equipped with more than one steam hammer (Mott 1908:11). Hand operated hammers were probably also used at the

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Hamersley Forge, as well as one or more squeezer, which was used to compress iron balls from the puddling furnace. The tilt hammer could be either water powered or driven by belts or leather straps from a steam engine, and thus would have been compatible with the steam technology documented for the Hamersley Forge (See Figure 9).

The hammer described by Ward in the Journal of the Franklin Institute Report cited above was certainly very powerful and steam powered. Steam is the cheapest motive power in an iron works, because surplus heat for its generation is always available. Mr. James Nasmyth's steam hammer, patented 1843, may well have been the type used at the Hamersley Forge that same year. Mr. Nasmyth's invention was considered "one of the most important that has occurred in the art of forging iron" (Fairbairn 1865:135). This steam hammer made possible "the welding of large masses of iron upon a scale previously unknown to the workers in that metal" (op. cit.:132). This type of steam hammer can be characterized generally as a mechanical hammer with a piston raised and driven down by steam. Not all steam hammers were of the Nasmyth pattern (Gale 1971:199). The Merrick and Town steam hammer, for example, was also widely used, being especially well adapted for forging steam-engine shafts (Overman 1854:337). See Fairbairn 1865, pp. 133-36 for a detailed description of parts and use of the Nasmyth steam hammer. Figures 9a-9c illustrate some of the forge hammers used at the Hamersley Forge.

The Dripps' 1854 map represents the only cartographic source dating to the forge's period of operation to designate the forge and illustrate its structures (See Figure 5). Unfortunately, Dripps' 1854 map is somewhat lacking in accuracy, and its depiction of the structures at the Hamersley Forge is far from exact or detailed. The 1854 map shows four, presumably brick structures located within the western half of the fast land that then lay west of Eleventh Avenue. One of these structures is centrally located and relatively large. The remaining three structures are shown lining 59th Street. These are all of similar dimensions and approximately one quarter the size of the main, central structure (See Figure 5).

As the site of the Hamersley Forge became, by 1862, that of a bone black factory, a comparison of the layout of structures shown on the 1854 map with that of the bone black factory on Perris' 1862 map is useful. The manufacture of bone black or animal char, which is discussed in greater detail below, required the use of a boiler system and furnaces. One can, therefore, assume that certain components of the Hamersley Forge were reused in the later bone black factory's processes. Four of the brick structures illustrated on the Perris 1862 map correspond approximately in both relative size and location to those described on the Dripps 1854 map, while providing a more accurate representation of these structures (See Figures 5 and 6).

An 1857 map, the Harbor Commissioners' Map, which shows the first stage of land filling within this block, depicts the layout of an undesignated industrial complex which is similar to that shown on the 1862 map (See Plate 7). As we do not know the precise year in which the Hamersley Forge ceased operating and have only Perris' 1862 map as the earliest indication of bone black production at this site, it is not possible to ascertain which of the two industries is depicted on the 1857 map. If this map does not in fact represent the layout of the bone black factory, which may well have dated to the late 1850's, it may simply illustrate the standing structures of what was then an inoperative forge.

As depicted on the Perris 1862 map, the main structure of both industries measures approximately 50 by 60 feet. This is the only structure shown on the Dripps' 1854 map that is large enough to have housed the forge's puddling furnace and steam hammers. The 1854 map depicts a pier just opposite this main structure, a fact that further supports the assumption that the forge's large scale products were worked within this building. Although the Hudson River Railroad ran right along the site's eastern boundary, along Eleventh Avenue, this section was built in the late 1840's and did not run to Albany until 1853, when the Spuyten Duyvil Railroad bridge was opened (Buttenweiser 1987:49). The forge would have therefore relied heavily on water transportation to obtain its primary materials and to ship out its products. The forge probably owned a number of its own sloops for these purposes.

The central building therefore provided the location for the double puddling furnace (which would have measured approximately 18 by 8 feet), the steam hammers and the boiler(s). The steam engine which powered the works may have been located at one end of this building, or it may have been housed in a frame structure just outside where it may have also been connected to a blast engine, if the forge in fact did ever use hot blast in any of its puddling processes. As the puddling furnace's stack would have been 30 to 40 feet tall (and the largest steam hammer up to 15 feet in height), this relatively tall structure would have been, as it is shown on the Perris 1862 map, necessarily one story. The Forge's main structure may have also contained smaller forges or fineries, providing space for iron workers using smaller steam driven or hand operated hammers.

The remaining three brick structures shown on both the Dripps' 1854 map and the Perris 1862 map front 59th Street and are (according to Perris 1862) of the following dimensions east to west: 2r by 25 feet, 40 by 20 feet, and 20 by 35 feet. The westernmost of these three brick structures is described on the Perris 1862 map as a three story building, the remaining two are both shown as having two stories. These three structures would have provided the spaces required for the forge's various other needs. Machine shop(s) with steam powered tools would have probably filled one of these structures. The machine shops of better documented mid-nineteenth century iron works, such as those of the Norris Locomotive Works in Philadelphia, provide some indication of what those at the Hamersley Forge may have been like. Although the Norris Works was one of the largest mid-nineteenth century industrial complexes in Philadelphia and almost twice the size of the Hamersley Forge, many of the machine tools used there would have formed part of the Hamersley Forge's equipment.

The Hamersley Forge's machine shop would have certainly included several lathes and planing machines. As noted above, Mr. Ward referred, in his response to the Franklin Institute committee's questions, to having "trimmed" and "cut off" the fag ends of the bars used in the "Peacemaker"'s fabrication (Jones 1844:209). The most common machine tools, lathes and planing machines, would have been used in this and many other instance at the Forge:

> The lathe spun the piece of metal; a sharpened steel cutter applied to the edge produced a perfectly cylindrical finished product of exactly correct size. A cutter applied to the inside produced a finely finished interior cavity . . . A planing machine did for flat pieces what the lathe did for cylindrical ones. These machines . . . cut flat items like engine frames, crossheads and crosshead guides, and cut pumps to proper size, and gave them the necessary smooth finish . . Lathes and planers were the essential machine tools of a mid-nineteenth century shop (Hindle and Lubar 1986:173).

Slotters and shapers were also often included in a machine shop's array of tools. Most machine tools were self-acting, requiring attention only to be set up, to be stopped, or to have the work or tools changed (ibid.). A steam engine powered the shafting that ran down the center of each shop, near the ceiling; "from pulleys on the shafts, leather belts stretched to pulleys attached to each machine tool" (op. cit.:172). Each machine tool had a clutch that served as an on-off switch. Although largely automatic, each machine required the close attention of a machinist, who chose the cutting tools, set the cutting speed and depth of cut, and made sure that the final product was cut to its exact intended dimensions.

Hand tools employed by skilled workmen, however, remained essential to every aspect of the work. Parts of the Forge's three smaller structures, which housed machine shops, would have also provided work areas for machinists whose tools would have included dividers, calipers and rules for measuring, hammers, hand drills, and scrapers and files for smoothing and fitting.

The structures at the Hamersley Forge would have also contained offices, storage and probably repair areas. As the Forge's operations required twenty-four hour supervision, one of the structures (probably the westernmost, three story building) would have provided housing for the workmen. Generally, mid-nineteenth century iron works included housing for its employees. Many of the Hamersley Forge's workers would have lived nearby and it is likely that accommodations for those considered most crucial to the forge's operations would have formed part of the forge's complex. To ensure smooth operations during the forging of large scale products, alternating shifts of one or more ironworkers would have to be able to switch over easily and quickly. It is possible that other frame structures, not depicted on the 1854 Dripps' map, may have been located within the area covered by the works, serving storage and other needs.

THE BONE BLACK INDUSTRY

By 1862, the site of the Hamersley Forge had become that of a bone black manufactory. Perris' 1862 map depicts a complex of frame and brick buildings and marks the industry's large boiler and retorts (See Figure 6). Perris' 1862 map and Perris and Brown's 1871 Atlas constitute the only evidence, cartographic or literary, that could be obtained concerning this manufactory. No listing for a bone black factory at this location was found in New York City Directories dating between 1850 and 1875 (Roberts, Zakalak et al. 1987:7).

As Ward retained ownership of this property until 1874, when it was sold to William H. Vanderbilt, the bone black manufactory probably represents his second, and possibly more successful, business venture at this site. The site was well suited to the needs of a bone black manufactory. The first phases of land filling operations between 59th and 60th Streets, which the 1862 map illustrates, and the proximity of the Hudson River Railroad line further enhanced the site's advantageous location. In 1852, Lebbeus B. Ward purchased a water grant from the City of New York which was bounded by the westerly side of Thirteenth Avenue, the northerly side of 59th Street and the center line of 60th Street. By 1852, Ward evidently had intentions of extending his property through the filling activities then permitted to him by law, and of presumably enlarging the industrial complex within it.

The 1857 Harbor Commissioners Map shows many of the structures illustrated on the 1862 Perris Map (See Plate 7 and Figure 6). The 1857 map shows the first cartographic evidence of land filling operations at the site, and indicates the next stage of filling which was completed by 1862, as shown on the Perris map of that year. As noted above, the 1857 map, which does not designate the complex of structures within Block 240, may represent the bone black manufactory which was in operation here until at least 1871.

Although limited in number, the references dealing with bone black manufacturing that were located provide thorough descriptions of its general processes, machinery, etc. Bone black or animal charcoal represents only one of the many products and by-products which can result from the processing of animal bones. Sources on this subject, dating to the early twentieth century, suggest that industries in this field were rarely limited to the production of a single commodity. In the case of animal charcoal, "subsidiary products of pitch, sulphate of ammonia, etc." would have been expected (Lambert 1913:16). Animal charcoal was utilized by a variety of industries. It was used as a filter in the purification and decolorization of liquor, drinking water and edible oils, in sugar refining as well as in the manufacture of paints and varnishes (Rideal 1902:199 and 1920:129).

The location and design of a bone factory, whether it produced glue, manures or animal charcoal, is of great importance: "The works should have easy access to main lines of railway . . . (and) a plentiful supply of water and a good outflow for all effluents are of a necessity" (Lambert 1913:3). The site chosen for a bone factory had to be outside the boundaries of a town "so that the offensive smell which arises from a works of this character may not be made a matter of complaint by a populous community" (ibid.). Ward's property was thoroughly suited to meet the basic needs of such a factory.

According to one source, bones were "mainly bought by contract from various dealers in towns within easy railway access to the works, the rates being generally fixed for twelve months, to cover all classes of common bones, whether fresh butchers' or a mixture with partly boiled bones" (op. cit.:2). Once the factory received a delivery of bones, the first step in the manufacturing process was the sorting of the bones. The bones were separated into different classes, as the type or size of a bone would determine which end product it was best suited to (Dawidowsky 1905:104). Thick compact bones were thought to yield the best results in the manufacture of animal charcoal (ibid.).

The bones selected for the production of animal charcoal were first crushed in a stamping mill or bone crusher (See Figure 10). The crushed bones were then sorted into pieces of equal size, often through a sieve "consisting of a drum constructed of narrow boards covered with wire-netting of different degrees of fineness" (op. cit.:36). The next stage in the process consisted of the degreasing and cleaning of the crushed bone. Lambert (1913) discusses the use of a "Benzene Extraction Plant" for the degreasing of bones and of a "mechanical cleanser" in his description of bone processing (Lambert 1913:4-16). However, Lambert does note that the plant and equipment he describes represented "the most modern type(s)" and it likely that the bone black factory at 59th Street, operating between circa 1862 and 1871 would not have been equipped with the machinery referred to by Lambert (op. cit.:4). Although the general processes in the 1860's would have been the same, the machinery used would necessarily have been less technologically advanced.

The bone black manufactory may have simply degreased crushed bones by steaming or boiling, followed by cleansing in a lime vat (Dawidowsky 1905:36). After they were removed from the lime vat and washed, the crushed bones were "subjected to the action of high-pressure steam" (op. cit.:105; See Figure -- for an illustration of the cylinder employed in the high-pressure steam apparatus referred to). For the purposes of bone black manufacturing the selection of larger pieces of crushed bones would be steamed to eliminate their fat, and then charred: "for the manufacture of animal charcoal it is the utmost importance that steaming should be interrupted at the time when the bones are completely degreased" (op. cit.:107). According to one source, previous to their carbonization, bones to be utilized in the production of animal charcoal, were simply "degreased by extraction with benzine or carbon disulphide, and then crushed" (Dawidowsky 1905:108). It is likely that this simpler preliminary processing, requiring fewer steps, would have been carried out at the 1860's manufactory.

Carbonization of bone results in the following changes and by-products:

> When a bone is burnt or carbonised out of contact with air, it undergoes a great change, losing 38 to 40 per cent of its weight, emitting empyreumatic, tarry and ammoniacal vapours, and leaving a black porous mass, retaining the shape of the original bone. This mass, when milled, forms the granular body called 'char.' The products of distillation are classified into --
>
> (1) Ammoniacal liquor
> (2) Tar
> (3) Illuminating and other gases
> (4) Char (Lambert 1913:17).

The bones were carbonized in a series of retorts, "whereby large quantities of animal charcoal are in a comparatively short time obtained, and besides, the products of destructive distillation can be completely utilized. An essential product of distillation is a large quantity of inflammable gases, which can be used fo: heating the retort-furnace or for illuminating the entire plant, it being, however, best to arrange the conduits so that the gases can be used for either purpose" (Dawidowsky 1905:109). Figure 11 illustrates the cast-iron Belgian retort-furnace and simpler brick "Bench of Retorts." For a detailed description of both these retort furnaces, see Dawidowsky, pp. 108-112 and Lambert, pp. 18-21. The iron retorts were placed horizontally within the furnace and heated by means of a fire beneath. Generally five retorts were fitted into each furnace and arranged so that "by the

Dripps, Matthew
1854 Topographical Map of the City of New York North of 50th Street.

Ensign, T. and E.H.
1845 City of New York. Published by Ensign, Bridgeman and Fanning, New York.

Harbor Commissioners.
1857 Map of 1857 from 57th to 61st Streets.

Harbor Commissioners.
1857 Map of 1857 from 60th to 72nd Streets.

New York City Department of City Planning.
1982 New York City Mapped Streets, Section 8.

Office of the Hudson River Railroad Company.
1847 A Map of the Line of the Hudson River Railroad as Located in the County of New York.

Perris, William
1862 Maps of the City of New York, Surveyed under the Direction of
1871 Insurance Companies of Said City.

Randel, John Jr.
1820 Randel's Manuscript Map of Farms.

Viele, Egbert
1874 Topographic Atlas of the City of New York.

aid of dampers and pigeon-holes, the flame may be made to sweep equally round each retort, so that each will receive its full complement of heat" (Lambert 1913:19). "Bench" furnaces were lined internally with fire-brick.

When ready for withdrawal of the bone char, the door of the retort was "slightly loosened by turning the lever, the escaping gases are burnt at the mouth of the retort" and the safe opening of the door ensured by simultaneously destroying the internal pressure (op. cit.:20). The char, then red hot, was quickly withdrawn and taken to the "canister" placed nearby to receive it, and then rolled to the plant's cooling shed, where it was cooled for twenty-four to thirty hours. In order to minimize the loss of heat in the retort, which occurs between withdrawal of the char and charging, each retort was closed after withdrawal and immediateiy refilled to the brim with crushed bones and "closed gas-tight" (Dawidowsky 1905:113).

After cooling the char was emptied from the canisters, and processed through a grading and cutting mill. The char was refined to varying extents, according to the refiner's or client's request: "the bones, after being calcined, are crushed to coarse powder between iron rollers, to sizes the refiner may order, some preferring finer charcoal than others. The quality of the charcoal thus obtained depends on the skill employed in its manufacture and the care shown in selecting the bones" (ARmstrong 1874:3). For a description of the spaces required for the various processes involved in the bone black manufacturing and their arrangement, see Roberts, Zakalak et al., page 7. As one source notes, the many procedures and equipment utilized by a bone black factory were best served by a efficient plant lay out: "The plant should be arranged so that the different processes can be carried through with a minimum of labour, quick transition between each being essential, and every facility for loading the finished goods" (Lambert 1913:3). The number and layout of structures, as well as the location of boilers and retorts at the 59th Street bone black manufactory, as they are depicted on the 1862 Perris map, appear thoroughly suited to the needs and processes of such a plant.

THE ORIGINAL SHORELINE

The issue of the location of the original shoreline relative to the project area is being addressed here because two of the previous reports on this project presented rather different views. The initial Phase I survey of cultural resources presented a redrafted version of the shoreline and the eastern boundary of the project area which was based on information derived from E.C. Viele's 1874 map (Rothschild & Dublin 1985:Figure 1). This figure shows the shoreline as entirely within the eastern boundary so that from approximately 100 to 1050 feet of fast land would exist along this boundary. The Phase I report concluded that portions of this shoreline adjacent to the three streams shown on the map could have supported prehistoric occupation, particularly temporary fishing camps (Rothschild & Dublin 1985:19). The second report prepared on the project area, although concentrating on the architectural and historical resources within the southernmost block of the project area, presented a different view of the original shoreline throughout the project area. This map, credited to W. Bridges, was surveyed in 1807 for the purpose of laying out the street grid in the central portion of Manhattan island. It shows that nearly all of the project area is built on landfill and that only in the blocks south of 62nd Street is there any substantial amount of fast land (Roberts, Zakalak et al. 1987:Figure 2). A number of repositories were visited with the purpose of obtaining additional cartographic information to resolve this dispute, and a series of maps were collected that show the shoreline at various times during the 19th and 20th centuries.

As part of the research into the shoreline, a report which compiled over one hundred soil borings from the project area and its vicinity was sent to Dr. Dennis Weiss of City College. This was done to provide evidence which could confirm or deny the shoreline location(s) as shown on the maps, as well as to provide estimates of the depth of deposits which potentially could preserve archaeological evidence. His report is presented here as Appendix I.

An examination of the various maps surveyed during the first quarter of the nineteenth century, Plates 1-3 and Figure 2, show a shoreline without obvious large areas of fill. These depictions are all in relative agreement, showing a series of three coves with at least two fed by streams. The earliest of these maps, Bridges' or the Commissioners Map of 1807-1811, presented here as Figure 2, shows two streams feeding the northern cove between 66th and 69th Streets and one feeding the southern cove between 60th and 61st Streets. When the boundary of the project area is overlaid on this information (Roberts, Zakalak et al. 1987:Figure 2), it is obvious that the only substantial area of fast land within the project area are the two points of land immediately north and south of the southern cove. These two points, located between 59th and 62nd Streets, extend approximately 140 and 380 feet into the project area. Bridges and Poppleton's 1810-1812 shoreline map shows nearly identical information, as does Randel's Farm Maps of 1820 (See Plates 1-3). All of these maps were surveyed in the field by professional surveyors when the shoreline was visible. The same three coves consistently appear on the maps produced during the 1830's and 1840's. Although Colton's 1836 map is difficult to read, it does include graphic renderings of topographic features (See Figure 3). Ensign's 1845 map clearly shows the three coves with the northern and southern ones fed by streams. The only difference here is the addition of a second small stream feeding the southern cove (See Figure 4). The next map in chronological order is one of the most important. Plates 4 and 5 illustrate two pages of this bound volume which was prepared to show the line of the Hudson River Railroad as laid out in 1847. This railroad later became part of the New York Central and subsequently the Penn Central Railroad. It still exists as the easement owned by Conrail which marks the eastern boundary of the project area. The shoreline depicted on this map closely resembles all of the preceding evidence. The same three coves appear and the only obvious area of fill appears to be close to the line of 72nd Street where several buildings are shown to the west of the railroad right-of-way, which therefore should lie within the project area. These fall between the southern and central coves, between the central and northern coves, and between the northern cove and 72nd Street. The latter two are 100 feet and 50 feet wide at their maximums, while the former extends up to 275 feet into the project area. The next map, shown here as Plate 6, depicts the original high water mark for the water lot granted in 1852 covering 63rd to 67th Streets. This is the point of land between the central and northern coves, and it shows 13th Avenue as the maximum extent of the proposed landfill. The Harbor Commissioners Map of 1857, illustrated here as Plates 7 and 8, shows the railroad as built, and several areas of obvious fill. These appear on the 59th to 60th Street block, just south of 64th Street, at the foot of 70th Street, and just south of 72nd Street. One interesting change is that the northern cove is now shown as a marsh because the railroad has sealed off this location from the Hudson. Dripps' 1854 map, shown here as Figure 5, depicts virtually the same situation. Perris' 1862 map shows only the section from 59th to 60th Streets. By this time the southernmost block has been filled to create a rectangular piece of land where the southernmost point had been. The point between the southern and central coves is shown primarily between 61st and 62nd Street and it extends approximately 260 feet into the project area (See Figure 6). Plate 9 illustrates part of Boyle's 1865 atlas. This map shows the same situation as on Perris, although the details of the layout of the Bone Black Manufactory are omitted. The areas of landfilling are unchanged from the 1857 and 1862 depictions. The Street Opening map, presented here as Plate 10, illustrates the shoreline at a point later than 1865 but prior to 1869 when 12th Avenue was officially opened. A pier has been added at the foot of 59th Street and the 65th to 66th Street block has been extended by fill. The northernmost cove has now been filled in, although its original position is traced in pencil on this copy. This is evidently the shoreline used by Viele in his 1879 map, shown here as Figure 7. It is obvious that Viele has misplaced the shoreline since he shows it as entirely east of the railroad. It is clear from the analysis of the maps presented here that the railroad followed the original shoreline very closely. Viele's shoreline parallels the railroad but is displaced several hundred feet to the west.

The report on the evidence derived from soil borings provides information taken from 125 boring logs. Dr. Weiss located the interface between the overlying landfill deposits and organic silt below, and produced two maps. One of these shows the approximate thickness of the fill deposits, while the other plots a series of Paleo-shorelines. The zero line on this map approximates a shoreline of the second quarter of the nineteenth century. A comparison of this line with the shorelines shown on the Bridges and Randel maps (Figure 2 and Plates 1-3) indicates that the boring data confirms their information and refutes that of Viele (Figure 7). See Appendix I for Paleo-shoreline analysis.

CONCLUSIONS

The above discussions of the forging and bone black making industries provide reasonably clear explanations of how these industries functioned during the mid 19th century. In the case of the Hamersley Forge, the Franklin Institute's report provides some information regarding how this specific forge was organized circa 1844. The general discussion provides other inferences regarding forging which combined with the aforementioned report provide a clear idea of how the industrial processes were carried out at the Hamersley Forge. Although no specific description of the subsequent bone black manufactory on this site could be found,several general discussions provide the characteristics of these processes. It is probable that several major features of the forge were retained while other features were removed or modified for use by the bone black manufactory. The general discussion provides a reasonable idea of how the bone black manufactory was organized and how these industrial processes were carried out on this site. The purpose of this research was to determine whether or not to recommend additional subsurface testing to recover information regarding these industries and the complex that housed them. Limited Phase IB testing of this location was carried out by Greenhouse Consultants during May of 1987. This investigation resulted in the discovery of remains which clearly pre-dated the Union Stockyards building, part of which remains standing today. These archaeological remains included a dry-laid schist wall that was probably part of the central structure of the complex that served both the forge and the bone black maker. The structural remains were sealed by a layer of destruction debris which contained ferrous slag and calcined bone fragments (Roberts & Stehling 1987:5-6). It is our belief that the destruction debris represented the demolition of the structures used by the bone black maker. Since the entire complex was re-used by the bone black makerafter the Hamersley Forge ceased operations, it is probable that a number of alterations were made to the structures and the machinery that housed to facilitate this conversion. Certain features such as the main furnace and the steam boiler were quite likely retained, but it is probable that the hammers and their massive bases would have been removed. It is therefore unlikely that archaeological investigations of this industrial complex would provide any significant additional information regarding the Hamersley Forge. The information which might be gained from such work would reflect the complex during its final period of operation as a bone black maker. It is our opinion that the documentary research presented in this report provides a reasonably clear picture of how the bone black manufactory operated, and that although additional archaeological work is likely to provide information regarding the foundations of the buildings and the layout of the complex, much of this information is already available from the maps and documents. It is our assessment that no further work is required for these issues, and we are not recommending any additional documentary research or subsurface testing.

The above discussion of the cartography of the Trump City project area has demonstrated that the only locations where fast land existed adjacent to stream courses within the project area fall between 59th and 62nd Streets. See figure 2 for the location of the fast land within the project area. Although two additional narrow strips of fast land may lie within the project area, they are both over 200 feet distant from the known stream courses and are less than 50 feet in width. It is possible that the prehistoric population utilized the points of land on either side of the cove between 60th and 61st Streets, considering their proximity to fresh water. The southern point lies between the northern sides of 59th and 60th Streets and is approximately 200 feet by 250 feet in size. The northern point extends from 40 feet south of 61st Street to 60 feet north of that street, and is approximately 200 feet by 60 feet in size. These two points are considered potentially sensitive and therefore may preserve subsurface evidence of prehistoric occupation such as shell middens. This is due to their proximity to the confluence of the small stream formerly located just north of 60th Street and the Hudson River. This would have provided access to a fresh water supply as well as the food resources of the estuarine environment. Such locations have proven in the past to be possible locations of prehistoric fishing camps. Both of these locations have been covered with fill. Research into the paleo-shorelines in the project area presented here as Appendix I also generated information on the thickness of the fill. This data indicates that the northern point of land is covered by approximately ten feet of fill. The southern point evidently is also covered by about ten feet of fill along the eastern boundary of the project area. Greenhouse Consultants Phase IB investigations indicate that the western portion of this point lies under approximately sixteen feet of fill (Roberts & Stehling 1987:Fig. 4). It is our recommendation that a Phase IB Archaeological Survey of all portions of these two buried points of fast land that will be impacted by the planned development. This testing is recommended to provide evidence of the presence or absence of prehistoric archaeological evidence on these buried land surfaces.

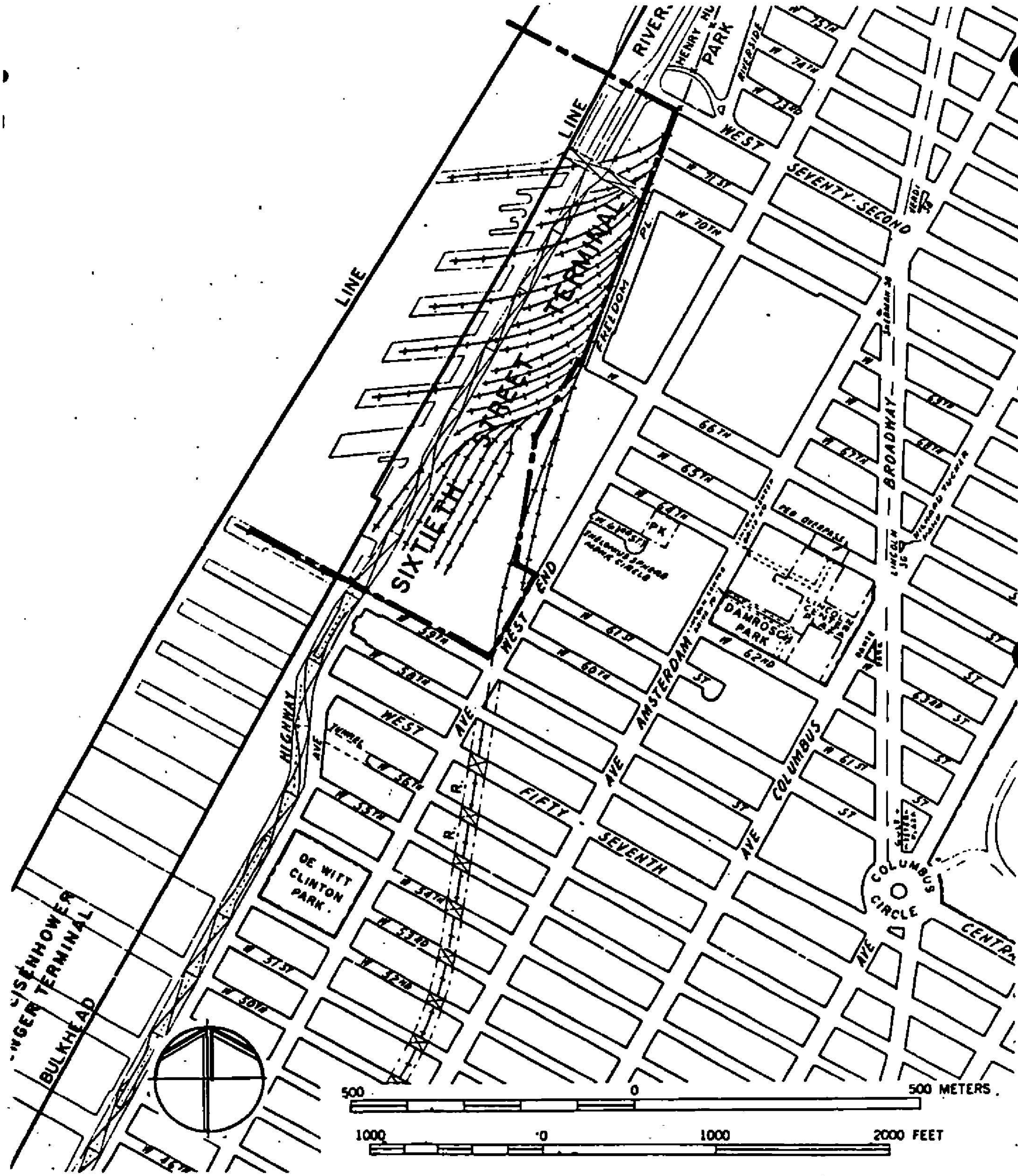

Figure 1: Project Area (indicated by bold line) shown on 1982 New York City Mapped Streets, Section 8.

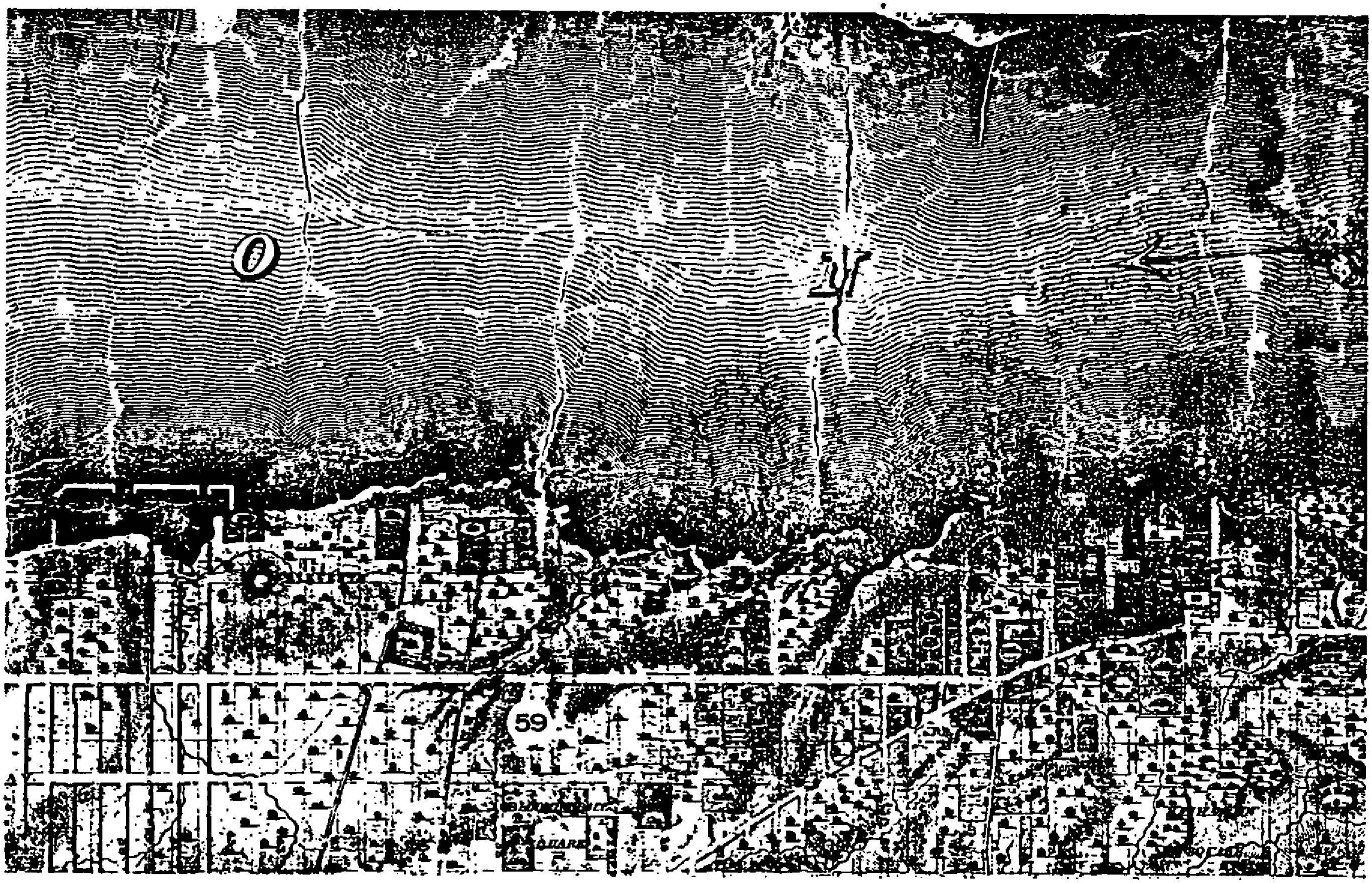

Figure 3: From Colton's 1836 Topographical Map of the City of New York.

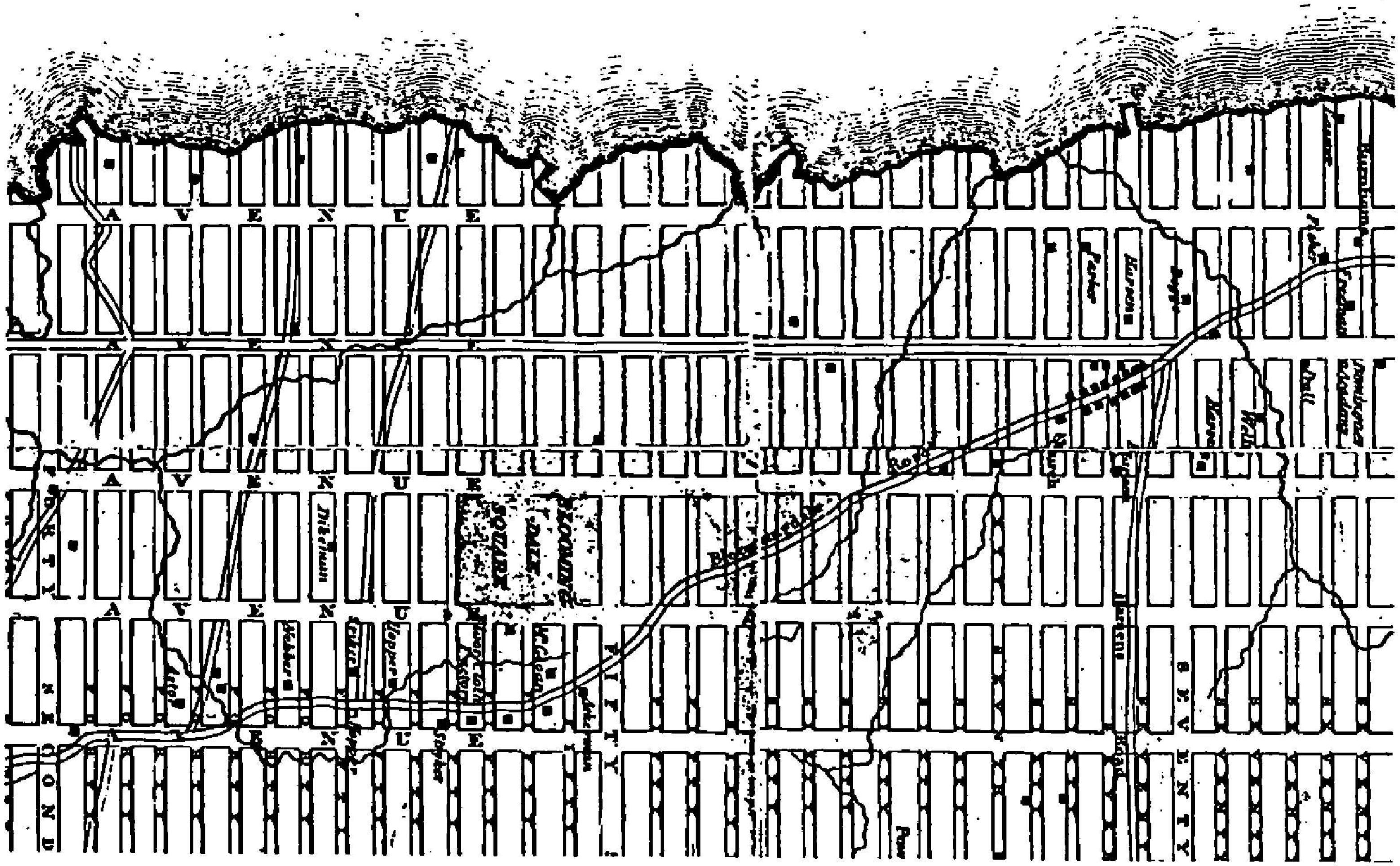

Figure 4: From Ensign's 1845 City of New York.

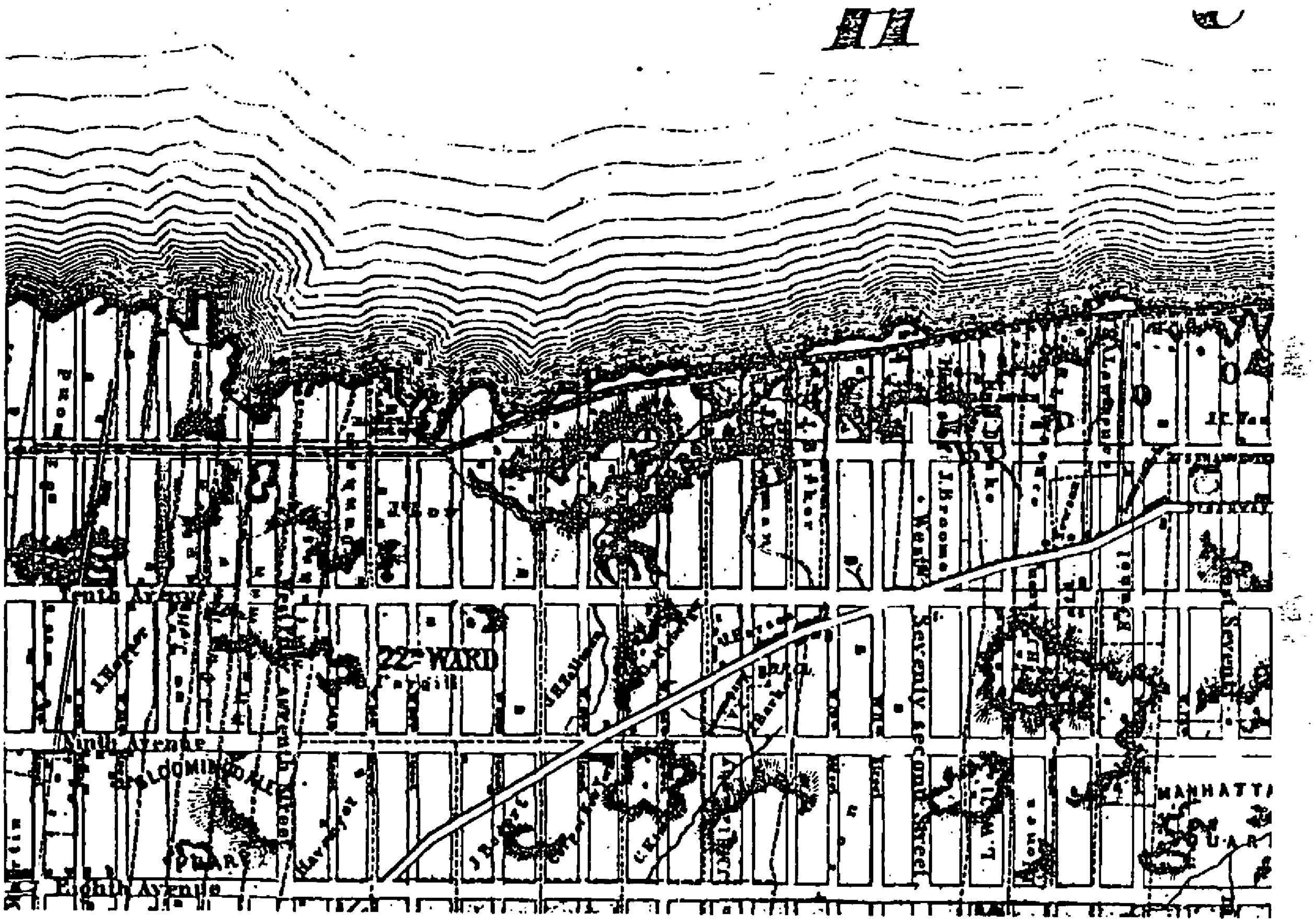

Figure 5: From Dripps' 1854 Map of the City of New York.

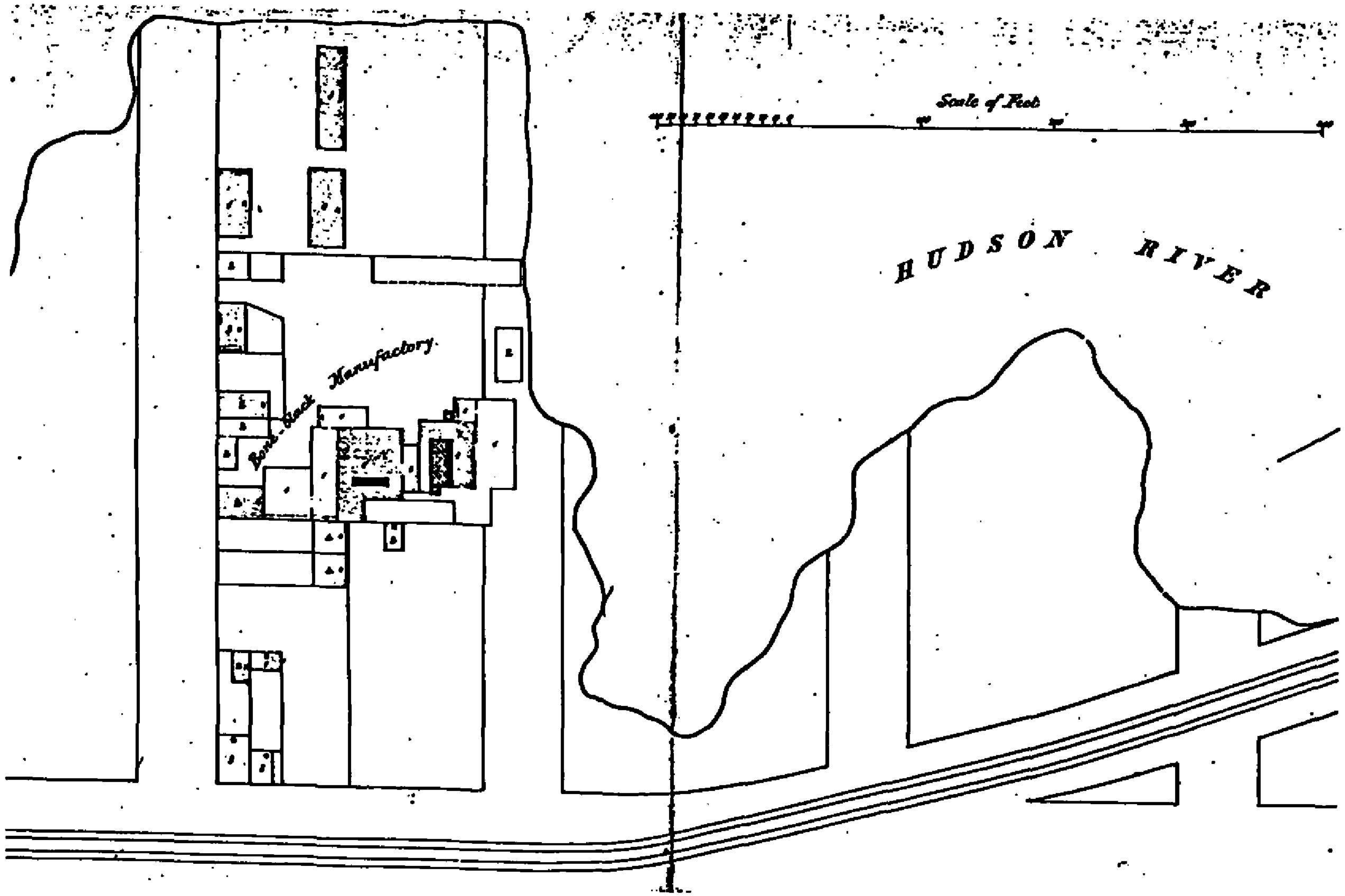

Figure 6: From Perris' 1862 Maps of the City of New York.

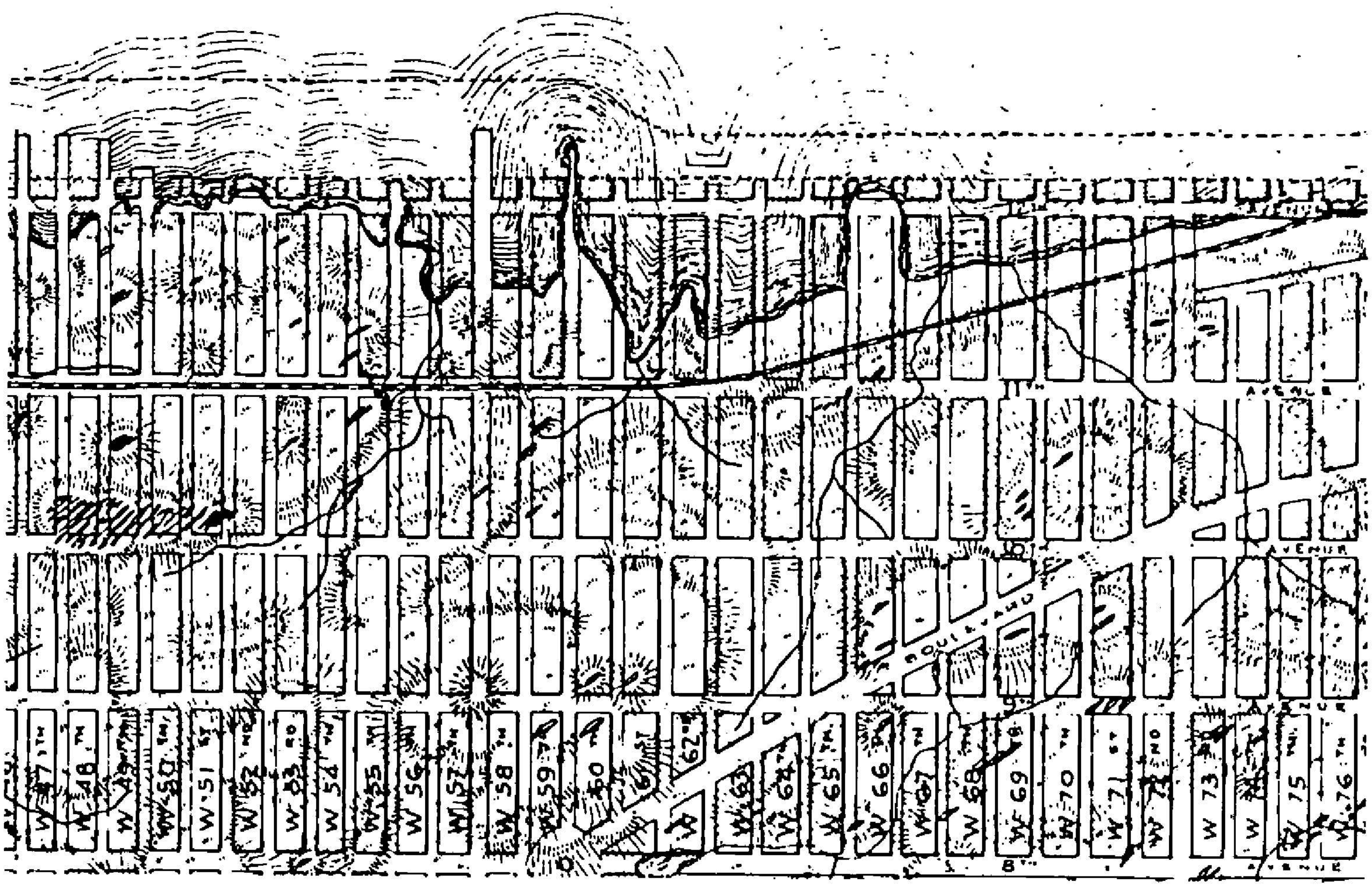

Figure 7:   From Viele's 1874 Topographical Atlas of the City of New York.

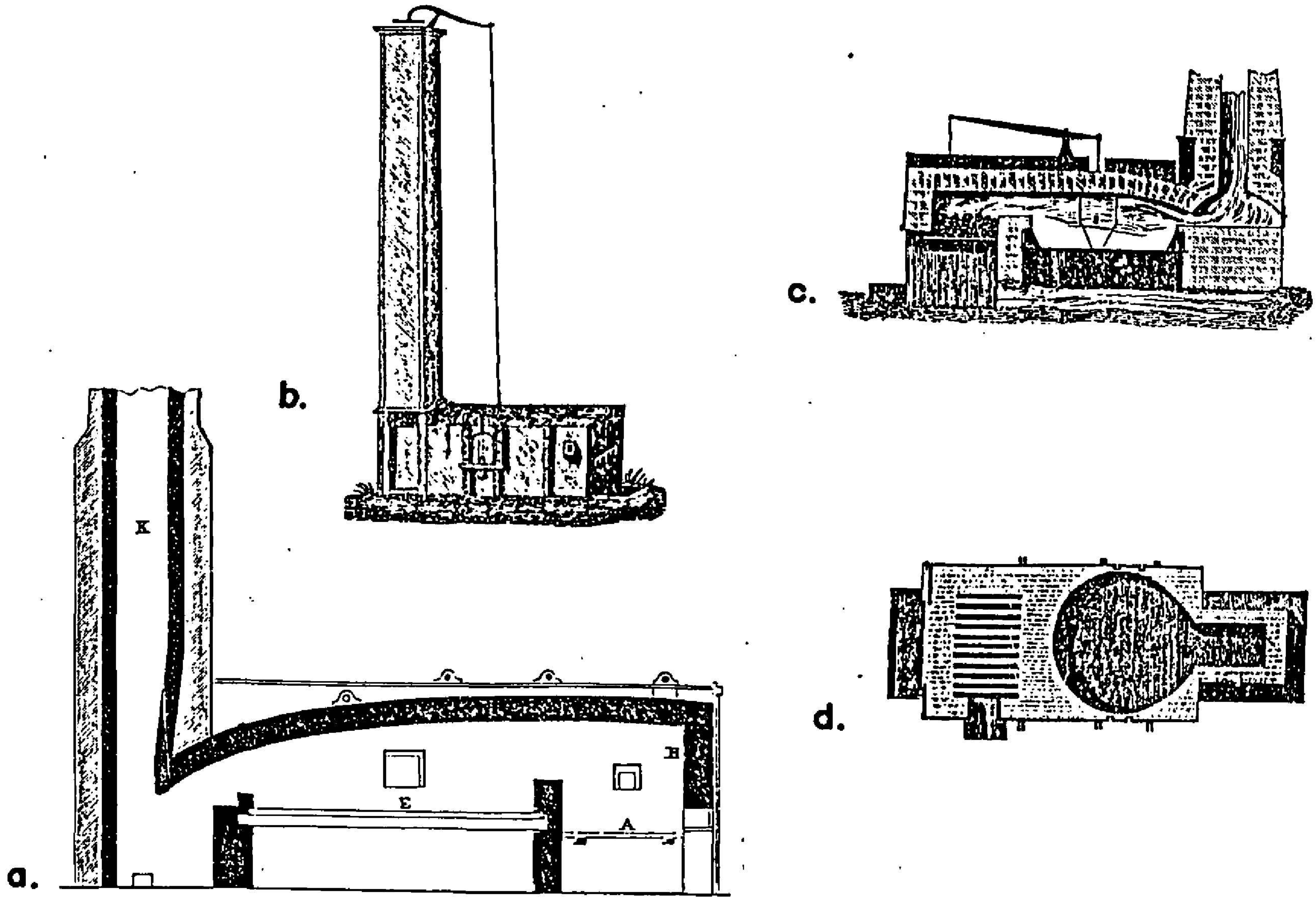

Figure 8: Puddling Furnaces. a) keyed section of a single puddling furnace; b) elevation showing exterior details; c) vertical section of a double puddling furnace; d) ground plan of a double puddling furnace.

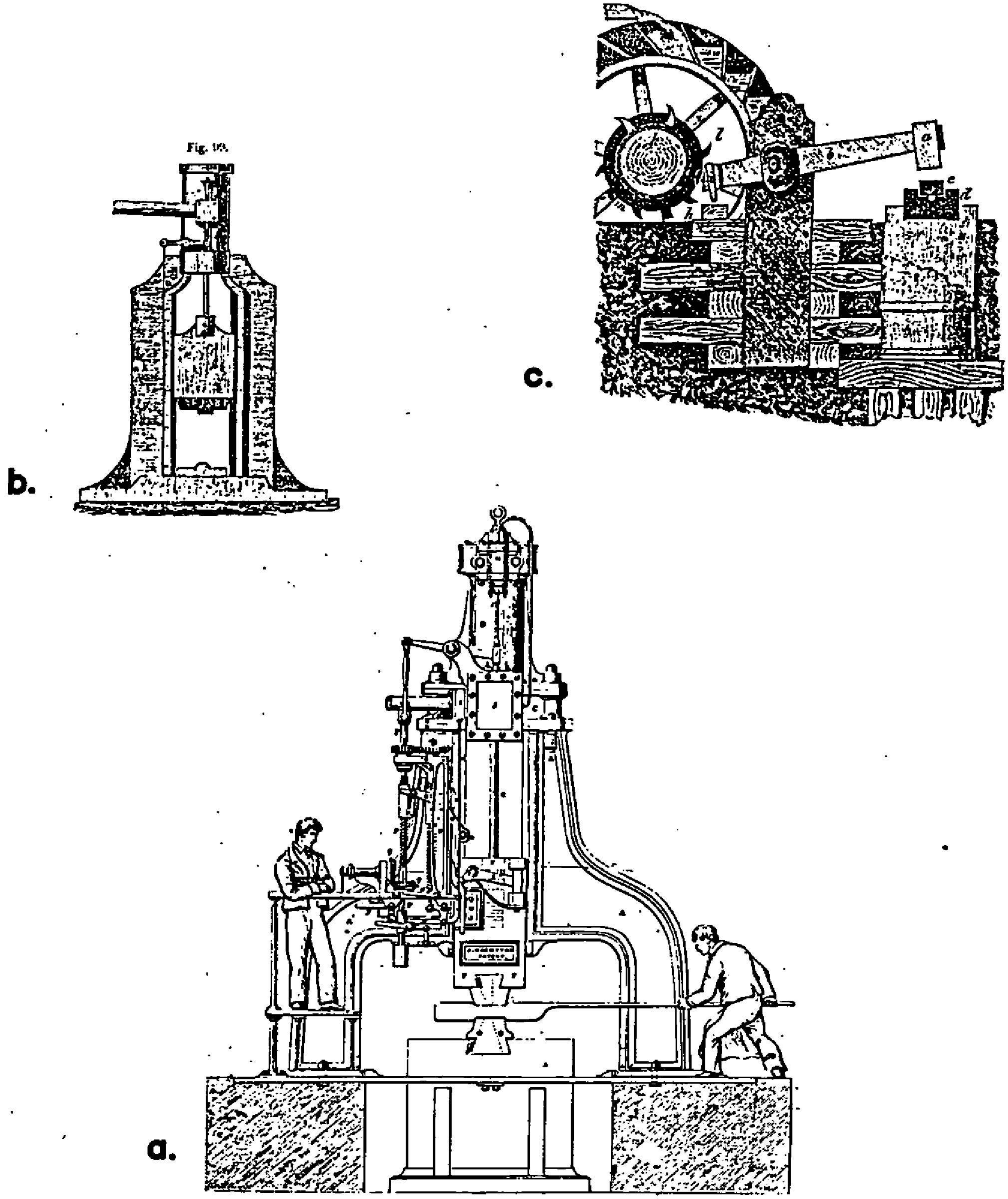

Figure 9: Forge Hammers. a) Nasmyth steam hammer, patented 1843; b) generic steam hammer; c) tilt hammer.

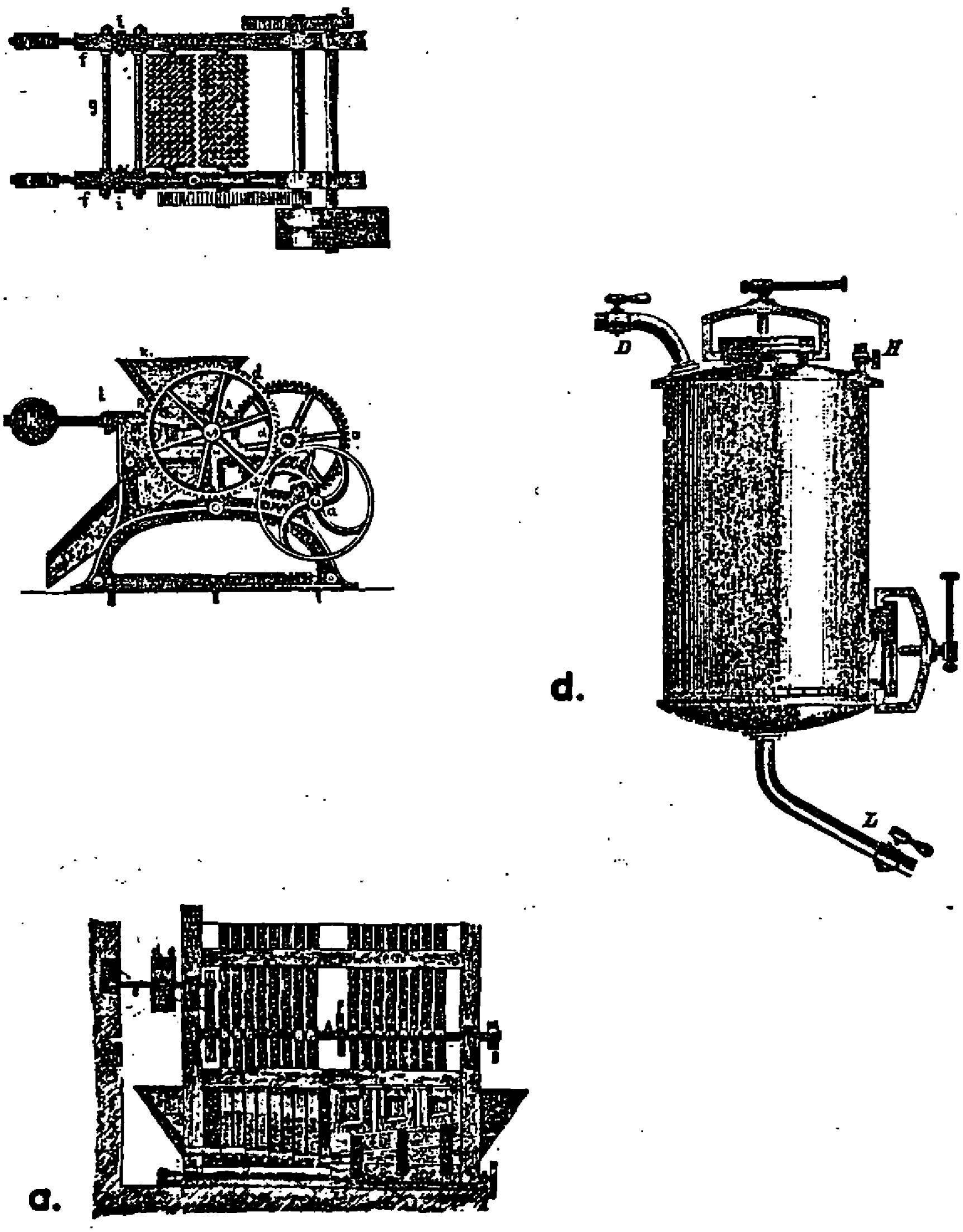

Figure 10: Equipment utilized in bone black processing.
a) stamping mill; b) and c) bone crusher;
d) cylinder in which crushed bones are subjected
to the action of high-pressure steam.

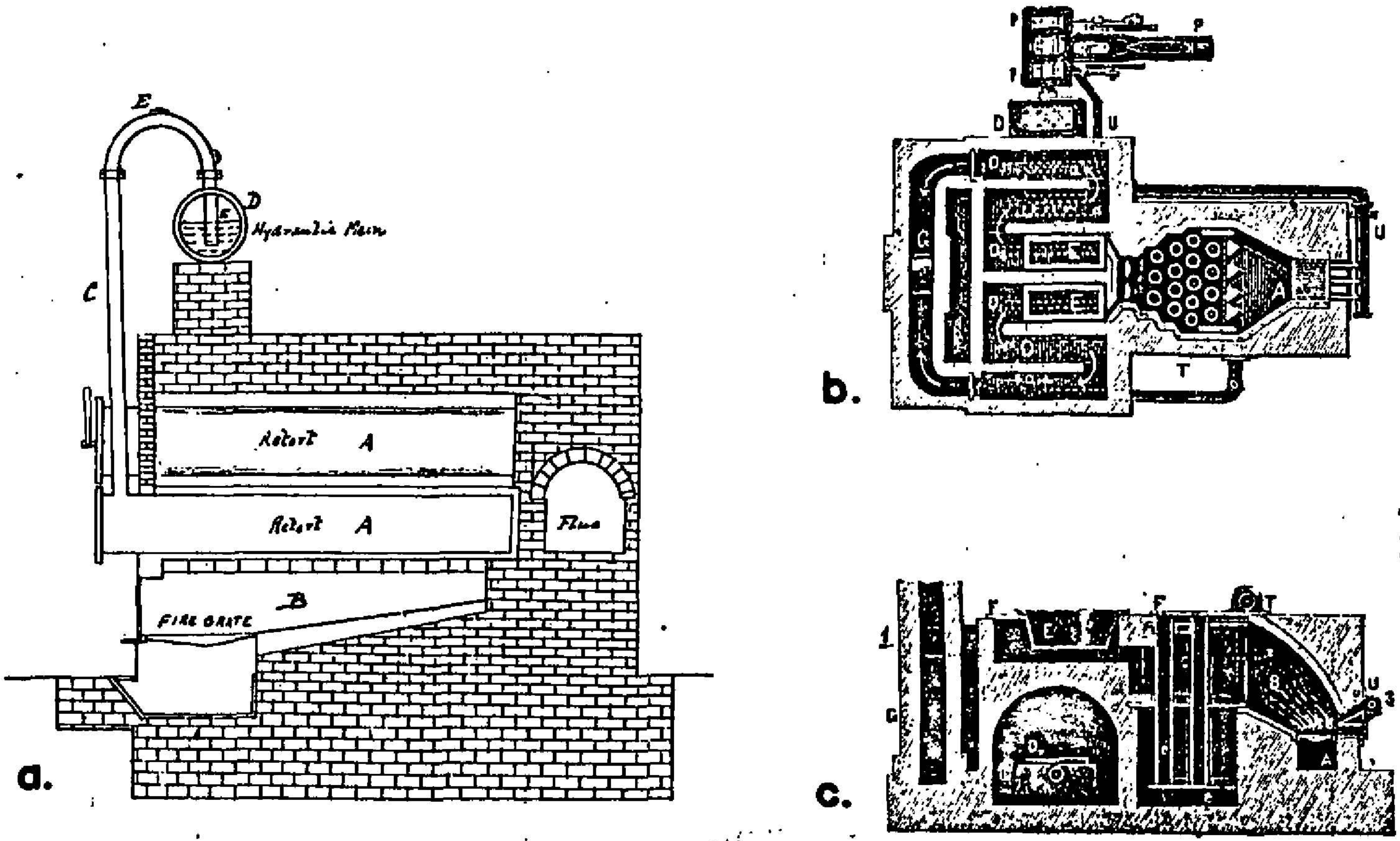

Figure 11: Bone black retorts. a) "Bench of Retorts for Char-making"; b) plan of a Belgium retort furnace; c) cross-section of a Belgium retort furnace.

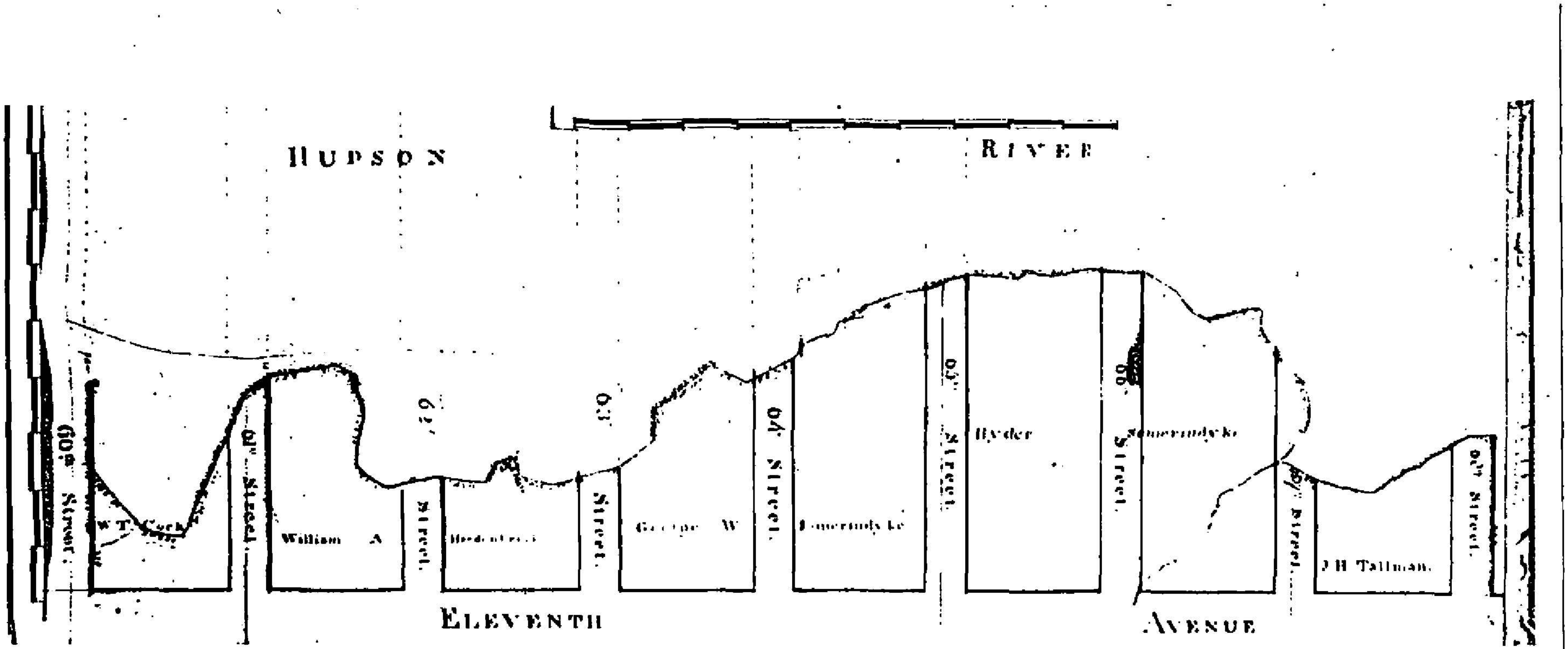

Plate 1: Bridges and Poppleton's 1810 - 1812 Shore of the Hudson River Showing Piers, etc. from the Battery to 75th Street. Scale: 125'=1". Courtesy of the Manhattan Borough President's Office.

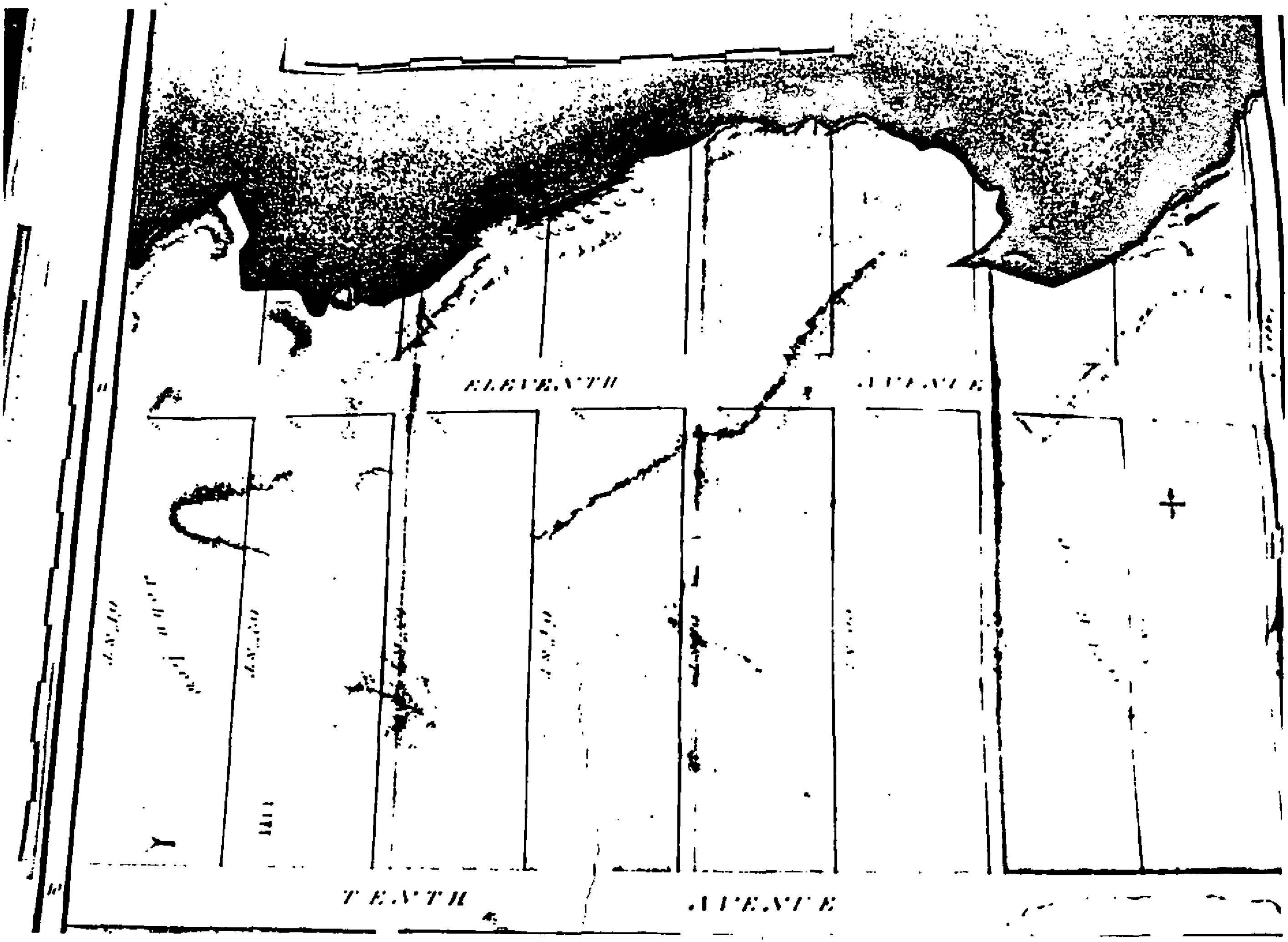

Plate 2: From the John Randel, Jr. Farm Maps, 1820. Scale: 100'=1". Courtesy of the Manhattan Borough President' Off

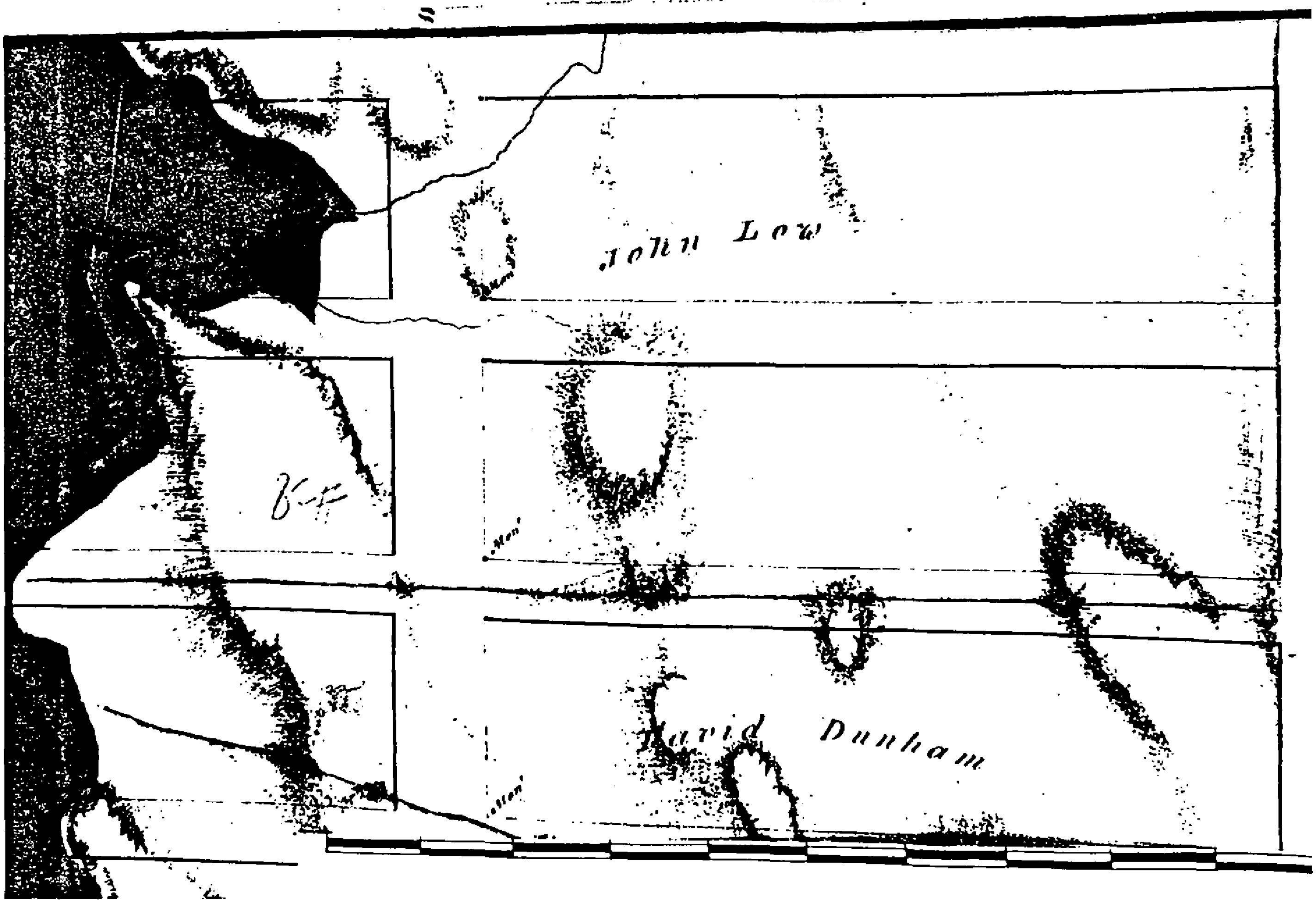

Plate 3: From the John Randel, Jr. Farm Maps, 1820, showing 58th to 61st Streets.
Courtesy of the Manhattan Borough President's Office.

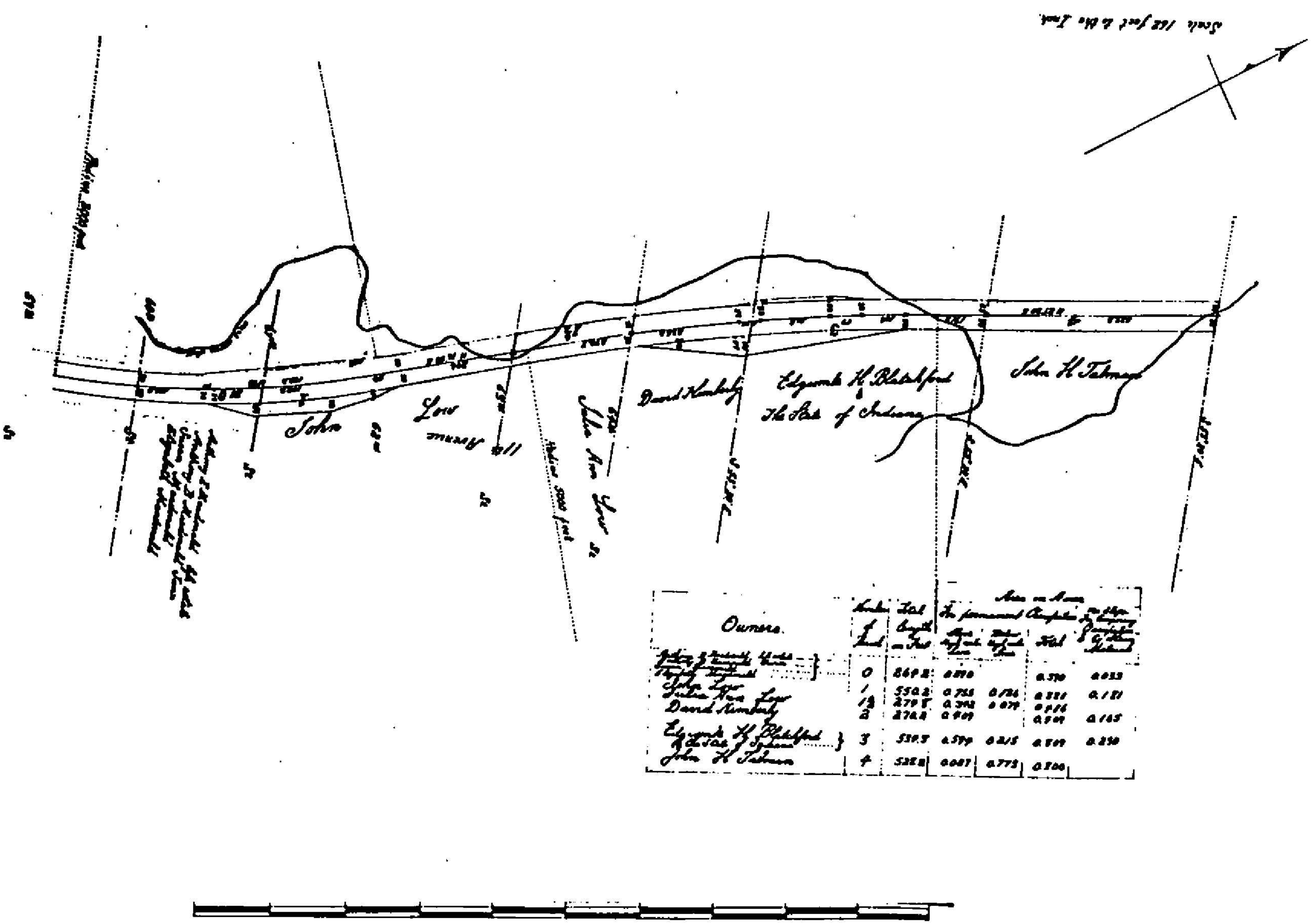

Plate 4: Line of the Hudson River Railroad, 1847. Scale: 162'=1". Courtesy

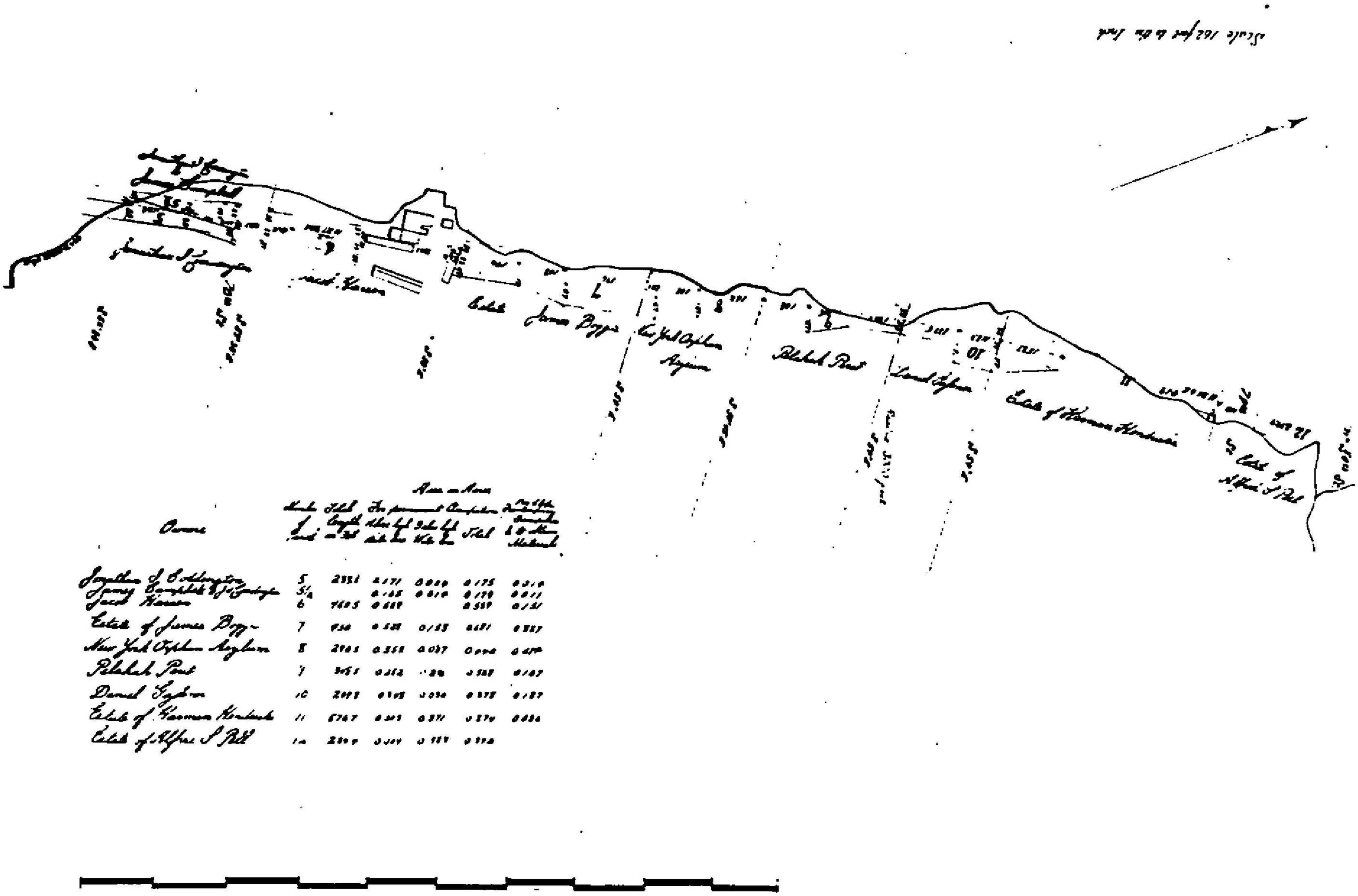

Plate 5: Line of the Hudson River Railroad, 1847. Scale: 162'=1". Courtesy of the Manhattan Borough President's Office

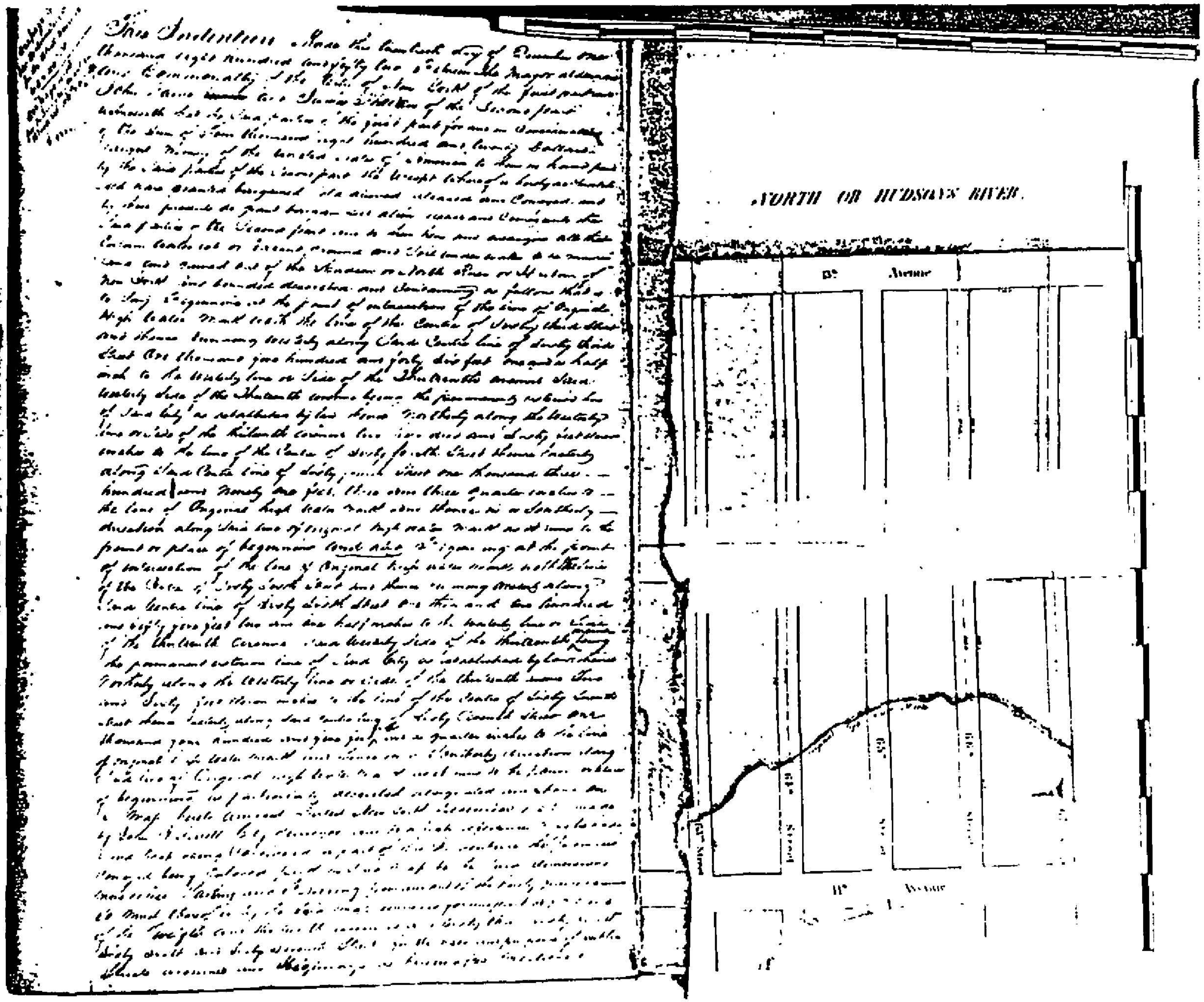

Plate 6: Water Lot Grant of 1852. Courtesy of the Manhatten Borough President's Office

Plate7: Harbour Commissioners Map of 1857, Sheet7. Scale: 80'=1"

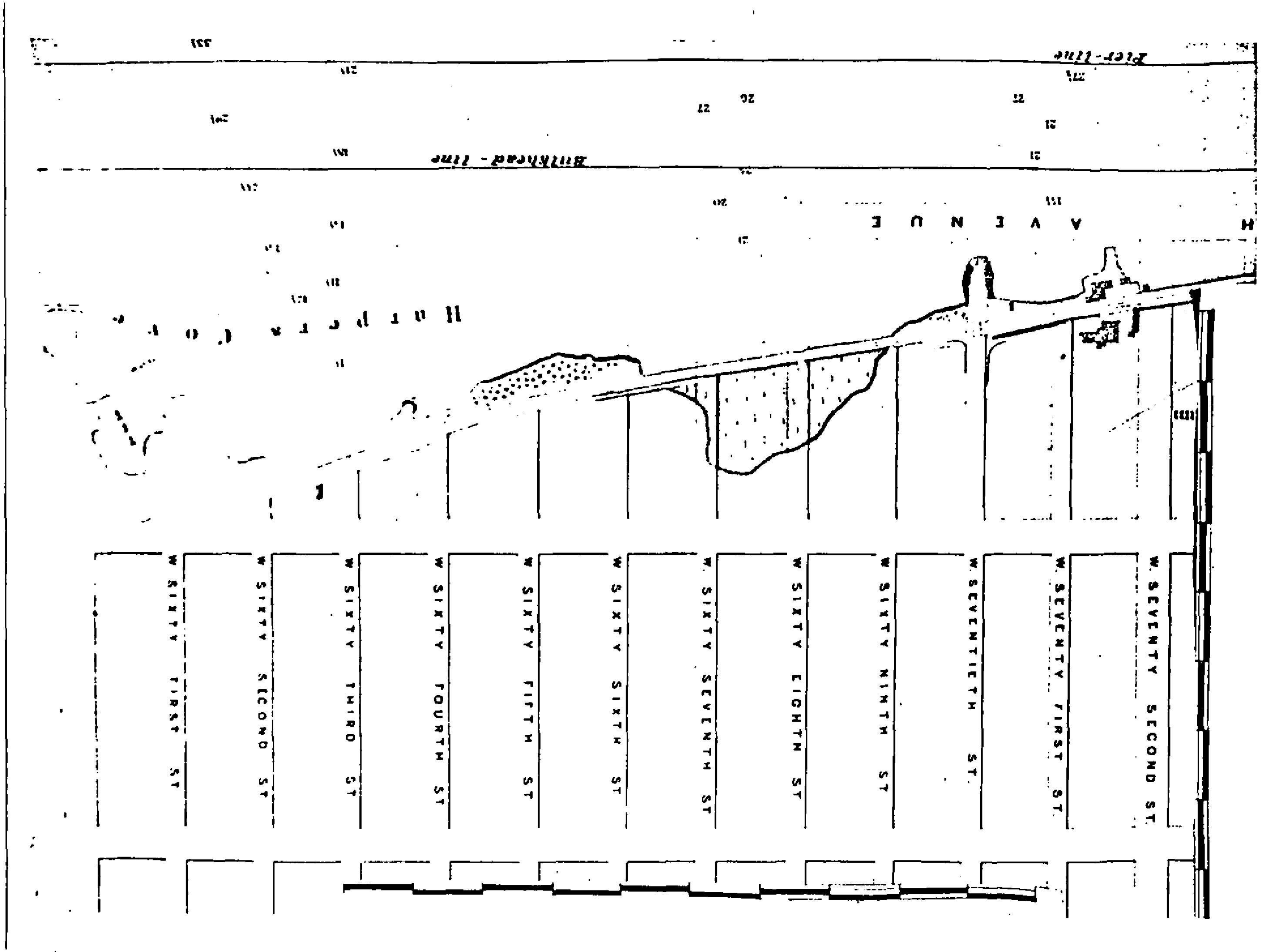

Plate 8: Harbour Commissioners Map of 1857, Sheet 8. Scale: 200' = 1"
Courtesy of the Manhatten Borough President's Office

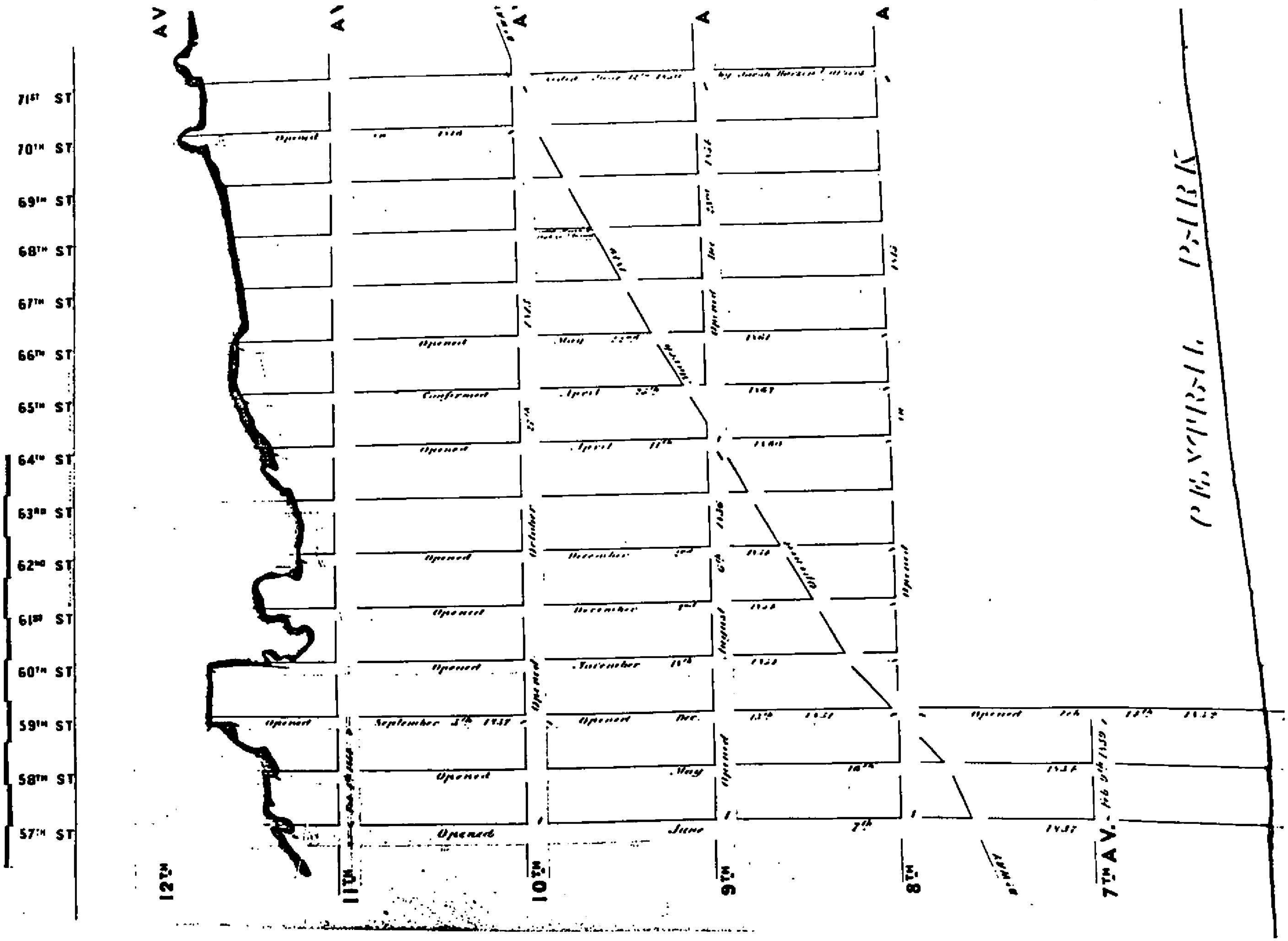

Plate 9: Edward Boyle, Atlas City of New York 1865. Scale: 200' = 1"
Courtesy of the Manhatten Borough President's Office

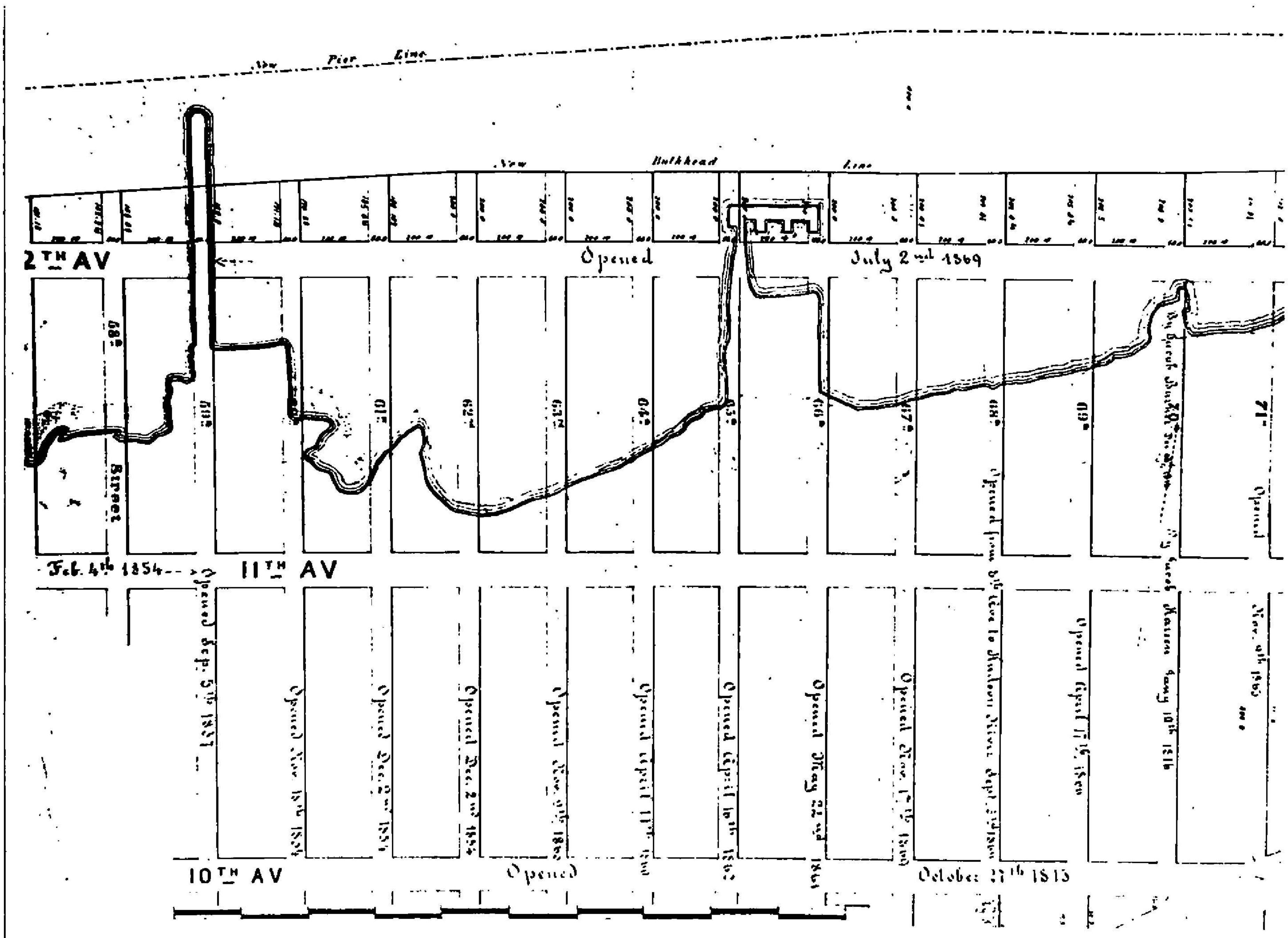

Plate 10: Map of Street Openings 54th Street to 154th Street. Late 19 Century.
Courtesy of the Manhatten Borough President's Office

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