UNIVERSITY HEIGHTS BRIDGE
Spanning the Harlem River at 207th Street
and West Fordham Road
New York City
New York County
New York

HAER No. NY-199

HAER
NY
31-NEYO
178-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
Northeast Region
Philadelphia Support Office
U.S. Custom House
200 Chestnut Street
Philadelphia, PA 19106

HAER
NY
31-NEYO
178-

HISTORIC AMERICAN ENGINEERING RECORD

UNIVERSITY HEIGHTS BRIDGE - HAER No. NY-199

Location: Spanning the Harlem River from West 207th Street, Borough of Manhattan, New York County; to West Fordham Road, County and Borough of the Bronx, New York City, N.Y.

UTM: 18.591410.4523890
Quad: Central Park

Engineers: William H. Burr,
Alfred P. Boller and
George W. Birdsall, 1893-1895
Othniel F. Nichols, 1905-1908

Dates of Construction: 1893-1895; Moved 1905
West approach span constructed 1905-1908.

Present Owner: New York City Department of Transportation
40 Worth Street, New York, N.Y.

Present Use: Vehicular Bridge

Significance:

The University Heights Bridge, a steel Pratt/Howe truss, pin-connected, rim bearing swing span draw, with Warren truss approach spans, is one of the oldest swing-type bridges and the third oldest major bridge in New York City. It is the work of some of America's most prominent late 19th. century engineers. Although the bridge originally was built at the northern end of Manhattan, continuing Broadway into the Bronx, it was moved to its present site in a complex process beginning in 1905. It is important as an example of circa 1900 bridge technology, and was a vital link in the extension of the Harlem River, which greatly contributed to the development of New York City. It was designated a New York City Landmark by the New York City Landmarks Preservation Commission in 1984.

Project Information:

This documentation was undertaken in January 1989 in accordance with the Memorandum of Agreement by the Advisory Council on Historic Preservation as a mitigative measure prior to the replacement and rehabilitation of the bridge.

The University Heights Bridge is planned to replaced in the near future due to its generally deteriorated condition; to conform with new government regulations for highway widening; and to achieve contemporary engineering standards. The replacement trusses will be close geometric replicas of the original design and represent a unique design challenge undertaken by N.H. Bettigole, P.C. Consulting Engineers (Paramus, N.J.), with Garreth Reese, Electrical Consultant. Edward Rory McGinnis, Architect and Preservationist, and Milton Stafford, Mechanical Engineer, acting as subconsultants. Contemporary design standards will be applied. Preservation standards will be employed for the relocated decorative architectural elements, along with restoration of the masonry. New computerized controls will be located in a new Control Room above the roadway within the draw trusses. (See Contemporary Engineering in Appendix)

Edward Rory McGinnis, Architect/Preservationist, N.Y., N.Y.
J. Jay Jerome, Historical Research
Peter Neumann, Photographer

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HISTORY OF HARLEM RIVER BRIDGES, (10 pages)
Vol. 1, Chief Engineer's report 1917, Historical Facts Connected with New York City Bridges, Internal publication kept at NYC Department of Transportation office at 300 West 206th St., Manhattan, New York, N.Y.

INTRODUCTION

The late 19th century was a period of monumental civic achievement in New York City. It was a time of rapid political and physical transformation, and of extraordinary commercial development. In the twenty-five years following 1874, a Greater New York was formed by joining Manhattan to the boroughs of the Bronx, Brooklyn, Queens and Staten Island. In 1898, New York City was formally consolidated via the New York City Charter. New York was the final destination for hundreds of thousands of immigrants, with a corresponding building boom taking place throughout the city. Some of the era's crowning achievements included the opening of the Brooklyn Bridge, the development of a park system under the tutelage of Olmstead and Vaux, and the beginning of a city-wide rapid transit system. In short, it was during this period that New York fully took shape as one of the world's great cities.

The development of river crossings helped to unify the new city. The construction of the University Heights Bridge was a part of that process. When it first opened in 1895, on its original site as the Harlem Ship Canal Bridge, it was one of a series of new bridges to span the Harlem River. The bridge was built to conform with New York State regulations enacted to enhance shipping on the Harlem. Furthermore, its construction was coordinated with an ambitious and long-contemplated project to improve New York's shipping lanes -- the creation of the Harlem Ship Canal to bypass a low-water tidal marsh. The bridge was designed with unusual concern for its aesthetic effect by some of New York's most prominent engineers. In a rare and complex operation, it was later dismantled and floated to a new location where it was rebuilt as the University Heights Bridge. Its history is closely tied to the continued evolution of New York as a trading capital and the development of northern Manhattan and the Bronx as integral parts of the city.

EARLY HISTORY

The Harlem River and the connecting low-water Spuyten Duyvil Creek was a continuous tidal waterway, of varying depths, approximately eight miles in length. It separated northern Manhattan "Island" from the Bronx and connected the Hudson and East Rivers (See Location Map in Appendix). The river and creek had always been a weak link for New

York's shipping traffic. The Harlem River's width varied greatly, ranging from 300 to 1500 feet; its available depth ran from ten feet to six feet at mean low water. The Spuyten Duyvil varied in width from 150 to 1000 feet; its depth was as little as one foot in places.[1] Navigation was greatly hampered by the shallow depths, and by the meandering and twisted course of the Spuyten Duyvil. The narrow widths, and the occasional steep drop-off of the shoreline, helped prevent the construction of adequate piers and warehouses in many sections of the river's course. Moreover, traffic was obstructed by a series of ill-designed bridges and dams that were erected haphazardly during New York's early history and into the 19th century. The waterway's condition greatly restricted its usefulness as a commercial thoroughfare. What commerce was conducted consisted almost entirely of the unloading of limited amounts of building supplies, produce, fuel, etc., that was required in the immediate area of the waterfront.[2]

The improvement of the Harlem River, and the creation of a navigable canal to bypass and replace the Spuyten Duyvil, were long contemplated in New York. A deeper channel would allow ship traffic coming down the Hudson to quickly cross the north of Manhattan and access the Long Island Sound or East River, while avoiding the treacherous course around New York's southern Battery. It would also allow the development of the river as an unloading point for the barges traveling from the Great Lakes through New York State's canal system. Area property owners had continually agitated for a project that would ensure the navigability of the waterways, while correspondingly increasing the value of their landholdings.

City officials began to take notice in response to the continued northern expansion of the City, and the increasingly congested state of New York's harbor and pier facilities. For example, the mayor of New York, in an 1856 communication to the City Council, wrote that "the Harlaem River is capable, with very little outlay, of being made of great service to our domestic commerce, and long before the city has reached any approximation to the maximum of its population, it will become indispensable, and its banks on either side will be entirely occupied with depots, wharves, and store-houses."[3]

Records show that as early as 1827, a private company was chartered by the City to effect a canal and improvements to the Harlem.[4]

The company accomplished nothing, and in 1863 a second private venture -- the Hudson and Harlem River Canal Company -- was founded, which also produced no results.[5] The river and creek were surveyed in 1836, 1860, and again in 1873-74 by, respectively, City, State and Federal representatives. U.S. Engineer John Newton, in an 1875 report on his survey of the previous year, noted that there currently existed seven bridges over the waterway, all of which would have to be replaced or adjusted if navigation was to be improved. He advocated straightening and dredging the Spuyten Duyvil, dredging in parts of the Harlem, and clearing the river of obstructions by replacing most of the existing bridges with either tunnels or suspension bridges.[6]

Newton's survey and recommendations served as the basis for later improvements to the Harlem. The plan, as adopted by an Act of Congress in 1876 and later amended, called for dredging the Harlem to ensure a continuous channel at least 400 feet wide and 15 feet deep at mean low water. The Spuyten Duyvil was to be widened in parts to 350 feet and excavated to minimum depth of 18 feet.[7] The Spuyten Duyvil would also be straightened by means of a cut that the Federal Government would dig, thereby greatly shortening the distance between the Hudson and the upper Harlem. This cut would later be called the Harlem Ship Canal. Money was appropriated by Congress in 1878 and 1879 to begin the work, on the condition that right-of-ways be provided free of charge to the Government. The State of New York passed an act in 1879 which ceded jurisdiction for the improvement to the Federal Government and authorized the acquiring of the necessary land for right of ways. The State also mandated that any new bridges built over the Harlem be movable draws standing at least 24 feet above mean high water, and that their plans be subject to the approval of the Army Corps of Engineers.[8]

Problems in negotiating the requisite right of ways for the improvement prevented any work prior to 1887. It should also be noted that there was some potent opposition to the improvement plans. Many felt that New York's future lay not with improving its shipping lanes, but rather with its land based communication with the rest of the country. Some advocated filling in parts of the Harlem to connect sections of Manhattan to the Bronx.[9] The New York Times supported this idea on at least four separate occasions, calling the Harlem "a public nuisance".[10] Railroad interests opposed the plan because it would require the rebuilding of their bridges to conform with Federal and State mandates.

The railroads strongly objected to having to build any bridges with movable draws which would interfere with and slow down their commerce. Also, improved navigation on the river would naturally compete with some of their freight business. Typical was Chauncey M. Depew, President of the New York Central Railroad, who testified before the N.Y. State Legislature that the proposed Harlem Canal was "the most monstrous piece of folly of which I know".[11] Some newspapers supported the railroads' case. The N.Y. Evening Sun editorialized that "the real everyday public opinion of New York City should be aroused about the injuries likely to be done to the city by making a second Suez Canal out of the bed of the Harlem River. That there should be a canal connecting the East and North Rivers has become a hoary and time-honored fetich (sic)."[12]

Nevertheless, work was begun under the authority and supervision of the Army Corps of Engineers in 1888.[13] By 1892, the work had been greatly advanced, both in the Harlem and the Spuyten Duyvil. The dredging of the Spuyten Duyvil was conducted between two cofferdams, constructed of sheet piling and earth, which were designed to hold back the creek's water during the excavation process. The easterly cofferdam, roughly near the present upper Broadway in Manhattan, also served as a bridge for traffic to the north. It replaced an earlier Broadway extension over the Creek.[14]

THE HARLEM SHIP CANAL BRIDGE

As early as 1889, city authorities were notified by the Army Corps of Engineers that when the work was completed on the Harlem Ship Canal, a bridge would be required to continue Broadway in Manhattan into the Bronx.[15] Delays in negotiating a right of way, and the approval for a change of grade at Broadway, prevented any advancement of the project until 1892. In April of 1892, the New York State Legislature passed an act authorizing construction of the bridge.[16] In late 1892, William H. Burr was appointed Consulting Engineer to design the bridge. His associate, Alfred P. Boller, and George W. Birdsall, Chief Engineer of New York's Department of Public Works, also assisted in the design.[17] Final plans for the bridge were approved by the relevant city agencies and the Secretary of War in February of 1893.[18]

Burr and Boller were well-suited to the task at hand. By 1892, Burr had twenty years experience in bridge design; Boller had thirty. It is difficult to ascertain who should receive supreme credit for the bridge's design. Both men later wrote about the bridge without explaining the nature of their collaboration. Burr only cited Boller and Birdsall with developing "some of the main features of the foundation plans."[19] Boller, while emphasizing that the work was officially carried out in Burr's name, seemed to later take credit for the design of the superstructure as well.[20] Some observers also believe Boller responsible for the design of the bridge's ornamental ironwork and railings.[21] (For Biographical Sketches, see Appendix.)

The plans called for a central swing span 268 feet in length, with two approach spans each approximately 102 feet.[22] The bridge's width was 50 feet, which encompassed an asphalt roadway with two concrete sidewalks. The bridge would be supported by three piers and two abutments of granite masonry built on concrete foundations (See Original Drawings of Ship Canal Bridge). The central pier contained the engine room and afforded 104 feet of clearance for shipping traffic on each of its sides. Special attention was given to the design of the swing-span's trusses. Burr composed the center lines of the trusses's top chords with reversed curves, a somewhat unusual design approach for truss bridges.[23]

Bidding for the construction of the bridge was closed on March 28, 1893, and a contract was signed with Arthur McMullen and Company in April.[24] It had been planned to construct the three support piers in the dry area between the existing cofferdams. The digging of the canal was nearly completed by this time, and the U.S. Corps of Engineers had agreed to leave the earthen dams in place to facilitate the building of the bridge.[25] However, an intensive storm struck on April 21, causing an excess high tide which destroyed the dams.[26] The flooding through of the dams caused $20,000 damage to the contractor's equipment, and nearly drowned the night watchman charged with guarding the site. Moreover, the destruction of the cofferdams materially set back the work on the bridge.

A three month delay ensued, while a temporary pile bridge was constructed to maintain pedestrian traffic flow over the canal, and a separate contractor was retained to clear the obstructions in the riverbed caused by the destroyed cofferdams.[27] Also, it was now necessary to use caissons to build the pier foundations in the flooded canal. Pneumatic timber caissons were used to sink the foundations of both abutments and one of the piers. A timber cofferdam was used for the center pier, while an open caisson served the third.[28]

The work proceeded without any reported difficulties. Dubbed the Harlem Ship Canal Bridge, it was opened to public traffic on January 1, 1895, and was considered fully completed by March 1st of that year. Its total cost was approximately $450,000.[29] The temporary bridge was removed and the Harlem Ship Canal was opened in a gala ceremony on June 17, 1895. The New York Times reported that "500,000 people" turned out to witness the opening of the canal which was commemorated with an elaborate ship parade from the East River to the Hudson.[30]

The completed bridge was highly acclaimed by architectural critics of the time.[31] Yet, the bridge remained at its Broadway location for only ten years. In this period it evidently served its purpose as a vehicular and pedestrian bridge without major problems. The New York City Department of Bridges records show that at least thirteen men were employed fulltime at the bridge.[32] In 1900, for example, the bridge was opened an average of nearly five times a day for river traffic. Total operating expense for the bridge in that year, including labor costs, was under $14,000.[33] Records for 1902-1904 show that the bridge was closed to street traffic for around thirty minutes per day while its spans were opened and closed. Traffic surveys conducted during those years noted that as many as 4,000 foot passengers, vehicles, horses, and "vehicles without horses" crossed the bridge each day.[34] The only major alteration reported during this period was the replacement of the bridge's hydraulic system by a mechanical apparatus to drive the end-lifts. The change was apparently made because of problems and excessive cost in maintaining the hydraulic system.[35]

An interesting set of coincidences led to the moving of the Harlem Ship Canal Bridge to its current site. In 1902, New York's Rapid Transit Commission asked permission to extend the IRT subway line over the bridge.[36] Shortly thereafter, the New York City Railway Company, which held a franchise for crossing the bridge, also requested use of the bridge for its subway line. Meanwhile, the New York Central and Hudson River Railroad Company wanted an alteration to the bridge's northern approach span to allow a passage of a new four-track line running parallel to the Ship Canal. The bridge, however, had not been designed to carry such increased loads. Proposals were entertained to strengthen the bridge and add an upper deck for the transit lines. Plans were even prepared to rebuild the bridge utilizing its floor system, turntable and machinery.[37] It was clear, though, that to please all the parties involved would require the extensive rebuilding of what was virtually a brand new bridge.

By chance, the city decided at this time that a bridge was needed lower down the Harlem at 207th Street in Manhattan. A wooden footbridge had previously existed at this location, built in 1882, but had been removed after 1892 with the improvement of this section of the Harlem.[38] It was resolved to move the superstructure of the Ship Canal Bridge to the new site and to build an entirely new bridge in its former place. The Department of Bridges report for 1904 states that, "It was originally proposed to build a bridge from Amsterdam Ave and 210th Street in Manhattan, to the intersection of Sedgwick Ave and Fordham Road, in the Bronx. It would have been 2,600 feet long, 80 feet wide and 50 feet above the river (See Location Map in Appendix). In the interest of economy, the site has been changed to 207th Street, the width reduced to 50 feet and the length to 1,250 feet."[39] In 1904, the New York Central and Hudson River Railroad Company agreed to construct a railway station (See Historical View #1315 and Drawing C21-143) above track level at the base of the Bronx approach ramp at 184th Street extension (later renamed West Fordham Road), between Harlem River Terrace and Exterior Street (later renamed Fordham Landing Road), and to extend the bridge roadway over the railroad tracks.[40]

THE UNIVERSITY HEIGHTS BRIDGE

Plans for the move began in earnest in 1903. Surviving drawings show that Othniel Foster Nichols, Chief Engineer with New York's Department of Bridges, was responsible for the redesign of the bridge (See all Original Drawings of the University Heights Bridge). The plans called for the construction at the new site of masonry piers, fenders, and an added approach span before the bridge could be moved. Additional dredging around the new central pier would also be required, along with a change of grade on the Bronx side of the site (See Drawing C21-144). The plans were accepted by the city in August of 1903, and by the Secretary of War in September.[41] Bidding was held in November for the construction of a pneumatic center pier, fenders, and the necessary dredging. The contract was awarded to the low bidder - The Foundation and Contracting Company - and the work was completed in September of 1904 at a total cost of

$134,000. Also, on May 24, 1904, the name University Heights Bridge was officially adopted for the new bridge, having originally been named the Fordham Heights Bridge.[42]

The moving of the superstructure of the Ship Canal Bridge had to be coordinated with the building of its replacement. City officials had mandated that the crossing could be closed for a maximum total of five days, of which only three could be consecutive.[43] Therefore, the new spans for the replacement bridge were constructed on the shoreline, near the Broadway site, and then exchanged with the old spans which were stored prior to moving to the University Heights location. This helped minimize the amount of interruption to the use of the Ship Canal Bridge.

The moving of the existing spans was conducted by the Rapid Transit Subway Construction Company for the sum of $80,000, and the move was supervised by John B. McDonald, under the direction of the Board of Rapid Transit Commissioners, with George Staples Rice as chief engineer.[44] The move was approved by the Municipal Art Commission on January 22, 1905.[45] As the new bridge was to be longer than the Ship Canal bridge, a contract was signed with the Snare and Triest Company on April 27, 1905, to construct new supporting columns and a new approach span of some 70 feet in length at the western side of the University Height's site, and to attach them to the older spans.[46] (See Drawings C21-153 & 151)

The south approach span was replaced on October 19th, 1905. It was floated to University Heights on May 1st, 1906, and put into place a few days later.[47] The north approach span was moved on November 6th, 1905. It was floated to the south shore of the canal, west of Broadway, where it was put on cribs and left.[48] On November 27, 1907, the span was moved to University Heights by three tugs and "a large force of men."[49]

On June 14th, 1906, the swing span was moved to University Heights. Shortly thereafter, Scientific American magazine published the following:

> "The bridge was carried on four pontoons, two at each side of the center. The pontoons were 110 feet long by 32 feet beam, with sides 9 feet high, and capable of lifting 600 tons each. The draw was partly opened, so that it could be floated away without being obstructed by

the approaches. The pontoons were weighted with water and, from the decks of each pair, heavy timber cribs were built up to the floor beams of the bridge. This was done at low tide, so that as the tide began to come in the span was slowly bouyed up by the pontoons, and to expedite matters the water was at the same time pumped out of the pontoons. The bridge was, of course, built to rest on a central support; consequently, when it was lifted off the center pier, and supported on the cribwork near the ends, the strains in certain members of the frame were reversed. For instance, the tension members at the center of the bridge were placed under compression. To prevent these members from buckling, they were stiffened with wooden beams.... The draw was towed downstream by four tugs, two in front and two behind, by which it was carefully guided to the new pier nearly a mile away.... Then water was pumped into the pontoons until they lowered the span gently into place. The entire task was accomplished in just an hour. The bridge was towed to its new quarters with steam up, and as soon as it was properly mounted and the pontoons removed, it was swung to the open position under its own steam. In this position it must lie at present until the approaches are completed."[50] (See Historical View #5205 and June 14, 1905 artist rendering)

The replacement center pier had been completed two years before. The next day the new draw-span was positioned at the Harlem Canal location.[51]

No serious problems were encountered during any of the moves of the spans. One of the engineers involved in the operation later wrote the following:

"Each of the six operations, that is, moving out an old span or moving in a new one, was not of itself a very complex problem, but, taken altogether, it was a work of considerable magnitude, and considering the cramped space in which the contractor was obliged to maneuver the approach spans, the uncertainly of the tides, and the short space of time during which he could obstruct travel, the problem was one requiring nice calculation and unusual judgement."[52]

The Harlem Ship Canal Bridge was apparently closed to travel for the cumulative total of less than four days during all the moves.[53]

Considerable work on the relocated bridge was necessary before it was opened, such as painting and repairing, removing gas tanks, pipes, lamps and rebuilding the smoke stack. Timbers of the new fender were treated with a wood preservative called Armanies Carbolineum, and the tops of all piles were capped with zinc.[54] In addition, new decorative railings and pedestrian waiting shelters were constructed to match those of the original draw (See Drawing C21-151).

The total cost was approximately $1,000,000.[55] The University Heights Bridge was opened in an official ceremony on January 8th, 1908, before a crowd of 350 students from the nearby campus of New York University. The New York Times reported that "the ceremony was brief. The Mayor arrived on time in his automobile...walked across the bridge, and drove away."[56] When the trolley tracks were installed in 1910, the Bronx base of the bridge with the railroad station became a major public transportation hub. (See Historical View #1315)

The bridge was not considered completed until March of 1908, when further improvements consisting of new fixed aprons, new brakes fitted to the main turning shafts, a shop and storehouse built in the fender pier, and an iron sheathed house for the sweepers erected under the Manhattan span were finished.

CHRONOLOGY OF REPAIRS AND MAINTENANCE

The University Heights Bridge has been altered and repaired many times since its opening. Major events are recorded via the original drawings and by Department of Transportation records and personnel.[57]

1905 - Sewers were changed with required street regrading at Fordham Road in the Bronx to accommodate the proposed new bridge.

1908 - University Heights Bridge was opened to the public. Within ten months of opening, the steam engine providing power for operation was replaced by electrical power.

1910 - The bridge decking was refurbished in October: the transverse floor beams had cover plates added to the tops and bottoms; the buckle plates were reversed to reduce dead load and retain new concrete fill; new steel stringers were added to the road deck to support new trolley tracks; the end lift operating shaft had new gears installed; the swing span deck was rehabilitated to include new concrete fill, 1/2" of setting mortar and 3" thick wood pavers; the approach spans were also rehabilitated with variable depth concrete fill, 1" sand/mortar setting bed and granite block paving.

1922 - Reconstruction of roadways and sidewalks.

1924 - New cast iron bases for lampposts were installed.

1925 - (Possibly 1928) The Manhattan approach was renovated to include new asphalt pavement (replacing granite pavers), concrete curbs and sidewalks . Concrete fill was added to bring the roadway to the redesigned grade. (See Historical Views #9868, 9945, 9944, 9942, 9943)

1932 - Reconstruction of roadway with new electric lamps on trolley poles. Replacement of some cast iron posts with steel tubular members.

1934 - A new clutch assembly was installed as part of the operating machinery. (See Drawing C21-175)

1935 - New railing posts of tubular steel replaced the cast iron posts along the Manhattan approach.

1937 - The bulkheads required restoration: new timbers and concrete were added along the Manhattan (west) bank; the cast iron pipes and concrete slab at the Bronx (east) bank were removed. The concrete backing in the Bronx bulkhead wall was replaced, and several granite stone blocks were lifted and cleaned, and joints repointed above the low water line. New masonry and reinforced concrete replaced deteriorated concrete along the north and east Bronx bulkhead walls, and the north wall had timber sheeting installed. (See Drawing C21-176)

1939 - A new 365 gallon cold water storage tank was installed in the Machine Room (See Photograph AA).

1946 - The center pivot pier fender was rebuilt, including the south and north ends, and encompassing work on the oiler's platform and the electrical system of the fender.

1949 - A major reconstruction by the Peerless Construction Co. was undertaken, consisting of main structural member replacement and the removal of the trolley tracks. The swing span had the top cover plates of the floor beams replaced along with accompanying stiffeners; fascia girders and struts were replaced, as were the curved roadway girders at the joints between the draw and the approaches. Roadway stringers at both ends of the swing span and those of the adjacent approach spans were replaced with new beams. New 5" deep open steel deck grating was installed. In addition, curb and sidewalk girders, and floor stringers were replaced on the approach spans; and all sidewalks were rebuilt with reinforced concrete. New concrete was installed at both approach roadways. Deck truss bearings for the approach spans at all rest piers were replaced. Truss supports on the Manhattan masonry abutment were reconstructed, and new roadway expansion planks were replaced. Many ornamental railing posts at the Bronx and Manhattan abutments were replaced with tubular posts. The operator's machine room and the electrical system were partially rehabilitated.

1950 - Eight new truss post brackets at Panel points U-1 and U-5 of the swing span were installed.

1960 - New drainage facilities were installed in part of the Manhattan approach, which also required new reinforced concrete pavement to meet new grades. The south curb was realigned. The granite block pavement was replaced on the Manhattan approach with asphalt concrete.

1964 - Fence guards along the north and south swing span railings were installed. New electrically operated barrier gates were installed along the approaches, along with electric heaters in the gatehouses by W.L. Blume Inc. for $35,000.00.

1970 - New electrification of the bridge: submarine power cables were run between the two rest piers and the center pivot pier; new collector rings were installed in the turntable space below the machine room.

1970's - A new oiler's inspection platform was erected on the southern end of the fender.

1970's - The brick railway station on the Bronx approach was demolished and a new station at the lower track level was constructed.

1980 - Supplementary stringers were added to the swing-span (No.s 3 and 4).

1984 - Designated a New York City Landmark by the New York City Landmarks Preservation Commission, 225 Broadway, New York, N.Y.

1989 - Drawings were prepared from 1986 through 1988 for the replacement and reconstruction of the bridge, by N.H. Bettigole, P.C., Consulting Engineer with G. Reese, Electrical Consultant; and Edward Rory McGinnis, Architect and Preservationist and Milton Stafford, Mechanical Engineer as sub-consultants. Contemporary engineering standards were applied in order to simulate the original aesthetic and appearances. Preservation standards were employed for retaining the decorative architectural elements, along with general cleaning of the granite masonry. All efforts were made to preserve and match the landmark structure applying state-of-the-art technologies. A new, "appropriate" prefabricated control room will be placed within the truss portal bracing over the central pivot pier. The new deck designs allow only for a single sidewalk which will pass through the southern gatehouse, requiring enlargement of the present window opening for a passageway. New terracotta roof tiles and copper finials will be installed at both gatehouses. The existing decorative cast iron railing panels and pedestrian waiting shelters with gates will be refurbished. New computerized controls for the span drive system will be located in the new Control Room within the draw trusses. Work is slated to begin in early mid-1989 and be complete in mid-1992. (See Appendix for detailed description of Contemporary Engineering)

TECHNICAL INFORMATION

Location: See Explanatory Drawing No. 1 in Appendix

When it first opened in 1895, at Broadway as the Harlem Ship Canal Bridge, it was one of six new bridges to span the Harlem River and was one of the earliest to open at its initial location.[58] The University Heights Bridge spans the Harlem River connecting West 207th Street in the borough of Manhattan and West Fordham Road, formally 184th Street, in the borough of the Bronx.

The Landmark site as designated by the New York City Landmarks Preservation Commission for the University Heights Bridge is encompassed by a line running eastward along the northern curb line of West 207th Street, Manhattan; a line running eastward which is the extension of the northern curb line of West 207th Street to the point where it meets the western curb line of Exterior Street (presently Landing Road) in the Bronx; south along a line which is an extension of the western curb line of Exterior Street; west along a line which is an extension of the southern curb line of West 207th Street, Manhattan to its intersection with Ninth Ave; north along a line which is an extension of the eastern curb line of Ninth Ave, to the point of beginning. The bridge spans between West 207th Street and Ninth Ave in Manhattan to West Fordham Road and Exterior Street (Landing Road) in the Bronx. [59]

Although most historical references, including the project site plans and the Landmark designation refer to Exterior Street as being on the western shore of the Bronx, the latest maps of the area show Exterior Street to be along the east bank of the Bronx (although it "continues" in northern Bronx), and the eastern approach springing from Landing Road.

General:

The University Heights Bridge is a steel truss, rim-bearing, pin-connected bridge, typical of medium span bridges built in the United States between 1875 and 1925. This design was first used extensively in many bridges erected over the Mississippi River in this period. This type of bridge also proved popular along the Harlem, although after 1910, vertical lift bridges were employed. The bridge consists of five separate spans. The swing-span is composed of six-panel Howe trusses connected to a central tower structure of four uprights supporting two spans. The approaches consist of three individual fixed spans. The University Heights Bridge is a total of 1,100 feet long, measured from ends of the approach ramps (plus an approximate 400 feet long roadway extending over the railroad; not considered a part of the landmark structure). It affords 25 feet clearance from the bottom of the draw at mean high tide, and offers 100 feet wide shipping channels on two sides of the pivot pier fenders when the draw is open. The center truss system- the draw or swing-span of 268 feet in length- pivots 360^{0} on a center support or pier to open and let ships pass; and is swung in a direction away from the oncoming ship. It offers a 14'-11" vehicle clearance above the roadway deck. The adjacent fixed approach trusses and masonry clad, earth-filled ramps are simply means to raise the roadway to the draw heights.

Structural Design:

Boller wrote of his structural design for the Harlem River Bridge that:

> "The length of the ship canal draw being only 270 feet, it was difficult to arrange graceful lines for the trusses. A mistake was made in hipping the end panels, as they give a squat effect to the portals....The girders for the approach spans...being latticed deck spans, in which relief from angularity is sought to be obtained by shaping the gusset and intersection plates in curves, about the only thing that can be done in the way of "decorating" lattice girders in themselves not unsightly when well proportioned and arranged."[60]

The swing-span draw, which can be considered as two cantilevered spans tied together in the center, is precisely 268 feet long, 36 feet wide from center-to-center of the trusses, plus concrete sidewalks along each side (See Photos C, F, G & H) totaling a 50'-0" width. The two original approach truss spans are 100 feet long, and the fifth inclined span, erected with new columns at the University Heights location, is 70 feet long (See Photos B & X). The draw structure is a rim-bearing (double) swing span with a center guide pin.

An interesting feature of the design of the swing-span draw is that it incorporates two different types of truss designs. When the draw is in a closed position, resting on the center and the end-lifts of a rest pier (two points of support), the truss span is most similar to a Howe truss. This is evidenced by the diagonal box girders called batter braces or inclined end posts, which are at panel points U-1, U-2 and U-5. These members, along with the chords, compensate for compression stresses in a simple span. Actually, the end of the swing span is never fully resting on the end lifts, therefore the truss is always partially cantilevered from the center. But when the draw is in a fully open position, resting on the single center pier and hanging from the central posts (one point of cantilever support), the truss span is most similar to a Pratt truss, whereas all of the diagonal members (eye-bars and box-girders) are in tension, beginning with panel point U-1 through U-6.

The draw trusses are pin-connected with decorative star plates at the top and bottom chords (See Photo O, and Drawings C21-019, 004 & 005). The top chords and batter braces (inclined end posts) are built-up plate box-members with lacing bars, as are the vertical posts. All connections are riveted. The bottom chords, of much deeper construction, are also built-up plate box-members with lacing bars, and the floor beams are riveted plate girders (See Photos S & T). The stringers appear to be rolled sections, inclusive of the reinforcement trolly beams installed in 1910. The upper lateral struts are double intersection (quadrangular) Warren trusses with half-round connecting plates (See Drawings C21-047 & 050), and the portal bracing is of an apex design (See Photos F, G, H, L, M, & N). It has not been determined when the delicate ornate portal and knee-braces beneath the portal and horizontal struts (See Drawing C21-047, 050 & 072) were replaced with the present riveted triangular plates (See Photos J & K), although they existed in 1925 (see Historical View #9942). The sway bracing is of similar truss designs, but composed of smaller steel elements and is more delicate in appearance. The tension member diagonals are double and quadruple metal eye-bars (See Drawing C21-004 & 005). Lateral bracing is accomplished by steel rods crossing within each structural bay.

The two original approach spans are double-intersection (quadrangular) Warren trusses (See Drawing C21-009). The third approach span, also a Warren truss, was added along with new columns when the bridge was reconstructed at its present location (See Photo X and Drawings C21-150 & 151).

The swing and approach spans had a bridge deck consisting of 3/8" buckle plates with the panels concave down, with a 4-1/2" bituminous concrete fill and a 1-1/2" overlay. The pedestrian sidewalks at the north and south sides of the roadway, are supported by steel angle outriggers from the sides of the bottom chords of the swing trusses and top chords of the approach span trusses (See Photos S & T, and Drawings C21-009 & 006).

The original draw design did not adequately take thermal expansions of the steel into consideration. When the draw is open it faces a different direction to the sun and therefore expands in length making it difficult to properly rotate fully closed. This also prohibits the draw from rotating a full 360^{0}. Operating crews have been known to pull the draw closed with a steel cable attached to a pick-up truck, after hosing the trusses down with cool water to reduce the expansion. This operation, sometimes fortified by several workmen pushing on hand-held levers, has caused the steel cover plates over the sidewalks joints to split.[61]

Architectural Design: 2

In October 1897, Boller wrote of the Harlem River bridges he had designed, outlining his aesthetic philosophy:

> "It is very gratifying that attention is being directed to the fact that bridges are very obtrusive objects in the landscape, and as such, cultivated taste requires that they be designed as sightly as the limitations of each special problem will permit... The splendor of a city is made by its architecture... the aims of the art must be classed under three heads, that of.....fitness, in the adaption of a work to the requirement and limitations of the problem; stability, in the correct applications of constructive principles to physical conditions and the materials employed; and beauty, in so arranging forms, lines and colors as to excite agreeable emotions....There are no empirical rules for beauty in building anymore than for painting, nor is it easy to

trace the sources of disgust or pleasure in the mind, on contemplating material objects.

Ornament, of course, has its place in architecture, but as applied to bridge design, it is rarely in bridges, excepting in railings or cornices, and even there should be used with wise discretion. Much otherwise good architecture is spoiled by overloaded ornament, and it takes very little to make a bridge appear ridiculous. In no other class of constructions is it so important to bear in mind that ornament should not be constructed, but the construction ornamented, and even then only so far as it serves to accentuate a feature.... The detail is not seen, except under comparatively close inspection, but the lines and masses, the relations of the units to each other, such as the proportions of piers and spans, down to subordinate relations of railings and cornice, are what gives character to such structures."[62]

The design of the draw had been aesthetically embellished with sheet steel finials at the apexes, which have since been removed (See Drawing C21-0036).

Noted architectural critic Montgomery Schuyler, called the Harlem Ship Canal Bridge a "highly creditable" work, "in an artistic as well as in a scientific sense."[63] Burr considered the bridge to be a special design because "the trusses of the swing-span possess a somewhat different outline than hitherto adopted in American practice, in that the center lines of the top chords exhibit reversed curves. This outline was adopted to obtain a more pleasing appearance than that usually employed."[64] Engineering Magazine in 1909 called the bridge "probably the prettiest of the swing bridges along the Harlem River."[65]

Boller had earlier written that: "The appearance of a roadway-bridge having sidewalks is very much enhanced, and at a very small cost, by neatly designed railings...a light lattice railing of wrought-iron, with one or more intersections, with or without rosettes, always looking well and harmonizing with the constructive character of a truss..."[66] The design of the bridge's decorative pedestrian railing system was in keeping with this principle. Boller described the bridge's rail system as: "substantial in effect, produced largely by the frequency of the newel posts and the solidity of the base. They are entirely of wrought metal, excepting the newel posts and bottom panelling, which are of cast iron...", consisting of panels with floral-pinwheel design at the lower sections and floral wrought-iron scrolls and cast iron rossettes at the top halves.[67] The top rails of polished bronze, presently painted to disguise them to avoid pilferage, are inserted into cast iron collars attached to decorative cast iron railing posts of "nautical" design, consisting of inset corner rope motifs and bosses.[68] The small diameter spheres, originally welded to the tops of the posts, are presently missing. As the original Ship Canal bridge had railings only along the swing span and approach trusses, new railings, mostly of duplicated design, had to be erected at the University Heights site. New decorative castings to match the existing ones were prepared for the new approach ramps, although the railings along the ramp from West Fordham Road to Landing Road were of slightly different design, having only three wrought iron horizontal rails and a simplified post design (See Photo E, and Drawings C21-070 & 151). The railing panel castings have weathered poorly, and most posts have sheared off at the cast iron bases, and have either been reinforced by steel angles or have been replaced with capped unadorned steel tube members.

Upon relocation to the present site, waiting shelters at the end of each approach ramp were installed in order to protect pedestrians from the weather when traffic was stopped for the bridge opening (See Historical Views, Photo P and Drawings C21-152,107 & 111). These four shelters were integrated into the old Ship Canal railing panel system, each having six cast iron columns from which sprang wrought iron decorative trim to form curved arches within. Each shelter was provided with a full height wind barrier, consisting of solid railing panels facing the water side with glazed windows above and within the upper portions of the arches, which existed at least until 1925. The wood plank decks of the hipped roofs are covered with copper tiles, modillioned cornice, ridge, finial, hiprolls and gutters with downspouts of typical late Victorian design. Vehicular and pedestrian safety gates, of lattice design with round connection plates, echoing the lattice of the structural members, were attached to a heavier roadside column of each shelter. The lower portions of the gates were part of the original Ship Canal Bridge design, and the upper curved braces were added at the new location (See C21-152).

The original colors of the bridge were black and white, although all metal elements are presently painted brown. A prime coat of red-lead and two coats of white-lead of standard Department of Bridges colors were used on all surfaces, "except the railings, fascia, lampposts, gates and other ornamental parts of structure, which shall be painted two coats of drop black and boiled linseed oil with sufficient japan to give a permanent and lustrous finish".[69] The columns and decorative arch trim of the pedestrian shelters were also originally painted white. (See Historical View of January 8, 1908 photograph)

Boller designed the granite stone masonry with aesthetic considerations in mind. He wrote that the design was:

> "made so effective by properly massing the parts, by straight lines and batter lines, by projection courses, copings, bridge seats, newels and parapets, coupled with the judicious use and proportion of dressed surface to rock face, as to be worthy of the most careful study, remembering that shadow effects are what count in emphasizing masonry lines....The piers themselves carry out the ideas of column divisions, each having a shaft, necking, cornice and cap. The superstructure railing finishes at stone newels carried up from the pier caps... breaking back by molded offsets from the broad base.... Strong shadow lines are necessary to bring out the strength and vigor of design, and, therefore much attention must be paid to proportions and overhangs, copings and masonry forms...."[70]

The granite approach ramps, abutments, rest piers with gatehouses and the center pivot pier consist of rock-faced granite ashlar with concrete backing supported by concrete footings on timber piles.(See Photo E, and Drawings C21-151, 153, 154 & 156). The approximate size of the granite blocks are 2'-0" high by 4'-0" long by 3'-6" deep, and they are laid in a running bond pattern. All lime-mortar joints are tooled convex and lay on a common plane, from which the broken face of the masonry stone protrudes. The top of all masonry is capped with a continuous coping stone, upon which the railing systems along the approaches are attached. Ornamental stone pedestals or newels were employed at locations where lampposts were designated (See Photo R and Drawings C21-153 & 156).

The gatehouses, which are incorporated into the rest piers, were built to house the gate operators. They are of granite masonry construction, and were originally capped with a fish-scale pattern, terracotta tile roof with a copper apron and decorative finial (See Photo C & Q, and Drawing C21-145). Boller described them as, "stone houses... designed in harmonious lines with the piers,the masses of which are accentuated by them, a spot of color being given by the red tiled peaked roofs."[71] The roofing has been replaced with asphalt tiles, although the copper items are mostly intact (See C21-111). The bridge is seldom opened now, due to the reduced flow of shipping along the Harlem River. The gatehouses have not been used since the electrically operated gates were installed in 1964.[72]

Electrical Design:

The original Ship Canal swing span was operated by coal fired steam engines. From January 8 to November 12, 1908, the relocated draw bridge at University Heights was also operated by steam. After this period, electrical equipment was installed, bringing electrical power to the machinery room, and powering a 45 horsepower electric motor drive to open and close the swing-span.[73] (See Photo AB & AC, and Drawing C21-160)

The Ship Canal Bridge had decorative gas lighting fixtures which were not relocated with the structure to the University Heights location. The original drawings indicate that decorative cast iron electrical lighting fixtures of Art Nouveau design were installed at the new location (See Drawing C21-110). The electricifation of the bridge continued with the installation of arc lights in 1920 and, much later, with standard contemporary high pressure sodium luminaires.

Electrical power lines for trolleys were installed in 1910, and were supported on the undersides of the sway bracing of the swing span. As the lines had to be detached when the draw was swung, coupling devices, similar to fuse switches were installed over the expansion joints. The major feeder lines were then supported by a newly erected, latticed beam with posts spanning the roadway. (See Historical View #9868)

Mechanical Design:

In its original location at the Ship Canal, the swing draw was released from its four rest pedestals by a hydraulically activated device, and rotated by a steam-driven 45 HP engine. The hydraulic system was replaced by a mechanical end-lifting device in 1899.[74]

During the heyday of shipping along the Harlem - due mainly to heavy industrial and construction material manufacturing - the University Heights Bridge was opened frequently and was occupied around the clock by a full staff of ironworkers, laborers, carpenters, etc. who maintained and operated the bridge. Until the mid- 1970's, personnel were stationed at the gatehouses to open and close the iron gates and to offer assistance to vehicles and the public.[75] Some random statistics provide an indication of the bridge's use. In 1939 for example, 21,081 vehicles and 1815 cars crossed the bridge, while the bridge was swung 440 times for an average open time of 5.78 minutes. In 1945, 11,729 vehicles and 984 cars crossed, with an average of 9.94 minutes of open time in 482 openings.[76] Today, the bridge is opened only a few times a year.

The swing span and end lift systems are driven by one of two electrical motors housed in the machine-operator's room below the roadbed (See Photo AB and Drawing C21-160 & 162). When the motor is used as the primary drive, it is positioned so that it is engaged with the common driven gear. The driven gear is keyed to two pinions, each having a clutch which can be engaged to permit the pinion to rotate a horizontal shaft to transmit power from the electrical motor to the end-lifting device or the draw turntable . The two clutches, one of which was installed in 1905 and both replaced in 1934 (See Drawing C21-175), can be engaged only singularly by a rotating hand wheel.

The controls for the bridge are operated blindly from the Machine Room, whereas the alignment of the swing draw is determined by a hand painted dial and by verbal communication from above. Alignment of the draw is determined by observation of a painted stick below the roadway, which must be lit by a spotlight when the bridge is opened at night. The swing span can also be manually rotated through a roadway box with a socket for a cross-tee "key", which is turned by a dozen men, rotating the hand wheel and pinion gear.[77]

The end lifts (also called ram supports) are driven by a horizontal end-lift shaft from the machine room (See Photos Z & Y) to a "tee" like bevel gear connection (See Photo V) to cross shafts over the rest piers (See Photos T & U). These threaded cross shafts are screwed through a fixed casting (See Drawings C21-157, 014, 012 & 011)), and pull horizontal/vertical slide assemblies upward and out of the four corner metal pedestals (See Photo W), thereby releasing the draw for swing clearances. The designs for the rehabilitation dictate roller end-lifts, as the present lifts do not allow precise alignment nor proper end bearing, mostly due to thermal expansion and contraction of the draw.

The swing span is operated similarly by a horizontal shaft with a bevel gear which transfers the circular motion to two vertical shafts. There are pinion gears at the bottom of the vertical shafts which are toothed to a circular fixed rack of the turntable (See Photo Z). There is a manual hand drive gear and hand wheel at the top of this shaft, accessible from the roadway deck above. The turntable supports the machine room and the swing span assembly and consists of a 5'-0" high circular drum girder (See Photos Y & Z, and Drawing C21-007, 008 & 021) with radial struts resting on 66 tapered, cast iron rollers (See Photos Z & AD). The rollers are connected to a center pin type bushing by radial rods of 1-1/2" diameter, not unlike spokes of a wheel, with turnbuckles to adjust roller alignments. In essence, the turntable "walks" around the circular fixed pinion.

Although the coal fired steam engine was removed in 1908, coal was still needed to fuel a "pot bellied stove" to heat the machine room. Water for the domestic needs in the Machine Room was stored in a water tank, supplied by a pipe from the Manhattan approach (See Photo AA and Drawing C21-071). A flexible hose-type coupling is removed when the bridge must be opened.

FOOTNOTES

1. State of New York, Report of the Board of Conference Relative to the Proposed Improvement of the Harlem River (Albany: J.B. Lyon, 1920) pp. 6-7.

2. For the early history of the Harlem River see L.G. Morris editor, Harlaem River Its Use Previous to and Since the Revolutionary War (New York: J.D. Torrey, 1857) en passim. For commerce on the Harlem see Morris and also Lieut. Col. McFarland, "Improvement of The Harlem River New York", in Annual Report of the the Chief of Engineers, United States Army, to the Secretary of War, for the Year 1887, Part 1. (Washington: Government Printing Office, 1887) pp. 687-89.

3. "Extract from Mayor Woods Communication" transmitted to the Common Council of the City of New York, February 4th, 1856," in Morris, pg. 126.

4. "An Act to incorporate the Harlem River Canal Company", in Morris, pg.55.

5. See Chronology in Harlem River and Spuyten Duyvil Improvement Association, Report on the Origin and Present Condition of the Improvement, With Some Suggestions as to the Drawbridge Question and the Commercial Interests Affected Thereby, (New York: The Evening Post Job Printing House, 1893) pp. 25-27.

6. John Newton, "Survey of Harlem River from Randall's Island, by way of Spuyten Duyvil Creek, to Hudson River, in Annual Report of the Chief of Engineers to the Secretary of War for the Year 1875, Part 2 (Washington: Government Printing Office, 1875) pp. 225-226.

7. State of New York, pg. 7.

8. McFarland, pp. 668-670.

9. Simon Stevens, Harlem River Ship Canal (New York, C.G. Burgoyne, 1892) en passim.

10. "The Harlem River", Editorial. New York Times, 3 March 1892, pg. 4, col. 4.; "The Harlem Viaduct", Editorial, New York Times, 15 March 1892, pg. 4, cols. 3-4.; "The Harlem and the City", Editorial, New York Times, 14 July 1892, pg. 4, col. 4.; "The Central and the Harlem", Editorial, New York Times, 20 July 1892.

11. Chauncey M. Depew, cited in Stevens, pg. 25.

12. "The Harlem Ship Canal", Editorial, New York Evening Sun, 2 March 1892, reprinted in Stevens, pg. 28.

13. Lieut. Col. McFarland, "Improvement of the Harlem River, New York," in Annual Report of the Chief of Engineers to the Secretary of War for the Year 1888 (Washington: Government Printing Office, 1888) pp. 599-600.

14. Lieut. Col. Gillespie, "Improvement of Harlem River, New York," in Annual Report of the Chief of Engineers to the Secretary of War for the Year 1889 (Washington: Government Printing Office, 1889) pg. 771.

15. Lieut. Col. Gillespie, "Improvement of the Harlem River, New York," in Annual Report of the Chief of Engineers to the Secretary of War for the Year 1890 (Washington: Government Printing Office, 1890) pg. 708.

16. Lieut. Col. Gillespie, "Improvement of the Harlem River, New York," in Annual Report of the Chief of Engineers to the Secretary of War for the Year 1892 (Washington: Government Printing Office, 1892) pg. 788.

17. William Hubert Burr, The Harlem Ship Canal Bridge, (London: The Institution of Civil Engineers, 1897) pg. 16.

18. Lieut. Col. Gillespie, "Improvement of the Harlem River, New York", in Annual Report of the Chief of Engineers to the Secretary of War for the Year 1893 (Washington: Government Printing Office, 1893) pg. 1029.

19. Burr, pg. 16.

20. Alfred P. Boller, "The Aesthetics of Bridge Design as Exemplified by Two Recent New York Bridges," Engineering News, (Oct. 7, 1897), pg. 227.

21. Jay Shockley, "University Heights Bridge," New York City Landmarks Preservation Commission - Committee Report, September 11, 1984, pg.2.

22. Burr, en passim; Boller, en passim; Engineering News, (March 8, 1893).

23. Burr, pg. 13.

24. "Swing Bridge", Engineering News, (April 6, 1893), pg. 338; Department of Bridges, City of New York, "Ship Canal Bridge," in Historical Facts Connected with New York City Bridges, (New York: Unpublished, 1917) pp. 1-4.

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29. Department of Bridges , "Ship Canal Bridge", pg. 3.

30. "Hudson Weds the Sound", New York Times, 18 June 1895, pg. 1, col 7.

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41. Department of Bridges, "University Heights Bridge," pp. 1-2.

42. Department of Bridges, Report ...1904, pp. 169-170.

43. Howe, pg. 3.

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51. Scientific American, pg. 539. ; Howe, pp. 8-12.

52. Martin Gay in Howe, pg. 25.

53. Martin Gay in Howe, pg. 25.

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55. Department of Bridges, "University Heights Bridge," p. 3.

56. "Mayor Opens Bronx Bridge, "New York Times, 9 January,1908, pg.5, col. 2.

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59. Shockley, pg.1.

60. Boller, pp. 227-228.

61 . Personal Interview with Rocco DiRuggiero, Deputy Engineer In Charge-Bridge Construction, New York City Department of Transportation, 11 January 1989.

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64. Burr, pg. 13.

65. T. Kennard Thomson, "The Bridges of New York City," The Engineering Magazine, 37 (September-October 1909), pg. 915.

66. Alfred P. Boller, Practical Treatise on the Construction of Iron Highway Bridges (New York: John Wiley& Sons, 1876), PP. 83-87.

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69. Department of Bridges, New York City, Specifications for the Construction of the University Heights Bridge and Approaches (New York: Martin Brown, 1905) cited in Shockley, pg. 7.

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71. Boller, " The Aesthetic's of Bridge Design...." , pg. 227.

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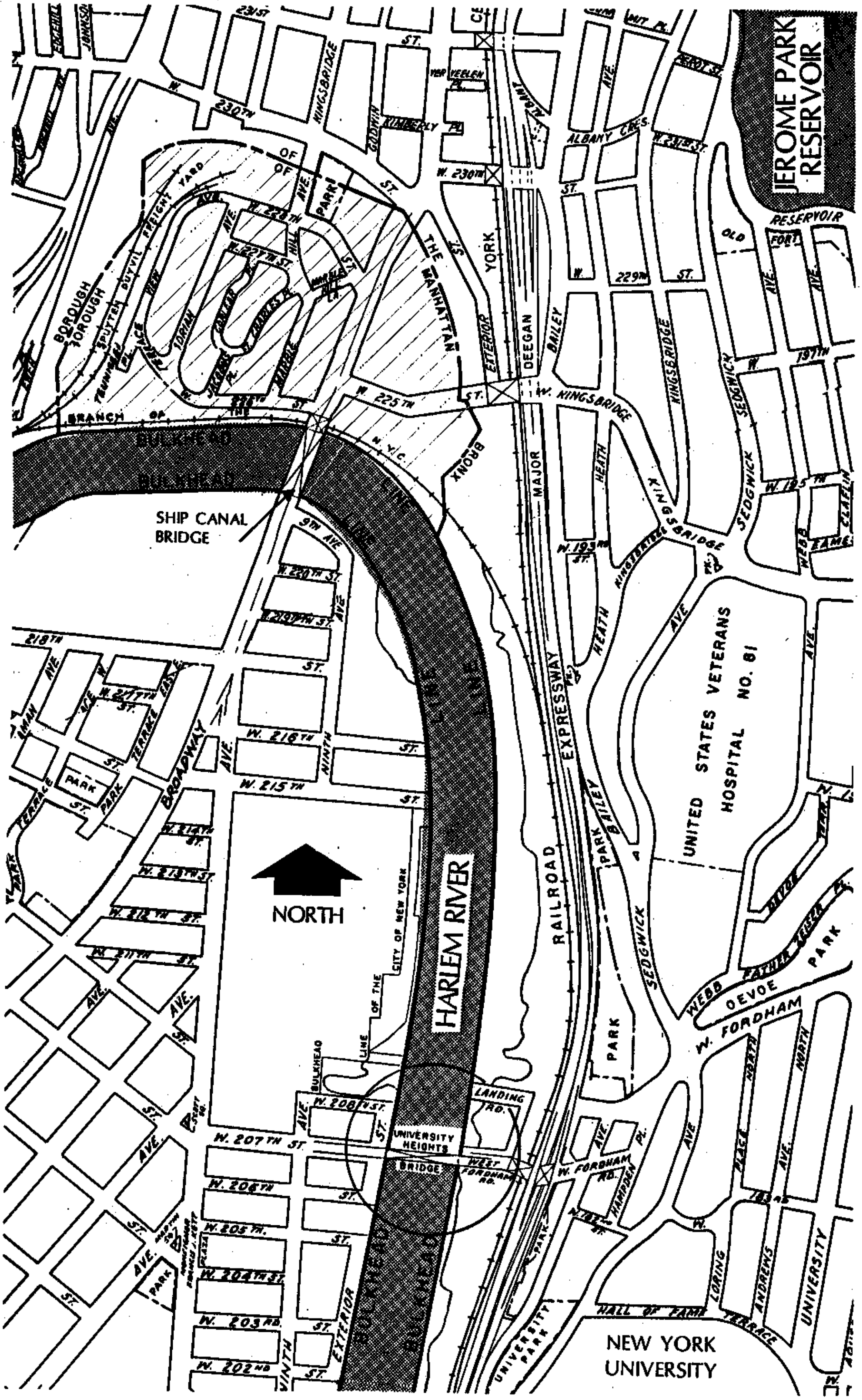

EXPLANATORY DRAWING NO.1 AREA LOCATION MAP

APPENDIX

BIOGRAPHICAL SKETCHES

CONTEMPORARY ENGINEERING

HISTORY OF HARLEM RIVER BRIDGES, (10 pages)
Vol. I, Chief Engineer's report 1917, Historical Facts Connected with New York City Bridges, Internal publication kept at NYC Department of Transportation office at 300 West 206th St., Manhattan, New York, N.Y.

BIOGRAPHICAL SKETCHES

George W. Birdsall (1835?-1911)

Birdsall joined New York City's Department of Public Works in 1872 as an assistant engineer. He became chief engineer in 1881, serving in that capacity until 1902. He continued after that year as a consulting engineer, until his death in January of 1911. Birdsall was especially noted for his knowledge of New York City's water system. The Bronx River system was planned during his tenure, as well as the replacement of the Croton Aqueduct. Birdsall's obituary noted that "he was frequently consulted . . . on the construction of reservoirs and dams."[1]

[1] "George W. Birdsall", New York Times, 24 January 1911, pg. 9, col. 5.

Alfred Pancoast Boller (1840-1912)

Alfred Pancoast Boller was a leading specialist in bridge design in 19th century and early 20th century America. He is especially noted for his skill in solving difficult engineering problems, and for his emphasis on the aesthetics of bridge design. Born in 1840 in Philadelphia, he studied at the University of Pennsylvania and the Rensselaer Polytechnic Institute, graduating in 1861 with a degree in civil engineering. Boller gained early practical experience working for various railroad companies in Pennsylvania.

In 1866, he joined the Atlantic and Great Western Railroad with the title of "engineer of bridges". In this capacity he helped plan an international bridge over the Niagara River at Black Rock, New York. Boller left after a few months to briefly join the Hudson River Railroad. He then spent four years as an agent of the Phoenix Iron Company in New York. Some of the projects he was involved with during these years include the Bridgeport Bridge, the construction of piers 38 and 39 on the Hudson, and the design of the St. John's Park Station for the New York Central and Hudson River Railroad. From 1871 to 1874, Boller worked for a number of different companies including the Phillipsburg Manufacturing Company, the

Manhattan Elevated Railroad, the Yonkers Rapid Transit Commission, and the West Side and Yonkers Railroad.

In 1874, Boller established his own office in New York as a consulting engineer and contractor. The firm, known after 1898 as Boller and Hodge, and later as Boller, Hodge and Baird, was responsible for bridges throughout the United States and in many foreign countries. Some of the firm's more ambitious projects included the Thames River Bridge at New London, Conn. (1890), whose 503 foot central draw-span was the longest constructed up to that time; New York's Central Bridge over the Harlem River at 155th Street (1895), which was called the heaviest movable bridge ever built; and the Municipal Bridge over the Mississippi at St. Louis (1912), which when designed had the world's longest fixed truss span at 670 feet.

In New York City, Boller consulted with the Department of Parks, Public Works, and the Rapid Transit Commission. He helped design the foundation of the Statue of Liberty, and consulted on the design of the steel framework of such early sky-scrapers as the Singer Building (1907) and the Metropolitan Life Insurance Company Building (1909). Boller worked at various times with most of the leading railroad companies in New York. His firm was also retained as Consulting Engineers by the State of New York and the Federal Government.

Boller is perhaps best remembered for his longstanding interest in the architectural effect of bridges. A dedicated amateur painter, he addressed the relationship between bridge design and architecture in his one major work Practical Treatise on the Construction of Iron Highway Bridges (1876).

While emphasizing the supremacy of intelligent construction and engineering, Boller felt that engineers needed to consider the aesthetic effect of their works. "Public works, in a certain sense, play a part in the education of a people," declared Boller, "and their authors and builders have consequently . . . a responsibility in addition to the mere utilitarian idea of endurance and safety."[1] More than twenty years later, Boller wrote that "when there are waterways demanding bridge crossings, such crossings should be studied on architectural principles, as well as those of purely constructive engineering."[2] He wrote that he approached each project with three specific goals in mind -- that of fitness, stability and beauty. Boller was notably successful in his efforts. The American Society of Civil Engineers remembered him after his death by writing that, "his appreciation of architectural symmetry had a marked influence on his bridge designs, his constant effort being to combine technical principles and practical utility with symmetrical and pleasing outlines".[3]

[1] Alfred P. Boller, Practical Treatise on the Construction of Iron Highway Bridges (New York: John Wiley & Sons, 1876) pg. 83.

[2] Alfred P. Boller, "The Aesthetics of Bridge Design as Exemplified by Two Recent New York Bridges", Engineering News, 7 October 1897, pg. 227.

[3] S. Whinery, "Alfred Pancoast Boller", Transactions of the American Society of Civil Engineers, Vol. LXXXV, 1922, pg. 1655.

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William Hubert Burr (1851-1934)

William Hubert Burr was one of the most influential engineers of his day. His accomplishments span over fifty years of American engineering history. Throughout his long and distinguished career, Burr was renowned as a teacher, author, and practicing engineer. Born on July 14, 1851, to an old line Connecticut family, Burr was a direct descendant of Aaron Burr. He studied at the Watertown Academy in Connecticut, and graduated from the Rensselaer Polytechnic Institute in 1872 with a degree in civil engineering. Burr's first position was as an assistant with the Phillipsburg Manufacturing Company in New York (where he incidentally would have worked with Alfred Boller). Burr gained practical experience in the design of wrought-iron bridges with Phillipsburg. The knowledge proved valuable, as he later played an important role in formulating the standards for the use of steel in bridge construction.

Burr began his career in teaching as an instructor at Rensselaer in 1875, and he was appointed - at the age of 25 - Professor of Rational and Technical Mechanics the following year. During his tenure at Rensselaer, Burr authored a number of highly influential works including The Stresses of Bridge and Roof Trusses (1881); and Elasticity and Resistance of the Materials of Engineering (1883). Both works went through numerous printings, and were standard engineering texts for decades to come.

Burr left Rensselaer in 1884 to become assistant to the chief engineer of the Phoenix Bridge Company at Phoenixville, PA. He quickly became a general manager of the company, and as such, superintended the design and construction of some of the most important bridges built in America during these years. Among these included the Chesapeake and Ohio Railroad bridge over the Ohio River at Cincinnati. The bridge was a three span truss, and its center span of 550 feet was a record at the time. Burr also worked on the Red Rock cantilever bridge over the Colorado River, and the Pecos viaduct in Texas.

In 1891, Burr became a vice-president of the firm of Sooysmith and Company in New York, which specialized in the design of bridge foundations. He left the company the following year to accept a professorship at Harvard. Burr left Harvard after a year to accept the chair of professor of civil engineering at Columbia University, a position he held until his retirement in 1913. In New York, Burr began a long period as a consulting engineer. From 1893 on, Burr consulted with various New York City agencies on a diverse range of projects. These included the Harlem Ship Canal Bridge; the construction of the Harlem River Drive; the George Washington Bridge; and the Holland Tunnel.

Burr also served on a number of impressive committees formed to consider the leading engineering projects of the day. In 1894, he was named to a presidential committee to consider the feasibility of a bridge over the Hudson River. He was also part of a board of experts in that year who considered improvements to New York's waterfront, and planned the extension of the rapid transit system. In 1896, he served on a committee formed to locate a deep water harbor in southern California. From 1899 to 1906, Burr was a member of a series of committees charged with locating and planning what would become the Panama Canal. He also consulted on New York City's water system, and the New York Sate Barge Canal System.

The preceding is clearly only a partial listing of Burr's accomplishments. His influence was felt throughout his long career through his teaching, writing, and counsel. "There were few major American engineering undertakings," memorialized the American Society of Civil Engineers, "in connection with which his approval or advice was not sought."

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Othniel Foster Nichols (1845-1908)

Nichols was associated throughout his career with public works in New York City, as well as many private ventures. He was born in Newport, Rhode Island on July 29th, 1845, and attended public schools in Brooklyn, New York. He graduated from the Rensselaer Polytechnic Institute in 1868, with a degree in civil engineering. Upon graduation, Nichols worked on the construction of Brooklyn's Prospect Park, and also assisted with New York's first elevated railroad. In 1870, he joined the firm of Cooper &

Hewitt as an assistant engineer. From 1871 to 1876, Nichols worked in Peru designing tunnels for the Chimbote Railroad. Returning to New York, he was engaged by the Edge Moor Bridge Works on the construction of the elevated railroad in New York. Nichols was also employed during this time by New York's Park Department to oversee the installation of drainage sewers in the newly annexed Bronx. He returned to South America in 1878, as the resident engineer for the Madeira and Mamore Railroad of Brazil. The enterprise apparently failed, and Nichols returned to the States the following year, rejoining Cooper & Hewitt for a short time. He then spent two years as assistant engineer in the bridge shops of the New Jersey Steel and Iron Co. at Trenton. In 1882, Nichols served as resident engineer of the Henderson Bridge over the Ohio River. In 1886, he was appointed chief engineer of the Water Works Co. of Westerly, R.I. He resigned this position to accept the post of principal assistant engineer of the Suburban Rapid Transit Co. of New York.

Nichols spent the rest of his career in the service of various New York City agencies. From 1888-1895, he served as chief engineer of the Brooklyn Elevated Railroad Co., and after 1892 was also a general manager of the company. He then became principal assistant engineer of the Williamsburg Bridge, working in this capacity from 1896-1903. Nichols was chief engineer of New York's Department of Bridges from 1904-06. He continued as a consultant to the Department until his death in 1908. Nichols taught at various times at both New York's Cooper Union and the Brooklyn Institute of Arts and Sciences. He was an active member of engineering societies and served, for a time, as secretary of the Engineers Club of New York.

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CONTEMPORARY ENGINEERING (1989)

Drawings were prepared from 1986 through 1988 for the replacement and reconstruction of the bridge by N.H. Bettigole, P.C., Consulting Engineer with Garreth Reese, Electrical Consultant; and Edward Rory McGinnis, Architect and Preservationist and Milton Stafford, Mechanical Engineer as subconsultants. Bids were received for the replacement of the draw with modified approach ramps to conform to federal regulations for roadway widenings. As the structure is a New York City Landmark, designs consisted of replicating the original appearance of the bridge and preserving as much of the original materials and elements as possible. Engineers. Contemporary design standards will be applied, such as gusset plate connections for the truss members, rather than the antiquated flexible pin-connections; and high strength bolts in lieu of structural rivets, in order to simulate the original aesthetic and appearances. Preservation efforts will be employed for decorative architectural elements, along with general cleaning of the granite masonry. All efforts will be made to preserve and match the landmark structure applying state-of-the-art technologies.

A new, "appropriate" prefabricated control room will be placed within the truss portal bracing over the central pivot pier. Due to regrading of the approach ramps, several courses of the abutment masonry will be modified and reset, and all deteriorated mortar joints will be repointed; all masonry surfaces will be cleaned. The new deck designs allow only for a single sidewalk which will pass through the southern gatehouse, requiring enlargement of the present window opening for a passageway. New terracotta roof tiles and copper finials will be installed at both gatehouses. The existing pedestrian waiting shelters and gates will be removed, refurbished inclusive of new copper roofs and cast iron columns, and erected in new locations. All of the decorative cast iron railing panels will be removed, refurbished and installed in a single railing system on the south side.

New computerized controls for monitoring and controlling the span drive system will be located in the new Machine Room space and in the new Control Room within the draw trusses.

Low bid prices for the construction (and demolition) work was received on February 2, 1989. A construction contract was awarded to the Karl Koch Erecting Co., Inc., 400 Roosevelt Ave., Careret, N.J. on March 20, 1989 for the price of $34,817,120.00. Work is planned to begin in early mid-1989 and be complete in mid-1992.

SHIP CANAL BRIDGE

The possibilities of the Harlem River as a navigable communication between the North and East Rivers were appreciated at an early day, and at the meeting of the New York County Board of Supervisors, May 10, 1860, the Committee on Annual Taxes was authorized to employ a competent engineer to survey a channel, with the view of ascertaining what improvements might be made for navigation, and to recommend such measures as would promote it.

The Committee appointed J. McLeod Murphy to make the survey, and at the meeting of the Board December 28, 1860, presented his report with maps, profiles and estimates. He proposed to dredge a channel from Macombs Dam to Kingsbridge 10 feet deep and 150 feet wide, and to construct a canal on the line of the old "Nichols or Dyckman Canal" (the location of the present Ship Canal) to Spuyten Duyvil Creek. The total estimated cost of the improvement was $199,837.85. The report was laid on the table.

May 22, 1860, the Board of Supervisors passed a resolution, requesting the representatives of the County in Congress to urge upon the Federal Government the importance of improving navigation of the Harlem River, and to procure an appropriation for that purpose. Nothing, however, was done by Congress until, largely through the efforts of the late Andrew H. Green, the River and Harbor Act of June 23, 1874, provided for a survey of Harlem River.

The survey, and plan of improvement, was made by Major-General John Newton, U. S. Eng. Corps, and was incorporated in the annual report of the Chief of Engineers for 1875. It proposed to open a channel through Dyckman Creek from the North River to the Harlem, at a cost of $2,100,000., and to deepen the channel of Harlem River as far as Third Avenue at a cost of $600,000.

Work was begun on the "Dyckman Cut" in the summer of 1887, and by July, 1892, the work had been excavated to a depth of 18 feet below mean low water over the greater part of the area between cofferdams at each end of the cut; and it was ~~reported~~ expected the excavation would be completed and water let in during the autumn.

Although the Commissioners of the Department of Parks had been notified in 1890 by the United States authorities that a bridge would be required over the Ship Canal on line of the Kingsbridge Road (now Broadway), authority to build one was not promptly obtained, and April 25, 1892, the Commissioner of Public Works informed the United States Engineer that, legislation having only just been procured, the bridge could not be completed before November, 1893; and if the easterly cofferdam, over which the Kingsbridge Road traffic had been passing, was removed, travel would be interrupted for at least one year. The Commissioner's request, that the easterly cofferdam remain until the bridge was completed, was granted by the Secretary of War June 13, 1892, but before the foundations for the piers in the canal prism could be begun, an unusually high tide which occurred during a severe easterly storm [illegible] overtopped the dam, destroyed it, and filled the canal with water.

The act of the Legislature (Chap. 232 Laws 1892, passed April 5) gave the Commissioner of Public Works power to build a bridge over Ship Canal, and to change grades of Kingsbridge Road and adjoining streets. The bridge to be not less than 50 feet wide, nor less than 26 feet above mean high water, and to conform to Section 676, Chapter 13 of Chapter 410 of the Laws of 1882 (Consolidation Act). The cost of bridge and land not to exceed $400,000., with the damages from change of grade in addition. William H. Burr was appointed Consulting Engineer by the Commissioner of Public Works.

The premature flooding of the canal increased the cost of the bridge materially, as three piers had to be built in 24 feet of water; the site of these and the fender piers had to be cleared of obstructions, and a temporary bridge had to be built to accommodate travel, in place of the cofferdam. Plans for the bridge were approved by the Secretary of War February 11, 1893.

This increased cost was provided for by Chapter 48 of the Laws of 1894, which permitted the expenditure of $450,000 for the construction of the bridge, and such further sums as might be necessary for land and damages.

A temporary pile bridge was built near the remains of the cofferdam, and the site of the new bridge cleared ~~by~~ of obstructions by P. Sanford Ross, contractor, for the sum of $8,906.50, and a contract for building the new bridge was made with Arthur McMullen & Company April 13, 1893. The bridge was opened to public travel January 1, 1895, and completed March 1st of the same year.

The principal dimensions were:

Length of draw span, ...		268 ft. 7 in.
Length of each approach span, ...		102 ft.
Width of roadway, ...		33 ft. 6 in.
Width of each sidewalk, ...		7 ft.
Height of draw span in clear above H. W. Spring Tides,		24 ft.
Clear water way each side of center pier, . . .		104 ft.
Weight of steel superstructure of draw span,	535 tons,	
Weight of steel turn-table, ...	174 tons,	709 tons.
Weight of machinery, etc., say . . .	30 tons,	
Weight of railings, say, ...	5 tons,	
Weight of asphalt pavements, say . . .	191 tons,	226 tons.
Approximate total weight on center pier, . . .		935 tons.
Weight of steel in each approach span,	160 tons,	
Weight of railings, say, ...	2 tons,	
Weight of asphalt pavements, say, . . .	72 tons,	
Approximate total weight each approach span,	234 tons.	
Cost of construction under McMullen Contract,	$404,603.90	
Cost of temporary bridge and dredging, . .	8,906.50	
Cost of removing do. borne by Dept. of Parks	1,150.00	
Cost of engineering, ...	26,798.45	441,458.85
Cost of awards for change of grade damage, . . .		36,555.09
Cost of 3 double deck spans, as given by Public Service . . .	Total,	$478,013.94
		213,959.

The temporary bridge was removed in the spring of 1895, and the cofferdams and other obstructions in the canal having been dredged out, the waterway was officially opened with a marine procession and other formalities June 17, 1895.

Under authority of the Rapid Transit Act (Chap. 4, Laws of 1891), and its amendments, the Rapid Transit Commission laid out a route up Broadway to Van Cortlandt Park, and to cross the Ship Canal it was proposed to strengthen the three spans of Ship Canal Bridge and add an upper deck to carry the railroad trains.

This was objected to, on the ground that the turntable had not been designed for such loading; but before a decision was reached, the project of building a new bridge at University Heights came forward, and it was decided to move the three spans from Ship Canal to 207th street, and to build three new double-deck spans for the old site. Plans for the new bridge were approved by the Municipal Art Commission December 13, 1904, and by the Secretary of War April 20, 1905.

To carry out this project, a contract was made March 9, 1905, authorized by resolution of the Board of Aldermen September 2, 1904, with John B. McDonald, contractor for building the Rapid Transit Subway, to build three new spans, three feet wider than the old ones, and to deliver the three old spans on the piers at University Heights.

As the Kingsbridge Railway Company had obtained a franchise December 30, 1899, and expected to cross the bridge in the near future, and the New York Central and Hudson River Railroad proposed to relocate its line and run alongside the canal and under the ~~easterly~~ northerly approach span of the bridge, they were made parties to the contract.

New York City, through the Department of Bridges, for the additional 3 feet of width in new spans and for delivering the three old spans at University Heights, contributed	$ 80,000.
Kingsbridge Railway Company, for the additional strength necessary for the floor system, besides furnishing its appurtenances, contributed, ...	35,000.
New York Central & Hudson River Railroad took down and re-erected the face of the north abutment, to provide an additional width of 12 feet for its tracks, and for the increased length of span (114 feet) contributed	12,000.
Total,	$127,000.

The two new approach spans were built on the bulkheads east of the bridge. They were moved into place and the old spans moved out during the

UNIVERSITY HEIGHTS BRIDGE.

Previous to 1891 when some dredging north of Fordham foot bridge was done by the Federal Government in pursuance of the plan for the general improvement of the Harlem River, proposed by Gen. Newton in 1874, there was no navigation above Fordham Landing and very little above Morris Dock. Therefore a narrow foot bridge crossing the river a little above the site of the present University Heights Bridge was not a serious obstruction.

This foot bridge was built under the authority of a resolution of the Commissioners of Public Parks, dated September 28, 1881, at the expense of certain residents of Inwood, and is described in a list of Harlem River Bridges in the report for 1891 of the Chief of Engineers U. S. Army, as: "Foot Bridge, Fordham. Width of draw 32 feet, height of bottom chords above mean low water, 3.9 feet. Single draw; wooden trestle; soon to be removed." It was removed soon afterwards and no other means of crossing the Harlem River between the Washington Bridge at 181st Street and Farmers Bridge at 225th Street was provided until the University Heights Bridge was opened in 1908. The building of this bridge was primarily due to the Hon. Wm. D. Peck, Alderman from the 41st Bronx District, to whose efforts his constituents are indebted for this important means of communication with the Borough of Manhattan.

The University Heights Bridge extends from Ninth Avenue in Manhattan to 184th Street in The Bronx. As well as affording means of crossing the river, it gives access to the water front at Fordham Landing by a ramp on the north side of The Bronx Approach, and also, under Chap. 423, Laws 1903, eliminates the grade crossing at Fordham Landing Road.

Various propositions for the location and design of the bridge were made by several authorities and considered by the Board of Public Improvement and the Board of Estimate and Apportionment during 1901, 2 and 3.

August 6, 1903, plans showing a bridge containing the three spans from Ship Canal were presented to the Secretary of War by the Commissioner of Bridges, and September 4, 1903, were approved on condition that a channel 2200 feet long, and west of the center pier, and an area in the immediate vicinity of the draw span, be dredged to a depth of 15 feet below mean low water. The same plans had already been approved by the Board of Estimate and Apportionment July 29, 1903, and by the Board of Aldermen August 18, 1903, and $250,000 appropriated for beginning the work.

November 5, 1903, bids were opened for dredging, sinking a caisson, building a center pier thereon and constructing a pile fender for the draw span, and the contract was executed with the lowest bidder, The Foundation and Contracting Company, November 18, 1903.

As explained in the article on Ship Canal Bridge, the three old spans were bought from John B. McDonald, to whom they reverted under his contract with the Rapid Transit Subway Commission, to be delivered at University Heights when piers could be built to receive them.

June 14, 1906, the draw span was lifted from its pier at Broadway, brought down the river and deposited on the new center pier which had been prepared, with a new wheel-tread and pinion-rack, to receive it.

The Board of Estimate and Apportionment had adopted a resolution, December 4, 1903, approving the plan of abolishing the grade-crossing of the tracks of the Spuyten Duyvil and Port Morris Railroad Company at the Fordham Road, under Chapter 423 of the Laws of 1903, and the Municipal Art Commission had approved the design of the bridge January 10, 1905.

The name "University Heights Bridge" had been formally adopted by resolution of the Board of Aldermen May 17, 1904.

April 27, 1905, a contract was entered into with the Snare and Triest Company for the construction of the bridge and approaches not already provided for, and the work not yet quite completed, was opened to public travel January 8, 1908.

To lay cables and equip the bridge for electric operation, a contract was made with the Spiro Company, which completed the work November 12, 1908.

The boiler was retained for heating the engine room, but the steam engines were removed and electric motors substituted for them.

A petition from the Union Railway Company for permission to operate in certain streets and to cross University Heights Bridge was received by the Board of Estimate and Apportionment June 2, 1905, and after prolonged negotiations a contract granting a franchise was executed June 10, 1910, and the work of laying rails across the bridge began soon afterward. As this necessitated tearing up a large part of the pavement, it was decided to take advantage of the opportunity to remove the asphalt and repave with more durable wood blocks over the four spans of the bridge.

To allow for the greater depth of the wood blocks, the buckle plates which formed the deck of the bridge, and were laid with the domes upward, were taken up and replaced with the domes down. This was done by the repair force of the Department in conjunction with the Railroad Company's contractor, who removed the buckled plates and repaved between the tracks and for two feet outside of the rails. The work was completed and the Union Railway Company began running cars across the bridge November 29, 1910.

In order to make use of the wharfage facilities offered by the bulkhead space between the river and the east abutment, a timber roadway was authorized by the Board of Estimate and Apportionment November 23, 1911, on the north side of the approach, connecting the wharf with Exterior Street. A contract for the work was made with Thomas O'Connor.

The cost of University Heights Bridge was:

Foundation & Contracting Co.,	Contract	Nov. 18, 1903,	$133,910.26
John B. McDonald,	"	Mar. 9, 1905,	80,000.00
The Snare & Triest Company,	"	Apr. 27, 1905,	680,877.09
The Spiro Company,	"	July 3, 1908,	6,690.00
Thomas O'Connor,	"	Jan. 9, 1912,	2,130.00
		Total Contracts, ...	$ 903,607.35
		Land, damages and costs of proceedings,	189,980.54
		Engineering and Miscellaneous, ...	89,194.03
		Total Cost,	$1,182,781.92

Weight of metal structure;

Cast iron gratings on draw span, ...	15 tons,		
Steel & iron, Superstructure, turntable & railings, ditto	699 "		
Two old fixed spans, including railings, ...	324 "	1038 tons.	
Two new spans, ...		197	"
	Total,	1235	"

Length of draw span, 268 feet 7 inches.

Width of draw span, 53 feet 6 inches.

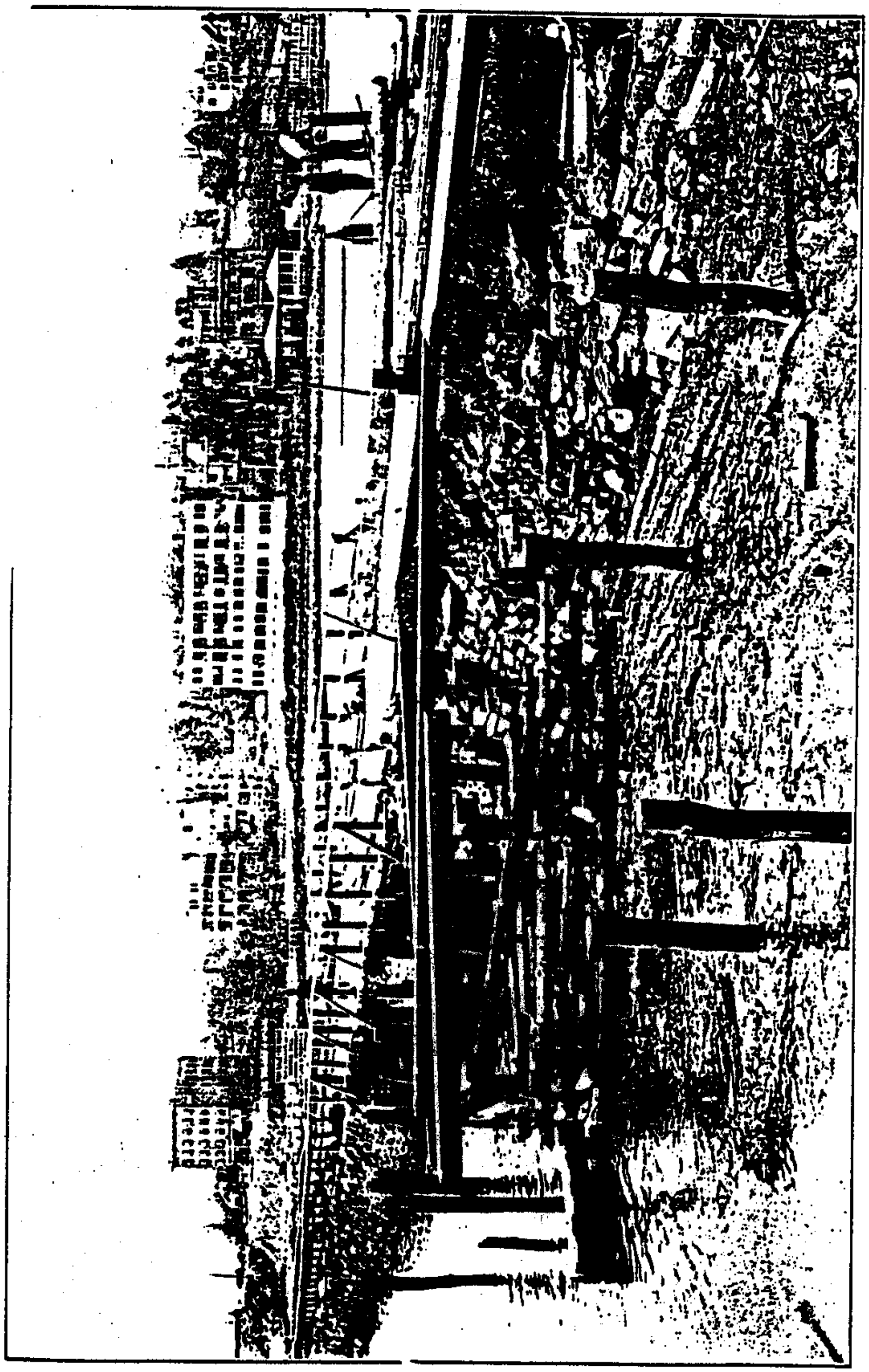
Width of draw span sidewalks, 7 feet each.

Height in clear above high water spring tides, 24 feet.

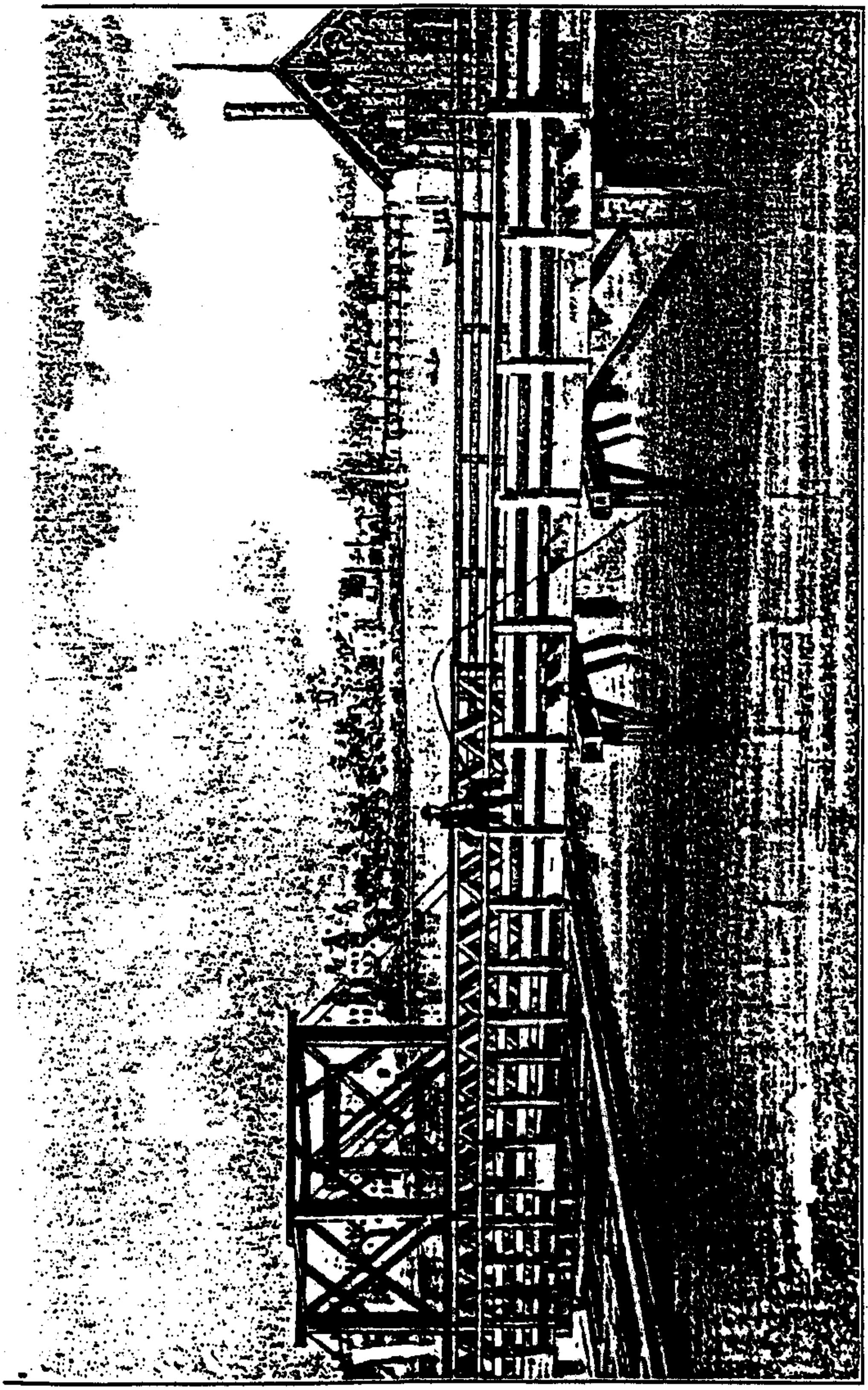
Clear waterway both sides center pier, 100 feet.

To afford proper approaches to the bridge, land was acquired on the north side of East 184th street 20 feet in width from Harlem River Terrace to Fordham Road, Exterior street from bridge approach to Fordham Road, 40 feet wide, and the Bronx approach from bulkhead line to railroad right of way, 160 feet wide.

On the Manhattan side 207th street was widened 10 feet on each side from Ninth avenue to the bulkhead line.



NO. 148—FARMER'S BRIDGE OVER SPUYTEN DUYVIL CREEK (DISCONTINUED AUGUST, 1911) NOW FILLED IN.



NO. 14A—FARMER'S BRIDGE (DYCKMAN'S) OVER SPUYTEN DUYVIL CREEK IN 1861.