Delaware & Hudson Canal
Delaware Aqueduct
Crossing the Delaware River
between Lackawaxen, Pike
County, Pennsylvania, and
Minisink Ford, Highland
Township, Sullivan County,
New York

HAER No. PA-1 ~~NY-5~~

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PA,
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PHOTOGRAPHS
WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
Office of Archeology and Historic Preservation
National Park Service
U.S. Department of the Interior
Washington, D.C. 20240

HISTORIC AMERICAN ENGINEERING RECORD

DELAWARE & HUDSON CANAL, DELAWARE AQUEDUCT
HAER No. [redacted] PA-1

Location: Crossing the Delaware River between Lackawaxen, Pike County, Pennsylvania and Minisink Ford, Highland Township, Sullivan County, New York
Latitude: 41° 28' 57" N. Longitude: 74° 59' 05" W.

Date of Erection: 1847-1848

Designer and Builder: John A. Roebling, C.E.

Present Owner: Lackawaxen Bridge Company (owned by E. H. Huber, Scranton, Pennsylvania)

Present Use: Highway toll bridge crossing the Delaware River approximately twenty miles northwest of Port Jervis, New York.

Significance: Probably the oldest suspension bridge in the United States that retains its original elements and the earliest extant example of Roebling's engineering genius. The Secretary of the U.S. Department of the Interior has designated the Delaware and Hudson Canal a National Historic Landmark and an NHL bronze plaque has been placed on the aqueduct. New York State has also recognized the structure with a roadside historical marker.

PART I. HISTORICAL INFORMATION

A. The Delaware & Hudson Canal

The Delaware & Hudson Canal, opened in 1829, unlike the Erie and most other American barge canals, was built as an essentially one-way route to transport a single commodity--anthracite coal--rather than general freight in two directions. It was projected by Maurice and William Wurts, as a means of exploiting their great coal fields in northeastern Pennsylvania, a canal at that time being the only feasible way of getting the bulk coal to the seaboard. As New York City was potentially the most profitable market, the canal was planned to strike for the Hudson River, down which the coal could be readily transported to the city. Charters were granted to the Wurts' by the Pennsylvania and New York Legislatures to improve the navigation of the Lackawaxen River--reaching practically into the Lackawanna coal fields at Honesdale and at its mouth joining the Delaware--and to built a line of water communication between the Delaware and Hudson Rivers.

The Delaware & Hudson Canal Company was formed and in the spring of 1823 contracted with Benjamin Wright, at the time still serving as chief engineer of the Erie Canal, to survey and locate a suitable route. Wright was instructed to select a line from tidewater on the Hudson at Rondout (near Kingston), up the valleys of the Rondout, Neversink, Delaware and Lackawaxen Rivers to the coalfields. The total distance was 108 miles with a lockage of 1,086 feet. Construction began in 1825, the year of the Erie's opening, Wright acting as chief engineer with the later renowned John B. Jervis as assistant. The entire canal was opened for business in October 1829. It reached its operational peak in 1872 when 2.9 million tons were moved. From that time, competition from an expanding railway network rendered the canal obsolete with increasing rapidity, tonnage gradually declining until final cessation and abandonment in 1898.[1]

B. Improvements and Enlargements

When the canal was opened, it was the sole means for transporting coal out of the anthracite region. It was shallow--four feet in depth--with a waterline width of 28 feet (soon increased to 32 feet) and a bottom width of 20 feet. The first boats held 20 tons of coal. With a supply assured, the use of anthracite for heating, iron smelting, and steam generation expanded rapidly engendering more business for the mines and canal. Even with the introduction of 30-ton boats, by 1841 the demand for coal had so increased that the canal's limit had been about reached.

The Delaware Aqueduct was built as an integral element in an almost continuous program to increase the canal's capacity. The need for periodic enlargements had been assumed almost from the outset, since the modest capital initially available and the uncertainty of later needs dictated many expediencies and compromises in the first works.

With the profits from the first decade's operation, it was possible to begin enlarging the canal. The first enlargement, begun in 1842 and finished in 1844, accommodated 40-ton boats (original capacity was 30 tons), and in 1845 the canal was deepened to 5-1/2 feet to pass boats of 50 tons capacity. The most ambitious enlargement plan, authorized by the Delaware and Hudson directors in 1846, was to increase both the canal's capacity and the speed of passage in order to compete economically with the Erie Railroad which by then had progressed into

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[1]The history of the D & H Canal has been well documented and related. The best account is Wakefield's extremely detailed, well illustrated Coal Boats of Tidewater, 1965. See Sources of Information.

the Delaware Valley and toward the coal regions. This involved deepening the canal to 6 feet and widening it to accommodate 98-ton boats, thus approximately quintupling the canal's original capacity, an indication of the growing importance of both anthracite and the canal in the coal industry. The principal consequence of the widening was the necessity for rebuilding all locks and aqueducts.

The most significant improvement to the canal's operation, however, was to be a material reduction in the passage time by removal of the worst bottleneck in the system: the slack water crossing of the Delaware between Lackawaxen, Pa. and Minisink Ford, N.Y., just above the mouth of the Lackawaxen. As capital originally had been inadequate to built an aqueduct across the Delaware, a still pool had been formed by damming the river, into which the boats were locked down on each bank. They then crossed either by momentum or hand haulage along a ferry rope strung between the banks, the mules being carried over separately on a small rope ferry. Under ideal conditions the crossing was slow and a serious operational snag. At worst, during high water in spring and fall, the passage was impossible and canal operations came to a halt for days at a time. A further hazard was conflict with the considerable traffic of timber rafts on the river. The raftsmen, forced to traverse the low canal dam either by shooting it on the flowage over the crest or passing through a sluiceway, in general were understandably hostile to the canal interests and engaged the company in constant physical and legal harassment. An aqueduct had, in fact, been projected from the canal's beginning. The need now being pressing and the capital available, it was included in the enlargement plan.

C. Construction of the Delaware Aqueduct

R. F. Lord, chief engineer of the canal, in planning the enlargement relocated the canal route at Lackawaxen, establishing the aqueduct over the Delaware not above the mouth of the Lackawaxen River at the rope ferry site, but just below. This necessitated, in addition, construction of a second new aqueduct, over the Lackawaxen. Every D&H canal scholar and author has speculated on Lord's reasons for planning the new route in that seemingly extravagant way, without having drawn any very convincing conclusions. There were obvious disadvantages to the scheme, notably the added cost of the second aqueduct and the fact that the piers of the Delaware aqueduct would be subject to the collective flow and battering of ice from both rivers. Two reasons are most commonly assumed for the rerouting: political consideration; and river bed and bank conditions unfavorable to the upstream location. The first, in the case of a private company under the scrutiny of its stockholders, seems unlikely, and there is nothing in the topography of the site lending much support to the second. More reasonable is a recent belief of Manville B. Wakefield, author of the definitive D & H Canal history, that if the aqueduct <u>had</u> been built at the ferry, practically opposite the Lackawaxen's mouth, the piers would have been in constant jeopardy from the great ice floes that annually came down the Lackawaxen, grinding across the Delaware to the eastern shore with great force.

However, another likelihood is suggested by the site conditions. Had the ferry location been selected, the aqueduct would have been right in the slack water pool, with several consequences. First, there would have been less vertical clearance under the aqueduct for the rafts, probably an insufficient amount at spring high water when much of the rafting was done. Worse, the cofferdams used in building the aqueduct piers would have to have been considerably higher and heavier, and the entire problem of pier construction would have been a good deal more difficult in the deeper water of the dammed pool, probably to a degree more than offsetting the added cost of the Lackawaxen aqueduct. There is also the probability that in the twenty years the Delaware had been stilled above the dam, quantities of silt had been deposited in the pool so that there would have been that much more material to excavate before reaching a solid footing. Finally, the river, in addition to being deeper, was, on the evidence of contemporary photographs, apparently somewhat wider above the dam, which would have necessitated a longer structure.

In February 1846, the canal directors authorized the two aqueducts at Lackawaxen, and by late December that year two proposals had been received. One was for a conventional trussed timber structure on masonry piers, in six spans. The other, submitted by John A. Roebling, C.E., of Saxonburg, Pa., was for a wire-cable suspension aqueduct of four spans. The management inclined toward the latter scheme as it not only was cheaper, but more important, the longer spans meant two less river piers, and thus reduced impedance to flood water and ice, as well as greater horizontal clearance for the river traffic. Another major advantage, not generally recognized by D & H historians, was that suspension spans, unlike either truss or masonry-arch spans, could be erected without falsework in the river, a matter of some significance at a site so subject to flooding and ice jams.[2]

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[2] The cables were spun in place without support. When they were complete and the suspenders attached, the timber cross frames of the trunk were hoisted into position from barges anchored below, following which the rest of the suspended structure was easily laid down. The freedom from falsework continues to be one of the suspension bridge's great advantages.

Roebling's plan was tentatively accepted on 6 January 1847. On the 19th Lord arrived in Pittsburgh for a four-day visit to inspect a similar aqueduct built by Roebling in 1844-45 to carry the Pennsylvania Canal over the Allegheny.[3] Lord was impressed with both it and Roebling's Smithfield Street suspension bridge over the Monongahela, also in Pittsburgh, built in 1845-46, and concluded that Roebling's abilities were far ahead of their time. The contract for both final design and construction of the Delaware and Lackawaxen aqueducts was given to Roebling, for a combined price of $60,400, and work began almost immediately.[4] Aside from Lord's report and the natural advantages of a suspension aqueduct, a further factor no doubt influencing the D & H's selection of Roebling to build the aqueducts was their confidence in him resulting from the long and satisfactory use of Roebling wire ropes on the inclined planes of the company's gravity railroad at the west end of the canal.

Roebling's construction contract covered only the superstructure or suspended spans, "including all iron, timber and wire work, the company to do all masonry and cement." His presentation and estimating drawings were apparently based on only general site information, for shortly after his return from Pittsburgh Lord sent Roebling detailed data on the bank and riverbed conditions for preparing the working drawings. With these in hand, Lord's crews in March 1847, despite the dual handicaps of weather and probable river ice, commenced the foundation work and the laying of the pier and abutment masonry. Although the canal company was primarily responsible for that portion of the work, continual coordination with Roebling (during most of this period at home) was necessary concerning setting of the great iron anchor plates in the abutments. These huge castings resisted the pull of the chains of eyebar links that rose up through the masonry mass ultimately to restrain the main cables.

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[3]The Allegheny Aqueduct was the first bridge of any kind built by Roebling, who until then had done general civil engineering--mostly railroad surveys--and manufactured wire ropes for haulage on the inclined planes of the Pennsylvania state and other canal systems. The aqueduct replaced, and was erected on the piers of, an earlier timber structure of seven spans that had been damaged by ice.

[4]The contract price for the Delaware Aqueduct was $41,750, the Lackawaxen, $18,650. Roebling claimed a clear profit of $8600. While almost 15% of his actual cost, it is hardly excessive when we realize that his contracting profit included his engineering fee as well. Possibly because of their remote location, these structures cost considerably more, relatively, than the Pittsburgh aqueduct: $82 and $78 per foot vs $48.

Roebling presumably visited the site periodically, but much of the consultation was conducted through correspondence. In late March Lord advised him that "We are proposing to get the abutments for Delaware Aqueduct in a state of forwardness so that the anchors may be put down soon after 1st of July; and have the piers all done so that you can have a chance to commence the superstructure in the fall and pursue it during the winter." The substructure work on the Lackawaxen span lagged somewhat behind, Lord anticipating that the last of the four anchor plates there could not be placed until well into the winter, "... probably by building a roof over it (the abutment foundation) so that we can use a fire, hot water &c." That excavation and masonry work could be carried on in that period, at that season, in that notoriously cruel climate is something of a miracle, and a sure reflection of the company's eagerness to capitalize on the improvement.

Roebling took up his work at Lackawaxen in the summer or fall of 1847, working on both aqueducts simultaneously throughout 1848, completing them by about year's end in time for the opening of the 1848 canal season on 26 April. They were, needless to say, an unqualified success structurally and operationally. The Lackawaxen Aqueduct, about half a mile west of the Delaware, was almost identical but had only two spans, each of slightly less than 115 feet, with a single river pier.

D. Decline and Recent History

The 1847-50 enlargement of the canal was spectacularly successful. In the D&H Annual Report for 1849 the management noted that "The two Wire-Suspension Aqueducts over the Delaware and Lackawaxen Rivers, are a part of the new work brought into use last year, and proved to be all that was expected or can be desired of such structures, and a great facility to the navigation." With a slight additional deepening and widening, the canal by 1852 was able to pass 130-ton capacity boats, which had the coincident advantage of being large enough to be river-worthy. They could thus make the down-Hudson trip to New York directly, eliminating the expensive trans-shipment of the coal to schooners at Rondout, the boats being hauled up and down river by tugs.

Chief Engineer Lord estimated that the project, particularly the advent of the Delaware and Lackawaxen Aqueducts, had avoided nine days-stoppage of boating due to high water in the first year of operation, and cut a full day from the passage time. All in all, the company could reduce rates by half, bringing the transportation cost down to about fifty cents per ton. On this basis the canal was able to compete quite successfully with the railroads for bulk coal haulage well into the 1870's. From the peak year of 1872, however, the competitive situation deteriorated rapidly for the canal. Whereas it had by then about reached its maximum practical capacity, the technology of the railroad was in a state of flourishing and seemingly unlimited advance. In the last three decades of the century, locomotive weights doubled, with corresponding increases in car capacity and train lengths, and decreases in rates.

The Delaware & Hudson management had the wisdom to march with rather than against this trend, and although the canal was operated almost to the century's end, it was under rapidly declining conditions as the company expanded its own rail network, commenced decades earlier. In 1898 the last boat moved over the waterway, and the following year the physical plant of the system was liquidated.

Of the four suspension aqueducts that Roebling designed as part of the major enlargement operation, only the Delaware had any apparent adaptive usefulness. The spans over the Lackawaxen, Neversink, and Rondout were all simply abandoned and eventually demolished. Abutments and remains of anchor chains are evident at all three sites.

The Delaware Aqueduct, however, being in a strategic location well away from any other road crossing of the river, was purchased privately and converted into a highway bridge. From the evidence of photographs the process of adaptation was simplicity itself. The tow paths were sawn off, a low railing was run along the downstream side of the trunk floor to provide a separated pedestrian walk, a toll house was built at the New York end, some grading was done at each end for accommodation to the existing roads, and Open For Business.

The first private owner was Charles Spruks, a Scranton lumber dealer who specialized in the heavy timbers used as supports in the area's coal mines. His principal timber lands being in Sullivan County, N.Y., he purchased the aqueduct primarily to afford a simple means of getting the logs across the Delaware to the railhead in Lackawaxen. The collecting of tolls from common-road traffic was actually a side line.[5]

In about 1929 the bridge was purchased by the Federal Bridge Company of Washington, D.C., a toll bridge holding company, which operated it under the style Lackawaxen Bridge Company, incorporated 10 January 1930. In late 1930 plans were announced by Col. P. K. Schuyler, Federal's president, to rebuild the floor system for "highway traffic of the heaviest class." It may have been at that time, or in about 1932, after a fire that

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[5]Information from Edward H. Huber, Scranton.

destroyed the woodwork of the west (Penna.) span and part of the one adjacent, that virtually all of the original timber was removed--trunk, floor beams and all. The simple floor system of today was substituted, consisting of transverse floor beams hung from the suspenders, longitudinal stringers, and plain transverse plank decking.

The Lackawaxen Bridge Company was purchased in March 1942 by E. H. Huber of Scranton, who presently maintains the operation. A toll of 25 cents for cars and 5 cents for pedestrians is charged, all passage free when the collector goes home at night. The fabric is generally in good condition. The masonry, except for an understandable minor deterioration of the upstream pier faces from river ice, is quite perfect. The floor system is good, the planking being periodically replaced, and the cables, despite unwinding of the outer wrapping in a few areas, are kept painted and appear as adequate as when made. The posted allowable load of six tons is almost ludicrous in view of the fact that <u>each span</u> originally contained about 500 tons of water plus the additional dead load of the trunk and tow paths. True, it was an evenly-distributed, non-moving, non-impact load, but there can be little doubt that the cable system today is not working very hard.

E. The Aqueduct's Relative Historical Status

There is good reason to believe that the Delaware Aqueduct is the oldest suspension bridge in the United States today. There are, however, two other possible contenders for this distinction: the famed Essex-Merrimack bridge designed by James Finley and erected in 1810 over the Merrimack River at Newburyport, Massachusetts; and the "Wire Bridge" over the Carrabassett River at New Portland in central Maine. While the Finley bridge at first appears the oldest, its entire superstructure was replaced in 1909. The new one only loosely resembles the original form with the pier masonry below deck level the only remaining original fabric.

Although the "Wire Bridge" has undergone a certain amount of rebuilding, the majority of the tower framing, the main cables and their anchorage hardware--the prime elements of a suspension bridge--are entirely original. According to local tradition, the bridge was built in 1842. This date could be valid, as Charles Ellet's wire bridge over the Schuylkill River in Fairmount Park, Philadelphia, the first consequential wire suspension bridge in America, was built in 1841-42; and there is no technical reason why the Maine bridge could not also have gone up then. If it did, then it would rightfully supersede the Delaware Aqueduct as the oldest standing suspension bridge in the U.S.

The 1842 date is doubtful, however, considering the lack of historical authority and the former presence of two similar suspension bridges in the immediate area, one built in Kingfield in 1852-53 and the other in Strong in 1856. Since the cables of the Kingfield span are not of wire as in the other two, but of chain, a more familiar and less novel material, it seems safe to assume that it was erected first. The New Portland bridge, in that case, must have been built after 1852, invalidating its traditional date of 1842. Taken altogether it seems reasonable to consider the Delaware Aqueduct to be in fact America's earliest standing suspension bridge.

Its future seems reasonably secure. Although it too is in a remote area, it is happily situated between the Poconos and the Catskills, and still is the only crossing of the Delaware for ten miles upstream and four down so that enough vacation and local traffic uses it to make it an economic if not wildly profitable venture for its owner, worth adequate maintenance expenditures.

F. Sources of Information (partial):

Published:

Bryant, William Cullen. Picturesque America. Volume 2. New York, 1874.

A Century of Progress--History of the Delaware & Hudson Company 1823-1923. Albany, 1925.

Delaware & Hudson Canal Company. Annual Report for 1849. New York.

Erie Railroad. Erie Route. N.P., 1887.

Wakefield, Manville B. Coal Boats to Tidewater--the Story of the Delaware & Hudson Canal. South Fallsburg, N.Y., 1965.

PART II. ENGINEERING INFORMATION

The aqueducts were designed like the locks to pass only a single boat, but nevertheless had a path on each side. The design closely followed that used by Roebling at Pittsburgh with a heavy wood trunk or flume holding between six and six-and-a-half feet of water, nineteen feet wide at the water line. The trunk sides were built up of two thicknesses of 2 1/2-inch untreated white-pine plank, laid tight on opposite diagonals and caulked up to the water line, in effect forming a rigid, solid lattice truss, but without functional top and bottom chords. The stiffness of these great trusses was such that they were capable of sustaining their own dead weight, leaving the cables to carry only the water load. The floor was also of double plank, carried by transverse double floor beams, in turn hung from the suspenders as in a conventional suspension bridge. The eight-foot tow and foot paths, on opposite sides, were bracketed out from the trunk sides, level with its top.

All was supported by the continuous main cables, one on each side of the trunk. At the bottom of their dip the cables were slightly above floor level, rising to be carried at each pier and the abutments over cast-iron saddles atop squat stone towers that stood about four feet above the trunk top. The suspenders were (are) plain 1 1/4-inch-round wrought-iron rods, doubled over the cables into stirrup form, the bottom ends threaded for the floor-beam nuts. They bear upon the cables on small cast-iron saddles, those nearest the towers where the cable slope is greatest being prevented from sliding downhill by wrought-iron restraining links or stays.

Roebling had developed at Pittsburgh a method for fabricating the cables and anchoring them at their ends. It was used by him in every bridge he built (except the Smithfield Street), as well as by most of his successors, to the present day, for major suspension bridges.[6] The 2150 iron wires forming each of the Delaware Aqueduct's 8 1/2-inch cables were individually laid up in place. Each cable is composed of seven strands, formed by carrying the wires across from anchorage to anchorage, over the saddles, in a bight of two wires at a time carried by a traveling sheave, so that at each anchorage a loop was formed which passed over a cast-iron strand shoe, pinned to the anchor bars, anchoring the strand. The strands are thus actually skeins formed of a single, continuous wire, spliced at the ends. Between the towers the seven strands were compacted into a single cylindrical form, virtually solid, then varnished and served with a continuous wrapping of iron wire for protection from the weather. However, where they splay out between the abutment towers and the anchor bars, the strand loops are exposed to view, clearly showing their formation as they join the strand shoes. Although photographs of the aqueducts in use show wood guards over these sections, the loops would still have been subject to a certain amount of condensation and other moisture. The exposure to the weather of so much area of such small-diameter strands, without wrapping, is in odd discord with Roebling's consistent advocacy of solid, single cables, the wires within protected overall by the envelopment of a close wrapping. It was, in fact,

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[6] Roebling patented the system after its successful application on the Pittsburgh Aqueduct: U.S. Patent No. 4945, 26 January 1847; Apparatus for Passing Suspension Wires for Bridges Across Rivers, &c.

on this very point that he inveighed most critically against Charles Ellet, a contemporary and sometimes rival suspension bridge builder, and other members of his school. Ellet favored, rather, cables composed of many small, separate wire bundles, because, he claimed, with the solid, wrapped cable it was impossible to so lay the individual wires that each carried its proportional share of the total load. Unwilling to encase any wires in masonry because of the difficulty in achieving the positive airtight seal needed to prevent corrosion, and aware that the stress on these backspan sections was less than on those carrying the suspenders, Roebling seems to have been satisfied to depend for weather protection upon the varnish and oil coating of the individual wires and on a heavy coating of the completed loops.

Another of Roebling's principal reasons for favoring the solid wire cable was that it added considerably to the overall stiffness of the suspended structure in its resistance to the dangerous oscillations caused by gusting winds under certain conditions. Here again, this effect would have been of no consequence in the aqueducts' short, unloaded backspans between the end towers and anchorages, where there were no suspenders.

The anchor bars were carried down through the anchorage masonry, terminating in six-foot-square cast-iron anchor plates upon which the masonry bears, its dead weight resisting the pull of the cables. Roebling calculated the ultimate strength of the pair of cables at 3870 tons and the stress on them (and thus on the anchors) from the loaded trunk at 770 tons.

The difference in the four span lengths of the aqueduct has been a matter of occasional speculation. The three spans closest to the New York shore are all so close to 131 feet that the present differences are obviously the result only of construction discrepancies and the shiftings of age and long service. The original design did indeed call for equal lengths of 131'0". But what of the odd 142-foot length of the first Pennsylvania span? That too, is specified, as early as 27 February 1847, in Lord's rough sketch, which is the earliest mention found on the subject of the aqueduct's relationship to the site. The correspondence between them does not make it clear whether Roebling or Lord made the basic determination of the span lengths. Undoubtedly they conferred during the Pittsburgh visit and perhaps reached a joint conclusion. However, that does not answer the initial question. Although Lord obviously had far greater knowledge of the site conditions, his sketch shows a relatively level river bed, with no particular circumstances on the Pennsylvania side that would have led to a span variation there. However, in a (presumably) later refined sectional drawing of the river and masonry, Roebling clearly does show a slight rise in the surface of the river bottom at the first Pennsylvania pier, and it was probably to take advantage of the shallower water at that point that the pier was placed there. Had the adjacent abutment been located further out into the stream to make that span also 131 feet, it would have projected so far beyond the bank as to form an impediment to the flow of river and ice during high water. The span lengths (in feet:inches), from the Pennsylvania to the New York sides, are:

Original design	Shown by Roebling as built	As measured August 1969
142:0	141:9	141:5
131:0	131:0	131:4
131:0	131:0	130:10
131:0	131:5	131:6
535:0	535:2	535:1

Abstracted from Robert M. Vogel, Roebling's Delaware & Hudson Canal Aqueducts (No. 10 in Smithsonian Studies in History and Technology) Washington: Smithsonian Institution, 1971

PART III. PROJECT INFORMATION

These records were prepared as part of the Mohawk-Hudson Area Survey, a pilot study for the Historic American Engineering Record which was established in 1969 under the aegis of the Historic American Buildings Survey. The project was sponsored jointly by the National Park Service (Historic American Buildings Survey), the Smithsonian Institution (National Museum of History and Technology), the American Society of Civil Engineers (National Headquarters and Mohawk-Hudson Section), and the New York State Historic Trust. The field work and historical research were conducted under the general direction of Robert M. Vogel, Curator of Mechanical and Civil Engineering, Smithsonian Institution; James C. Massey, Chief, Historic American Buildings Survey; and Richard J. Pollak, Professor of Architecture, Ball State University, Project Supervisor; and with the cooperation of the Department of Architecture, Rensselaer Polytechnic Institute.

ADDENDUM TO:
Delaware and Hudson Canal: Delaware Aqueduct
Spanning the Delaware River
Lackawaxen
Pike County
Pennsylvania

HAER No. PA-1

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PHOTOGRAPHS

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COLOR TRANSPARENCIES

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U.S. Department of the Interior
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