WALNUT LANE BRIDGE
Spanning Lincoln Drive and the Monoshone Creek
at Walnut Lane
Philadelphia
Philadelphia County
Pennsylvania

HAER No. PA-125

HAER
PA
51-PHILA,
715-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN BUILDINGS SURVEY
Northeast Field Area
Chesapeake/Allegheny System Support Office
National Park Service
U.S. Custom House
200 Chestnut Street
Philadelphia, PA 19106

HAER
PA
51-PHILA,
715-

HISTORIC AMERICAN ENGINEERING RECORD

WALNUT LANE BRIDGE HAER No. PA-125

Location: Walnut Lane spanning Lincoln Drive and the Monoshone Creek in the Germantown section of the City of Philadelphia, Philadelphia County, Pennsylvania.

UTM: 18.483910.4431200
Quad: Germantown, Pennsylvania

Engineer: Gustave Magnel (1889-1955), Professor of Engineering, University of Ghent, Belgium

General Contractor: Henry W. Horst Company, Philadelphia

Beam Subcontractor: The Preload Corporation, New York City

Date of Construction: 1949-50. Major Repairs 1969. Reconstruction of superstructure in 1989-90.

Present Owner: Pennsylvania Department of Transportation
Harrisburg, PA 17120

Present Use: Vehicular bridge with pedestrian sidewalks. Superstructure demolished during reconstruction, 1989-90. Date of completion of superstructure reconstruction - late 1990.

Significance: The Walnut Lane Bridge is the first prestressed concrete beam bridge built in the United States. It is important as it provided the impetus for the development of design and construction methods for this type of structure in the U.S. It was the design of Professor Gustave Magnel, regarded as one of the world's leading authorities on concrete prestressing. The bridge was determined eligible for listing in the National Register of Historic Places in 1984.

Project Information: This documentation was undertaken in March, 1988 in accordance with the Memorandum of Agreement the Advisory Council on Historic Preservation ratified March 22, 1985 as a mitigative measure prior to reconstruction of the superstructure. The new superstructure will also be prestressed concrete. New aluminum pedestrian railings of the original design will be erected on the new structure.

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For PA Dept. of Transportation

Walnut Lane, in the City of Philadelphia, extends from Ridge Avenue where it connects to Shurs Lane in the Manayunk section to Chew Avenue, just north of Germantown Avenue in the Morton Section. Walnut Lane courses approximately 3 miles largely through Germantown and the City's Fairmount Park, listed on the National Register of Historic Places; the world's largest landscaped municipal park. Walnut Lane, between Wissahickon Avenue and Morris Street, the site of the Walnut Lane Bridge, is a two lane city street presently accommodating an average daily traffic volume of 11,210 vehicles. Walnut Lane Bridge is considered an important local transportation link through the Park area for both vehicular and pedestrian traffic.

Walnut Lane was legally opened in 1876, prior to the surrounding area's acquisition by the Fairmount Park Commission and before Lincoln Drive's construction. The first crossing of Lincoln Drive and Monoshone Creek (formerly known as Paper Mill Run) was constructed in 1876 at a cost of about $40,000. This structure was a six span wrought iron bridge with a main span of inverted king post construction. It had a timber deck and footway on the north side. This bridge became a major link between the communities of Germantown to the East and Manayunk and Roxborough to the West.

The City of Philadelphia Bureau of Highways determined the need to replace the original structure around 1925 when the deteriorated bridge was closed to vehicles over two tons. An ordinance of City Council was approved on June 28, 1929 for reconstruction. In 1931 a solid-spandrel, stone faced arch replacement bridge was bid, however the lowest bid exceeded the budget and the contract was not awarded. On February 11, 1932, the bridge was closed to all vehicular traffic. Pedestrians still used the footway, however.

In 1947, an open-spandrel, stone faced arch bridge was bid and again the lowest bid exceeded the budget. This contract was not awarded.

Any structure built with City funds required approval of the Art Jury and, in this case, that of the Fairmount Park Commission. It was apparent that the foundation conditions were not favorable for an arch structure at this site due to the depth of rock and the excavation that would be required to construct foundations to accept the thrusts required by such a design. Several sketches were proposed for girder and rigid frame structures in both steel and concrete, but none were acceptable to the Art Jury architect. The arch structure was bid in 1947, but again the lowest bid ($1,047,789.75) exceeded the budget and the contract was not awarded.

At this point, Mr. Edwin R. Schofield, the Principal Assistant Engineer for the Bureau of Engineering, Survey and Zoning, proposed to the Art Jury architect, Mr. Roy Larson, that the site would be suitable for the introduction of prestressed concrete technology to the bridge construction industry of this country. Mr. Larson encouraged Mr. Schofield to proceed in this direction, and actively assisted in the development of an acceptable design.

The initial design was for a three-span continuous, full width, cast-in-place variable depth box girder bridge designed for use with the Roebling Company's prestressing cable system. In this design, the cables were to have been draped over and under saddles inside the voids of the box beams and not bonded to the concrete except through the end anchorages and saddles. This system was seen to have advantages in that the cables could be monitored, and if need be the loads in the cables could be adjusted in the future.

Mr. Schofield was concerned, however, that it would not be possible to load test a full scale model of the Roebling design. Mr. Schoefield believed that full scale testing was necessary to establish public and engineering confidence in prestressed concrete bridge construction.

At this time, the Preload Corporation, U.S. Licensee of the proprietary Blaton-Magnel anchorage system, was constructing a series of prestressed concrete tanks for the City. Preload requested Mr. Schofield's permission to study the proposed bridge replacement. Preload retained Professor Gustave Magnel of the University of Ghent in Belgium, who proposed a prestressed multi-girder bridge, and developed preliminary plans.[1]

Unique features of Professor Magnel's design were the very high strengths required for both steel and concrete, typical of prestressed concrete but at this time uncustomary to the United States construction industry. Steel prestressing wires were required to have an ultimate tensile strength of 210,000 psi. Concrete was required to have a minimum 28 day strength of 5,400 psi. Another feature was the load testing to failure of a full size beam.

Bids were opened on January 19, 1949 for construction. The contract was awarded to the Henry W. Horst Company of Philadelphia for $698,383. The Preload Corporation was awarded the subcontract to fabricate the prestressed beams. Second low bid was from The Conduit and Foundation Corporation for $705,706.50.

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1 Professor Magnel was considered the world's foremost authority on prestressing at this time. A Professor of Engineering at the University of Ghent, Belgium, he was the Director of the Reinforced Concrete Laboratory which he had founded in 1926. By 1940 this had become the most advanced and sophisticated research and testing laboratory for reinforced concrete in Europe. Here, Professor Magnel conducted extensive research on prestressed concrete, testing full-sized concrete members. He collaborated with Blaton-Auberg, Belgian contractors, and in his laboratory developed the Blaton-Magnel or Belgian system of prestressing. Magnel remained in Belgium during the Nazi occupation of World War II despite attempts to arrest and deport him to Germany because of the Germans' suspicions of his working against their war efforts. After the war, he was named Belgian American Educational Foundation Scientist and appointed a member of the Belgian Scientific Mission to the United States. In April, 1946, Professor Magnel visited the United States, lecturing at universities, touring construction sites and meeting with consulting engineers.

Professor Magnel has been described as a mild mannered person, authoritative in his profession, a world-renowned lecturer, one of the most effective teachers of the time and a practical engineer. He was responsible for the design and construction of numerous prestressed concrete structures of all types in Europe.

Third low bid was from Frank Mark Company for $715,305. The Engineer's Estimate was $775,000. A bid was also received from a joint venture of Corbetta Construction Company and Raymond Concrete Pile, Inc. which was lower ($652,000) than the awarded bid, but was rejected as not meeting the specifications. This bid was based on an alternate design using the Freyssinet system of prestressing. This design required one additional beam in the main span due to the fact that smaller diameter prestressing wires had to be used with the Freyssinet system. The bid was rejected due to aesthetic considerations as not meeting the requirements of the Art Jury approved plans (the center span beams did not align with those in the end spans).

Ground was broken on April 20, 1949. Construction began in May.

The piers and abutments were under construction in June and were finished by the end of October. The only deviations from the contract plans were the shape of the pier cap and the founding elevation of the west abutment. The piers were originally designed and detailed with dimensions of 5 feet, 3 inches wide and 57 feet, 4 inches long. The contract drawings indicated bearings for the beams much smaller than those actually used. The top of the piers were flared out from the shafts to a width of 8 feet, 0 inches and a length of 59 feet, 6 inches in order to accommodate the two foot long masonry plates. The west abutment was founded 14 feet deeper than originally planned due to the depth of rock at this location. This abutment was constructed of a seven column open continuous frame whose top slab served as the bridge seat. Piers are 4 column open bents and the east abutment is a stub type.

The test beam, a full size representation of an interior beam of the center span, was constructed at a site near Walnut Lane and Wissahickon Avenue. Fabrication began in September, 1949 and was completed by the end of the month. Work was supervised by Mr. Clement Atchit of Blaton-Aubert. Prestress was applied beginning at age 15 days on October 7 and was completed on October 13. Strain gages were applied prior to prestressing under the supervision of Dr. Arthur R. Anderson, Consulting Engineer in charge of the strain gaging program for Preload during testing. Load testing began on October 22, 1949 at age 31 days. On October 25, an audience of between three and four hundred engineers from 17 states and five countries attended to witness the test. Professor Magnel acted as narrator to the audience, describing each stage of the testing program. The testing apparatus was designed by Professor Magnel in a manner that loaded the beam at 8 concentrated points equally spaced. A hydraulic jack was mounted atop the beam at each point and reacted against a frame attached by vertical rods to iron weights resting on the ground. Measurements were made during each stage of loading. Twenty-three strain gages were placed along the beam to record strains. Three fleximeters measured deflections at midspan, at the first quarter point and at 8 feet from one end of the beam during prestressing and were placed at midspan and at both third points during loading. Two clinometers measured the beams' end slopes. Testing stages, after prestressing, consisted of loading the beam up to the required working load (of the beams in place in the completed bridge), unloading, loading to two times the working load, unloading, loading to the cracking load, then loading to the breaking load. A load of 5,000 pounds per foot was reached on October 25. Although this was the predicted breaking load, the beam did not break. After relocating some of the iron weights to midspan, failure occurred on October 27, 1949 at 3:00 p.m. Cracking load was reached at 1,400 pounds per foot. The working load was 750 pounds per foot. A full description of the test is to be found in an excerpt from the Third Edition of Professor Magnel's book, "Prestressed Concrete".

The success of the testing program was acclaimed by all involved and work proceeded on construction of the bridge superstructure.

The contract specifications required a 28 day strength of 5,400 psi for the beams. Slump was not specified. Professor Magnel had originally required zero-slump concrete, consistently produced in Europe, but at this time practically unheard of in America. Due to several influencing factors, Magnel conceded to a 2 inch slump requirement with the provision that steel forms in conjunction with external vibration be used (in addition to internal vibration). However, Preload had based their estimate on wooden forms and internal vibration only. A compromise was eventually reached with wooden forms and whatever amount of external vibration that could be applied without damage to the forms. Professor Magnel, however, predicted problems which appeared after stripping the first beam (the south fascia beam). The beam was heavily honeycombed with cold joints and displacement of reinforcement and prestressing wires. This beam was repaired by patching and used in the bridge.

As a result of the difficulties in placing the concrete in the relatively thin web (congested by prestressing ducts and reinforcing bars), slump was gradually increased up to 3-1/2 inches. Construction time lengthened due to the additional time required to develop the concrete strengths needed because of the addition of water to facilitate placement. During construction, Samuel S. Baxter, Assistant Chief Engineer and Surveyor of the City of Philadelphia, helped resolve many disagreements such as concrete and beam production and ensured compliance by the Contractor.

An innovation, spurred by construction at Walnut Lane, was the improvement of Professor Magnel's method of stress-relieving wire. John A. Roebling & Sons Company, suppliers of the prestressing wire, developed a new manufacturing technique, used in their mills, for wire having superior characteristics to that previously used.

After completion of the testing, the production beams were constructed. The original design presumed that each beam would be constructed on the ground and lifted into place. The beams were actually constructed on falsework erected for each span adjacent to their final position in the bridge. After casting each beam, it was jacked laterally on greased, hardwood timbers to its final position. By early September, 1950, all beams but one had been finished, leaving the asphalt roadway surface and the pedestrian railing to be constructed. The bridge was formally dedicated on November 11, 1950 (Armistice Day). Construction was completed in January, 1951 and opened to traffic on February 1, 1951. Later that year Lincoln Drive was realigned through the bridge area so that it crossed at approximately 90 degrees, eliminating a dangerous curve beneath the old bridge. Paper Mill Run was also realigned north of the bridge.

The Walnut Lane Bridge is a prestressed (post-tensioned) concrete I-beam bridge of three simply supported spans. The end spans are 74 feet, 3-1/4 inches, measured from the centerline of the deck expansion joints at the abutments to the centerline of the piers. The center span measures 160 feet between pier center lines. The bearing arrangement is expansion at the west ends of each span and fixed at the east ends. The center span consists of thirteen beams placed at 4 feet, 4 inch centers, making their 4 feet, 3 inch wide top flanges practically in contact. The one inch space is grouted. The end spans consist of seven beams each in alignment with alternate beams of the center span at a spacing of 8 feet, 8 inches.

The roadway surface was originally constructed of 1 inch thick asphalt planks. In the center span, these were placed on top of a welded wire fabric-reinforced concrete base poured directly on top of the beams. This base is formed to a circular curvature of 726.406 foot radius between curb lines, varying in thickness between 2 inches at the curb lines to 6 inches at the centerline of the roadway, producing a 4 inch crown at the centerline. All beam top flanges are set at a constant elevation and, with all beams being identical in depth, the underside of the superstructure and the tops of the piers are level. The roadway surface in the end spans was also constructed of 1 inch asphalt planks set on a truss-bar arrangement reinforced concrete structural slab of 7-1/4 inch thickness. The 4 inch crown was achieved by varying the depths of the beams, the top flange thickness being reduced toward the curb lines so that the slab thickness remains uniform and the underside of the superstructure as well as the abutment bridge seats remain level. Sidewalk areas are constructed of reinforced concrete, the slabs cantilevering beyond the fascia beam flange a distance of 3 feet, 8-11/16 inches.

The bridge has an overall width of 63 feet, 9-3/8 inches. The roadway is 44 feet between curb lines with sidewalk areas 9 feet, 10-11/16 inches each side. The clear sidewalk widths measure 6 feet, 7-3/4 inches between aluminum pedestrian safety railings at the fascias and steel safety curbs at the curb lines.

The aluminum railings are constructed of extruded structural shapes, pipe and tubing and are mounted on continuous 4 inch high pedestals, 14 inches in width along the fascia lines. The steel curbs are constructed of structural shapes and plate, forming continuous railings 19-1/2 inches in height above the sidewalk surfaces, and set back from the curb lines a distance of 1 foot 4-11/16 inches. The curb faces are armored with 10 inch steel bulb angles to form a 9 inch high curb. Three aluminum lighting poles are located on the bridge, one on the south side at the center of the bridge and two on the north side, each 100 feet from the center of the bridge. The horizontal alignment is straight, with the piers and abutments built at 90 degrees to the bridge centerline. The vertical alignment is formed to a crest circular vertical curvature of 260 foot length and 4,000 foot radius connecting to sag vertical curves at each end. The west approach vertical curve is 1,332 foot radius and 64.8 foot length connecting to a tangent of 0.615% upward away from the bridge toward Wissahickon Avenue. The east approach vertical curve is 1,399 foot radius and 101.4 foot length connecting to a tangent of 5.00% upward away from the bridge towards Morris St. The soffit of the entire bridge conforms to a circular arc of 3,992.42 feet radius. The thickness of the bottom flanges are variable from a minimum dimension of 10 inches at the centerline to a maximum of 17-7/8 inches at the beginning of the center-span beam end block, 7 feet 7 inches from the pier centerlines. In the end spans, the bottom flange thickness varies from 10 inches at the pier to 11-1/4 inches at the abutment end blocks. The beams in the center span are 79 inch depth. Length of beams is 158 feet, 0 inches not including the end diaphragms. Intermediate diaphragms are an integral part of each beam at a spacing of 14 feet 6 inches and of 20 inch thickness. Diaphragms (or stiffeners) occur on each side of the web with the exception of the fascia beams where they are omitted from the outside.

Solid end blocks of 51 inch width and 6 feet 7 inch lengths are located at each end. Each beam contains four openings measuring 2-1/4 x 8 inches to accept the prestressing wires. The openings were formed by taping together a series of square rubber tubes which were subsequently removed. Two openings are straight from end to end and located in the projecting portions of the bottom flange outside of the mild steel web reinforcement. The remaining openings are draped parabolically one above the other in the web portion. Prestressing cables consist of 0.276 inch diameter wires which were preassembled into units of 64 wires reach, arranged in four columns of 16 rows. Perforated sheet metal spacers are located every 3 to 4 feet and were used during assembly of the units to keep the wires in position. This also provided a means for encapsulating each individual wire in grout. Each unit was then pulled through an opening and tensioned. Openings were provided with iron grout ports on the web which were used to detect the flow of grout, poured into the openings from the ends. Upon the appearance of grout through the first port, a wooden plug was inserted and the proces continued for the length of the beam. Wires were tensioned in pairs to a stress of 131,000 psi for an assumed prestress, after losses of 105,000 psi. After tensioning, the wires were locked off by means of steel wedges which fit into steel "sandwich" plates. The sandwich plates are 1 inch thick steel plates with wedge-shaped, dovetailed cutouts through which the wires pass. The wedge plates fit into the cutouts. Each sandwich plate accepts eight wires, two for each cutout. This was known as the Blaton-Magnel prestressing system. Sandwich plates distribute the load through a solid bearing plate, placed over the end of each opening, to the beam concrete. Beam ends are covered by a cast in place 10 inch thick solid concrete end diaphragm (anchorage encasement) over the entire width of the bridge beams. Mild steel reinforcement in the beams consists of 3/8 inch diameter deformed bars at 8 inch centers both horizontally and vertically in the 7 inch web. Vertical bars protrude from the top flange to tie the concrete paving base to the beams. There is no other reinforcement in the beams. All beams contain transverse openings through their top flanges and through the lower region of the web, just above the bottom flange, through each diaphragm. After placement of all beams, prestressing wires were threaded through the openings, 8 in each upper one and 16 in each lower one and prestressed, locking all beams together. Grout pockets were formed in the beam flange at the upper locations and filled after anchoring the wires. At the lower locations, the anchorage protrudes from the web face and is covered by a formed grout block.

Beams in the end spans are of the same general dimensions as those in the center span. The top flange width, however, is 4 feet, 4 inches. Beam lengths are 72 feet, 2 inches not including the end diaphragms. Intermediate diaphragms are located at a spacing of 16 feet 5 inches. Each diaphragm between beams contains 2 circular openings of 30 inch diameter through the 20 inch thickness. Three openings are located in each of these beams. Two straight openings, measuring 2-1/4 x 3 inches, contain 24 wires each and are located in the projecting portions of the bottom flange. One opening, measuring 2-1/4 x 6 inches, contains 48 wires and is draped parabolically in the web portion. Beam top flanges vary in thickness in order to accommodate the structural slab. Vertical web reinforcement projects above the beam, as in the case of the center span, with additional tie bars located across the width of the flange, placed in four rows at a spacing of 8 inches to tie the slab to the beams.

Other features of the bridge include expansion dams located at each abutment and pier. These were originally constructed of bulb angles cast in the concrete deck, end diaphragms and backwalls between curblines in the roadway portion of the bridge. Joints were 1- 1/2 inches wide set at a temperature of 60 degrees Fahrenheit. The joint space was sealed by inserting a 1-3/4 inch diameter rubber hose and pouring a hot rubber sealing material. A copper, lead-coated drainage trough was placed under and across the length of the joint and connected to cast iron pipes located in the backwalls and in the north exterior pier columns. Joints through the sidewalk were unarmored, but sealed in the same manner. Bridge approach slabs of 16 inch thickness overlaid with 2-1/2 inch thick asphalt were built, supported on the abutment backwalls. The bearing shoes are fabricated steel with a sole plate cast into the bottom of the beam set atop a masonry plate bolted into the substructure concrete. The two parts contact each other on machined surfaces fitted with a keyway. Fixed and expansion bearings are identical except that the key does not, in the case of the expansion bearing, protrude into the sole plate.

There are two cast aluminum plaques mounted on the aluminum railings, one at the northeast corner, the other at the southwest corner. These plaques dedicate the bridge to "the men and women of the 21st and 22nd Wards, City of Philadelphia who served and died in the U.S. Armed Forces during World War II".

An additional plaque is mounted at the base of the east pier noting that this is "the first prestressed concrete girder bridge built in the United States".

In 1957, during an inspection of the bridge by the City of Philadelphia, cracks were found in the bottom flanges of several of the main span beams, of up to 1/16" wide and 57 feet long in the south fascia beam. In order to prevent the intrusion of water, the cracks were sealed by painting the bottom flanges with a cementitious coating.

In 1963, the Commonwealth of Pennsylvania assumed ownership of the bridge when this section of Walnut Lane was designated Legislative Route 67345.

In 1964 and again in 1967, inspections were performed by the City of Philadelphia. Additional cracks were found each time and the south fascia beam crack had, by the 1967 inspection, propagated to full length and had widened. A more detailed inspection was performed by the City in November, 1967, who thereafter retained the consulting engineering firm, Zollman Associates, to perform an in-depth inspection and prepare a report and recommendations. The previously mentioned cracks in the south fascia beam were at that time recorded as 1/4 inch to 1/2 inch wide, 2-1/4 inch minimum depth, and full length of the beam. Due to the fact that the bottom flanges are unreinforced, immediate repairs were deemed necessary in order to prevent the loss of concrete. The presence of such large cracks would not only permit the intrusion of water to initiate spalling with freeze-thaw cycles and the corrosion of prestressed wires, but the fact that such substantial growth had been observed over the years indicated the possibility of deteriorating strength in the beams if left unchecked.

Following review of the Zollman report by PaDOT, engineers from the City Bridge Division and PaDOT conducted an inspection in 1968. An emergency contract was awarded by PaDOT in late fall, 1968 to Kauffman Construction Co. for repair of the prestressed beams. Work included installation and removal of scaffolding, removal of the existing coating on the beams, epoxy pressure injection of cracks and recoating the beam bottom flanges and exposed fascia beam sides with epoxy protective coating. Additional work performed as part of this contract included removal of the existing asphalt plank wearing surface, repairs to the underlying concrete deck and sidewalks which were deteriorated; application of an epoxy protective coating to the concrete deck surfaces; placement of a new 2 inch bituminous wearing surface and sealcoat; replacement of deteriorated and settled concrete approach slabs; replacement of deteriorated expansion joint material with new neoprene compression seals and cleaning and painting of steel curb barriers and beam bearings.

After work had begun, problems arose upon attempted removal of the 1957 - applied coating on the beams. It was discovered at that time that the cementitious coating had been applied on top of a polyvinyl acetate binder coat, making removal more difficult than anticipated. Upon completion of the coating removal work, many more cracks were discovered which, until that time were masked by the coating. Many were actively leaking water. It was also determined, after epoxy injection operations had begun, that the post-tensioning wires in the beams were incompletely grouted. Water was entering the openings through the deteriorated asphalt plank and concrete deck and corroding the prestressed wires. Entrance of water into the openings, it was concluded, occurred through a crack which had opened from impact on the deck joints at the juncture of the beam ends and the continuous cast-in-place end diaphragms. When cables were exposed in a number of areas, some were found to be rusted. A total of 324 gallons of epoxy material was eventually injected into all cracks and openings. The voids in the openings were injected through the iron tubes which were originally cast in the beams. Many of these still contained the original wooden plugs and, when cleared, showed no grout behind them. During injection of the epoxy, water was frequently forced out of the cracks and tubes ahead of the epoxy material. Epoxy injection was performed from scaffolding and in a controlled temperature environment by encapsulating the work area in polyethylene sheeting. External clamps were placed around the flanges prior to injection in order to prevent spalling under the pressure of the epoxy repairs. This operation was performed after removal of the asphalt plank wearing surface and completion of concrete deck repairs and installation of new joint seals.

In order to monitor the beams' behavior, a gaging apparatus was installed on both fascia beams and the beam adjacent to the north fascia beam of the main span. This consisted of a stainless steel wire strung along the bottom flange of each beam and fastened to the pier caps such that both vertical and horizontal movement could be read at the span quarter points. It was hoped that this device would provide a means of detecting any loss in cambers or increase in sweep which might occur from changes in the prestressing forces. This device eventually became frozen due to rusting and did not, in the long run, prove useful.

Work under this contract was completed in summer, 1969 with landscaping work beneath the bridge to restore the park areas affected by the construction. The total cost of these repairs amounted to approximately $140,000. Epoxy injection accounted for $31,000 of the total cost.

The repair program, it was felt at that time, had completely restored the structural integrity of the bridge.

During an inspection of the bridge by PaDOT in 1973 an open crack was observed in the south fascia beam as well as hairline cracks in both fascia beams.

In August, 1973 exploratory holes were drilled into the major crack in the south fascia beam. It was found that some of the epoxy injected in 1969 had not hardened. This crack was reinjected. At that time, it was felt that replacement of some of the main span beams should be given consideration. After reinjection, several schemes were considered to prevent chunks of concrete from separating at the cracks and falling to areas below. It was decided to inspect the beams 3 times yearly to monitor repair work and to detect any changes in the beam cracks.

In July, 1976, during an inspection, continued growth in the major cracks was noted, along with new hairline diagonal cracking in one end of the south fascia beam. Replacement of the fascia beams was recommended at this time with a suggestion to consider replacement of the entire superstructure.

In March, 1977, additional pressure grouting was attempted, but very little material was accepted by the beams. In April, 1978, three of the beams received extensive reinjection, but by the July 1980 inspection many cracks had reopened.

On May 5, 1978, at rededication ceremonies at the site of the bridge, the American Society of Civil Engineers bestowed the award of Outstanding Civil Engineering Achievement of the year. A bronze plaque was mounted at the base of the east pier above the original plaque.

In 1981, when continued deterioration was still being detected, it was concluded that the 1969 repairs could be considered only as a temporary repair which had extended the life of the bridge. The bridge was thereafter posted for a 13 ton load limit.

In 1982, it was concluded that the cause of the continuing problems could not be pinpointed and it was decided to replace the superstructure.

In June 1987, PaDOT returned to inspect the bridge under its program of periodic monitoring, and found that the north fascia beam had a 1 inch wide open crack, 25 feet long at midspan. The loose concrete, on the verge of falling to the roadway below, was removed by State forces, and the exposed ducts were painted.

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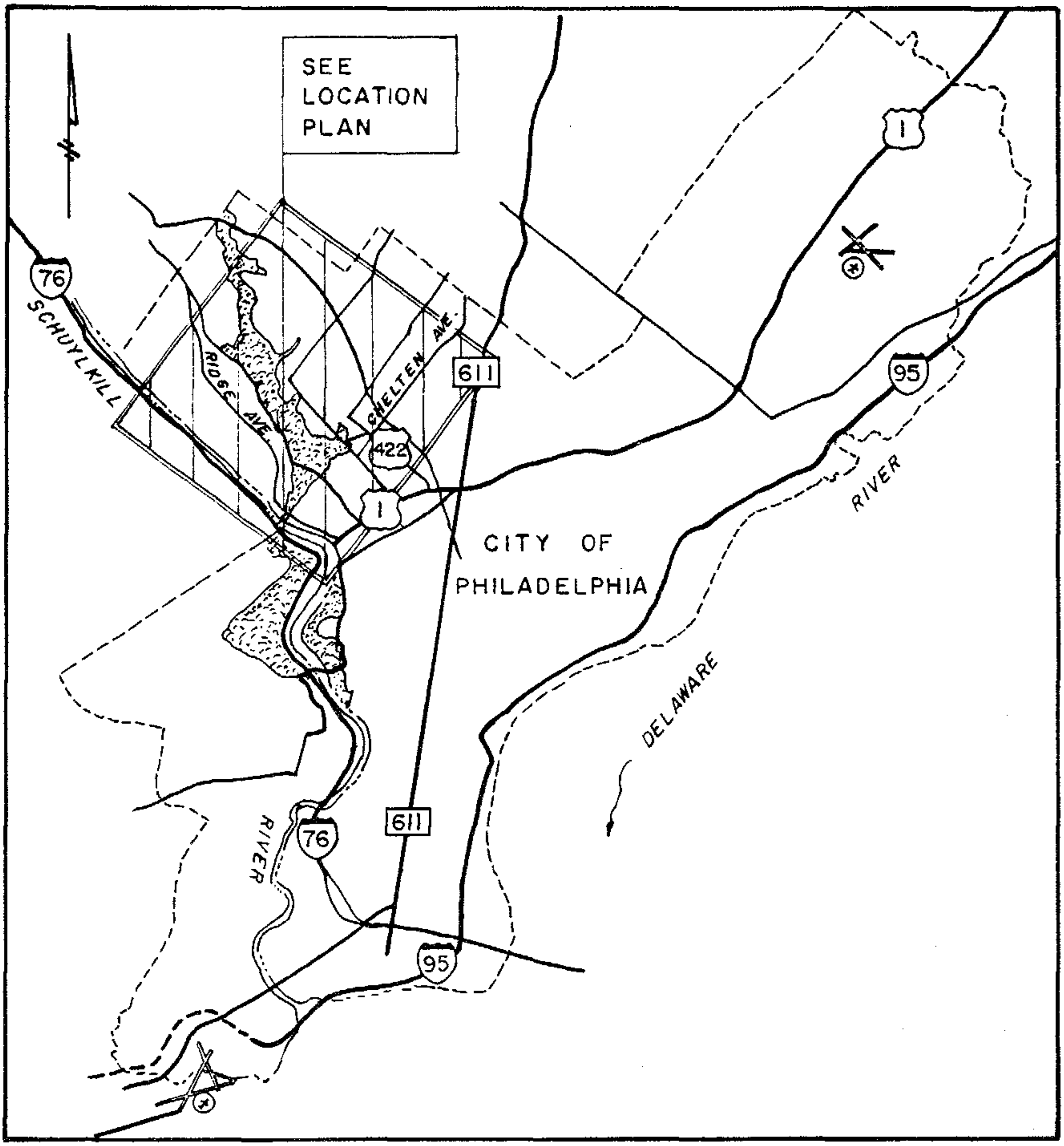
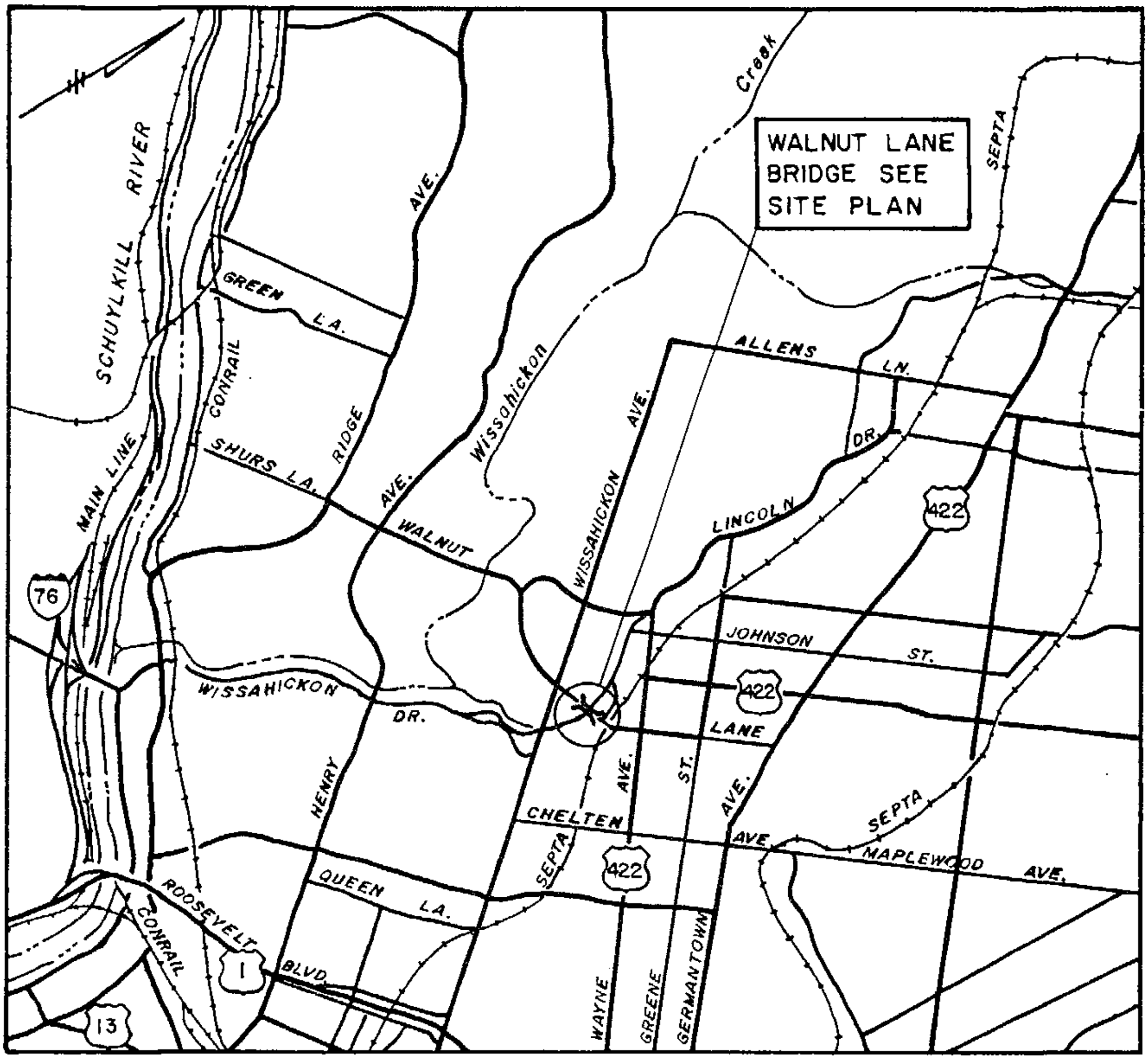


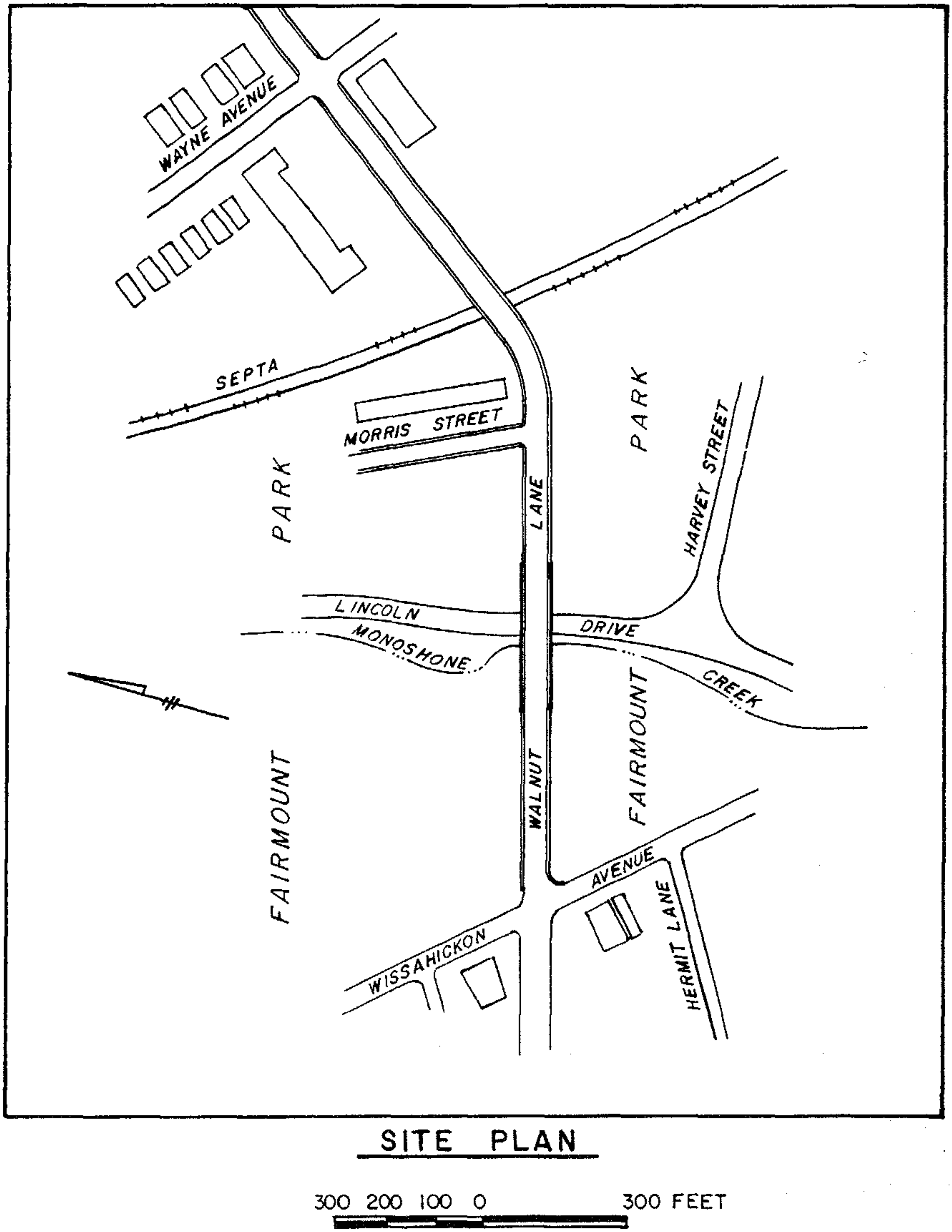
LOCATION MAP

2 1 0 2 MILES

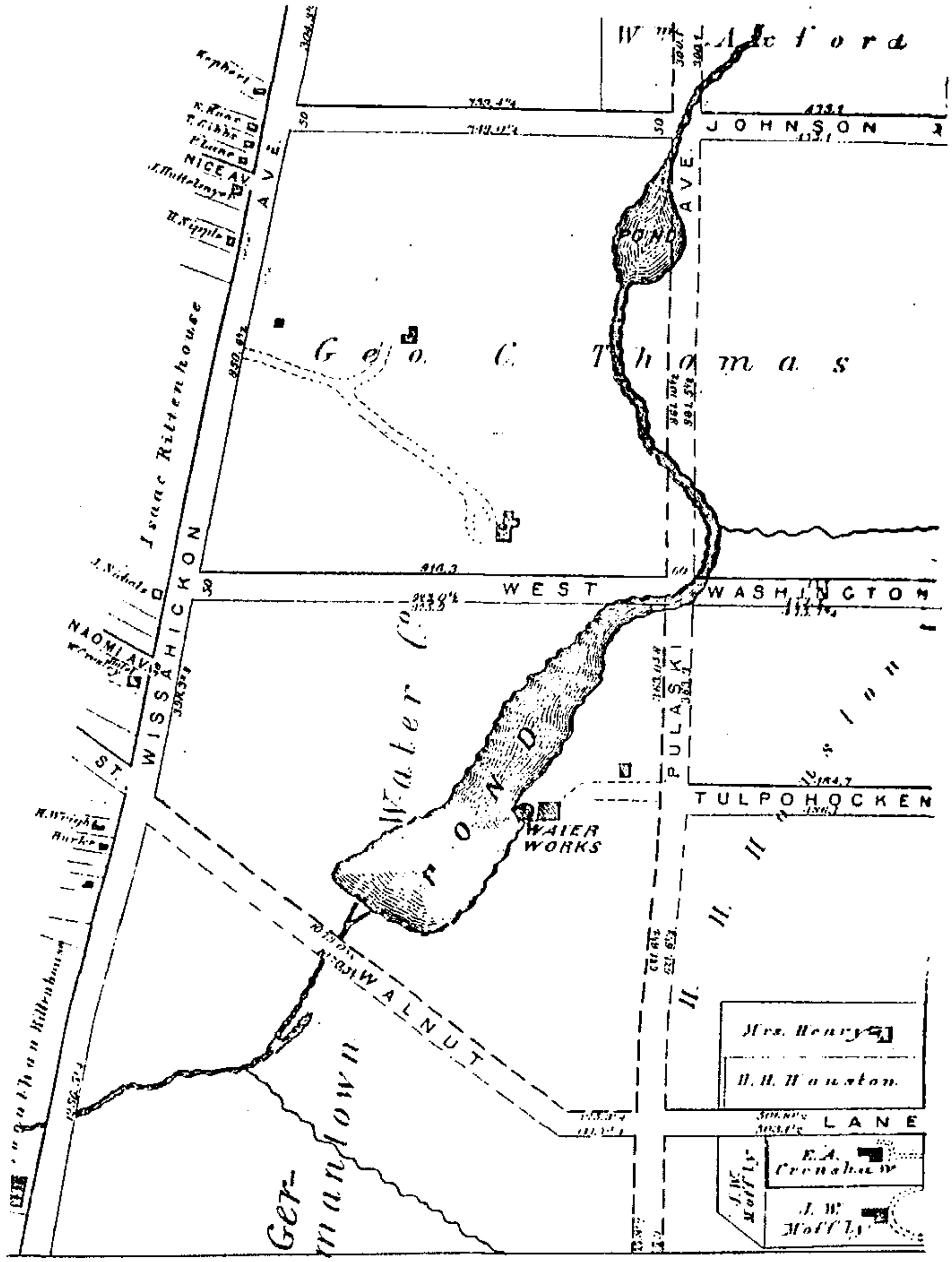


LOCATION PLAN

1 .5 0 1 MILES

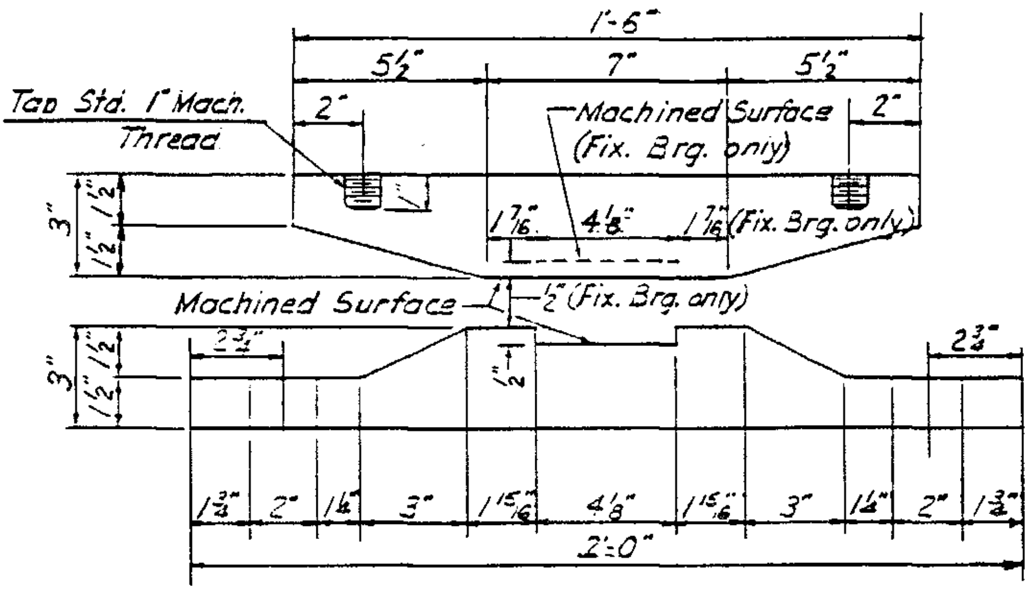

WAYNE AVENUE
SEPTA
MORRIS STREET
PARK
LANE
PARK
HARVEY STREET
LINCOLN
DRIVE
MONOSHONE
CREEK
FAIRMOUNT
WALNUT
FAIRMOUNT
AVENUE
WISSAHICKON
HERMIT LANE
300 200 100 0 300 FEET

SITE PLAN



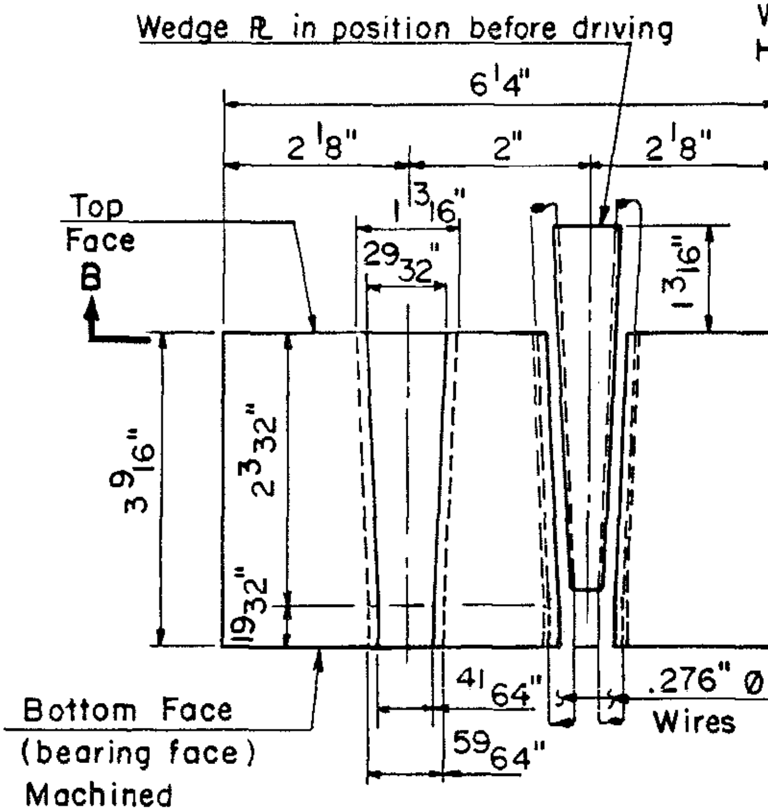
1871 SITE PLAN

Photocopy of mop from H. W. Hopkins' Atlas of the Late Borough of Germantown, 22nd Word, City of Philadelphia, Philodelphio, G.M. Hapkins, 1871. p. 28, plate 6, (original in passession of the Germontawn Histarical Saciety, Philadelphia, Pa.)

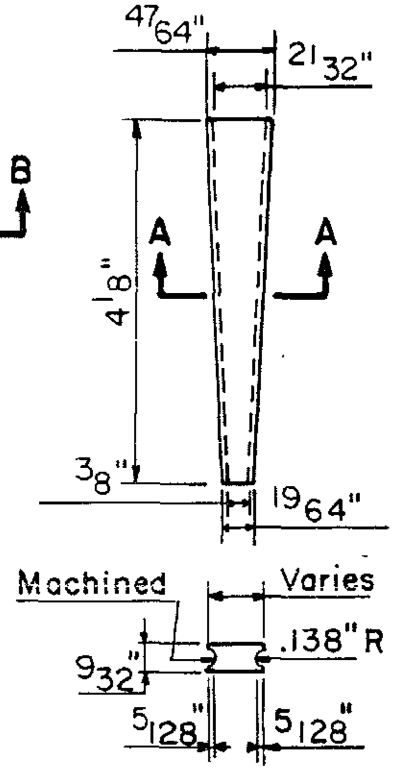


DETAIL OF BEARINGS

Photocopy from contract drawings for Restoration of Girders, Walnut Lane Bridge over Lincoln Drive S-9232. (Originals in possession of PA Dept. of Transportation, District 6-0, St Davids, PA.)

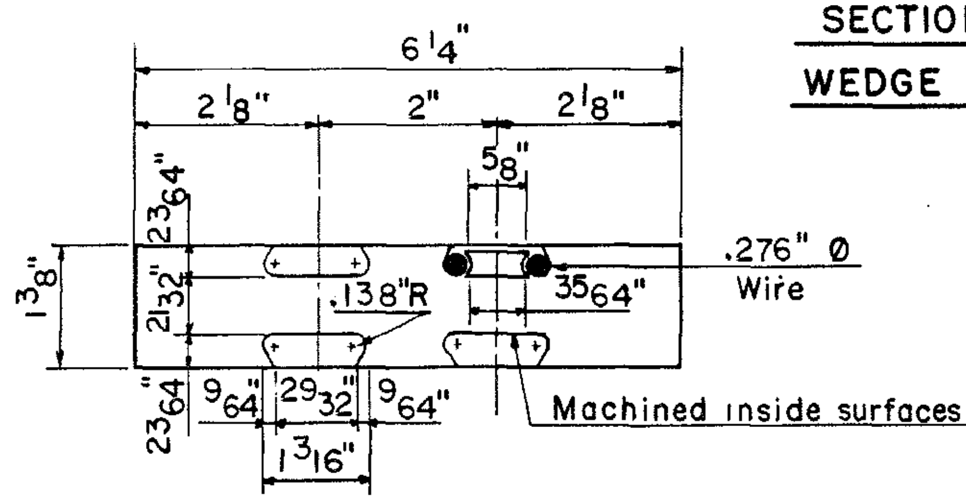


SANDWICH PLATE



SECTION A-A

WEDGE PLATE



SECTION B-B

BLATON-MAGNEL ANCHORAGE SYSTEM

Sketch prepared by A.G. Lichtenstein & Assocs., Inc., Langhorne, Pa. based on photocopy of shop drawing No. 9NY6-4 prepared by The Preload Corporation, 1949. (Photocopy in possession of A.G. Lichtenstein & Assocs., Inc., Langhorne, Pa.)