MARKET STREET ELEVATED RAILWAY, ALLISON SUBSTATION
Intersection of Market and Allison Streets (between
56th and 55th Streets)
Philadelphia
Philadelphia County
Pennsylvania

HAER No. PA-507-E

HAER
PA
51-PHILA,
719E-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

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

HAER
PA
51-PHILA
719E-

HISTORIC AMERICAN ENGINEERING RECORD

MARKET STREET ELEVATED RAILWAY, ALLISON SUBSTATION HAER NO. PA-507-E

Location: Intersection of Market and Allison Streets (between 56th and 55th Streets)
Philadelphia
Philadelphia County
Pennsylvania
USGS Quad: Lansdowne, PA and Philadelphia, PA 1:24,000
UTM Coordinates: 18.480306.4423223

Construction Date: 1906 - 1908

Builder: Philadelphia Rapid Transit Company

Chief Engineer: William S. Twining

Present Owner: Southeastern Pennsylvania Transportation Authority
1234 Market Street
Philadelphia, Pennsylvania 19107

Present Use: Market Street Elevated Railway Substation

Significance: The Allison Substation is one of approximately 10 electrical conversion-and-distribution stations built in Philadelphia between 1903 and 1908 by and for the Philadelphia Rapid Transit Company. Located on the north side of Market Street just east of the 56th Street Station, the Allison Substation was built primarily to convert centrally-generated alternating current power to direct current power for distribution to the Market Street line. Like the passenger stations along the Elevated, the Allison Street Substation embodies the distinctive characteristics of a particular early twentieth-century architectural style. The Allison Street Substation retains Classical-style details such as a round-arch central opening topped by a fanlight with a symmetrical wood design.

Project Information Statement: The Market Street Elevated Railway between Millbourne Station in Delaware County and 46th Street Station in Philadelphia will be reconstructed. The project includes replacement of the Millbourne Station and the Market Street Elevated superstructure. Plans call for the reconstruction of the stations from 63rd Street to 46th Street, but efforts will be made to retain historic features where possible. To mitigate the adverse effect, the Pennsylvania Historical and Museum Commission stipulated HAER documentation of the existing structures. This documentation was undertaken to fulfill that stipulation.

Neeta Jitendra Desai
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403 East Walnut Street
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INTRODUCTION

The Market Street Elevated Railway extends west-east along Market Street between 69th Street in Upper Darby Township, Delaware County, and 46th Street in the City of Philadelphia, Philadelphia County, Pennsylvania. Constructed between 1904 and 1908, the elevated structure is situated along Market Street between 63rd and 46th Streets. West of 63rd Street, the railway crosses Cobbs Creek, a waterway that forms the boundary between Philadelphia and Delaware Counties. From this point, the railway travels at ground level through Millbourne and terminates at the 69th Street Terminal in Upper Darby Township, Delaware County. The tracks and stations form part of the Market-Frankford Line, which is owned and operated by the Southeastern Pennsylvania Transit Authority (SEPTA), 1234 Market Street, Philadelphia, Pennsylvania, 19107.

The Market Street Elevated Railway (HAER No. PA-507) is composed of the Market Street Elevated superstructure, an associated substation (HAER No. PA-507-E), and the following railway stations: 69th Street Terminal (HAER No. PA-507-A); Millbourne Station (HAER No. PA-507-B); 63rd Street Station (HAER No. PA-507-C); 60th Street Station; 56th Street Station (HAER No. PA-507-D); 52nd Street Station (HAER No. PA-507-F); and 46th Street Station (HAER No. PA-507-G). The Market Street Elevated Railway Historic District, which consists of the Market Street Elevated Railway, was determined eligible for the National Register of Historic Places under Criterion A, historical significance and Criterion C, design/construction in August 1996.

The Allison Substation is one of approximately 10 electrical conversion-and-distribution stations built in Philadelphia between 1903 and 1908 by and for the Philadelphia Rapid Transit Company. Located on the north side of Market Street just east of the 56th Street Station, the Allison Substation was built primarily to convert centrally-generated alternating current power to direct current power for distribution to the Market Street line. Like the passenger stations along the Elevated, the Allison Street Substation embodies the distinctive characteristics of a particular early twentieth-century architectural style. The Allison Street Substation retains Classical-style details such as a round-arch central opening topped by a fanlight with a symmetrical wood design.

PHYSICAL DESCRIPTION

A large Classical-style electrical substation is located east of the 56th Street Station on the north side of Market Street. It is known as the Allison Substation because of its location near the Allison Street intersection. The substation was erected to house one of the main power sources for the Elevated. It is a two-story, rectilinear-plan, brick building set upon a concrete foundation. It is topped with an asphalt-clad flat roof. The building is one bay wide and seven bays long.

The south, or principal, facade is accented by a raised basement and decorative brick pattern. The bricks are laid in common bond with projecting courses occurring at regular intervals. The facade is dominated by a central wagon entry marked by a modern metal roll-up door. The entry is set within an arched brick surround. The projecting courses on the facade continue within the door surround. A stone cornice with Classical-style details accents the lintel. A large fanlight, which contains a symmetrical wood design, is located above the lintel. A stone keystone is located above the fanlight, and the roofline of the building is marked by a raised parapet with stone coping.

Seven brick buttresses accent the west facade of the substation. Arched windows with modern fenestration are located between the buttresses. The east facade of the building is dominated by a one-story, rectangular-plan addition. It is also topped with an asphalt-clad flat roof. The south, or principal, facade of the addition is embellished with the same decorative brick pattern found on the main building. A large entryway dominates this facade. The entry is marked by a modern door set within a brick surround. The doorway is capped by a brick segmental lintel with a stone keystone. A raised parapet with stone detailing finishes the roofline. The east facade of the addition is marked by multiple windows set within arched and rectangular brick surrounds. The north, or rear, facade contains modern fenestration.

HISTORICAL BACKGROUND

The Allison Substation was one of approximately ten electrical conversion-and-distribution stations built in Philadelphia between 1903 and 1908 by and for the Philadelphia Rapid Transit Company (PRT) (Anonymous 1905a:522). During that five-year period, the PRT replaced most of its direct current (DC) transmission lines and equipment with alternating current (AC)-compatible apparatus. It was also during these years that the company constructed its Market Street Elevated and Subway system. The Allison Substation was built primarily to convert centrally-generated AC power to DC power for distribution to the new Market Street line.

The need for an AC-to-DC conversion-and-distribution station at the intersection of Market and Allison streets—or any other location in the City—had only developed within recent years. As of the mid-1890s, Philadelphia's electrified streetcar system was powered by DC electricity generated and transmitted by an array of power stations scattered throughout the city. DC was then the preferred form of energy for powering not only streetcar motors, but arc and incandescent lighting, stationary engines, and industrial machinery (Hunter 1991:243). Streetcar motors were the largest class of electric engines then in use. Capable of operating at variable speeds, DC-powered motors were particularly well-suited to streetcars because they could develop high torque at low speeds. As streetcar motors proved themselves under demanding conditions, DC-powered motors were deployed in increasingly diverse applications throughout industry (Hunter 1991:205-206). By the early twentieth century it was generally believed that the DC-powered engine had been "perfected" (Eddy 1905:23).

Transmission and distribution of DC electricity, on the other hand, was anything but a perfected technology, especially as systems requiring electricity expanded, as was the case with the PRT's streetcar system. DC electricity could not be transmitted economically more than a few kilometers from a generating plant. The primary drawback of DC generators was that they could not produce currents stronger than 600 volts without risk of damage through internal sparking (Eddy 1905:23). When electricity is transmitted at low voltages, much energy is lost en route to the points of usage. For this reason, the PRT had to install a legion of stand-alone, low-capacity generating plants and battery facilities throughout its system. Each expansion of the system required construction of additional plants and/or battery facilities. Adding to the expense of expansion was the high cost of large-diameter, insulated copper wire that was necessary for conducting DC electricity (Hunter 1991:244).

The development of alternating current (AC) technology in the last years of the nineteenth century provided streetcar companies with a potential solution to their transmission-and-distribution dilemma (Hunter 1991:252). Using a new generation of dynamos without commutators (revolving components that collect current from and distribute it to the brushes), AC electricity could be generated at much higher voltages than DC electricity without the attendant risk in sparking. This was particularly beneficial because the higher the voltage sent through a wire, the smaller the percentage of lost power. Higher voltages, moreover, could be sent through thinner, less-expensive wire. AC voltage was also relatively easy to step up or down through transformers (Hunter 1991:245). For electric streetcar companies such as the PRT, these advantages meant that they could generate AC power economically in just a few strategically-located, high-capacity AC generating stations, then transmit this electricity via underground cables to an array of lower-cost and lower-maintenance substations. At the substations, AC power could be stepped up or down and transformed into DC electricity for localized distribution (International Correspondence Schools 1915:sec 17:18). Yet another advantage of an AC-DC power grid was its protection against power interruptions. The main generating stations—each with multiple engines—and every substation could be interconnected so that any substation could be run from any generating station, and any dynamo could be taken off-line without threatening the power supply to any one substation (Anonymous 1905a:510-512).

In 1903, as the PRT began constructing its Market Street Elevated and Subway line, it also began converting its existing DC-only system to an AC-DC, central-plant-and-substation system (the Market Street line, built on the new model, would require no conversion). The Company built its first central AC-generating plant—with a modest generating capacity of 2000 kilowatts—at 2nd Street and Wyoming Avenue, then constructed three AC-to-DC substations to distribute its output. By 1905, six more turbine engines were added to this plant, and its generating capacity was increased to 11,000 kilowatts. Also by 1905 the company had completed a second AC-generating station, located at the intersection of Delaware and Laurel Avenues (Anonymous 1905a:508). This power plant was initially outfitted with a 6,000 kilowatt-capacity engine, and most of its electricity was earmarked for the PRT's Market Street Elevated and Subway system, which was about midway to completion (Anonymous 1906:535).

As of September 1905, the PRT had reportedly completed construction of six substations, were midway through construction of two more, and had plans to construct substations nine and ten within the coming year. Of the two substations still on the drawing board, one was to be located "at Market Street west of Fifty-Fifth Street" (Anonymous 1905a:522). This facility would become known as the "Allison Substation." Substation location was determined by electrical loads, with stations placed as close as possible to the center of load distribution areas, in order to minimize transmission loss (International Correspondence School 1915, Sec. 17:54).

The first four substations built by the PRT were either extensions or modifications of existing structures. The remaining half-dozen—including the Allison Substation—were built from the ground up, in such a way that they were regarded as "very similar in design, and may be considered typical for their size" (Anonymous 1905a:522). One of these facilities—located at Glenside—was described in a *Street Railway Journal* article of September 23, 1905 as follows:

> The building is entirely fireproof, the outside walls being of brick and terra cotta, the roof and floors of reinforced concrete, and the window frames of metal, glazed with wire glass. The especially interesting feature about the construction is the use of reinforced concrete in floors and roof. The floor under the transformers is a slab, 8 ins. [20.32 centimeters] thick, supported on the walls of the air chamber below. The unusual thickness is necessary because of the openings under the transformers, which take up a greater part of the area. The balance of the floor of the main building is supported by reinforced concrete columns, one under the center of each converter spaced 15 feet [4.57 meters] center to center. . . .
>
> Each column was designed to carry the weight of the converter, with certain percentages added for vibration, amounting in all, in the case of the 1000-kilowatt machines, to 127,000 lbs. [57,606.23 kilograms], the weight of the floor being taken as a total load of 350 lbs. [158.75 kilograms] per square foot [0.09 square meters]. Each column supports traverse and longitudinal beams intersecting over the center of the column, the transverse beams spanning to the wall at each side and the longitudinal beams spanning from column to column and carrying the floor beams, spaced about 5 ft. [1.52 meters] center to center. This plan brings the heavy load directly on the concrete column, and is a radical modification of the usual practice of supporting machine loads by solid concrete or masonry foundations. . . . The floor slabs are 6 ins. [15.24 centimeters] thick, and embedded in the concrete are the pipes carrying the cables from the converters to the switchboard.
>
> In connection with the oil-switch and bus-bar compartments, it being necessary to construct below the floor duct ways or passages for the cables leading from these

compartments and to the transformers, an independent floor, with 6-in. [15.24-centimeter] slab, with beams spaced 4 ft. 4 ins. [1.31 meters] center to center, all of reinforced concrete, was first constructed, finishing 14 ins. [35.56 centimeters] below the main floor level. These duct ways were then formed with 4-in. [10.16-centimeter] walls of brick and covered with slate, finishing level to the floor. The floor space not so occupied was then filled up with cinder concrete and finished with cement level with the slate. The roof over the space occupied by these compartments and over the main building is of concrete with 4-in. [10.16-centimeter] thick slab, supported on beams spaced 5ft. 6 ins. [1.67 meters] center to center. . . .

The oil-switch and bus-bar compartments are constructed of a red pressed brick, with 4-in. [10.16-centimeter] walls, in which are built the rods which secure in place the channels at the top. This top and the shelves are of Alberene stone. . . .

The walls are wainscoted, with red brick matching the oil-switch compartments. Above this they are finished with plaster. The ceiling is simply whitewashed, no other finish being necessary on account of the smooth surface due to the rise of surfaced centering (Anonymous 1905a:523-24).

A diagram accompanying this verbal description indicated that the apparatus of this typical PRT substation was concentrated on two floors. There were three compartments in the basement: one housed the cable bell and power cables connected to the oil-switches on the upper floor; the second accommodated an array of fans; and a third compartment functioned as an air chamber for cooling the transformers on the upper floor. On the floor above, one compartment contained the oil-switches, and the other housed the transformers, rotary converters, motor generator, and the switchboard.

Each of the PRT's substations was connected to a generating plant by at least two high-tension underground cables. Because a single cable could carry enough electricity to supply a substation, cables were used one day at a time and then allowed to remain idle while each of the other cables operated for a 24-hour shift. An excessive voltage surge would therefore disable only one cable at a time, with at least one other cable ready to provide back-up service (Anonymous 1905b:504).

Underground power lines entered the Allison Substation in its basement level and terminated at the terminal bell. Conduction between the bell and the oil-switches continued by three single-conductor cables insulated with 1.11 centimeters (0.43 inches) of rubber compound and protected by a double water-proof braid (Anonymous 1905b:504). From the oil-switches, the current flowed to the step-down transformers. The principal components of a transformer are two coils of wire wound around a magnetic core of laminated iron. An AC current passing through the primary coil induces a voltage in the secondary coil. The induced voltage varies depending on the number of turns of wire in the two coils. If the secondary coil has fewer turns than the primary coil, the voltage is stepped down and the current is stepped up proportionally (Hunter 1991:247).

As in other substations, the step-down transformers at the Allison Substation reduced the in-bound current (13,200 volts at 25 cycles) to a voltage suitable for conversion to DC electricity by rotary converters. From a step-down transformer, current first passed through a potential regulator to the collection rings of a converter, then through the windings to a commutator. At that point, DC electricity was conveyed to brushes, before traveling on to the switchboard (Gear 1911:51). At the switchboard, DC electricity passed through a circuit breaker at the top of the board, through the switch to a positive bus-bar. On each feeder panel the current flowed through an ammeter which measured the flow in amperes. The current then passed through a voltmeter into an induction coil to eliminate any unwanted current. A knife blade switch completed the circuit to feeder lines, delivering 600 volts of DC electricity to the third rail of the Market Street Elevated and Subway line when it began operating in January 1907 (International Correspondence Schools 1915, Sec. 54:10-11). The Allison Substation also stepped down 13,200-volt, 25-cycle AC electricity to 1,100-volt, 25-cycle current to power rail signals and switches throughout its power district (The Union Switch and Signal Co. 1908:7).

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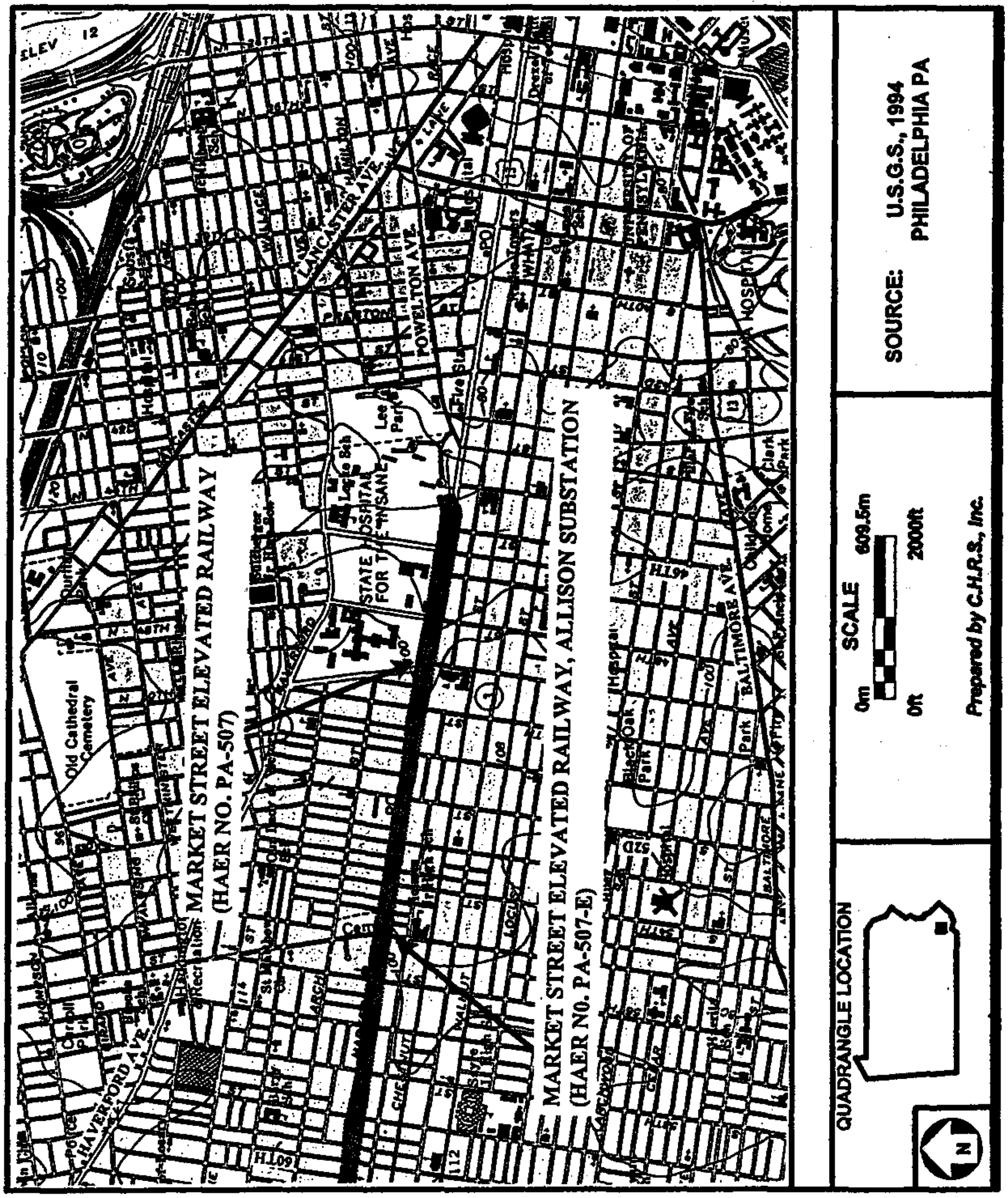
MARKET STREET ELEVATED RAILWAY
(HAER NO. PA-507)
MARKET STREET ELEVATED RAILWAY, ALLISON SUBSTATION
(HAER N0. PA-507-E)
QUADRANGLE LOCATION
SCALE
0m 609.5m
0ft 2000ft
SOURCE: U.S.G.S., 1994
PHILADELPHIA PA
Prepared by C.H.R.S., Inc.
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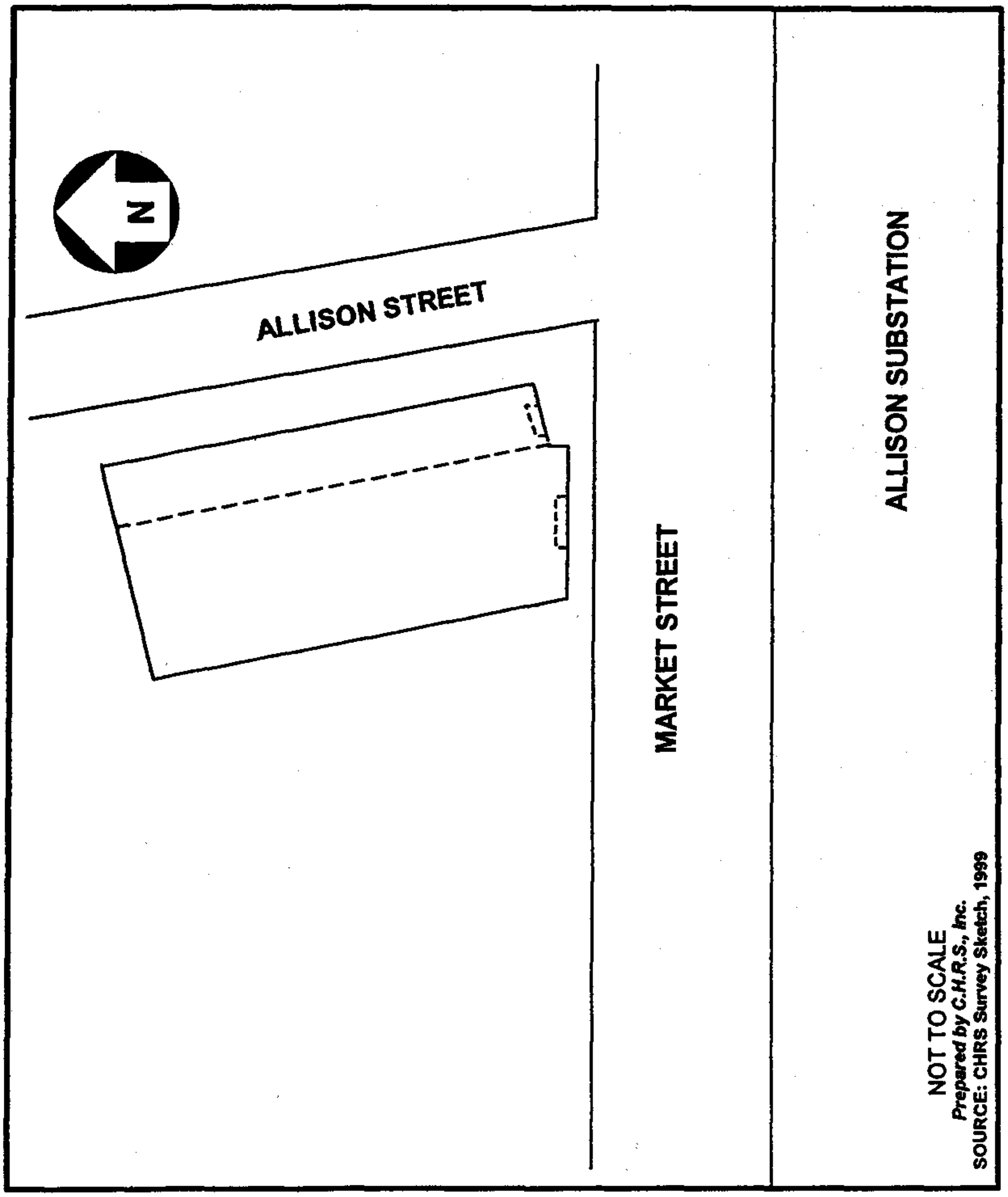
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ALLISON STREET
MARKET STREET
ALLISON SUBSTATION
NOT TO SCALE
Prepared by C.H.R.S., Inc.
SOURCE: CHRS Survey Sketch, 1999