HUNTER RESEARCH

THE CATENARY STRUCTURES AT THE INTERMODAL FERRY TRANSPORTATION CENTER SOUTH AMBOY, MIDDLESEX COUNTY NEW JERSEY

WITH A NOTE ON CAMDEN AND AMBOY RAILROAD STONE SLEEPERS

Historic Context, Description and Recommendations

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A. INTRODUCTION

This report has been undertaken to establish the historic context and significance of the surviving catenary[1] structures along the alignment of the former Camden and Amboy branch of the Pennsylvania Railroad at the Intermodal Ferry Transportation Center at South Amboy. This work forms part of the review of the project under Section 106 of the National Historic Preservation Act of 1966 (as amended). The report includes recommendations for treatment of the catenary structures as part of the Intermodal Ferry Transportation Center. Stone sleepers from the earliest phase of the Camden and Amboy Railroad in the 1830's are also briefly discussed.

B. HISTORIC CONTEXT OF OVERHEAD CATENARY ELECTRIFICATION ON THE PENNSYLVANIA RAILROAD

1. Historical Summary

The remaining elements of the catenary system at South Amboy are part of the last stage of the electrification program of the Pennsylvania Railroad (PRR) in 1938-39. The PRR was a leader in railroad electrification, eventually having over 2600 miles of track treated in this way. Electricity, however, never became a dominant power source for American railroads. In 1938 only 1.2% of the total U.S. track was electrified, and after World War II the diesel-electric locomotive came to dominate, eclipsing both steam and electric power (Bezilla 1980:1; Nesladek 1996).

Electrification of railroads in the U.S. began with the first successful installation in Richmond, Virginia in 1888. In the 1890's electrification of suburban lines and urban trolleys proceeded very rapidly, but the technology remained inadequate to provide power for the longer distances and heavier trains on the major railroads (Bezilla 1980:4).

The Pennsylvania Railroad's involvement with electrification began in 1895 with the installation of a direct current system on 7.2 miles of line from Burlington to Mount Holly. This system was not totally successful, but by the early 1900's it was becoming apparent that electric traction was becoming both feasible and necessary. The immediate stimulus for the PRR was the need to take trains under the Hudson River into the new station in Manhattan from New Jersey in order to compete with the New York Central Railroad, which had direct access into the City from the north. Steam trains could not operate in the tunnels, and the City of New York was in any case proposing to ban all steam locomotives from Manhattan because of their effect on air quality. The Baltimore and Ohio Railroad had earlier demonstrated that it was possible to carry D.C. electricity through tunnels on a third rail, and this system was therefore adopted for the Hudson tunnels (Nesladek 1996:16).

[1] Catenary "the curve assumed by a cord of uniform density and cross section that is perfectly flexible but not capable of being stretched and that hangs freely from two fixed points" (Webster's Ninth New Collegiate Dictionary).

The development of the overhead catenary system was a result of the adoption of alternating current (A.C.), which could transmit power over long distances without the numerous substations needed by D.C. systems. The PRR first adopted this new system on its suburban Philadelphia to Paoli line in 1914-15. It was so successful, both economically and in terms of public enthusiasm for the much cleaner trains, that electrification using catenaries had been extended to all the suburban passenger lines around Philadelphia by 1924.

In 1925 the PRR announced plans to electrify the Washington D.C. to New York mainline corridor, a massive and costly undertaking that required extensive infrastructure changes and also resulted in the replacement of the old semaphore signals with position light systems mounted on bridge structures between catenary poles. The work was completed in several stages, and it was not until 1935 that the first electric passenger train made the complete run between the two cities (Nesladek 1996:19-21).

The final major phase of electrification on the PRR involved conversion of the freight lines extending eastward to New Jersey and New York from the Enola Yards opposite Harrisburg in 1937-38. Plans to extend the catenary system to Pittsburgh, the subject of studies in 1936 and 1941, were never implemented because of the outbreak of World War II, the worsening economic condition of the PRR after 1945, and the greater flexibility and ease of introduction of diesel-electric traction (Nesladek 1996:21-22).

At South Amboy, electrification was introduced in two stages. The New York and Long Branch Railroad line (now the North Jersey Coast Line operated by New Jersey Transit) was electrified in 1935 as far south as South Amboy (John Burlage, West Jersey Chapter, National Railroad Historical Society, personal communication 11/5/02). This line does not connect to the former Camden and Amboy line, where catenaries were not erected until 1938 (Nesladek 1996:21). Numerous tracks on the Amboy branch are listed as electrified on a PRR New York region timetable dated October 28th 1956, but no map or diagram showing the tracks has been located (John Burlage, West Jersey Chapter, National Railroad Historical Society, personal communication 11/5/02). The timetable does however confirm that electric operation was continuing at the South Amboy yards into the late 1950's.

2. Catenary Structures

The purpose of the catenary (defined as an overhead system for distributing current, together with the whole assemblage of supporting poles, braces, overhead wires and related gear) is to enable electric locomotives to obtain continuous power from a wire suspended over the tracks, via a pantograph structure mounted on the locomotive. The power cable (termed the Trolley or Contact Wire) needs to run at a generally consistent height above the ground. In the later phases of the electrification the wire was maintained at about 22 feet above the rail. Changes in elevation down to about 15'8"could be accommodated, for example to bring the wire through tunnels lower than the main catenary, but these had to be gradual to ensure that the pantograph did not disengage.

The basic principle and method of construction of catenaries remained essentially the same throughout the main PRR construction period of 1914 to 1939 (Nesladek 1996 22-27). Vertical poles, initially of tubular steel, but in the1930's replaced by cheaper 14-inch square beams of H-section, were used as the primary support structures.

These H-section poles were between 70 and 110 feet high, set into concrete pedestals about four feet square and five feet high. These were normally finished with two coats of aluminum paint.

The poles were typically placed in pairs, one on each side of the tracks. The pairs were spaced at about 300 foot intervals on straight track alignments on the Philadelphia-Paoli alignment, reduced to 270 feet on the New York to Washington D.C. corridor. These poles carried both the transmission lines, which provided the main power and were typically placed on the tops of the poles, and the support structures for the Trolley/Contact wire. The transmission lines carried current at 44,000 volts, which was stepped down at transformer stations to 11,000 (later 12,000) volts for use on the actual catenary system.

The space over the tracks between each pair of poles was bridged by either a wire or steel beam structure termed a Cross Catenary or Body Span. From this bridging structure an arrangement of longitudinal and bracing wires carried the Trolley/Contact wire. The primary suspension wire, called the Messenger, was suspended in a true catenary arc from the bridging structure (thus giving the whole system its name). Below this was suspended a second wire, the Auxiliary Messenger, which provided extra flexibility to the structure and could carry additional current for the Trolley/Contact wire. The Trolley/Contact wire was suspended immediately below the Auxiliary and was attached to it by clips. Figure 1 shows the structure as installed on the New York to Philadelphia line in the early 1930's.

Deviations from this basic design were needed for special circumstances such as curves and switches, as well as for existing bridges and tunnels. Catenaries were also used to support other railroad infrastructure, particularly signal systems.

On freight lines, such as the Amboy Branch at South Amboy, the Auxiliary Messenger was often omitted because it was not needed for the lower speeds attained by freight trains. Freight tracks also more often used single poles, termed bracket arms, rather than pairs of poles. These had braced horizontal beams extending out over tracks on one or both sides of the pole.

C. THE SOUTH AMBOY CATENARY

The surviving catenary structures at the project site were inspected on December 10th 2002. Field survey was confined to the Camden and Amboy line and did not examine the New York and Long Branch Railroad of New Jersey alignment (the current New Jersey Transit coast line).

A total of 30 support structures are present within the Area of Potential Effect along the CARR alignment. These are identified on the map (Figure 2) as C1 through 26. All but one of them is of steel, the remaining one being of wood. The total includes a large lighting tower (C17: Plate 1) that is not truly a part of the catenary system, and four pairs of poles (C8a and b, C10a and b, C12a and b and C15a and b).

Inspection of the poles and remaining wiring confirm that the structures that remain today are those of the PRR installation of 1937-8. Changes and modifications have been made to some of the poles, particularly poles C1 through C6 at the western end of the APE, which have each been heightened with steel sections to carry wiring towards the single track that connects the CARR with the NJT tracks just east of the bridge (Plate 2).

While much of the catenary wiring has been removed, a section between poles C10a/b and C15a/b is largely intact and shows the complexity of these systems on multiple tracks and on curves. Much of the wiring seems to have ended at C15a/b, with a single line continuing to C20. A separate line must have once run as far as C26, but no wiring remains on poles C21-C26 which served this siding. It appears that electrification was never carried further east towards the thawing sheds and coal docks, nor into the area where the proposed ferry terminal is to be constructed. Both compound (three wire) and simple (two wire) catenary wiring was apparently used

The catenary poles that form the main structural element of the system are chiefly 14" square H-section steel beams placed on a concrete slab mat and encased in a concrete pedestal in typical PRR construction (Plate 3; Nesladek 1996:24). A few of the lower poles are of smaller dimension H-section steel.

The catenary structures are of four types:

Portal Bridges (C10a/b; C15a/b). In these cases the two poles are connected by a braced horizontal beam (Plate 4). This type of structure was often used to support signaling systems but there is no evidence for this at South Amboy.

Cross Catenaries or Body Span Structures (C8a/b; C12a/b). These are typical of mainline catenaries. The two poles are connected by wires, from which the longitudinal messenger, auxiliary messenger and contact/trolley wires are suspended. These and the Portal Bridge structures are concentrated on and each side of the bridge where the electrified tracks had to converge.

Bracket Arm Bridge Structures (C1-C5; C7; C13; C20; C21; C23). Typical of freight installations, these consist of a single pole supporting a T-shaped bracket arm spanning one track (Plate 5).

Single poles (C6; C9; C11; C13; C18; C19; C22; C24-C26). These served as braces for larger poles, or as tension supports for wires on curving section of track. The precise function of the westernmost row of single poles (C24-26) is not clear.

D. EVALUATION AND RECOMMENDATION

The catenary at the intermodal ferry site appears to be typical of the PRR freight line electrical installation of 1937-8 as described by Nesladek (1996), with some later modifications. The system has been abandoned for many years and most of the wires have been removed. There has been loss of integrity but the system is still comprehensible if the basic principles are understood.

The demolition of the bridge will remove one of the portal structures (C10a/b) and one single pole (C11), but the other poles are unaffected by the project and will remain.

This consultant was asked to make recommendations about the desirability of preserving all or part of this catenary system and which elements might merit preservation and interpretive treatment.

It is recommended that the Portal Bridge C15a/b be retained in place. It is in the best location to function as an entrance feature to the ferry terminal and should not require moving. One or two of the Bracket Arm poles (perhaps C20 and C21) could also be used in association with the portal since these are representative of freight electrifi-

cation systems on the PRR. These could perhaps be moved and placed forward (i.e. east) of the Portal bridge, one on each side and with the bracket arms either extending out into the roadway or to each side. Other arrangements could certainly be devised, but this is relatively simple and uses the catenaries in a way that marks the entrance to the terminal and memorializes the electrification history of the site.

The structures should be inspected to ensure that they are structurally sound. Those that are moved should be reset on a concrete slab mat and encased in a concrete pedestal to match the existing PRR construction. Original surface finish of aluminum paint could be restored. Interpretive information should be provided on one of the structures.

E. CAMDEN AND AMBOY RAILROAD STONE SLEEPERS

Re-examination of the shoreline area adjacent to the site of the Explosives Pier on December 10th 2002 identified at least 19 of the large sub-rectangular stone blocks used as sleepers for the earliest phase of the Camden and Amboy Railroad track in the 1830's. These blocks each have flat settings and drilled holes for mounting the iron plates to which the rails themselves were attached. These sleepers are not in situ and should be used as interpretive and landscape features for the new terminal.

REFERENCES

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1980 *Electric Traction on the Pennsylvania Railroad 1895-1968*. Pennsylvania University Press.

Nezladek, Mike
1996 Overhead Catenary of the PRR. The Keystone, 29(4), Winter 1996:15-49,

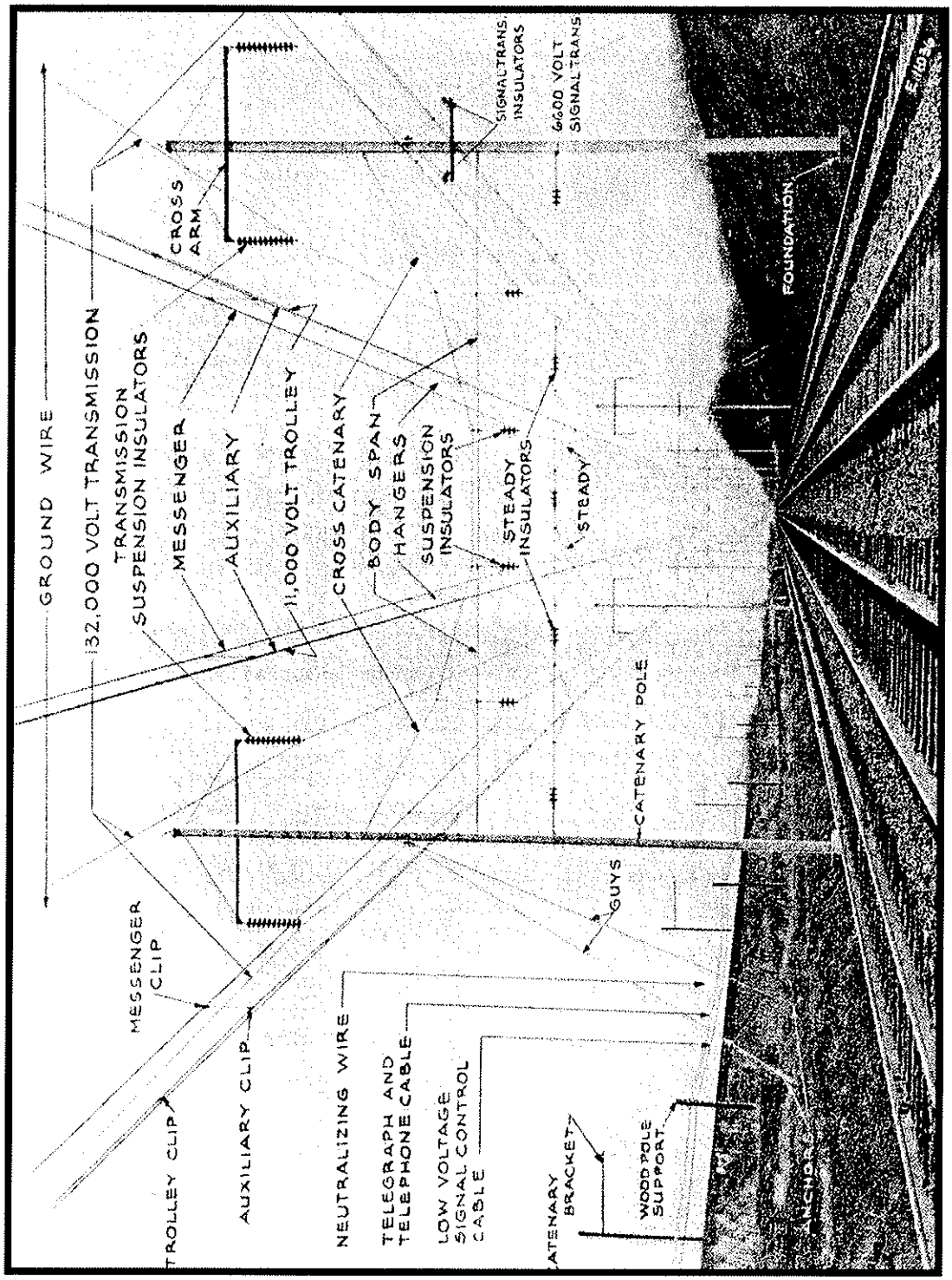


Figure 1. Typical catenary structure used on the New York to Philadelphia line in the 1930's. Source: Nesladek 1996:26.

Plate 1. Lighting tower (C17). View facing southeast (Photographer: Ian Burrow, December 2002). [Hunter Research Inc. Negative 02081/1:08].

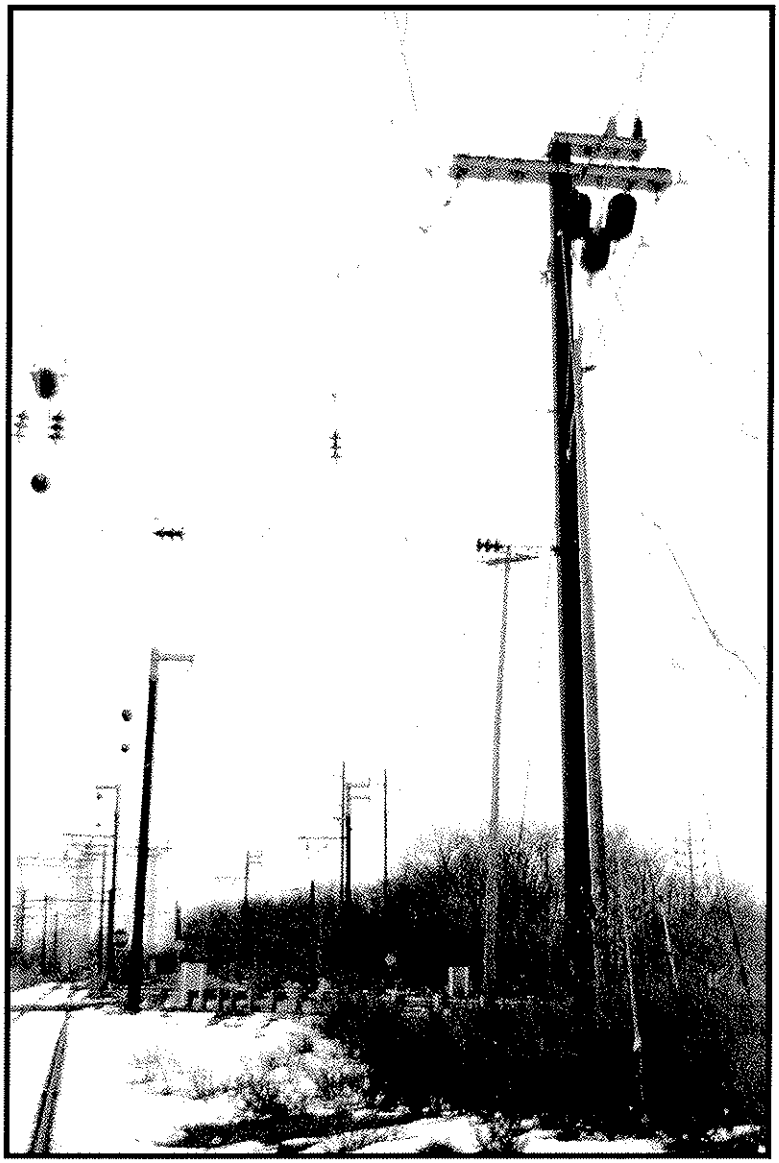


Plate 2. Catenary pole C8a. View facing northwest with poles C5 and C6 in the background. These originally single poles have had transmission structures added at the top. (Photographer: Ian Burrow, December 2002). [Hunter Research Inc. Negative 02081/1:22].

Plate 3. The base of Portal Bridge Catenary C10a from the southeast, showing concrete slab mat and concrete pedestal typical of Pennsylvania Railroad construction (Photographer: Ian Burrow, December 2002). [Hunter Research Inc. Negative 02081/D1:03].

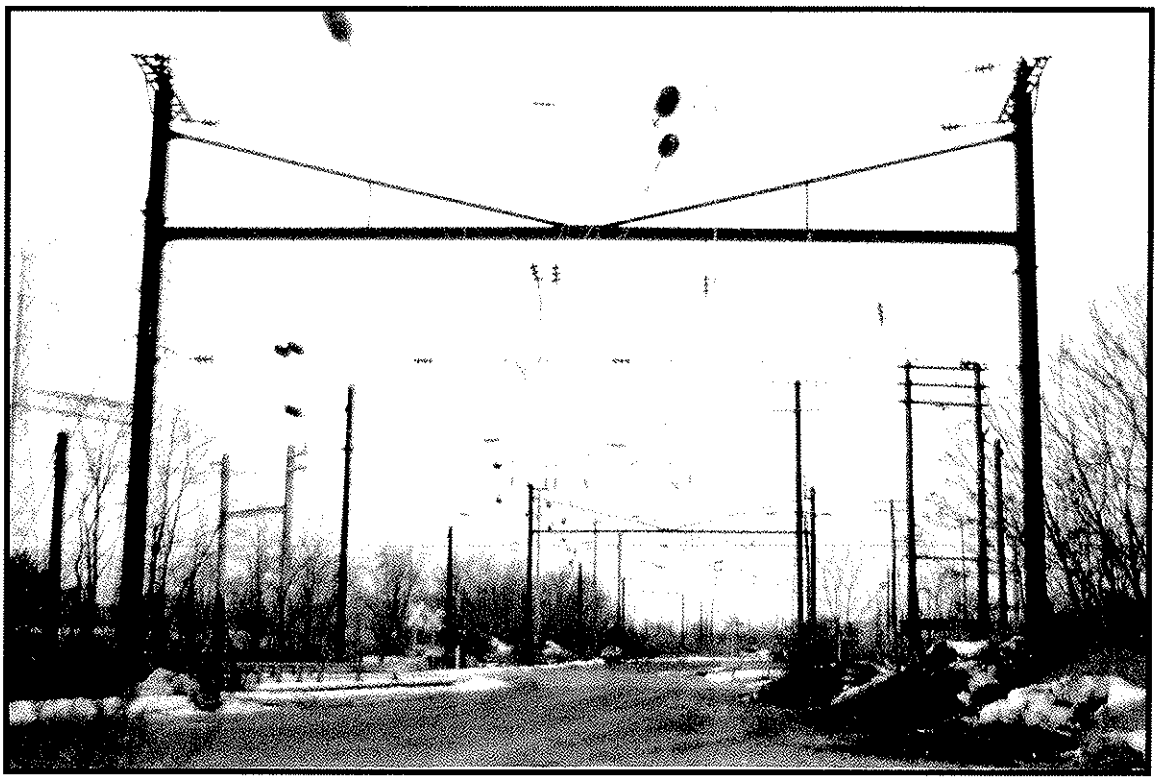
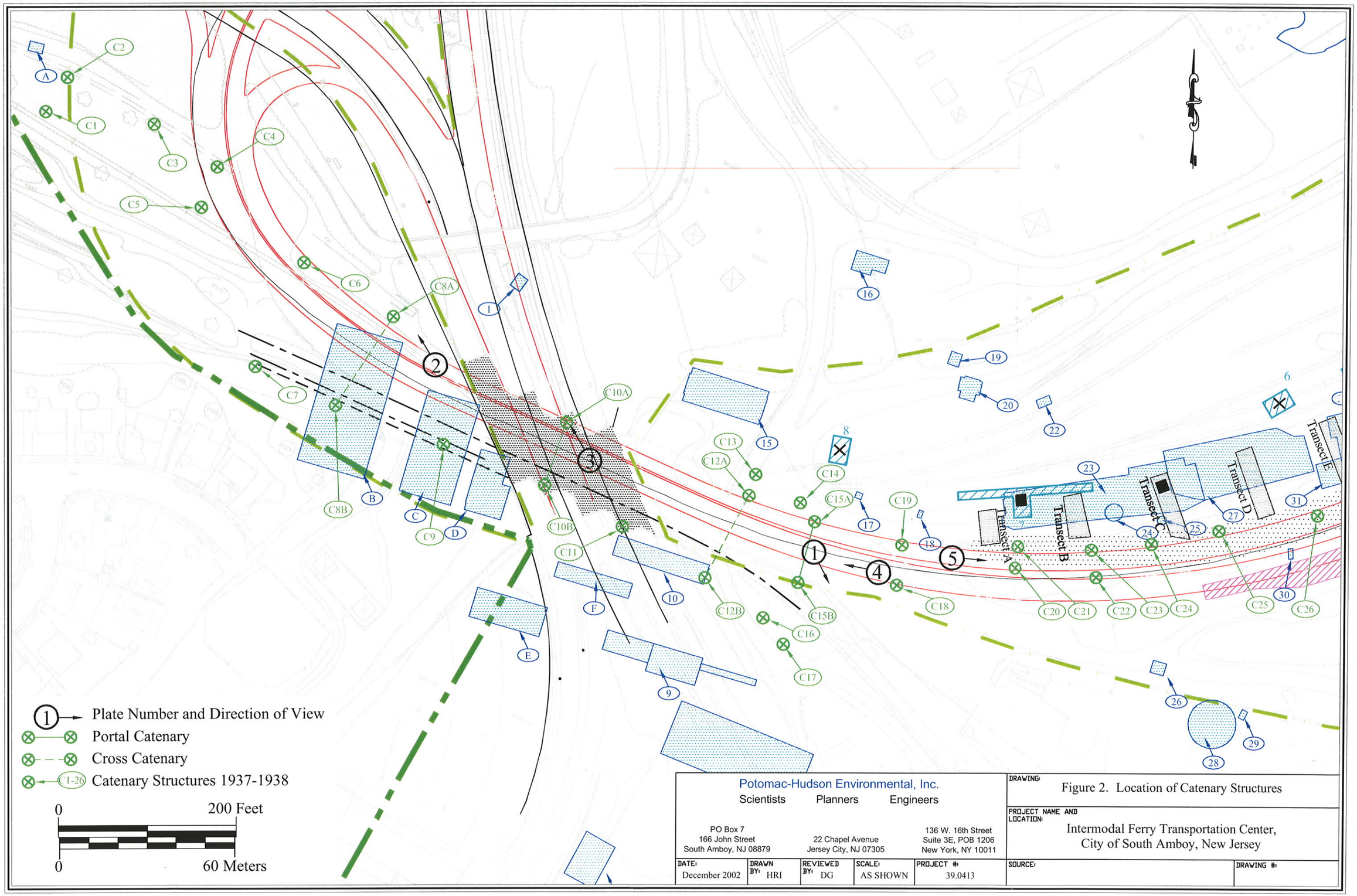


Plate 4. Portal Bridge Catenary C15a-b in foreground with C10a-b in background. View facing northwest (Photographer: Ian Burrow, December 2002). [Hunter Research Inc. Negative 02081/1:13].

Plate 5. Bracket Arm Catenary Structures C20 and C21. View facing northeast (Photographer: Ian Burrow, December 2002). [Hunter Research Inc. Negative 02081/1:10].



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DRAWING:
Figure 2. Location of Catenary Structures

PROJECT NAME AND LOCATION:
Intermodal Ferry Transportation Center,
City of South Amboy, New Jersey

DATE:	DRAWN BY:	REVIEWED BY:	SCALE:	PROJECT #:	SOURCE:	DRAWING #:
December 2002	HRI	DG	AS SHOWN	39.0413		