West Side Highway Project
Project Report

West Side Highway Project Report

P.I.N. 0024.11.111
Project No. 1-478-1(144)17
Interstate Route Connection 518

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
Raymond T. Schuler, Commissioner

Contents

Summary

Introduction

In December 1971, the West Side Highway Project was established by a memorandum of understanding signed by Governor Nelson A. Rockefeller and Mayor John V. Lindsay.

The Federal Government designated the route from the Brooklyn Battery Tunnel to the Lincoln Tunnel as Interstate Route 478. Alternative alignments were developed during the first phase of this work. A Draft Environmental Impact Statement (DEIS), which detailed the environmental impacts of each of the alternatives, and a Design Report which showed the engineering details of each alternative, were then prepared. These documents were circulated, and in June 1974 and September 1974 public hearings were held. The comments at the public hearing and after the public hearing from both the private and public area were studied and evaluated. The results of this work were incorporated into the alternatives, and modifications were developed. A modification of the original outboard alternative is being recommended for approval.

Description of the Selected Alignment

The Modified Outboard Alternative, or Westway, as approved by Governor Hugh L. Carey and Mayor Abraham D. Beame, is a unique urban transportation facility carefully designed to improve transportation as well as economic and social conditions on the West Side of Manhattan as well as act as a catalyst for redevelopment. The Plan of the Modified Outboard Alternative is shown on Illustration S-1. The Modified Outboard Alternative is similar to the original Outboard Alternative contained in the Draft EIS and presented at public hearings. The combination of highway and West Street traffic lanes was scaled down from that of the original Outboard Alternative to provide six lanes of highway capacity with special design features to reserve two lanes for express buses and high-occupancy vehicles during peak periods. The separate transitway was eliminated from Midtown to the Battery. The size of West Street was reduced in Greenwich Village and Chelsea from six to four lanes, and the design characteristics were changed to discourage through-travel use. The amount of landfill was reduced from about 240 acres to about 180 acres, particularly in the area of the Greenwich Village waterfront. Also, the scale and size of major interchanges was reduced, particularly the two-corridor Holland Tunnel Interchange which was reduced in size to a one-corridor interchange.

The Modified Outboard Alternative consists of a new six-lane highway with special design features to provide for express transit bus and high-occupancy vehicle use of two lanes during peak periods, the removal of the elevated highway structure and the reconstruction of the old highway corridor into a local street designed to serve local traffic. Importantly, an integral part of the alternative is a land use policy for the land created by the project as well as the corridor areas directly affected by the reconstruction of the Highway.

The Modified Outboard Alternative is proposed for construction between the Battery in Lower Manhattan and 42nd Street in the Midtown area. However, in order to disclose fully the policy and plans for the entire highway corridor, the Final Environmental Impact Statement (FEIS) describes the intent of the City and State to rebuild the section of highway from 42nd to 72nd Streets and to repair and improve the safety of the section of the highway known as the Henry Hudson Parkway from 72nd Street to the Bronx-Westchester County line.

The selected alternative as presented here has been redesigned in accordance with decisions by the Governor and Mayor and more detailed instructions from the Project Working Committee and takes into account the many suggestions, comments, criticisms, criteria, guidelines, and requests made during the public hearings and as a result of the review of the DEIS. The Modified Outboard Alternative has been designed to meet these goals, objectives, and policies and has been tailored to the diverse mobility and environmental requirements of the West Side of Manhattan.

The new 4.2-mile highway will be located on a new alignment in waterfront landfill for a large part of its length between the Brooklyn-Battery Tunnel and 42nd Street. This alignment would be approximately midway between the Hudson River pierhead and bulkhead lines, except in Lower Manhattan where it would remain largely in the space now occupied by the existing West Side Highway and West Street.

Approximately 55 percent, or 2.6 miles, of the new highway would be below grade in a covered section. Open sections will occur at interchange areas, including the Canal and 30th Street areas where direct elevated ramp connections would be provided to the Holland and Lincoln Tunnels, and to the northbound highway lanes in Lower Manhattan. This covered highway will provide a safe, efficient, express route along the perimeter of Manhattan for traffic that now uses existing north-south avenues and local streets. Environmentally, the enclosed and mechanically ventilated tunnel will help alleviate the problems of noise pollution and traffic fumes in sensitive residential areas of the corridor. In addition, investigations of noise impacts have resulted in including noise barriers in noise sensitive areas along the project.

For its entire length the highway will have six moving lanes, three in each direction, in order to accommodate projected volumes of auto, truck, express transit bus and high-occupancy vehicle traffic. Access ramps to the highway will be located at key points within the corridor such as the Battery Park Underpass, the Lower Manhattan Business District, Canal Street, 14th Street and the Midtown Business District. The highway will also have three direct Interstate connections to Brooklyn and Long Island via the Brooklyn-Battery Tunnel (I-278) and to New Jersey at the Holland (I-78) and Lincoln (I-495) Tunnels.


PATH TUBES
HOLLAND TUNNEL
PATH TUBES
VENT. BLDG. NO. 2
VENT. BLDG. NO. 1
BATTERY PARK CITY AREA
VENT. BLDG. NO. 3
BROOKLYN BATTERY TUNNEL
WEST ST.
GREENWICH ST
CHURCH ST
CHAMBERS ST.
AVE OF THE AMERICAS
W. BROADWAY
HOUSTON ST
CANAL ST
BROADWAY
14th ST.

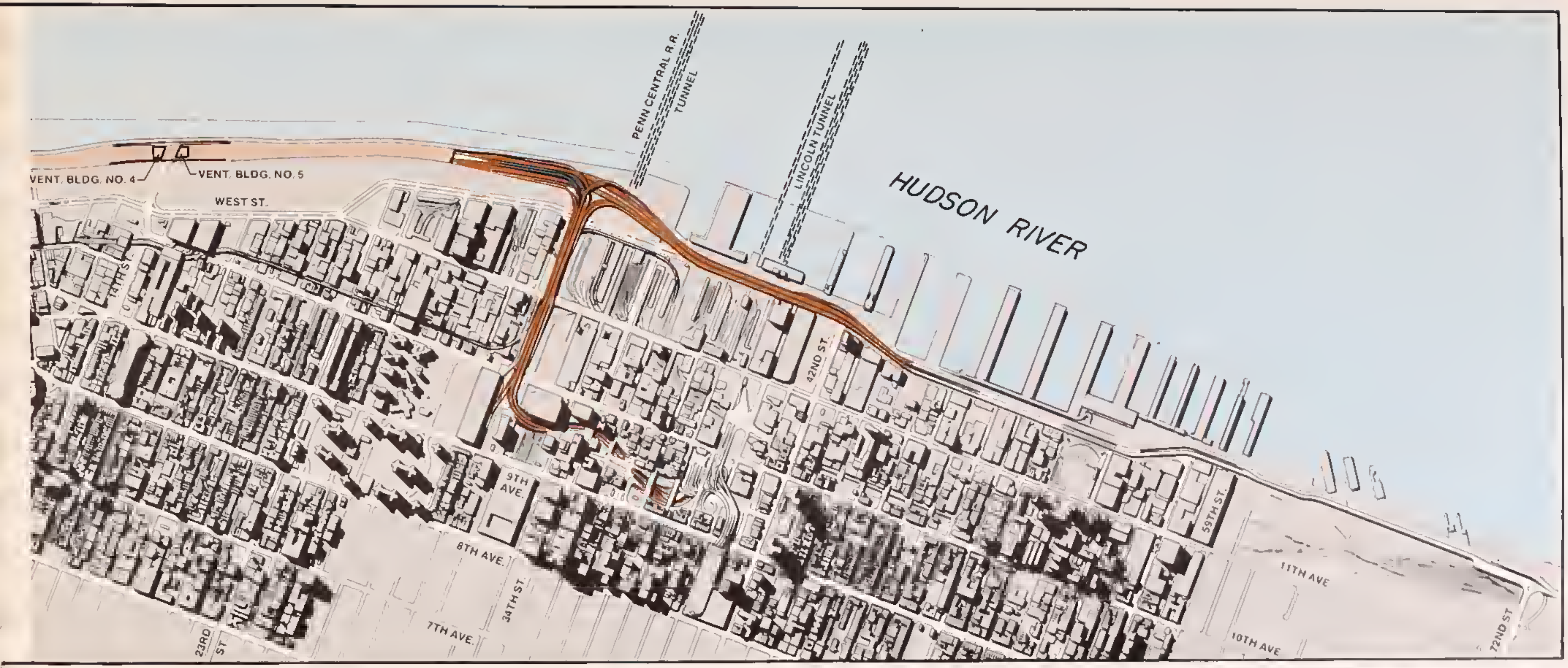
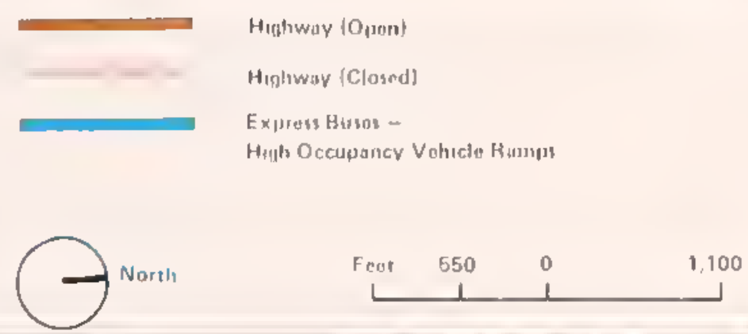


Illustration S-1 Selected Alternative



During the morning and evening rush hour periods, the inner lane of the highway in each direction will be designed to accommodate express buses and high-occupancy vehicles. These highway lanes will be connected to other existing express bus lanes and facilities within the corridor. In Midtown, bus ramps will be located within the Lincoln Tunnel interchange with access to the Port Authority Bus Terminal at 40th Street and a direct connection via the Lincoln Tunnel to the I-495 express bus lane to New Jersey. In Lower Manhattan, a two-way bus ramp would be provided at Laight Street, utilizing West Street between Battery Place and Laight Street for the collection and distribution of passengers in the financial district.

The final component of the Modified Outboard Alternative is a new West Street/Twelfth Avenue reconstructed in its present right-of-way. The design and traffic-carrying capacity of this facility would vary according to the local needs of existing adjacent areas within the corridor and the requirements of proposed development on the new waterfront landfill. In some sections such as the West Village and Chelsea, West Street will consist of four traffic lanes separated by a center median plus on-street parking space. In other areas, particularly Lower Manhattan, the facility will consist of six lanes. Both physical design techniques and traffic control devices will be used to achieve the desired operating characteristics of each section.

Cost Estimates

A detailed construction and right-of-way cost estimate, using 1976 cost, was prepared for the Modified Outboard Alternative. The construction cost estimate was determined by estimating quantities of major items of work from plans and work sheets, and applying unit cost to these quantities. The right-of-way estimate was prepared by the New York State Department of Transportation. Based on these estimates, the total construction cost of the Modified Outboard Alternative will be $1,008.6 million and the right-of-way cost will be $147.0 million, in 1976 dollars. Table S-1 shows the cost breakdown.

Table S-1

HIGHWAY CONSTRUCTION AND RIGHT-OF-WAY COSTS

(In Millions of Dollars)

	Construction Costs			Right-of-Way Costs [a]		
	Base Cost [a]	Miscellaneous [b]	Total	Market Value	Miscellaneous	Total
Modified Outboard Alternative	$877.0	$131.6	$1,008.0	$117.9	$29.1	$147.0

(a) Includes 4 percent for Survey and Mobilization.
(b) Includes 15 percent for Engineering and Contingencies.

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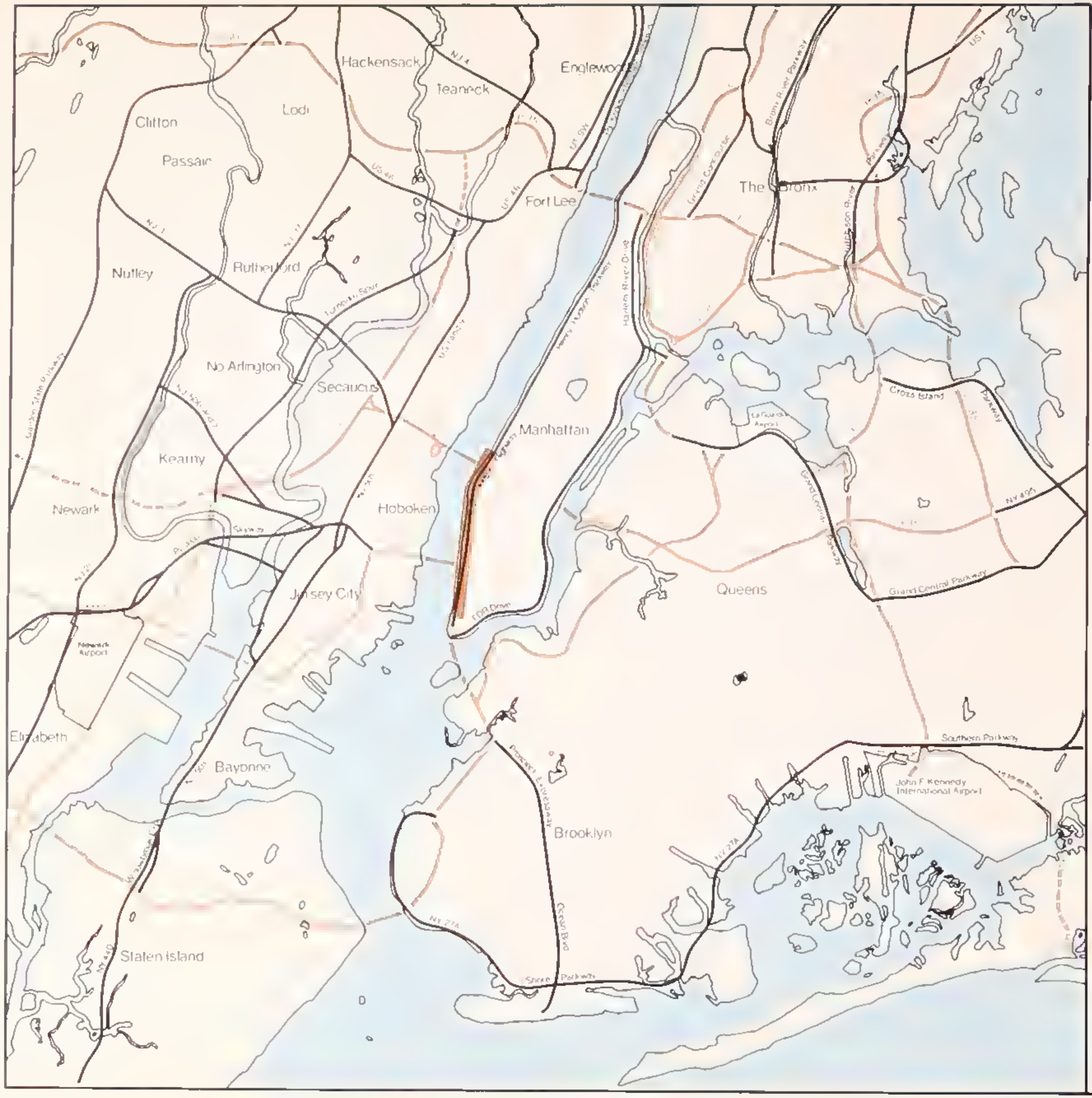

Illustration 1-1 Location Plan

Project Area
Existing Interstate Routes
Existing Highways

North

0 1 2 3 Miles

Section 1 - Introduction

Location of Project

The State and City of New York have for many years recognized the need to reconstruct the West Side Highway. Since the 1930s, when this highway was opened to traffic, the road has become obsolete in comparison with modern highway standards and, in many areas, has seriously deteriorated.

In late 1970, the New York State Department of Transportation began to reassess the Federal Interstate Highway Program and, with the full agreement of the City of New York, decided that the West Side Highway should be added to the Interstate System as an urban extension.

Following this decision, New York State requested that the Federal Government designate a route from the Brooklyn Battery Tunnel to the George Washington Bridge as part of the Interstate Highway System. Because of existing New York State legislation, in 1971 the United States Department of Transportation designated a segment of highway between the Brooklyn-Queens Expressway (Interstate Route 278) and the Lincoln Tunnel (Interstate Route 495) as Interstate Route 478. The New York State Department of Transportation has designated this route as Interstate Route Connection 518. This action established the northern and southern boundaries of the Interstate Project. The east building line on West Street and the U.S. Pierhead Line on the east side of the Hudson River established the width of the transportation corridor. Illustration 1-1 locates the study area with respect to the region.

The official State designation of this highway is:

P.I.N. 0024.11.111
Project No. I-478-1(144)17
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In addition to developing Interstate alternatives, limited highway or non-Interstate alternatives were also studied. For continuity with the existing streets and communities, these studies extended north of the Lincoln Tunnel to approximately 72nd Street.

Organization

In December of 1971, Governor Nelson A. Rockefeller and Mayor John V. Lindsay signed a "Memorandum of Understanding" which established the organizational and policy framework for a "West Side Highway Project." The stated objective was as follows:

"This Memorandum of Understanding between the City of New York and the State of New York sets forth mutually agreeable administrative and organizational arrangements by which a corridor plan will be prepared for the West Side Waterfront portion of Manhattan. The term corridor plan means the officially adopted end-product of the planning process; it includes a complete description of the desired pattern of land uses, reconstruction of the West Side Highway and the network of local services associated with a schedule of actions and fundings for which each of the involved entities is responsible. The corridor includes that portion of the Hudson River Waterfront in the general vicinity of the present West Side Highway."

The Memorandum created a Steering Committee, chaired by the New York State Commissioner of Transportation, as the Project's policy-making body. The Committee included the heads of 16 City, State, and special agencies concerned with planning and transportation, and the Chairmen of Manhattan Community Planning Boards 1, 2, 4, 7, 9, and 12. The area over which these Boards preside encompasses the West Side of Manhattan from the Battery to the George Washington Bridge.

The Memorandum sets forth the responsibilities of the Steering Committee as follows:

"Its members shall have responsibilities for establishing the basic policies governing the conduct of the study and for identifying and reconciling policy differences so that the planning process may produce the most desirable, economic, and timely overall plan. Policy will be determined and issues resolved by consensus of the Committee."

In addition to the policy direction provided by the Steering Committee, a smaller group called the Working Committee was formed of persons whose responsibilities bore most directly on Project decisions. Like the Steering Committee, it is chaired by the New York State Commissioner of Transportation.

The other members of the Working Committee are the President of the New York State Urban Development Corporation, the Administrator of the New York City Transportation Administration, and the Chairman of the New York City Planning Commission. An Executive Director was chosen, and under his direction the remaining study staff was assembled. Section 1 of the Environmental Impact Statement explains the organization of the Project in more detail.

In January of 1972, the Steering Committee approved a work program for the Project; and in April of 1972, a team of engineers, architects, urban planners, public transportation planners, environmental experts, and other specialists began working on alternative proposals for the new transportation facility in the West Side Highway corridor.

Goals and Objectives

In August 1972, the Steering Committee formally adopted a policy statement intended as a basis for all planning and design activities associated with the West Side Highway Project. In this document, the Steering Committee recognized the opportunity to combine major land use planning with transportation planning in an effort to provide solutions to the following problems:

1. Obsolescence and under-utilization of the waterfront area
2. Insufficient employment opportunities
3. Insufficient land area available for critical land uses
4. Continuing degradation of the physical environment
5. Excessive cost of goods movement and distribution
6. Inadequate transportation systems

To frame a response to the problems cited above, five broad goals were identified by the Steering Committee

1. Ensure that the alternative corridor plans meaningfully respond to the needs and aspirations of individuals and organizations affected by reconstruction of the Highway. The quality of the various alternatives will be dependent upon intimate awareness of these factors.
2. Minimize disruption, dislocation, and other social and economic costs which may occur from reconstructing the Highway
3. Achieve desirable physical and economic use of the West Side waterfront corridor.
4. Improve the quality of the physical environment by reducing pollution attributable to transportation sources in the West Side corridor
5. Improve the efficiency and quality of moving people and goods to and from Manhattan, especially within the West Side corridor.

The work effort of the Project has been oriented to accomplish these goals and objectives. It is the Project's intention to continue to pursue the involvement and participation of the local communities during the next stages of the Project.

Documents and Hearings

This Project Report and the following documents and reports have been published as part of the work effort by the Project Staff.

- Draft Environmental Impact Statement (DEIS)/Four (f) Statement
- Design Report
- Final Environmental Impact Statement (FEIS)/Four (f) Statement
- Technical Reports
  - Air Quality
  - Noise
  - Water Quality
  - Traffic
  - Traffic Surveillance and Control

The Design Report and the DEIS were prepared in accordance with the regulations of the New York State Department of Transportation and the Federal Highway Administration. The Design Report and the DEIS were informational documents presented for review to the interested parties prior to the Public Hearing. The Design Report and the DEIS, together, then became informational reports for which views and comments were solicited from advisory agencies, community boards, and other interested parties. The information presented in the DEIS and the Design Report was used as the basis for the Public Hearings held in four sessions. Two sessions were held in June 1974 and two were held in September 1974. After the Public Hearing, the reports were expanded further to incorporate the views and comments received during and following the Hearing. The FEIS includes the information developed after the Hearing.

This Project Report presents the engineering aspects of the recommended alternative and descriptions of the existing conditions of the Study Corridor. This Report is supplemented by the Final EIS and Four (f) Statement and the technical reports which are separate documents.

The original alternatives are considered and discussed in the Draft EIS and in the Design Report. The Modified Outboard Alternative, the Modified Arterial Alternative and interstate transfer are discussed in the Final EIS. This Project Report concentrates on the engineering aspects of the Modified Outboard Alternative and refers to the Final EIS and technical reports for those aspects which are not of an engineering nature.

Section 2 - Existing Conditions

Introduction

Section 3 of the FEIS describes the highway and mass transit networks of the metropolitan area, including more detailed information on how the network of transportation facilities is being used by the public. This section of this Project Report describes the existing conditions that directly affect the engineering aspects of the Modified Outboard Alternative.

An in-depth study was made of the existing traffic in the Project area. The details of this work, as well as the description of the existing traffic in the Project area, is also given in this section of this Project Report.

West Side Highway

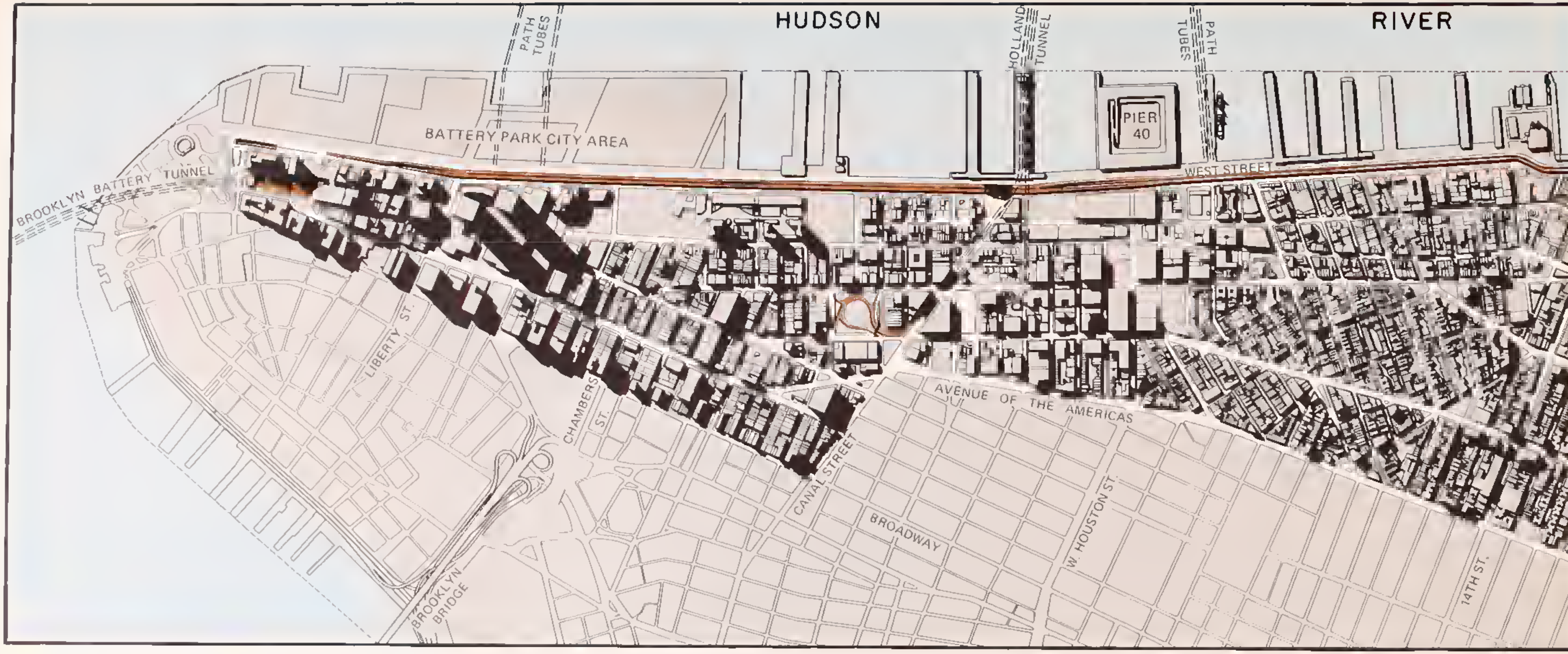
The West Side Highway is part of a continuous 15-mile-long artery from the Battery to the Westchester County line. The Highway is generally six lanes wide and is limited to automobile traffic. North of 72nd Street, this artery is designated as the Henry Hudson Parkway; south of 72nd Street, the highway is designated as the Miller Highway. The entire system between the Battery and the George Washington Bridge is commonly known as the West Side Highway.

The Miller Highway is a continuous elevated structure from 72nd Street to Rector Street in Lower Manhattan. It occupies rights-of-way in 12th Avenue, West Street, and Marginal Street throughout its length. The original portion of the Highway, extending from 72nd Street to Canal Street, was completed in 1937. Ten years later, the Highway was extended southward to Rector Street, where it connected with the Battery Park Underpass and to the Brooklyn Battery Tunnel. Illustration 2-1 shows the existing West Side Highway south of 72nd Street.

Highway Superstructure

The original Highway deck north of Canal Street had a 4-inch granite block riding surface supported on a reinforced concrete slab. Some time after the Highway was completed, the granite block was removed and the reinforced concrete deck was overlaid with asphalt, except for the areas from 17th to 26th Streets and from 56th to 72nd Streets.

Illustration 2-2 shows a typical cross section of the Miller Highway north of Canal Street. The superstructure consists of single-span longitudinal girders supported directly on columns. Transverse floor beams span the longitudinal girders, and the deck is supported on rolled steel stringers framed into or bearing on top of the transverse floor beams. The tops of the outside longitudinal girders are generally 3 feet above the curb line and form the fascia and railing. This portion of the Highway was originally designed to include provisions for the installation of a future second deck.


HUDSON
RIVER
PATH TUBES
HOLLAND TUNNEL
TUBES PATH
PIER 40
BATTERY PARK CITY AREA
WEST STREET
BROOKLYN BATTERY TUNNEL
LIBERTY ST.
CHAMBERS ST.
AVENUE OF THE AMERICAS
CANAL STREET
BROADWAY
W. HOUSTON ST.
14TH ST.
BROOKLYN BRIDGE

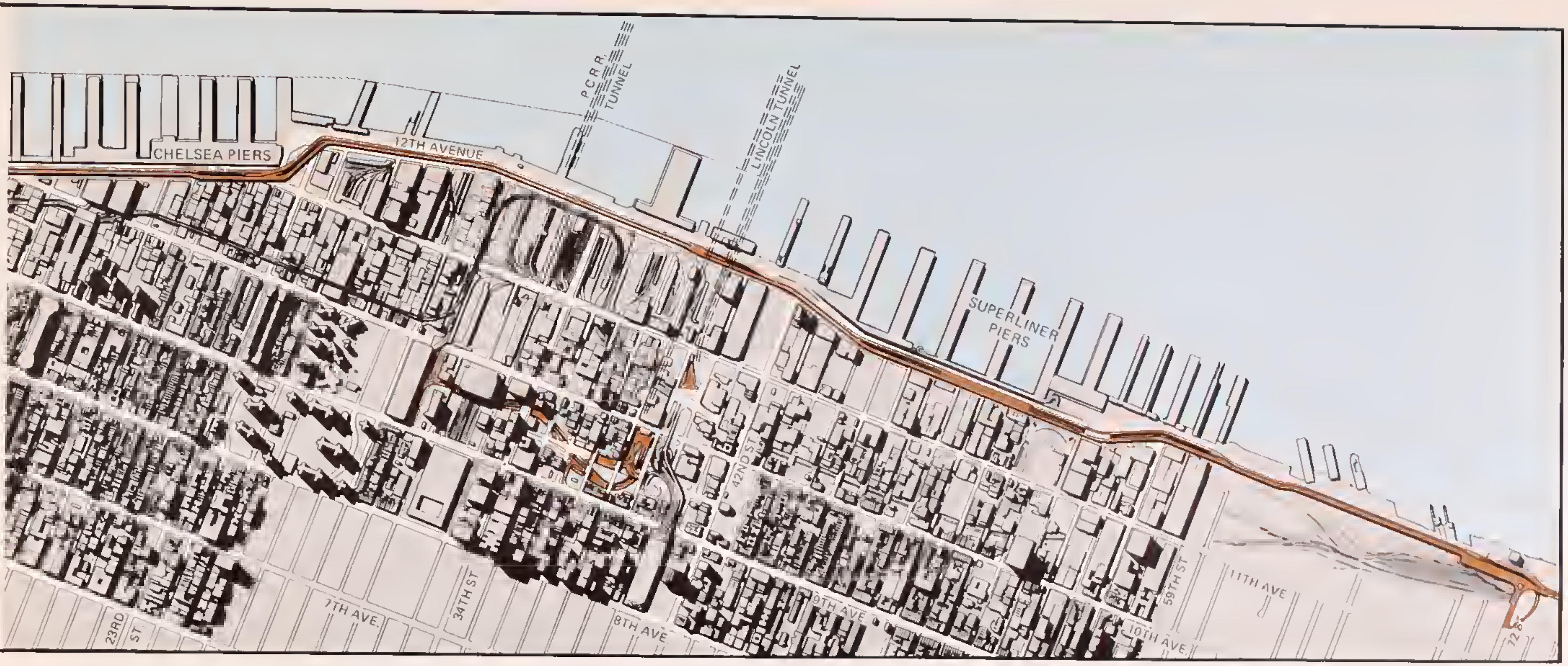


Illustration 2-1

Plan of Existing West Side Highway
Battery Park to 72nd Street

Existing West Side Highway
and Ramps to Tunnels

0 500 1000 1500 Feet

North

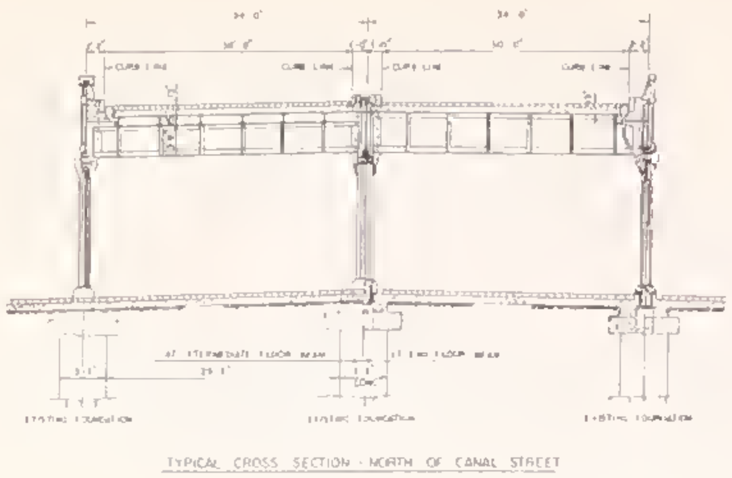


Illustration 2·2

The construction of the portion of the Miller Highway south of Canal Street incorporated a reinforced concrete deck with a monolithic wearing course. As indicated in Illustration 2·3, the framing consists of two main single-span longitudinal girders supported on columns. Transverse girders span the longitudinal girders with cantilevers on either side of the longitudinal girders. Stringers are framed into the transverse girders, and the concrete deck is supported by these stringers. The Miller Highway over Canal Street is supported on a through arch bridge with a span of approximately 300 feet. This is shown in a typical cross section on Illustration 2·4.

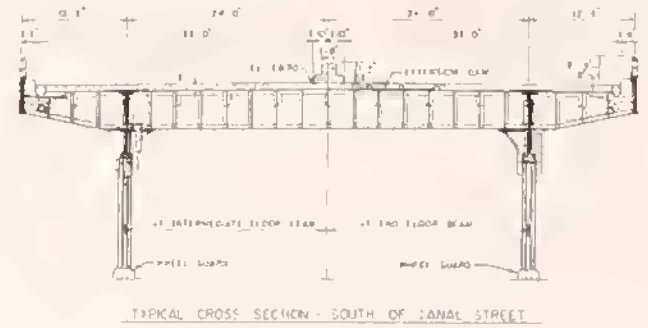


Illustration 2·3

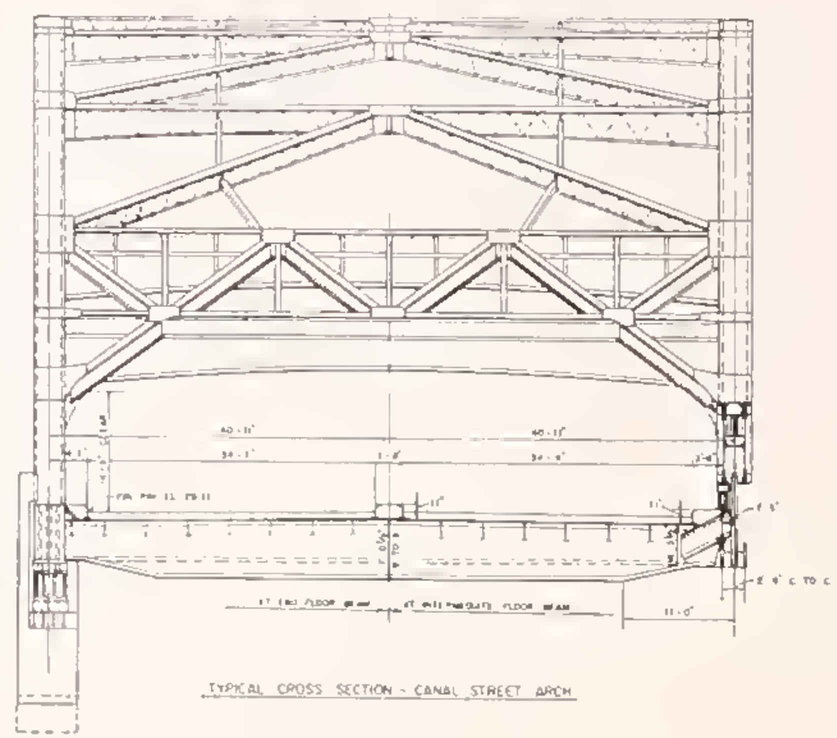


Illustration 2·4

Foundations

North of 59th Street, the viaduct is supported on concrete caissons founded on bedrock. Between 39th Street and 59th street, the structure loads are carried directly to rock on concrete piers. Below 39th Street, the viaduct columns are supported on footings. The footings generally contain a grillage and are supported by 18-inch diameter steel pipes, which were driven to bedrock and filled with concrete.

Geometrics

The following discussion of the geometrics of the existing highway is based upon a comparison with the current Highway Design Manual of the New York State Department of Transportation (1972 edition with addenda).

Highway and Ramp Lane Widths. North of Canal Street, the Highway generally has three 10-foot lanes in each direction, without shoulders. The northbound and southbound roadways are separated by a raised median, 3 feet 8 inches wide. South of Canal Street, the existing Highway provides three lanes in each direction, without shoulders. These roadways are separated by a 3-foot 8-inch wide raised median. Current standards for a primary type highway advocate 12-foot-wide traffic lanes, with shoulders, plus additional offset width to median barriers.

At Jay Street and Pier 40, the Highway narrows from three to two through-traffic lanes in a short transitional length. This through-traffic lane reduction was part of the initial design of the Highway. Present standards allow for lane drops only after a substantial volume of traffic has been taken off the Highway via an exit ramp nose with a long transition. In general, most of the existing Highway ramps are one-lane and have a pavement width of approximately 10 feet between curb lines. In accordance with present standards, ramps should have a least a 12-foot lane width plus additional width to permit traffic to pass a stalled vehicle.

Highway Curvature. At Gansevoort Street, 22nd Street, 29th Street, 42nd Street, and 56th Street the existing Highway curvature and viaduct parapet height is such that horizontal sight distance is limited. Each of these locations has its particular geometric features restricting horizontal sight distance; the resultant safe highway speed lies between 18 and 30 mph. There is apparently no superelevation for these mainline highway curves. In addition, the reverse curves in the 22nd Street area, in combination with the entrance and exit ramps, have necessitated Highway operation with only two through lanes in each direction at that location.

Ramp Entrances and Exits. Ramps enter and exit the Highway on the left without benefit of speed change lanes. At some locations, the entering or exiting highway traffic utilizes the left or inside lane as direct ramp access. In these areas, through highway traffic is restricted to two lanes. Current criteria require entering and exiting a primary highway from the right or outside lane, with sufficient length of a speed change lane to accommodate the acceleration or deceleration of the ramp traffic to safe speed levels.

Ramp Vertical Geometry. The profile grades of the existing ramps are approximately 5 to 7.5 percent. The ramp crest vertical curves limit the stopping sight distance, resulting in a safe speed between 15 and 25 mph. According to current criteria, a minimum ramp design speed of 25 mph is required for a highway design speed of 50 mph. For ramp design speeds of approximately 25 mph, the ramp grades should be between 4 and 6 percent.

Physical Condition of the Highway Structure

The deterioration of the West Side Highway is a cause of continuous concern. The use of salt to remove ice from the roadway surface and the heavy volume of traffic have caused disintegration of large areas of concrete slab, in some cases, portions of these slabs have fallen to the street below. The blacktop overlays are also in poor condition, with potholes and surface cracking. The damaged concrete has been temporarily maintained by placing steel plates over the voids; there are over 70 steel plates on the deck. There is also visual evidence that the steel superstructure in certain areas is extensively corroded.

In the fall of 1973, the City of New York awarded a contract for replacement of approximately 800 feet of deck in the southbound roadway in the area of 14th Street; the replacement was to be precast concrete slabs and a new asphalt wearing course. Also, a number of repairs were made to the existing supporting steel members. On December 15, 1973, a truck carrying asphalt for the surfacing of the rebuilt southbound deck was traveling in the northbound lanes of the elevated West Side Highway. As the truck crossed the vicinity of Gansevoort Street, the connections between the transverse floor beams and the east main longitudinal girder failed, causing a 70-foot section of the northbound deck to fall onto West Street. Fortunately, there were no fatalities. Illustration 2-5 is a photograph of this area taken shortly after the collapse. In January 1974, the entire Highway south of 46th Street was closed to traffic in both directions.

Illustration 2-5

Subsequent to the collapse of the highway section, engineering inspections were made of the entire Highway south of 46th Street to determine if repairs could be made and this section reopened. Analysis indicated that very extensive repairs would be required. The City decided not to make these repairs because of the excessive costs and the fact that these repairs would make no improvement to the Highway's inadequate operational and safety characteristics.

As a safety project entirely separate from the West Side Highway Project, the State and the City of New York have received FHWA approval to demolish a particularly dangerous and deteriorated section of the existing West Side Highway between Jane and West 26th Streets. Actual demolition of this section of the roadway is scheduled to begin in the early spring of 1977.

Street Below Viaduct

In the Project area, all the ramps from the elevated portion of the West Side Highway have access to an existing street beneath the Highway. The name of the street changes along the route from south to north. It is variously called West Street, Marginal Street, 11th Avenue, or 12th Avenue.

Free flow of traffic is hampered by the many columns and ramps of the elevated highway which are located irregularly in the street. Prior to the collapse of the highway section, the street had a cobblestone surface and travel speeds were relatively slow. Large areas under the existing structure were used for truck parking. There are truck loading docks along West Street, so oriented that trucks extend into the street when unloading, thus restricting the passage of traffic. A temporary detour roadway for West Side Highway traffic below 46th Street has been provided by partially repaving and signalizing West Street/12th Avenue and by relocating some of the truck parking west of the roadway, closer to the bulkhead line.

The Hudson River

The reach of the Hudson River in the vicinity of the Project varies in width from 2800 to 3500 feet between pierhead lines. The distance between the easterly pierhead line and the easterly bulkhead line varies from approximately 700 to 1000 feet. The U.S. Army Corps of Engineers maintains the channels between the pierhead lines to 45 feet below mean low water for the middle 2000 feet of the river, and to 40 feet below mean low water for the remaining channel between the pierhead lines.[1] The depth of the water between the pierhead and bulkhead lines on the east side of the river varies between 20 feet and 40 feet, depending on the type of active shipping using the piers and the amount of dredging in the slips. In many cases there has been no dredging and, in some cases, siltation under the existing finger piers is such that there is less than 3 feet of water beneath the piers.

Piers

There are 33 piers located between the bulkhead and pierhead lines from the Battery to 52nd Street along the east shoreline of the Hudson River. All the piers between the Battery and Reade Street have been demolished and replaced with landfill for the Battery Park City Authority development. The configuration of the piers varies along the inshore line, but generally a pier is 150 feet wide and 800 feet long. The spacing between the piers ranges between 200 and 300 feet. In general, the depth of the water below mean low water between the piers varies from 15 to 35 feet. The depth of water under the older piers is less than 3 feet, while the water under the newer piers is between 25 and 30 feet deep.

[1] Pierhead and Bulkhead Lines, Hudson River, N.Y. & N.J. Sheets 21A and 22A prepared by U.S. Army Corps of Engineers. June, 1941.

Except for piers 40, 57, 76, 79, and 94, all piers are supported on untreated timber piles. Pier 40 is supported on steel piles with prestressed concrete construction, pier 57 is supported on a submerged caisson, pier 76 is supported on creosoted timber piles with concrete jackets, pier 79 is supported on steel piles, and pier 94 is supported on treated timber and steel piles.

Detailed descriptions of the Hudson River, including the hydrodynamics of the river and the uses of the existing piers are given in the EIS.

Tunnels

Under the river bed in the Project area are five sets of tunnels, of which two are vehicular (the Holland and Lincoln Tunnels) and three are railroad facilities. Two of the railroad tunnels are part of the Port Authority-Trans Hudson (PATH) system, formerly the Hudson and Manhattan Railway. The third railroad tunnel is that of the Penn Central Railroad. Illustration 2-1 shows the locations of these tunnels.

PATH Tubes (World Trade Center). The PATH tubes in the vicinity of Fulton and Cortlandt Streets are twin cast-steel tunnels, built in the early 1900s. These tubes are spaced about 400 feet apart under the river and flare out as they approach their easterly turnaround terminal at the World Trade Center. A portion of the west end of the tunnel, built in the late 1800s, is brick lined. Westerly from the World Trade Center, the tubes descend as they approach the river. They are in silt and clay at West Street, then slope down, gradually reaching a depth at which they are entirely in rock, which occurs between the bulkhead and pierhead lines. The irregularity of the top-of-rock line required that a clay blanket be placed along the tubes in certain areas during their construction, as blasting for placement of the cast steel rings progressed across the river. Concrete linings were then placed inside the cast steel rings. Ventilation of and access to these tunnels is from the World Trade Center.

Holland Tunnel. The Holland Tunnel consists of twin vehicular tubes which cross the Hudson River in the vicinity of Canal Street and connect the west side of Manhattan to Jersey City, New Jersey. The twin tubes were constructed between 1921 and 1927 with cast-iron rings. Both tubes are approximately 30 feet outside diameter, and provide for 20-foot-wide roadways to accommodate two lanes of traffic in each direction. The tubes are approximately 15 feet apart, and the tops are 65 feet below mean sea level. The total length of each tube between portals is about 9000 linear feet. The east ventilation building for the tunnels is at the west end of pier 34.

PATH Tubes (Morton Street). The PATH tubes connecting midtown Manhattan with Hoboken, New Jersey are twin tubes crossing the river in the vicinity of Morton Street. The north tube was constructed between 1874 and 1893 and was reconstructed when the south tube was built. It is partially brick lined and partially cast-iron lined. The south tube has cast-iron rings and was completed in 1904. Each tube is 18 to 20 feet outside diameter and 15 to 30 feet apart. The top of the tubes is approximately 60 to 70 feet below mean sea level. The total length of each tube between the shafts on the New York and New Jersey sides is about 1 mile.

Penn Central Railroad Tunnels. The twin Penn Central Railroad tunnels at 32nd Street are each 19 feet inside diameter and about 6 feet apart. They were constructed in the early 1900s by shield-driven methods. The tubes consist of cast-iron segmental rings lined with reinforced concrete. Under the river, the tunnels lie in the highly compressible organic silt of the river bottom. Rail elevations are at a maximum 90 feet below the water surface. The Manhattan land approach, which is entirely in rock, is 1000 feet long, between 10th and 11th Avenues, of horseshoe shape and was constructed by a combination of cut-and-cover methods and underground rock excavation.

Lincoln Tunnel. The Lincoln Tunnel consists of three circular tubes, each about 31 feet external diameter, located in the general area of West 38th and West 39th Streets. All three tubes were constructed by the shield-driven method of tunnel construction, employing compressed air at sufficient pressure to prevent cave-ins. The tunnel lining consists of steel and cast-iron segments. The tunnel roadway surface elevation varies from about 60 feet below the water surface at the shorelines to about 100 feet at the center of the river. The tubes are generally located in the highly compressible organic silt layers of the river bottom. There are three ventilation buildings for the tunnels on the east side of the river. One building is at the bulkhead line near West 39th Street, another building is near 12th Avenue and West 38th Street, and the third building is near West 39th Street and 11th Avenue.

Soils and Geology

In January 1972, the Bureau of Soil Mechanics of the State of New York Department of Transportation undertook a soils study for the Project area. This work included obtaining available information such as existing boring logs and previous soil reports. In addition to the existing data, a boring program was undertaken in which soil samples were obtained in the Project area. These samples were studied and tested to determine the characteristics and properties of the soils.[1]

Soil Profiles

The soils in the Hudson River are composed of bedrock, glacial till, sand deposits, and organic silt. Each stratum of material varies radically both in depth and thickness. Illustration 2-6 shows a soils profile taken 100 feet east of the pierhead line and also sections showing the soil and rock configuration between West Street and the pierhead line.

Soils Profile West of U.S. Bulkhead Line. The bedrock surface undulates from about 40 to 50 feet below mean low water (MLW) at the southern end of the project corridor to a maximum depth of about 320 feet MLW in the vicinity of West 15th Street. The surface of the rock rises to about 60 feet below MLW at the northern end of the corridor. The rock is classified as a mica schist (Manhatten formation). It is highly folded and forms ridges, with the major axes trending generally north-south. The rock dips generally west from the bulkhead line, often at a very steep slope.

A glacial drift composed primarily of red or gray glacial till overlays the rock. This till is thickest in the rock valleys, on the rock ridges, the layer is very thin or non-existent. The red glacial till was deposited by ice moving in from the west; and the older gray till was deposited by ice moving in from the north. The red glacial till is basically composed of red and brown sand, silt and gravel, with boulders; the gray glacial till is composed of gray sand with a trace of silt and of gravel with boulders.

Above the glacial till is a varying layer of post-glacial sand deposits, with components of silt and gravel. This layer is found north of Canal Street and is of limited thickness.

The organic silt is a sediment which settles out of the river water and is deposited to form a very loose soil matrix. Eventually, as more sediment is deposited, the soil consolidates under its own weight. This type of recent deposition is one that has never been subjected to any loading other than the weight of the overlying material and is a normally consolidated soil deposit.

Two layers of organic silt can be recognized. The lower portion is layered with fine sand silt varves, while the upper 20 to 80 feet is composed of very soft gray organic material with a trace of sand, shells, and miscellaneous fill. The uppermost portion of the silt is still in a colloidal condition and is characterized by its black color, a high percentage of oil and other pollutants derived from the outflow of storm drainage directly into the river, and a very high corrosivity

[1] Preliminary Soils and Foundation Study for Interstate Route Connection 518—West Side Highway—From the Battery to 42nd Street, State of New York, Department of Transportation, Soil Mechanics Bureau.

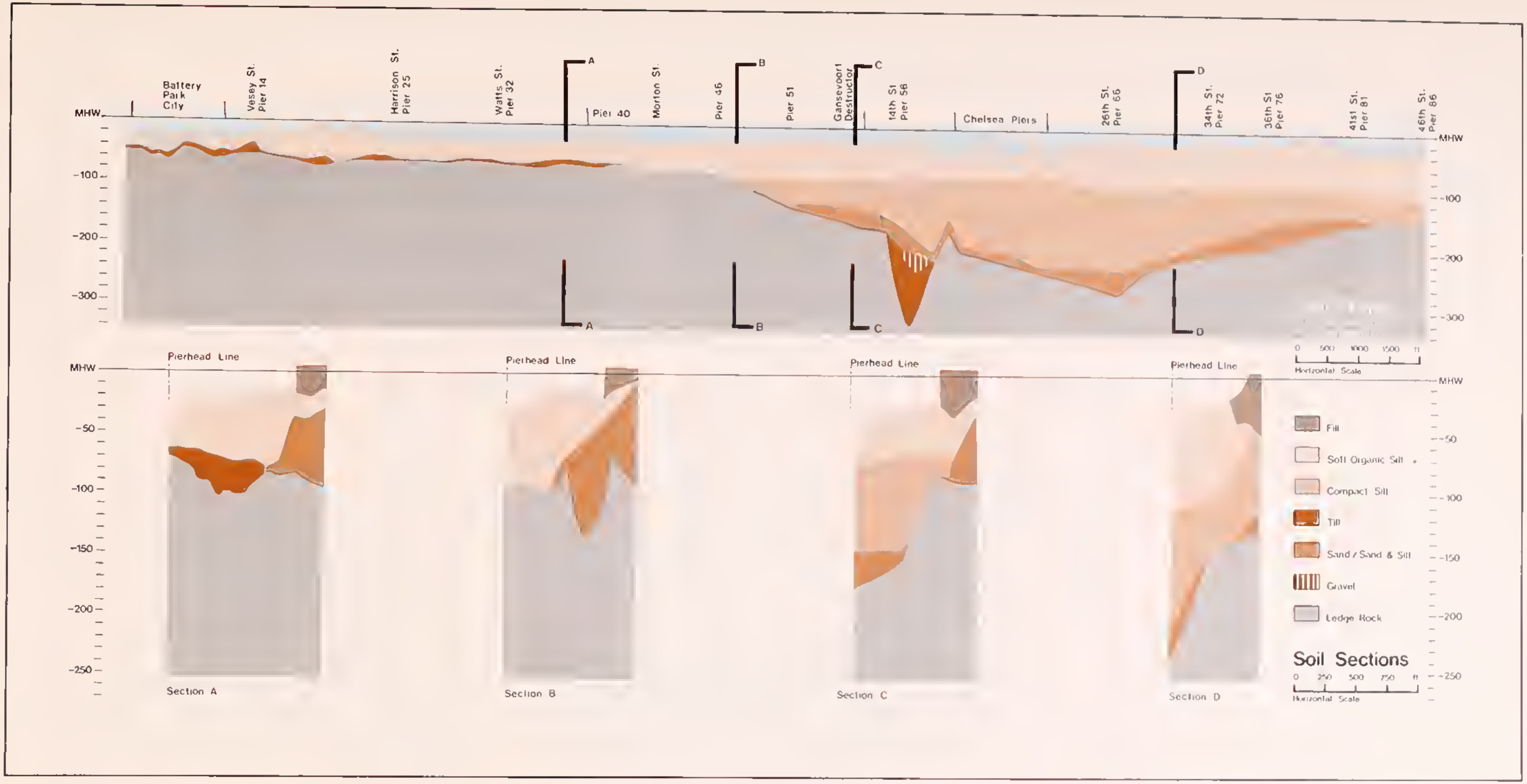
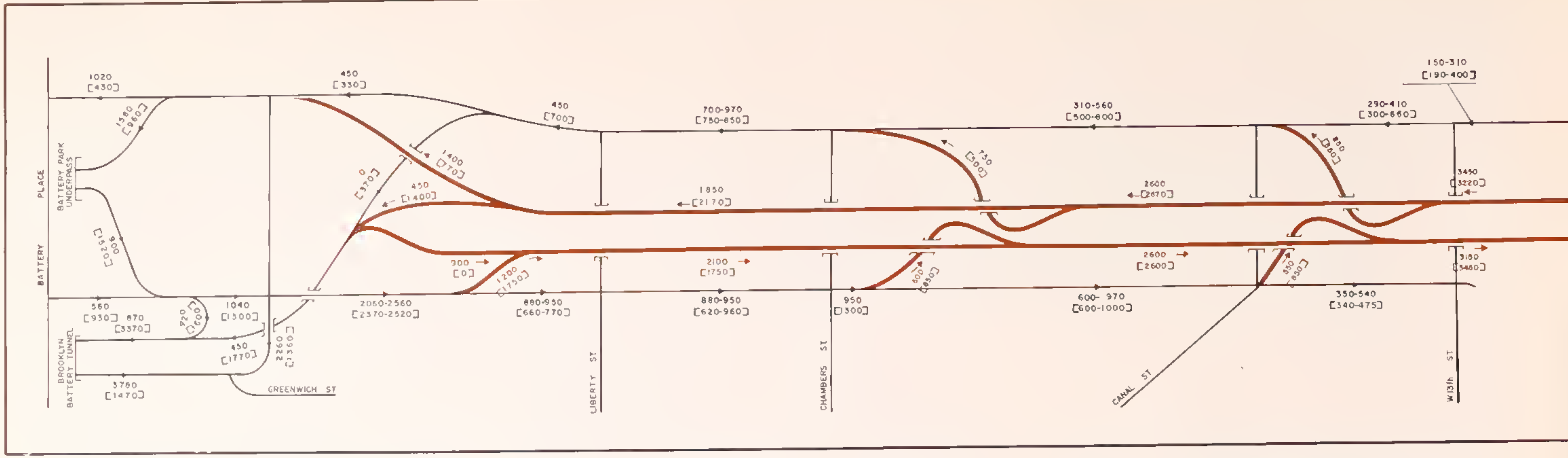


Illustration 2-6 Soil Profile and Sections

100 feet east of the pierhead line



The silt stratum varies in thickness in a manner similar to the glacial till at the southern end. Where the rock is high, the silt layer is as thin as 5 feet. Its thickness increases to as much as 200 feet in the area between West 17th and West 30th Streets and then decreases to about 100 feet at the northern end of the corridor.

Soils Profile East of the U.S. Bulkhead Line. The soils profile is similar on both sides of the bulkhead line, but the soil east of the bulkhead line is topped by a layer of fill. Added as Manhattan expanded westward, the fill consists generally of a mixture of fine and granular soil, rock, wood, and concrete and steel fragments of demolition. The fill also contains numerous timber cribbings, piles and old masonry walls which were part of the former waterfront structures.

Engineering Properties of the Soil Layers. The deeper strata have the better engineering properties. The deepest, which is bedrock, is competent to support very heavily loaded caissons. The glacial till is of sufficient density to support moderately to heavily loaded piles. Of the two layers of organic silt, only the lower one can be counted on to provide support for piles, provided that some settlement of the piles can be tolerated. Any loading applied to this layer will cause it to consolidate and settle. The upper organic silt layer is worse in this regard. Its uppermost part, which varies in thickness, is in a semi-liquid state and is not capable of supporting any type of loading. If a load is to be applied at this level, this portion of the organic silt would have to be removed and replaced with a suitable fill.

1972 Base Year Traffic

All available traffic counts were assembled, and an extensive traffic counting program was undertaken to provide information on actual volumes in 1972. Included were automatic machine counts as well as manual classification counts to indicate passenger car and truck volumes during morning and evening peak periods and off-peak periods as well as 24-hour volumes of total traffic.

The count data were used to prepare traffic maps which indicate 1972 traffic on the West Side Highway and major streets in the Project Impact Area. Illustration 2-7 is schematic diagram indicating 1972 AM and PM traffic volumes on the existing West Side Highway south of 42nd Street, West Street, 12th Avenue, and major intersecting streets. These counts and estimates reflect the traffic conditions prior to the closing of portions of the West Side Highway in December 1973.

The estimates shown on West Street/12th Avenue are intended to represent typical peak-hour volumes on each link which do not necessarily occur simultaneously during any particular hour. There are two sets of traffic figures shown for West Street. These numbers represent the low and the high volumes estimated to occur between the several local streets which intersect between the major cross streets shown on the schematics. These numbers reflect the changes in volume caused by traffic turning on and off West Street from and to the local streets between the major cross streets shown.

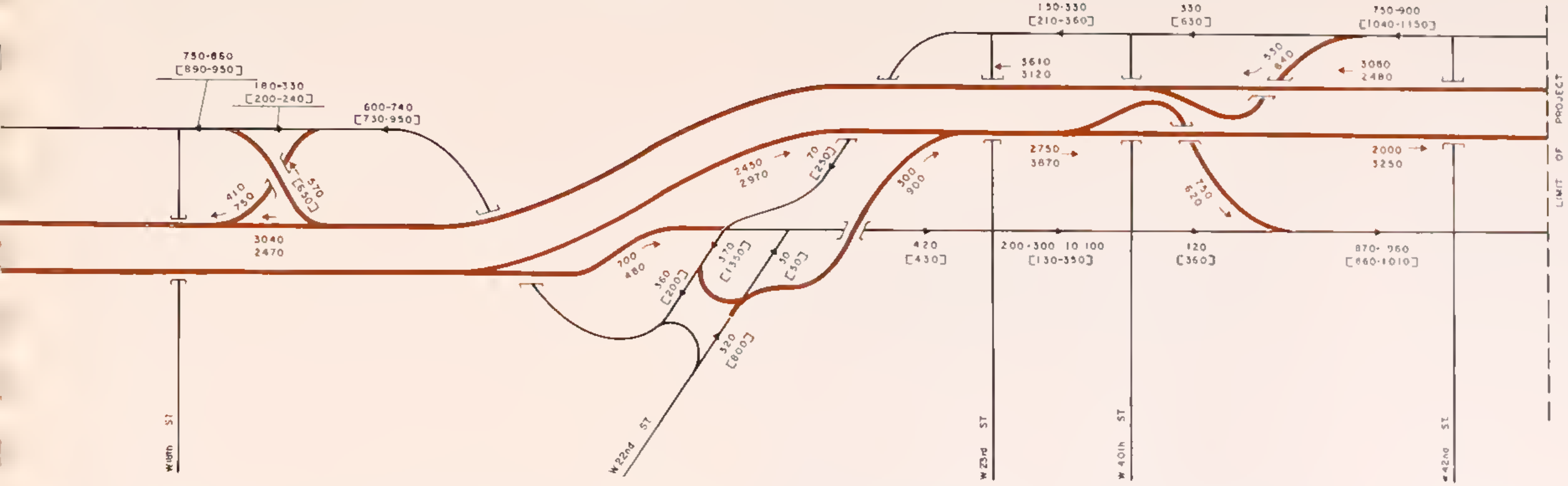


Illustration 2–7

1972 Base Year Traffic Volumes
Traffic Schematic

Highway Mainline and Ramps

West Street 12th Ave. and Major Cross Streets

3000 AM Volume

[3000] PM Volume

As an example, the set of figures shown in Illustration 2-7 for 1972 northbound traffic between Liberty and Chambers Streets means that the lowest traffic volume between two local streets in this section during the AM peak hour was 880 vehicles. The high volume between two local streets in this section was 950 vehicles. Similarly, during the PM peak hour, the volume ranges from 610 to 960 vehicles.

The schematic shows the roadways in correct relative positions, but they are not drawn to scale. The traffic capacity of the West Side Highway at 1972 base year levels prior to its closure was 4200 passenger car equivalents per hour in each direction on the full-width mainline sections. Heavy trucks were prohibited from using the Highway.

Southbound traffic in the AM peak hour was 3080 cars at 42nd Street which was joined by 530 from the 42nd Street entrance ramp to become 3610 in the section north of the 18th Street exit. At 18th Street, 570 cars exited and 410 entered resulting in 3450 vehicles on the highway. From this point south the volumes diminished as vehicles exited at Canal Street, Chambers Street, Battery Place, Battery Park Underpass, and Brooklyn Battery Tunnel. Low operating speeds were prevalent through the sharp curves at 23rd Street and 12th Street and queuing on the roadway approaching those sections was common.

Southbound in the PM peak hour, the volumes were lower than in the AM peak hour in all sections north of Canal Street, but higher south of the Canal Street exit, with the increase in volume destined for the Brooklyn Battery Tunnel. Queuing occurred frequently at the tunnel approach, caused by lack of capacity of the tunnel and its approach roadway system.

Northbound in the PM peak hour the volume on the mainline was 1750 in the World Trade Center area. This was joined by 850 at Chambers Street and 850 at Canal Street, resulting in a volume of 3450 in the section between Canal and 23rd Street. At 23rd Street 480 exited and 900 entered increasing the mainline volume to 3870, its largest volume in the section under study. At 42nd Street, 620 cars exited leaving 3250 at the Project limit. Low speeds and queuing were normally experienced in the PM peak along the entire northbound roadway north of Canal Street, resulting from poor operations through the sharp curves and inadequate roadway capacity to the north.

Northbound in the AM peak hour, the volumes from the Brooklyn Battery Tunnel and on the roadway south of Chambers Street were higher than in the PM peak. North of Chambers Street, the volume of 2600 vehicles was equal to the PM, and from Canal Street north to 42nd Street the AM volumes were lower than during the PM. The AM volumes were within the roadway's capacity, and flow was satisfactory except at the sharp curves where low speeds occurred.

West Street/12th Avenue had capacity to accommodate the AM and PM peak hour traffic at most locations during 1972, with the exception of the 13th to 23rd Street area where the northbound road was not continuous. Congestion at local points was caused by intensive use of the roadway for truck loading, parking, and maneuvering, particularly in the section between Chambers and 13th Streets.

Utilities

The many utilities within the limits of construction include sewers, water mains, steam lines, gas mains, telephone ducts and electric lines. In addition, there are major facilities, such as the World Trade Center, which have their own unique utility systems.

Sewers. Combined sewers, which are in an east-west direction, cross West Street, 11th Avenue and 12th Avenue and discharge into the Hudson River at the bulkhead line. These sewers range from 8-inch diameter pipe to 8-foot by 5-foot rectangular brick sewers. Two major interceptor sewers have been constructed in West Street, 11th Avenue and 12th Avenue which are not yet operational. One interceptor sewer system will serve the drainage area between West 11th Street and the Brooklyn Battery Tunnel. The flow will be discharged through a 6-foot diameter concrete pipe to the Manhattan Pumping Station located in the Bellevue Medical Center area. The other interceptor sewer system will serve the drainage area between Bank Street and the North River Treatment Plant at 145th Street. The flow will discharge through a 30-inch diameter pipe at Bank Street, the size of this interceptor increases to an 8-foot by 6-foot box sewer at 42nd Street. The sewers have regulator and diversion chambers as well as access manholes. The interceptor sewers will remove the dry-weather flow and a portion of the storm water flow. The excess flow during storms will be discharged through outfalls west of the interceptor sewers into the river. The sewer outfalls are located at intervals along the corridor at each regulator chamber. In each regulator chamber, a tide gate is provided to protect the local combined sewer collection system from flooding. The outfall sizes range from 4 feet in diameter to 6-foot by 11-foot box sewers.

Gas. Gas mains, including manholes, regulators, drip traps and pumping standpipes, are located near the east property line in West Street. Gas mains in the corridor are 4 inches and 6 inches in diameter, and are classified as medium pressure.

Steam Lines. Steam Lines coming from Rector Street, King Street, and 15th Street terminate in West Street. There are no steam lines running the length of the corridor.

Water. Water main systems in the corridor are both low and high pressure. The high pressure system provides fire protection water while the low pressure system services pier facilities and buildings located on either side of West Street. The sizes vary from 6 to 30 inches in diameter. Included in the system are valve chambers, gate valves, pressure-reducing valves, and hydrants.

Electric. Electric power lines are located throughout the corridor to provide power to both sides of the City and waterfront facilities. In addition, there are two 10-inch diameter steel pipes crossing the river in the vicinity of North Moore Street. One of the pipes carries a 345-kilovolt cable, the other pipe is empty and is reserved for future use.

Telephone. Telephone lines including splice chambers and terminal boxes are located throughout the corridor.

World Trade Center Facilities. Existing World Trade Center air-conditioning facilities cross West Street and connect to a pumping station near the river. The facilities comprise two 60-inch steel pipes, two 20-inch precast concrete cylinder pipes, a 36-inch ductile iron pipe, and an electric duct bank.

Section 3 - Design Parameters

Introduction

The engineering design parameters used to develop the Modified Outboard Alternative are divided into the following categories

- Geometrics
- Drainage
- Utilities
- Structural
- Ventilation
- Tunnel Finishes
- Lighting

The parameters incorporated the standards of the New York State Department of Transportation (NYSDOT), the American Association of State Highway and Transportation Officials (AASHTO), the Federal Highway Administration (FHWA), the New York City Transportation Administration (TAD), and the criteria of other agencies of jurisdiction where applicable These were supplemented or amended to accommodate special problem areas

In addition to the parameters given in this section, Section 4—Aesthetics presents other requirements for the development of alternatives

The environmental requirements for air, noise, and water quality are given in detail in the Final Environmental Impact Statement and Technical Reports

Geometrics

The Modified Outboard Alternative includes the Interstate Highway with its connecting roadways, ramps to local streets, city streets, and arterial roadways Each of the elements has a unique set of geometric requirements The values were based on functional characteristics, higher values were used wherever possible

Interstate Mainline

The Modified Outboard Alternative has been designed as Class Urban-1 modified to Interstate Standards

Design Speed. The minimum design speed was 50 mph The desirable design speed was 60 mph

Sight Distance. The stopping sight distance for 50 mph was 350 feet The stopping sight distance for 60 mph was 475 feet

Superelevation. Superelevation was in accordance with Table 3-2 of the NYSDOT Highway Design Manual, Vol. 1, with a maximum rate of 0 08 foot per foot

Horizontal Alignment. The maximum allowable curvature was 5 degrees in conjunction with an 0 08 superelevation

Vertical Alignment. Maximum gradients were 3 percent desirable, 5 percent absolute Minimum gradient was 0.5 percent

Cross-Section Elements. All mainline lanes and parallel auxiliary lanes were 12 feet wide Stabilized shoulders were 12 feet wide on the right and 6 feet on the left for three through-lane roadways In covered sections, the shoulders were 10 feet wide on the right with a raised safety walk adjacent to the shoulder, and on the left a shoulder 3 feet wide with a raised safety walk adjacent. On grade, the normal cross slope was 1/4 inch per foot for the pavement and 1 inch per foot for the shoulders On structure, the normal cross slope was 1/4 inch per foot for the pavement and shoulders

Vertical Clearance. The clear height of structures was designed as a minimum of 14 feet 6 inches over the entire roadway width, including the usable width of shoulder In covered sections, minimum vertical clearance to the soffit of the roof was 18 feet to allow for the installation of signing and traffic controls

Horizontal Clearance. Overpasses (mainline over) had a clearance from edge of through-travel lane to railing equal to the width of the shoulder of the approach highway Underpasses (mainline under) had a clearance of 15 feet from edge of through-travel lane with introduced guide rail Where a median barrier is used, the clearance was the width of the approach shoulder plus the width of the barrier Covered roadways had a clearance on right and left equal to the width of the shoulder plus the width of the safety walk

Connecting Roadways (Interstate Ramps)

The connecting roadways were defined as direct connection ramps between Interstate roadways Examples of this were the roadways from the mainline of the Project (Interstate 478) to the Lincoln Tunnel (Interstate 495)

Design Speed. The minimum design speed was 30 mph

Sight Distance. The stopping sight distance for 30 mph was 200 feet. As the length of the radius increases, longer sight distances were provided as follows:

ramp radius (ft.)	stopping sight distance (ft.)
230	200
310	240
430	275
550	315
690	350

Superelevation. Superelevation was designed in accordance with Table 3-2 in the NYSDOT Highway Design Manual, Vol. 1, with a maximum rate of 0.08 foot per foot.

Horizontal Alignment. The minimum radius of curvature was 230 feet in conjunction with a superelevation of 0.08 foot per foot. The ramp alignment adjacent to the Interstate mainline was compatible with the Interstate alignment. A minimum length of acceleration lane of 1350 feet from ramp nose to end of taper was used. Shoulder width was provided adjacent to these lanes as shown in Figure 6-O of NYSDOT Highway Design Manual, Vol. 1. A minimum deceleration lane of 670 feet from beginning of taper to ramp nose was provided. Shoulder widths adjacent to these lanes were as shown in Figure 6-N of NYSDOT Design Manual, Vol. 1.

Acceleration and deceleration lanes on gradients exceeding 3 percent were adjusted as per Part III, Chapter J of "A Policy on Design of Urban Highways and Arterial Streets" (1973) by AASHO.

Ramp distances between successive ramp terminals have been designed in accordance with Figure 6-P of NYSDOT Highway Design Manual, Vol. 1.

Weave lanes were designed in accordance with Chapters 7, 8, and 9 of the Highway Capacity Manual (1965) Highway Research Board Special Report 87.

Vertical Alignment. Maximum gradient was 5 percent. Minimum gradient was 0.5 percent.

Cross Section Elements. In general, one-lane roadways had a 15-foot roadway and two-lane roadways had a 24-foot roadway. Stabilized shoulders were 6-1/2 feet wide on the right and 3-1/2 feet wide on the left in the direction of traffic with a raised median barrier adjacent to the shoulder. Pavements were widened for curvature in accordance with Table 3-3 of NYSDOT Highway Design Manual, Vol. 1.

Vertical Clearance. The clear height of structures was designed as a minimum of 14 feet 6 inches over the entire width of pavement and usable shoulders. The immediate approaches to the four existing tunnels conformed to the vertical clearance provided in each tunnel.

Horizontal Clearance. Overpasses (connecting roadway over) had a clearance from edge of through-travel lane to parapet equal to the width of the approach shoulder area. Underpasses (connecting roadway under) had a clearance on the right of 6-1/2 feet plus the width of the median barrier. Clearance on the left was 3-1/2 feet plus the width of the median barrier.

Ramps to City Streets

In general, ramps to city streets were designed to operate at low speeds with traffic controlled termini at the city streets. The design adjacent to the interstate road was identical in all respects to that of the connecting roadways. Sufficient body of ramp was provided to decelerate to the design condition of the terminus.

Design Speed. The minimum design speed was 25 mph.

Sight Distance. The stopping sight distance for 25 mph was 160 feet. The sight distance was reduced as curvature restricts the operating speed, in accordance with Table J-3 AASHO, A Policy on Design of Urban Highways and Arterial Streets.

Superelevation. Superelevation has been designed in accordance with Table 3-2 in the NYSDOT Highway Design Manual, Vol. 1, with a maximum rate of 0.08 foot per foot.

Horizontal Alignment. The desirable minimum radius of curvature was 150 feet.

Vertical Alignment. Maximum gradients were 5 percent on upgrades, 7 percent on downgrades. Minimum gradient was 0.5 percent.

Cross Section Elements. Ramps to local streets had a 15-foot roadway with stabilized shoulders 6-1/2 feet right and 3-1/2 feet left, for an overall width of 25 feet or a total width of ramp pavement in accordance with Class II-B or III-B shown on Table 3-3 NYSDOT Highway Design Manual, Vol. 1.

Intersection Design. Design of intersections was developed in accordance with the guidelines of Chapter 5 of the NYSDOT Highway Design Manual, Vol. 1, and Chapter J of AASHTO, A Policy on Design of Urban Highways and Arterial Streets.

Vertical Clearances. The clear height of structure was a minimum of 14-1/2 feet above the entire width of roadway and usable shoulder.

Horizontal Clearance. Clearances from the edge of the traffic lane to obstructions or parapets were equal to the width of the approach-shoulder area. All obstructions and parapets were faced by median barriers.

City Streets

City streets, including West Street, conformed to the requirements of the New York City Transportation Administration (TAD). In general, the city streets were designed as 25 mph thoroughfares with parking areas, sidewalks, and traffic-controlled intersections.

Design Speed. The minimum design speed was 25 mph.

Sight Distance. The stopping sight distance for 25 mph was 160 feet.

Superelevation. No superelevation was used on city streets.

Horizontal Alignment. A minimum radius of curvature of 280 feet was used.

Vertical Alignment. Criteria for maximum gradients is not truly applicable since all gradients are less than 1.5 percent. Minimum gradient was 0.3 percent at the gutter.

Cross Section Elements. The desirable width of lane was 12 feet. Width of parking area or shoulder was 10 feet. Left or right turning lanes were a minimum of 12 feet wide.

Intersection Design. Design of intersections was in accordance with the guidelines in Chapter 5 of the NYSDOT Highway Design Manual, Vol. 1, and Chapter J of AASHTO, A Policy on Design of Urban Highways and Arterial Streets. The streets were crowned in accordance with the standards of TAD.

Vertical Clearance. The clear height of structure was maintained at 14-1/2 feet over the entire roadway, including the usable shoulders. The clear height of structure over sidewalk areas was 10 feet.

Horizontal Clearance. Overpasses (city streets over) included the full width of street, including sidewalk carried across the structure. The face of parapet was the back of sidewalk. Underpasses (city street under) were located with all walls or abutments beyond the back of sidewalk or street line. Piers or columns were set back from the curb lines a minimum of 5 feet on the right and 3-1/2 feet on the left.

Drainage

The removal and disposal of storm water from all roadways were designed to be environmentally acceptable to maintain safe operating conditions on all roadways and for uninterrupted service for existing drainage systems. All water was collected in a closed system and outfalled through special basins to minimize the flow of pollutants into the Hudson River

Design Storm

The drainage system was designed to provide for the rainfall intensity of a storm which would occur once in 10 years. The drainage systems at trapped underpasses and depressed roadways were designed for the rainfall intensity of a storm that would occur once in 50 years Covered roadway sections were designed to drain the water used in cleaning and in fighting fires

Drainage System

Drainage and construction details were in accordance with NYSDOT standard sheets, directives, and design data sheets, supplemented, as needed, by the construction details of the New York City Department of Water Resources, Bureau of Water Pollution Control

Minimum size of pipe was 15-inch diameter when located under roadway pavements. Minimum velocity was self-cleansing. Maximum velocity was 12 feet per second Low points were drained by three inlets

The spread of water on all roadways was confined to the shoulder area or parking lane On roadways without shoulders or parking lanes, the spread of water was limited to one-half of the outer traffic lane.

Utilities

The parameters for designing relocations, alterations, and modifications for existing utilities were in accordance with the regulations of the agencies and companies involved. Each relocation, alteration or modification was treated on an individual basis The relocation, alteration, and modification of the municipally owned utilities requiring adjustment and falling within the limits of work of the West Side Highway were relocated under the jurisdiction of the following agencies:

Water Lines	New York City Department of Water Resources—Bureau of Water Resources
Sanitary Sewers	New York City Department of Water Resources—Bureau of Water Pollution Control
Fire Alarms	New York City Fire Department—Bureau of Fire Communications
Police Call Boxes	New York City Police Department
MTA (NYCTA) Communications	MTA

The relocation, alteration, and modification of privately owned utilities requiring adjustment are as follows:

Electricity	Con Edison Co. of New York
Gas	Con Edison Co. of New York
Telephone	Empire City Subway Limited
Telegraph	Empire City Subway Limited
Steam	Con Edison Co of New York

Structures

The parameters used for the design of the structural components of this Project shall conform to the following

- New York State Department of Transportation Standards for Bridges (Standard Specifications).
- Parameters of other agencies of jurisdiction where applicable These agencies included the Metropolitan Transportation Authority, and the New York City Transportation Administration
- Additional parameters developed to accommodate special structural problems

Loads

Dead Load. Bridges were designed to include the items listed in Article 1 2 2 of the Standard Specifications Covered roadways in the areas where there is no traffic on the roof were designed to sustain 4 feet of earth on the roof. Retaining structures were designed to include the loads produced by both the earth and the hydrostatic pressure produced by salt water at the following elevations. These elevations are based on data supplied by the Borough President of Manhattan.

Water Elevation	Water Level	Percent of Allowable Stress
-0 35	mean high	100
+8.00	extreme high	125
-8 85	extreme low	125

Retaining structures were checked for all levels of water and designed for the one producing the maximum stress

Live Loads. Mainline and ramp bridges were designed for the following

- For spans greater than 40 feet—HS20-44
- For spans 40 feet or under or for beam and girder spans 8 feet 10 inches or more—HS20-44 or two 24,000-pound axles spaced 4 feet apart, whichever is greater.

Roadway bridges other than mainline and ramp bridges were designed for an HS20-44 live load Pedestrian bridges were designed using the live loads given in the Standard Specifications Transit structures were designed in accordance with the requirements of the agency operating the particular transit system

Buoyancy

Depressed sections were designed for a negative buoyancy of 5 percent of the dry weight of structure with the water level at elevation +8 0 The weights to be included in computing buoyancy are the weight of the structure and the weight of the earth on top of any extension of the bottom slab that is bounded by the wall against which the earth rests and a vertical line from the edge of the extended slab The friction between the earth and wall was neglected

If uplift devices were used, they were checked for the maximum uplift load produced with the water level at elevation +8 0

Ventilation

The determination of the capacity and type of the ventilation system required for vehicular tunnels is dependent on many factors, each of which was investigated to determine its overall influence. The factors involved include the type of vehicle, type of fuel, weight of vehicle, number of vehicles per hour, speed of vehicles, length of tunnel, percent grade of roadway, and elevation of tunnel above sea level.

Consideration of the requirements for ventilation of a vehicular tunnel recognized two basic situations:

1. Normal operation of vehicles through the tunnel

2. Emergency conditions within the tunnel

(An emergency condition is one in which an accident or fire has occurred necessitating smoke removal and possible evacuation of vehicle occupants.)

Types of Ventilation Systems

Space was made available for ducts and fans along with the necessary electrical switchgear, controls, and additional ventilation systems selected. This space is generally dependent on the length of the tunnel and the type of ventilation. The types of ventilation systems described below constitute general guidelines reflecting currently accepted good engineering practices. They may be varied where specific situations or conditions warrant variations.

Tunnels up to 250 Feet. Natural ventilation, created by meteorological conditions and the piston action of vehicles moving through the tunnel displacing air in front of them, is normally sufficient and mechanical ventilation is not normally required.

Tunnels From 250 to 750 Feet. It is generally considered adequate for tunnels of this length to be provided with emergency mechanical ventilation only, and to rely on the piston action of the vehicles (as described previously) to provide ventilation under normal operating conditions.

Tunnels From 750 up to Approximately 2500 Feet. For tunnels in this range of length, a uniform semi-transverse distribution or collection of ventilation air is normally provided and may be achieved by one of the following methods:

- Uniform distribution of supply air through the tunnel, allowing the exhaust air to exit through the portals

- Uniform collection of exhaust air through the tunnel with replacement supply air entering through the portals

In urban areas the second method is often preferred because it provides the capability of collecting the contaminated air and discharging it at a point causing least concern from an external environmental standpoint.

Tunnels Over 2500 Feet. Full transverse mechanical exhaust and supply ventilation is frequently provided for tunnels exceeding this length. Air is uniformly supplied at low level along the length of the tunnel to mix with the pollutants, and then exhausted at high level and discharged to atmosphere by exhaust fans.

Covered highways in this Project will be provided with full transverse mechanical exhaust and supply ventilation, except for short covered portions of the Northbound Mainline between Laight and Vestry Streets and Ramp LT2 at the Lincoln Tunnel approach, where the piston action of moving vehicles and the meteorological conditions are considered to create sufficient natural ventilation.

Basis of Design

During their normal operation through the tunnel, vehicles emit products of combustion which contain contaminants such as carbon monoxide, carbon dioxide, oxides of nitrogen, unburned hydrocarbons (particularly from diesel engines), and products of anti-knock lead compounds in gasoline. These emissions result in health hazards and in the generation of haze which affect safe vehicle operation if not removed.

Among the gasoline engine exhaust gases, the odorless and colorless carbon monoxide (CO) has been and still is the dominant toxic gas. By diluting it to a safe level, all the other toxic or irritant exhaust components have such a low concentration that a comfortable tunnel atmosphere is achieved.

The Federal Highway Administration issued a memorandum dated April 8, 1975 entitled, "Guidelines for Maximum Carbon Monoxide Level in Tunnels." Based upon these guidelines, the covered highway portions of this Project were designed to conform to a maximum operating CO concentration of 125 ppm.[1] The 125 ppm maximum CO level is applied when traffic is moving at 5 mph.

[1]ppm = parts per million

CO emission rates used in the ventilation design for the tunnel sections of the Project were calculated for 1976 traffic mix and the following traffic composition:

- 85% gasoline-powered passenger cars
- 5% light-duty gasoline trucks (weight under 8500 lbs.)
- 4% heavy-duty gasoline trucks (weight under 8500 lbs.)
- 6% buses and heavy-duty diesel trucks

Calculation of the CO emission rates was based on the method given in Supplement No. 5 for Compilation of Air Pollutant Emission Factors, Second Edition, published by the U.S. Environmental Protection Agency in December 1975. Correction factors were applied for 5-mph vehicle speed, percentage of hot/cold passenger vehicle operation, and 60°F ambient air temperature.

Application of these correction factors to the method described in Supplement No. 5 resulted in the following design emission rates for the various vehicle types:

- Gasoline-powered passenger cars - 137 grCO/mile[2]
- Light-duty gasoline trucks - 161 grCO/mile
- Heavy-duty gasoline trucks - 583 grCO/mile
- Buses and heavy-duty diesel trucks - 34 grCO/mile

The calculated ventilation rates required to satisfy the criteria described above were corrected (increased) to allow for an ambient air CO concentration of 6 ppm prevailing at the 1985 opening year.

It should be noted that CO emission rates for 1976 traffic mix are well above those projected for the traffic mix of 1980 and later years. However, at this point it is not known what the maximum permissible pollution levels in tunnels will be in the future. It is possible that the maximum allowable level of pollution in the tunnels will be reduced as the emission rates are reduced. Therefore, using published, present-day emission rates and allowed levels of pollution concentration is considered to be the proper approach in designing the ventilation for the tunnel sections of this Project.

The above parameters are based on the following assumptions:

- Maximum concentration should be reached only, and not be exceeded, under severe traffic conditions.
- Under normal traffic conditions, ventilation should be controlled to keep concentration below this maximum.

[2]grCO/mile = grams of carbon monoxide per mile

Air Velocity in Main Ducts

The selection of a suitable velocity is dependent upon several factors, but mainly on a consideration of first costs versus operating costs of the system. As velocities increase, fan horsepower and size increase and hence, operational costs. Studies indicate a velocity of 6000 feet per minute to be reasonable, and this value was not exceeded.

Location of Ventilation Ducts

Ventilation ducts for covered highways can be located over, under, or laterally adjacent to the roadway. In the use of a cut-and-cover section, as intended for the West Side Highway, the location of the ventilation duct was subjected to an analysis. Ducts placed alongside the roadway were found to be the most economical.

Another major advantage of placing ducts along the side of the roadway is that the profile can be kept up as high as possible, reducing ramp lengths and base slabs for the open depressed sections.

For these reasons, location of the vent ducts adjacent to the roadway has been adopted for this Project.

Ventilation Buildings

The ventilation structures for the covered highways were located in areas that are compatible with the surrounding land use.

Environmental studies were made to determine the heights of the stacks and the effect of exhausting the pollutants from the ventilation building to the surrounding area. This data is included in the Environmental Impact Statement.

Support System

The air distribution was through a full-transverse ventilation system for all fully enclosed tunnel sections.

The facility's electric power system was designed to have two independent full-capacity feeders from separate utility sources. This type of power system provides sufficient power for continuous maximum fan operation should one feeder fail. Should the tunnel fans become inoperable for any reason, the tunnel will have to be closed to all traffic.

The entire facility will be provided with an adequate fire protection system. The fire protection for the covered highway has been discussed with members of the New York City Fire Department, and their recommendations have been incorporated in the study. A wet fire main in the tunnels and a wet standpipe and hose station system at each building will be installed. A deluge system was provided for all exhaust fans to minimize damage to fan equipment and to keep the fans in operation during the exhausting of hot combustion gases in an emergency.

Control systems are recommended for all mechanical and electrical equipment. Ventilation system controls can be manually operated from both local and remote control points. The master control facility located in one ventilation building can be the control point for all tunnel sections on the highway. The main control panel will include manual stop-start pushbutton and fan running lights for each fan, an indicating light for the open position of each fan damper, recorders to monitor CO levels throughout the tunnel; and audible alarms for high CO level and high haze concentration within the tunnel, fan failure, and high temperature within the tunnel due to fire.

Adequate communication systems, CO analyzers, and haze detectors will be installed.

Interior Tunnel Finishes

The interior tunnel finishes conform to acceptable aesthetic standards, public safety, and economical cost. The materials provide corrosion and fire resistance, ease of maintenance, durability and reflectivity, and noise attenuation.

Tunnel finishes are subject to unfavorable environmental conditions such as vibration, fire, dampness, corrosive automotive exhaust gases, and continuous attrition due to washing with detergents, brushes and high-pressure water jets.

Frequent, high-quality maintenance cannot always be depended upon. Therefore, selection of materials with impervious surfaces that resist wear and soiling will tend to compensate for maintenance deficiencies.

All materials used for interior tunnel finish should be non-flammable and free from toxic gas or smoke emission during and after installation.

Recommendation

The sidewall finish selected was ceramic tile, and the color will be an off-white or light yellow. The ceiling is the uncovered soffit of the structural concrete roof, or where necessary, a noise absorbtion system will be incorporated in the ceiling.

Lighting

The Project will be lighted for its entire length. Each of the following elements of the highway requires a specific type of lighting arrangement.

- Mainline roadway, ramps, and busway
- Arterial and local streets
- Signs

Illumination Levels

Open Main Line Highway Ramps and Busways. An illumination level of 0.6 foot-candles was used because of the confined alignment and variety of roadways (elevated, at-grade, depressed, covered).

A transition from 0.6 foot-candles at a point approximately 500 linear feet from a tunnel exit or entrance, to 10.0 foot-candles at the tunnel portal, was provided.

Covered Main Line, Ramps and Busways (Tunnels). The illumination levels in foot-candles for these are as follows.

	Threshold Zone	Transition Zone	Interior Zone
Daytime	620	80	10
Nighttime	10	10	10

Frontage Roads and City Streets. Frontage roads and city streets are illuminated to 1.0 foot-candles, horizontal on the roadway.

Signs. Externally illuminated overhead traffic signs have a minimum average level of illumination of 20 foot-candles, with a ratio of maximum to minimum point not to exceed 5 to 1.

Back-lighted case signs have a luminance of 400 to 500 foot Lamberts properly diffused to prevent hot spots.

Section 4 - Aesthetics

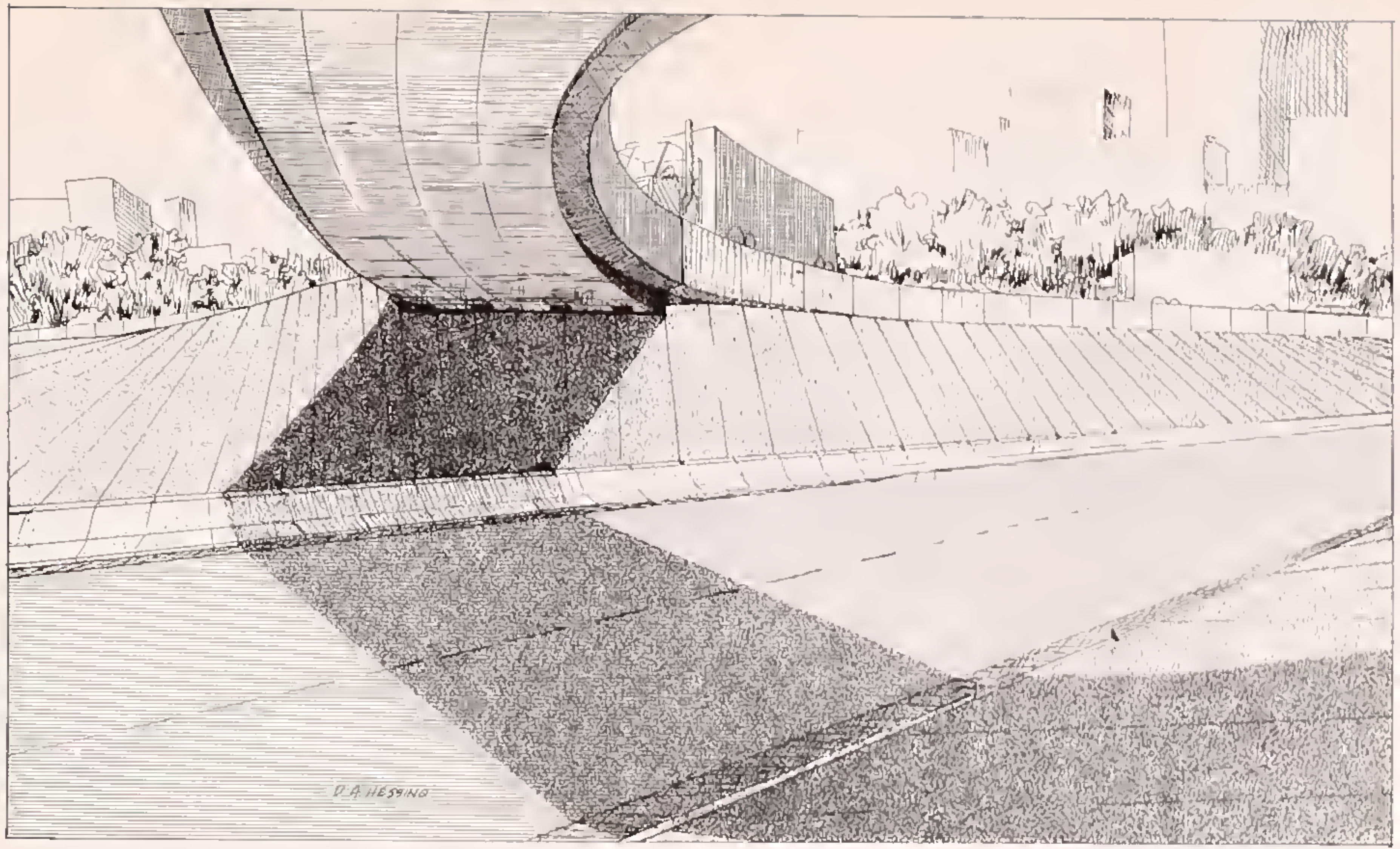


Illustration 4–1. Material compatibility and highway continuity, Holland Tunnel Plaza Interchange

Introduction

One of the most important efforts in planning the West Side Highway transportation facility was to maintain compatibility with neighborhood environments and to further project goals and objectives, while complying with Federal Interstate Highway standards. To accomplish this, a Design Control Committee consisting of architects, urban planners, engineers, and city, state, and federal representatives was formed. Of particular importance to the Committee in reviewing project planning and design were consideration of social, environmental, and economic factors, including significant impacts associated with the Modified Outboard Alternative, and consideration of optimum use of the potential for development of waterfront and other facilities with the design of the transportation facility so as not to preclude such use.

This section of the Project Report provides both the framework for detailed design work, to ensure systemwide consistency throughout the project corridor, and a record of design intent. Formal design concepts have been adopted to minimize noise, pollution and other adverse effects, to integrate the roadway facility by means of its form, scale, and materials into the urban fabric of the city, and to design the facility to preserve and enhance the attractiveness of future development within the corridor.

Formal Design Concepts

Since neighborhoods and buildings in New York City assume greater significance within the fabric of the city than roadway elements, visible portions of the Modified Outboard Alignment will necessarily be viewed in the context of a man-made environment. Therefore, the design of individual components has made every effort to:

1. Adjust perceivable scale to the adjacent areas and uses
2. Avoid overly plastic shapes for "interest" in favor of simple, geometrically pure elements
3. Express linear, horizontal continuity rather than discrete elements

The design of the West Side Highway will respond to many individual conditions of cross section which require specific structural and geometric solutions. However, while accommodating these variations, the Modified Outboard Alternative has been designed as a single unified experience, with systemwide continuity of materials and detail. At the same time, physical compatibility between the reconstructed facility and present development activities has been a major design consideration. In addition, aesthetic compatibility between the reconstructed facility and the accessibility of adjacent residential areas has been studied to establish criteria to accommodate desirable interfaces between the facility and impacted areas.

In recognition of the importance of physical and aesthetic compatibility, alternative facility designs reflect a variety of efforts to ensure such compatibility. For example, in addition to other considerations, depending on the importance of visual or physical access to the waterfront in individual areas of impact, the facility has been depressed, elevated, or designed at grade. Further, wherever possible, ramp structures have been employed to define areas of different land use, where such uses are especially incompatible.

Of particular importance has been the use of earth embankments constructed in conjunction with elevated portions of the roadway, and employed to:

1. Buffer the overall view and minimize the apparent incongruity of scale of structure from surrounding at-grade areas
2. Accentuate the continuity of roadway direction for the driver in complicated interchange areas
3. Minimize the visible portions of retaining structures
4. Create a more attractive urban form as viewed from above and from surrounding buildings.

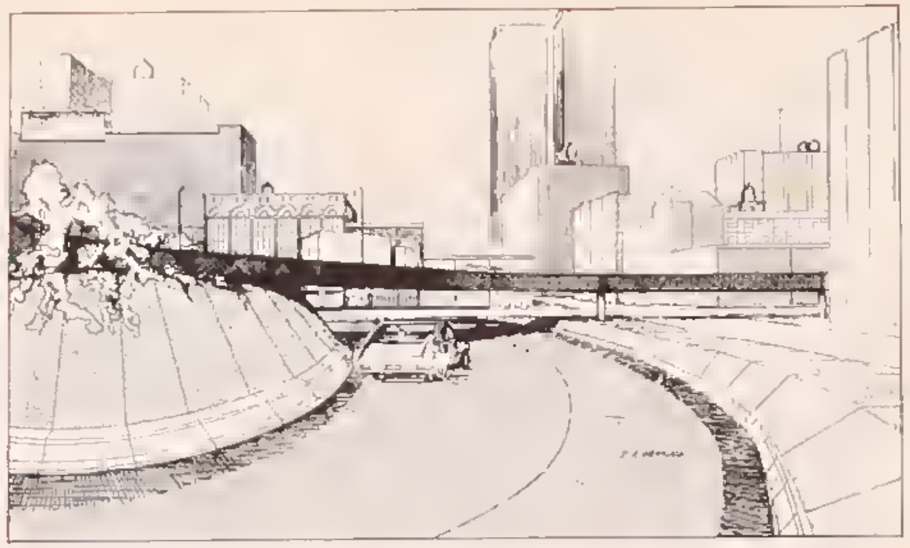
(Refer to Illustrations 4-1 and 4-2.)

How the reconstructed facility is perceived, its physical form and spatial context is defined by the systems design approach integrating roadway engineering principles of safety, efficiency, and geometry, local and community goals as set forth in the policy statements described in the Environmental Impact Statement, with an appreciable aesthetic practicality.

The Transportation Facility: Section and Structures

Whether the transportation facility is in depressed section, on elevated structure or transitioning from an at-grade condition, the configuration of the facility significantly affects the appearance of the city to its residents and to travelers along the facility or along local streets. The reconstructed transportation facility presents an opportunity to remove existing barriers and to enhance visual perspectives of the city and its western waterfront while improving the aesthetic and visual quality of West Street.

The facility and the surrounding areas through which it passes have been considered as integral parts of a single environment. Interchanges and areas of transition from depressed or at-grade section to elevated structure have been designed within a single systematic approach to the corridor employing consistent elements of roadway design.



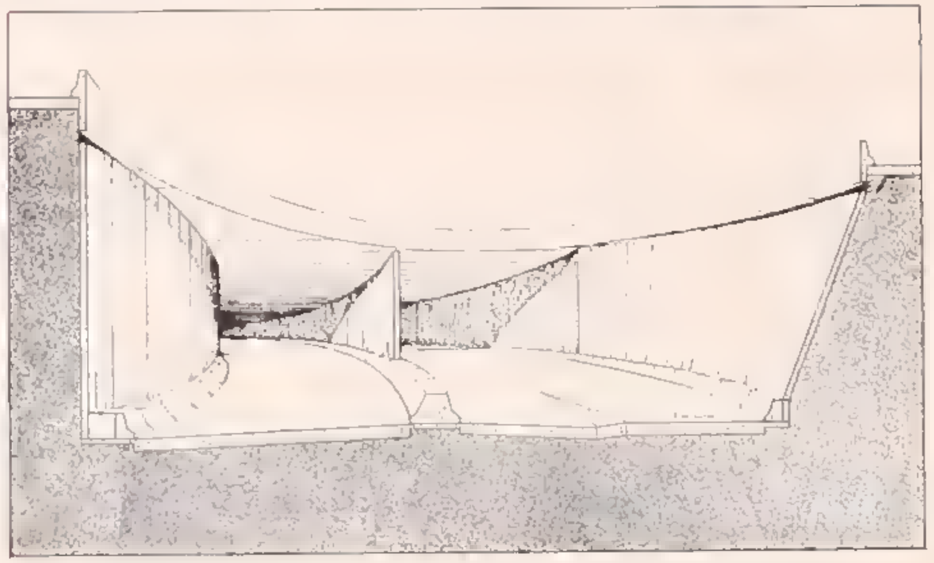


Illustration 4—2. Channelized driver experience, Holland Tunnel Plaza Interchange

Illustration 4—3. Battery Park Underpass Portal

This portion of the report discusses the transportation facility designed in depressed section, elevated on structure, interchange areas, and the relation to the West Street and roadway design elements.

The Facility in Depressed Section

Many portions of the Modified Outboard Alignment include depressed mainline roadways that are either open, partially covered, completely enclosed, or in transition to elevated structure. The designs for typical depressed sections take all conditions into consideration while maintaining continuity of the driver traveling in sequence through various cross sections. This has been accomplished by:

1. Establishing a uniform sidewall articulation for all conditions.

2. Forming the top of the sidewall as a continuous curve that follows grade conditions rather than as broken tangents or discontinuous stepped surfaces (Illustration 4-3).

3. Expressing open sections as cutouts in an implied ground plane, with the sidewall parapet as a separate edge to the ground plane that
   a. Runs parallel to the wall in open sections
   b. Slides out over the wall as the edge of cantilevered partial cover
   c. Crosses the mainline as the edge of overpass bridges
   d. Forms the top edge of covered section portals.
      (Refer to Illustrations 4-4, 4-5, and 4-6.)

4. Limiting the complexity of the visual experience to one comprehensive system used for grade crossings, covered deck structures, and cantilevered partial cover.

The structural requirements of depressed sections dictate the use of concrete for retaining walls and slab. In addition, sections of partial cover are cantilevered from the sidewall, thus requiring cast-in-place parapet and slab construction.

Since the edge of the ground plane around the depressed section is to be expressed as a uniform condition, all structures for cover and at-grade crossings are also in concrete.

Precast box girders used for straight covered sections and grade crossings provide a smooth underside, color, and surface texture compatible with the cast-in-place portions of cantilevers, curved structures, and irregular edge conditions.

To maintain consistent sidewall treatment throughout depressed sections, materials used appear to meet the visual criteria of both open and covered portions.

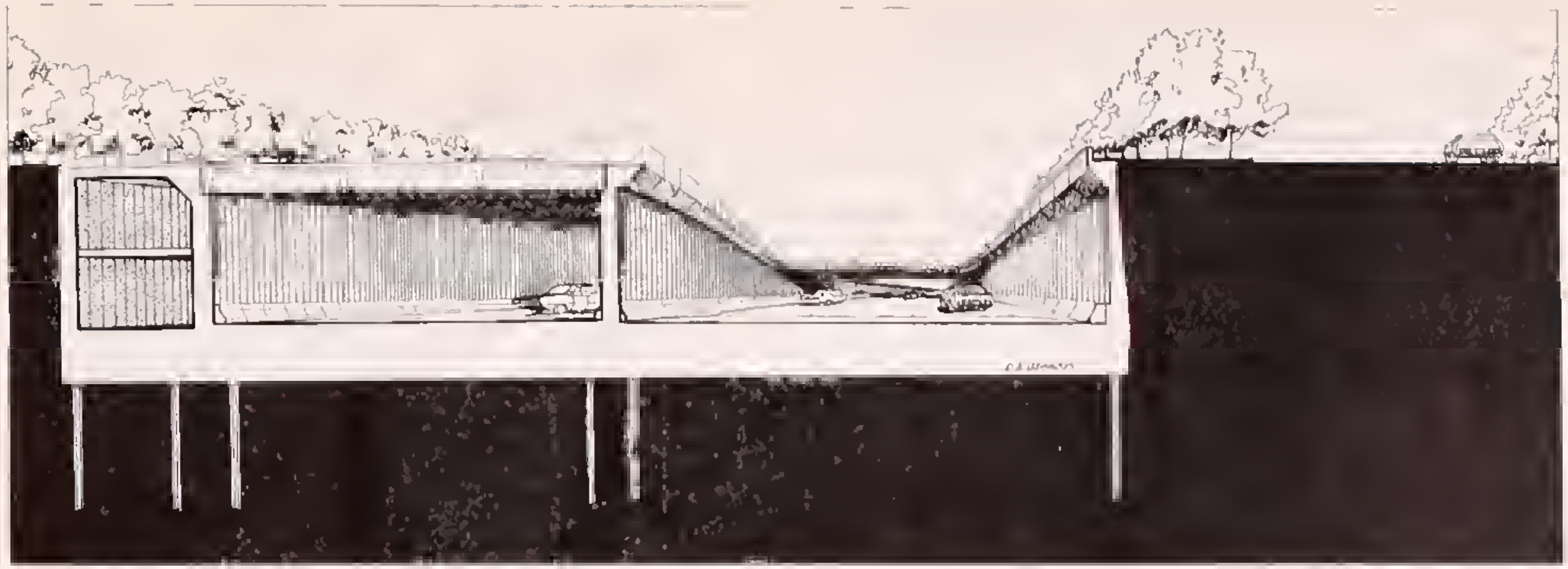


Illustration 4–5. Section view at Near Warren Street looking North

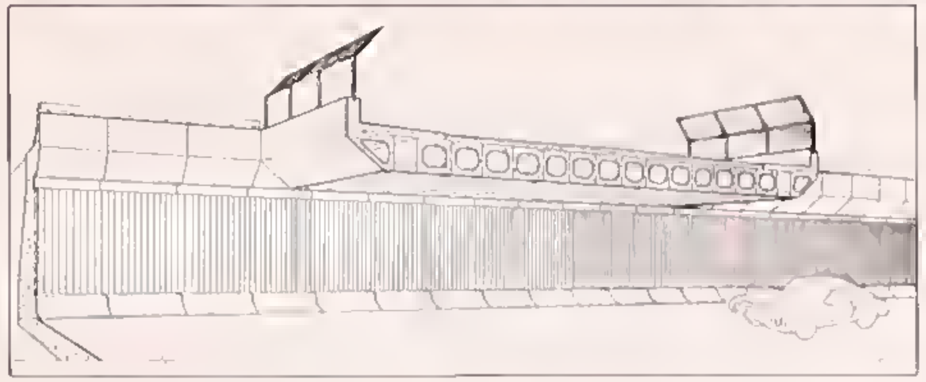


Illustration 4–4. Warren Street over Mainline Highway

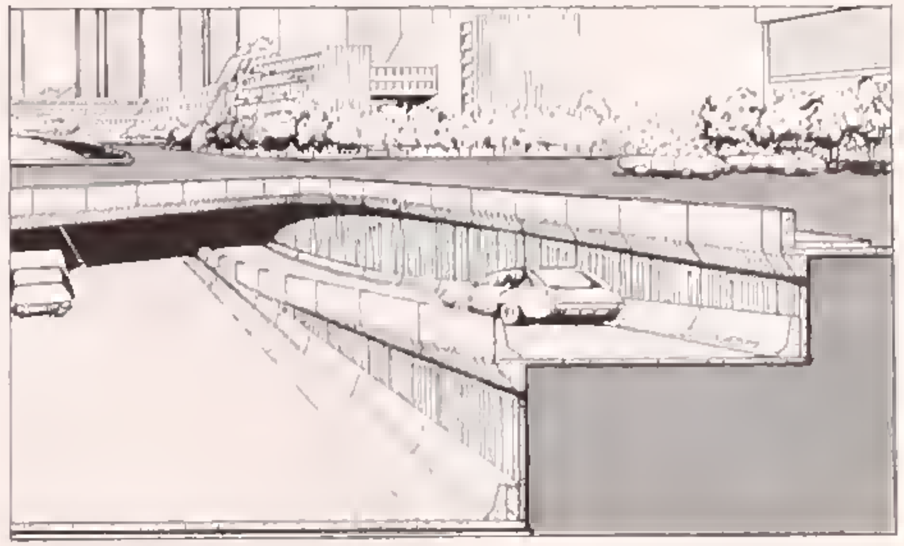


Illustration 4–6. Continuous Parapet Edge Expression, view south at Harrison Street

Although the exposed flat surface of structural concrete of the retaining walls provides a light, glare-free surface, it is too dense to provide acoustic absorption and, in addition, requires articulation to break up scale and control weathering. A glazed or vitreous wall cladding, while easier to clean in covered sections, provides even less acoustic absorption. Therefore, a ribbed texture in the structural concrete wall surface, visually matched to a tile of similar texture in the covered sections, has been employed.

Elevated Highway Structures

The expression of a continuous horizontal roadway band on elevated mainline and ramp structures dominates the design of substructure and superstructure components. This has been accomplished by:

1. A strong, uniform edge design for mainline and ramps, continuous for all elevated roadways.

2. Use of solid parapet for strongest visual statement.

Bridge structures have allowed for variations to suit the local area conditions of span lengths and required degree of finish. One system or family of structures that accommodates a wide range of variables has been used in lieu of major changes in structural type or materials. The underside of elevated structures may vary depending on the sensitivity of local area conditions, but edge conditions remain constant.

Illustrations 4-7 and 4-8 indicate the family of structures employed throughout the project. In sensitive residential areas, ramp structures have been designed to present clear expression of structure while maintaining a clean appearance. There is no articulation of a separate parapet band and no intermediate longitudinal girders on ramp structures. The roadway band is strongly expressed but in scale with local areas and the urban context. The underside of structure is flush and presents a smooth surface not incompatible with aesthetic concerns (Illustration 4-9).

Illustration 4-10 depicts less sensitive areas of light industry and warehouse use where underside appearance of structure is a lesser concern to that of economy. Steel box girders are used here. Yet, because the entire corridor has been conceived as one unified experience, the other design elements of elevated structure remain consistent. For example, the depths of adjacent spans have been held constant to present a uniform appearance by minimizing variation in the length of spans.

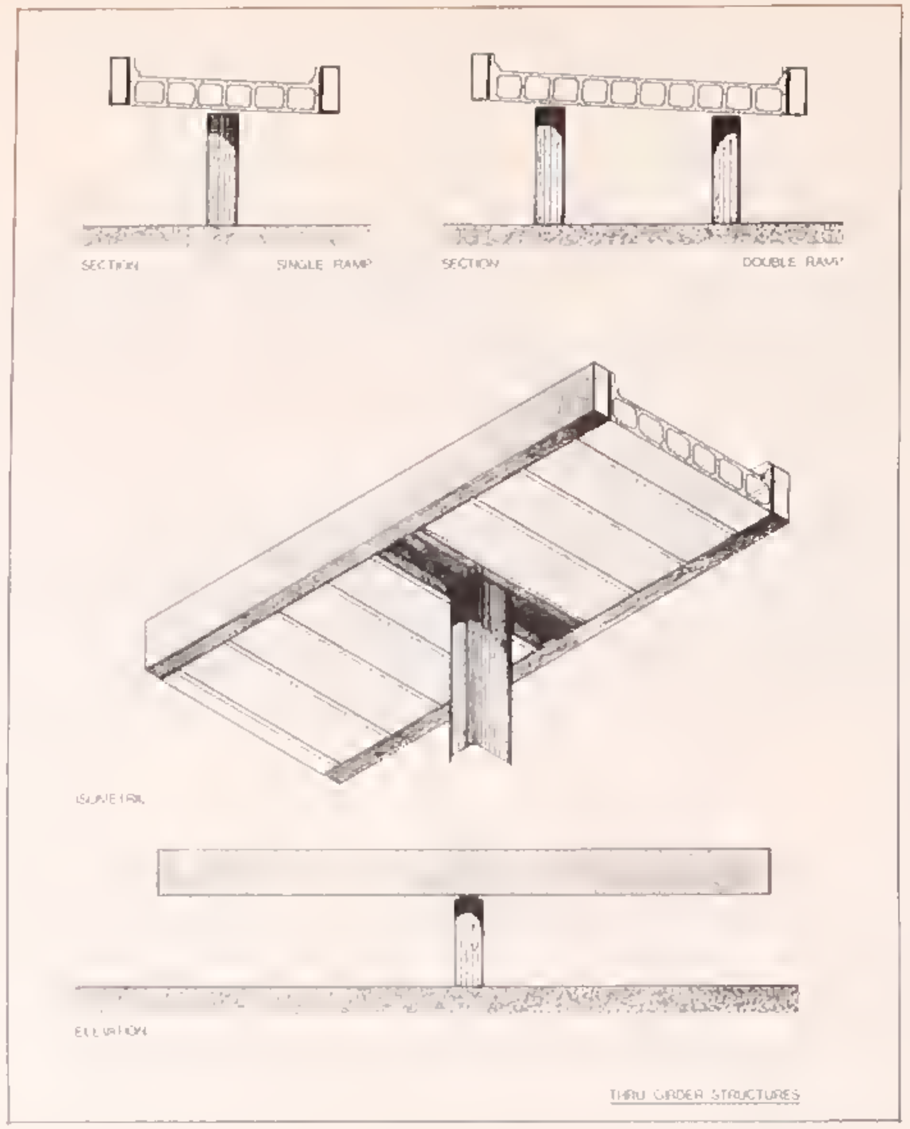


Illustration 4–7. Elevated Structures: Thru girder ramps

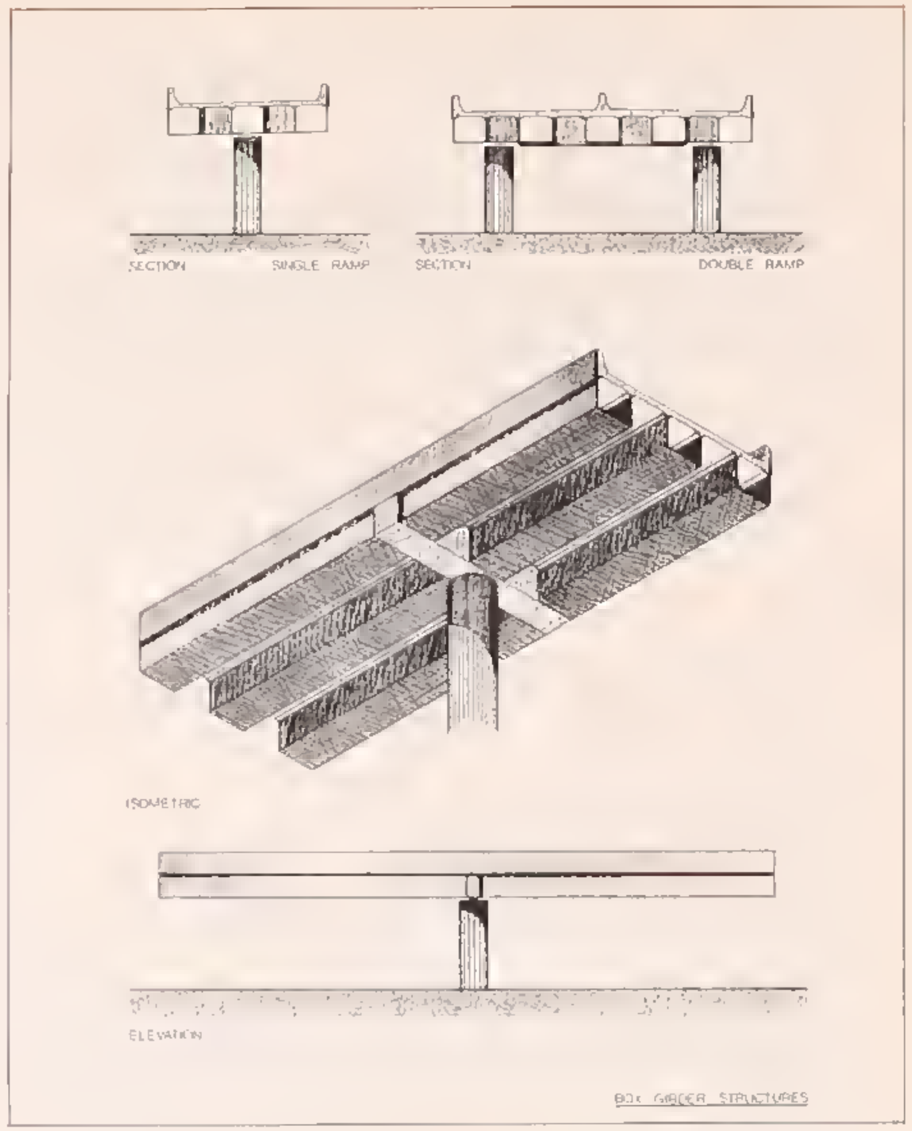


Illustration 4–8. Elevated Structures: Box girder ramps and Mainline Highway

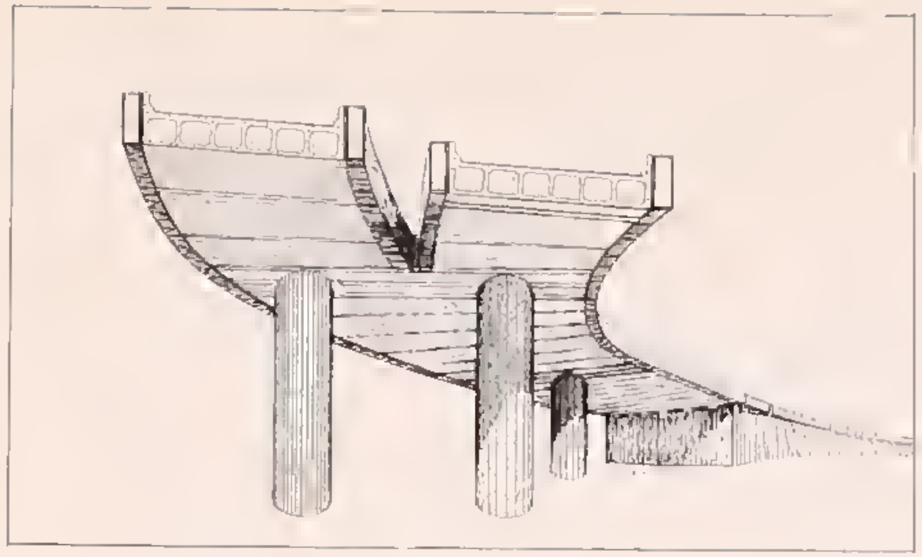


Illustration 4–9. Underside condition as Thru girder ramps split

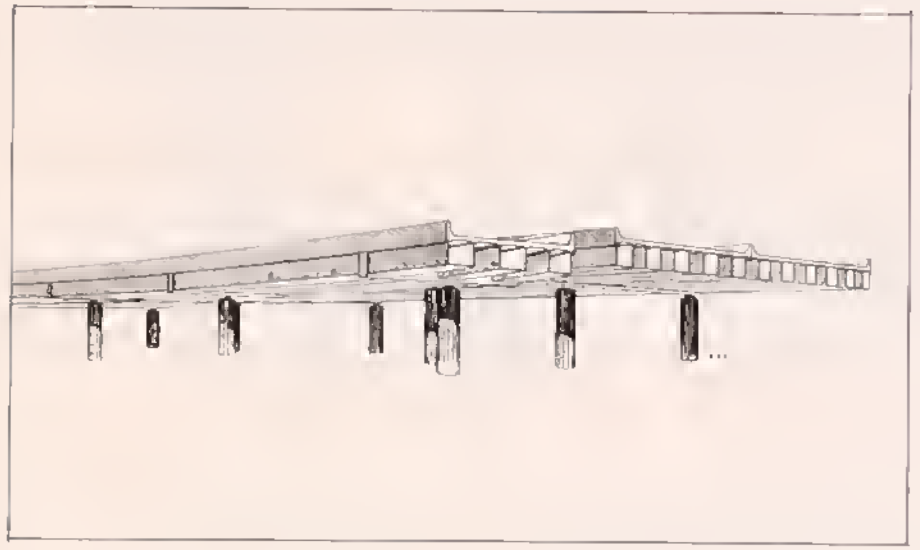


Illustration 4–10. Box girder ramp splitting from elevated Mainline

Substructure Components

Pier columns have been designed as simple, round concrete repetitive elements that, like superstructure, vary only to meet compelling local situations that cannot be accommodated through other means. Drainage systems will be concealed within the superstructure and inside the pier columns. The geometry of the roadway alternatives, especially in interchanges, has been developed in a manner to avoid awkward pier variations such as outriggers and ladder structures.

In keeping with the expression of the roadway's horizontal continuity, piers have not been designed as a continuation of superstructure.

The number of piers has been kept to a minimum through the use of

1. Maximum span lengths allowable by economy and reasonable depth of bridge section
2. Curved girders
3. Careful integration of structure with roadway geometry

Pier columns are non-directional to accommodate the changes in roadway geometrics easily. To this end, exposed pier caps have been eliminated in favor of concealed pier caps. All cross girders will be kept within the depth of the longitudinal structure, except where the elevated mainline section requires greater depth of cross girder structure. In this case the cross girders will taper from the consistent edge face to the required depth.

Where access below elevated roadways is not a planning requirement, every attempt has been made to minimize the apparent scale of structure by the use of embankment or retaining structures instead of bridge spans (as in certain interchange areas). Where access below the roadway is a planning consideration, pier spacing and substructure allow maximum flexibility for proposed joint use development.

Superstructure Components

The edge condition of elevated structures will be carried continuously across abutments and retaining structures, as a clearly defined separate band that gradually tapers. Abutments do not dominate the continuity of the gradually tapering band of the roadway.

The intent of requiring adjacent spans to be the same depth does not require all members of elevated structure to be sized to the maximum span requirements. The desired effect is to connect varying span depths by gradually tapered transitions rather than to abut them at unequal sizes. Elevated structures will be finished in either natural materials (weathering steel) or be painted a uniform neutral color (black, dark gray).

Interchanges and Transition Areas From West Street to Elevated Ramp

In areas where no future development is envisioned in the highway corridor, the roadway must form its full portion of the urban environment when built. Especially in many interchange areas that preclude future joint-use of space above, below, or adjacent to the road for other than highway uses, these sections have been designed to present complete environmental/spatial experiences in themselves.

Also, many locations within the highway corridor share portions of the following

1. At-grade pedestrian access across the corridor is not required, but is often to be discouraged in favor of pedestrians at other levels
2. No at-grade intersections for traffic that require open-sight angles, mandating long-span open bridge structures above grade
3. Grade-separated crossings only over roadways
4. In addition to at-grade and driver views, the area is seen from above from surrounding tall buildings
5. The areas are environmentally sensitive because of nearby pedestrian movement
6. Pedestrian views are not required through interchange area

In such areas, alternatives to conventional elevated ramp structures built over a flat ground plane have been explored to determine if they can be accomplished without consuming more land or blocking access to the waterfront.

These alternatives include:

1 Retaining wall structures cut into or built above a shaped ground plane with bridge spans only at grade crossings:
   a To minimize apparent structure on piers
   b To channelize the driver and thereby limit his experience of complexity only to relevant lane decisions
   c To limit pedestrians' view of the roadway

2 Bermed or sloped ground planes to simplify transitions between levels. These surfaces are to be planted, paved or use retaining walls depending on slope:
   a To buffer the view and minimize the apparent scale of the roadway from surrounding at-grade areas
   b To accentuate the continuity of roadway direction for the driver
   c To minimize the visible portions of retaining structures
   d To create an attractive urban form when viewed from above

The example illustrated is of the Holland Tunnel Plaza Interchange (Illustration 4-11). Illustrations 4-1 and 4-2 indicate the driver's channelized experience as he travels within this interchange area.

Different types of ramp structures in depressed sections offer a direct means of reinforcing highway sign messages. Except at the Brooklyn Battery Tunnel, where all interchange movements are depressed, there are two basic movements from the depressed section: to West Street at grade, or to elevated ramp structures leading to major interchanges with the Holland and Lincoln Tunnels.

Ramps between the depressed roadway and West Street connect the lower surface with the ground plane. Since all construction below an elevation of 8 feet will be concrete, the most direct ramp expression is the continuation of the concrete parapet edge down a wedge-shaped sidewall abutment.

Ramps between the depressed roadway and major interchanges connect the depressed surface with elevated ramp structures. Since these elevated portions will have a different edge condition from that of the ground plane, and are constructed of a different material (steel), the most direct ramp expression is the continuation of the elevated structural edge down into the depressed section. This can occur on an abutment similar to West Street connections, or preferably on an abutment that further differentiates between the ramp types.

A more traditional approach at the Lincoln Tunnel Interchange was dictated. Here the complicated movements create a multi-level interchange necessarily built on structure and geometrically compacted as much as possible to avoid greater consumption of area. In this area where the highway transitions to elevated structure, the surrounding local area land use pattern is not expected to change as the highway makes the transition. Architecturally important considerations, although restricting obtrusive outrigger conditions where possible, did not include the stated principle of embankment and earth berming. The Lincoln Tunnel Interchange will be the final urban form for this area. The channelized driver will not appreciate the complexity of the roadway geometry as will the high-rise dweller across the river who will view the Interchange in terms of pure geometry.

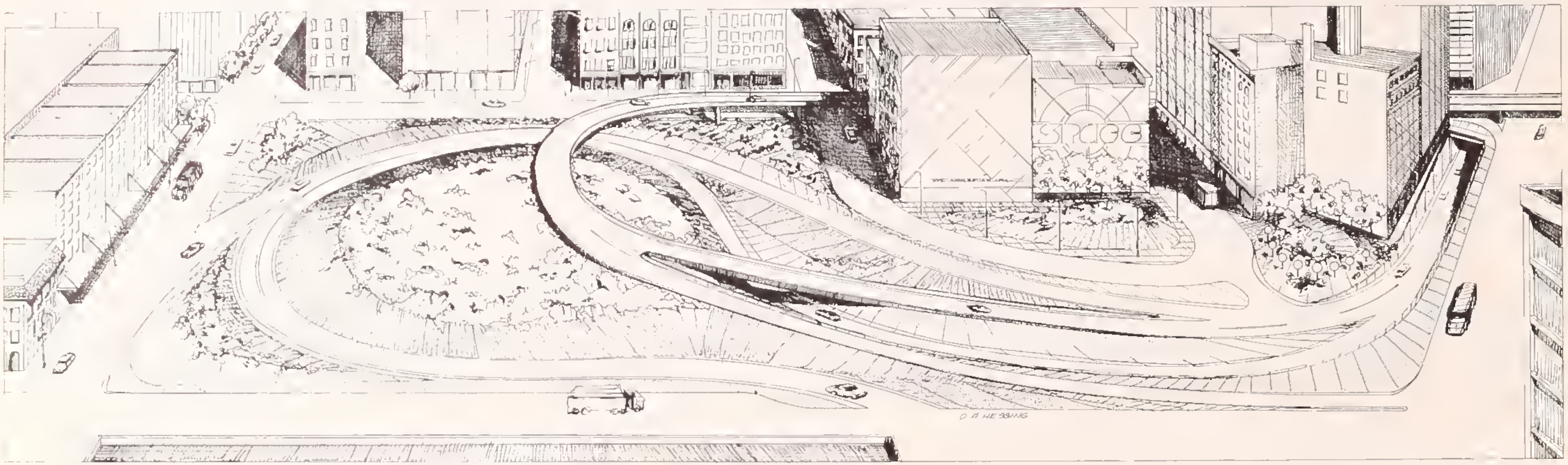


Illustration 4—11. Design Parameters Applied to Holland Tunnel Plaza

West Street

One component of the Modified Outboard Alternative is a new West Street/12th Avenue which will be reconstructed in its present right-of-way The design and traffic-carrying capacity of this facility would vary according to the local needs of the existing adjacent areas within the Study Corridor and the requirements of the proposed development on the new waterfront landfill Reconstructing this facility presents the opportunity to remove existing visual barriers and generally improve the quality of West Street/12th Avenue.

In some sections such as the West Village and Chelsea, West Street will consist of four traffic lanes separated by a center median plus on-street parking space. In other areas, particularly Lower Manhattan, the facility will consist of six lanes

Opportunities for plantings in the medians and sidewalks will be investigated for compatibility with the residential characteristics of the neighborhood through which it passes

Roadway Design Elements

The physical features that most immediately relate drivers to traffic flow are lane width, shoulders, barriers, and accessory design elements such as sidewall articulation, handrails, screening, and road signage Integral with the engineering design parameters established elsewhere in this report are the implications of safety, local area compatibility, and established criteria of presenting a unified driver experience

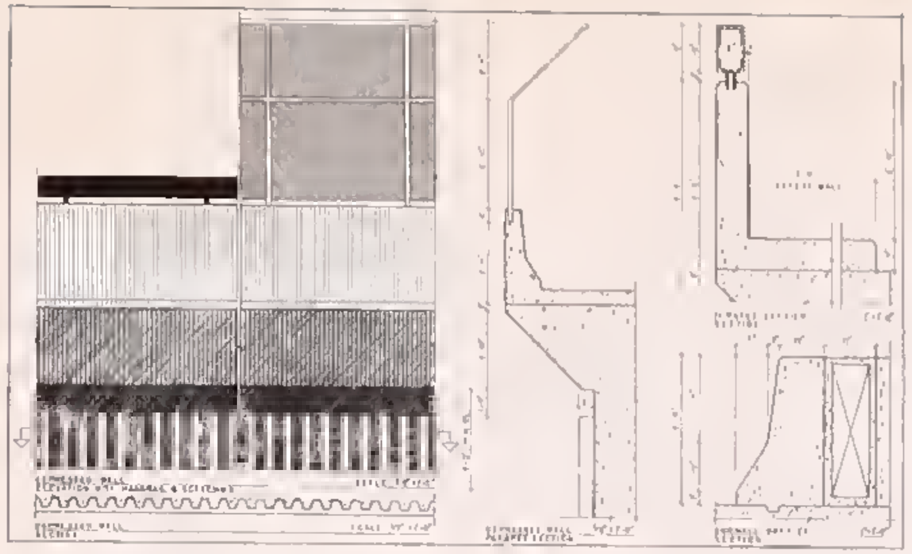


Illustration 4—12, Accessory Design Elements

An urban transportation facility is necessarily designed as a compact corridor Whereas highways in rural areas usually provide wide medians and clear rights-of-way as open recovery space for out-of-control vehicles, these strips would increase the right-of-way width in a dense urban corridor For this reason, the West Side Highway mainline and ramps have been designed with continuous New York State standard brush curb concrete barriers shaped in accordance with the latest research on roadway safety These barriers will be used continuously at the base of walls in depressed section, as bridge parapets, and in the mainline median.

Illustration 4-12 shows the brush curb barrier as it is employed against the sidewall and as it appears along the cantilevered frontage road in conjuction with cross-street overpass protection The protective screening employed sympathetically reflects the angled parapet edge used throughout the project

When the cantilevered edge parapet parallels both the depressed mainline and West Street sidewalk, a handrail is employed as illustrated

When the brush curb barrier is used as a bridge parapet on elevated structures that preclude pedestrian access, it will be used without screening or handrail to minimize obstructions to the view

Ventilation Structures

The Modified Outboard Alternative has depressed, covered sections which will require mechanical ventilation and hence, structures to house the required mechanical equipment as well as to provide fresh air intake and exhaust air stacks. There are five buildings located in conjunction with the covered highway sections and compatible with existing and projected land use opportunities Using project-stated goals and design criteria, the buildings were sized and architectural studies made to determine the configuration of the buildings

Planning considerations have largely determined placement and configurations. In order not to disrupt the continuity of proposed open space and park development, in many instances the buildings have been programmed to serve as links or bridges ensuring that continuity Wherever possible, the use of earth berming has been employed to provide gradual transition from park to rooftop park

Buildings located at entrances to covered sections of the highway become logical and dramatic portals while helping to block sunlight as the driver transitions from open to covered section Where required, ventilation structures geometrically respond to the continuation of stated visual corridor axes while accommodating the open space and water-edge accessibility goals of the project

Landscaping

To ensure due consideration of the landscape architectural aspects of the project, a landscape architect was consulted

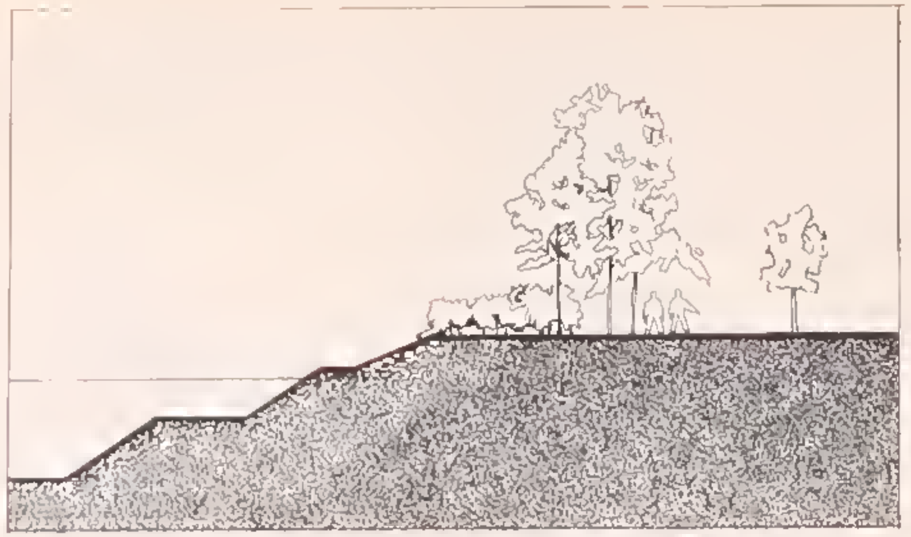
The construction of Modified Outboard Alternative will produce a variety of landscape conditions that depend upon a detailed planning area analysis. The cross sections of the road and various types of roadway structures have been studied in conjunction with the surrounding land uses, proposed new development and environment to develop a series of design concepts for the study corridor as a whole

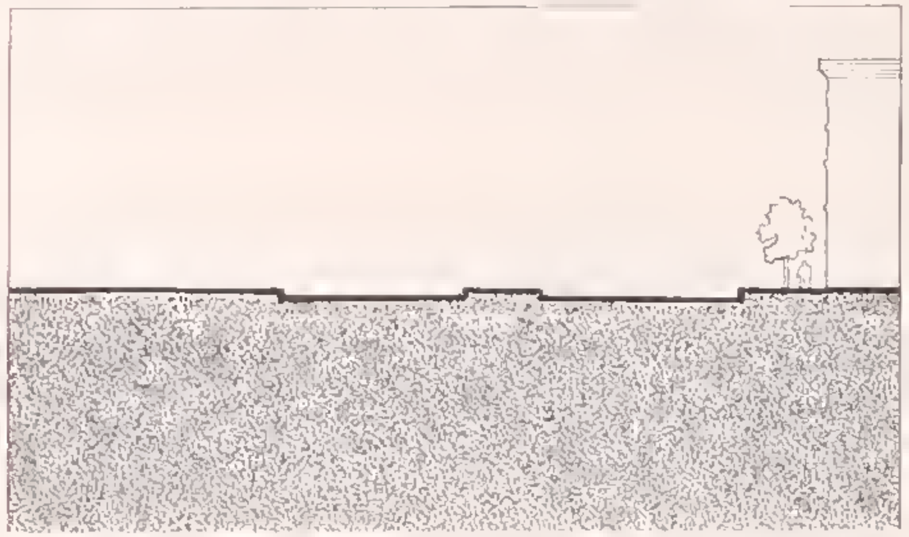
Although conditions of alignment may vary, certain elements of cross section are repetitive. These four typical conditions include wateredge stabilization, overstructure planting, West Street treatment, and interchange infield and transition areas (Illustrations 4-13, 4-14, 4-15, and 4-16) These areas immediately adjacent to the reconstructed facility have been studied within a systemwide corridor approach to planting location and density However, the intent of this portion of the report is not to present actual design solutions for any portion of the West Side Highway Project It is rather an attempt to illustrate some of the components and criteria that represent design opportunities to enhance, in a qualitative sense, those areas created or affected by the facility It is understood that the nature of landscape construction will require further detailed study during and after the construction of the facility relating to the design elements and variables identified in this section

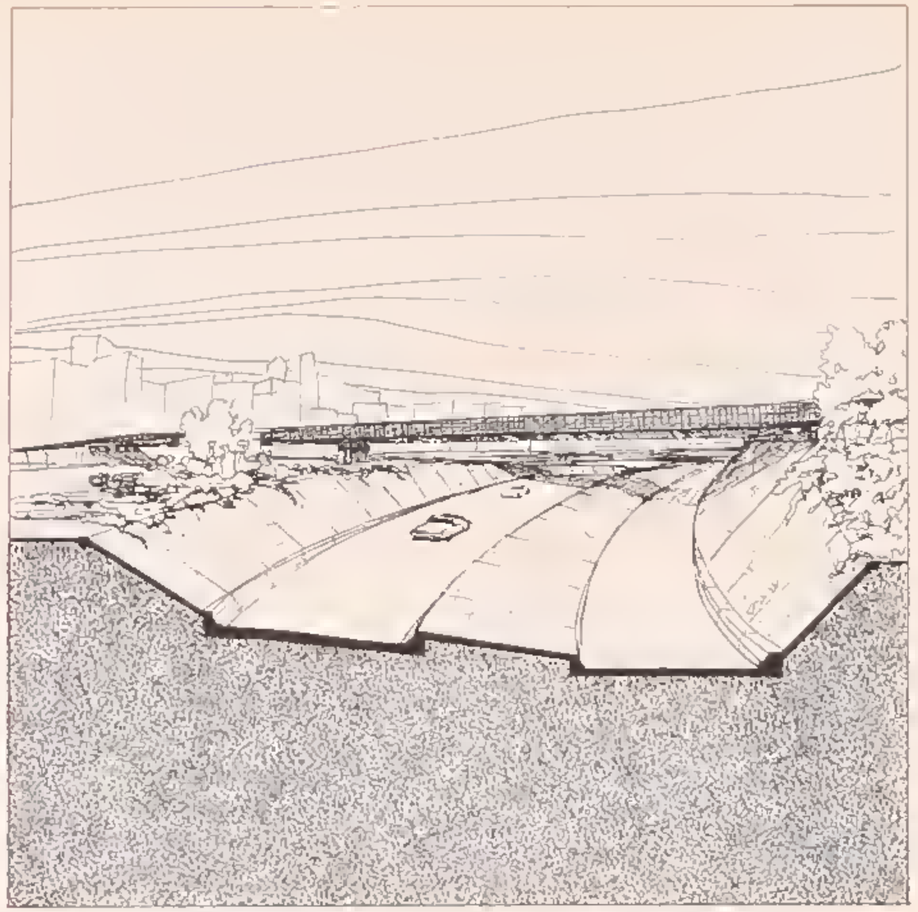
The major objective of roadway landscape design, however, is to relate the facility to the city, reducing its impact on the urban fabric while minimizing the visual disturbance usually caused by such transportation facilities In addition to increasing safety on the roadway where appropriate, planting, land forms, and structures should be compatible with the natural ecology of the region and should be easily maintained Plants used close to the roadway have been selected for their resistance to exhaust fumes and salt spray, whereas, planting suggested over structure has been selected for shallow soil condition compatibility

Riverfront Embankment Areas

The construction of the Modified Outboard Alternative affords a unique opportunity to plan for new waterfront activities The changing land uses along Manhattan's western riverfront are indicative of attempts to open up the area for public uses Projected open space and development areas have been outlined by the Highway Project Of concern is not an evaluation or delineation of the alternatives for the redevelopment of the wateredge, but rather, the way that specific cross-section condition is treated Illustration 4-17 suggests possible treatments







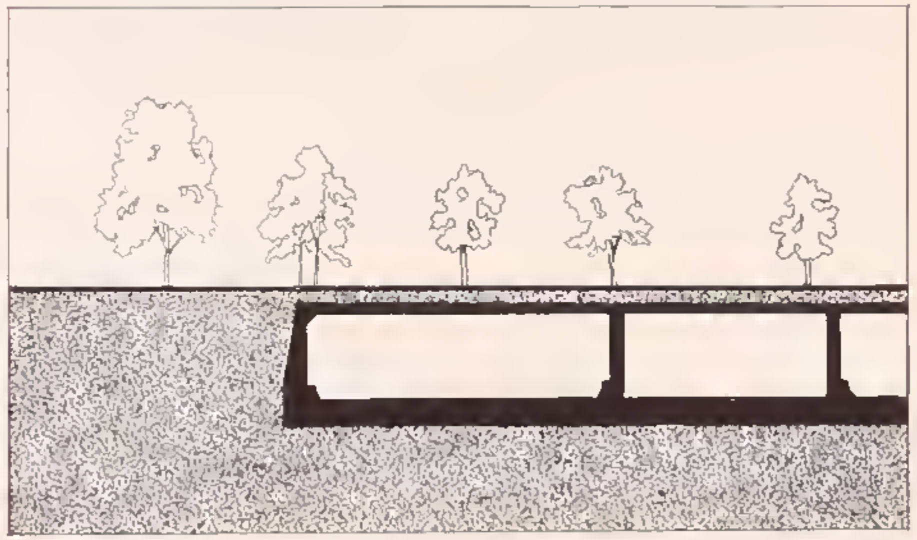


Illustration 4–13.	Riverfront Embankment
Illustration 4–14.	West Street Treatment
Illustration 4–15.	Interchange Infield Areas
Illustration 4–16.	Overstructure Planting

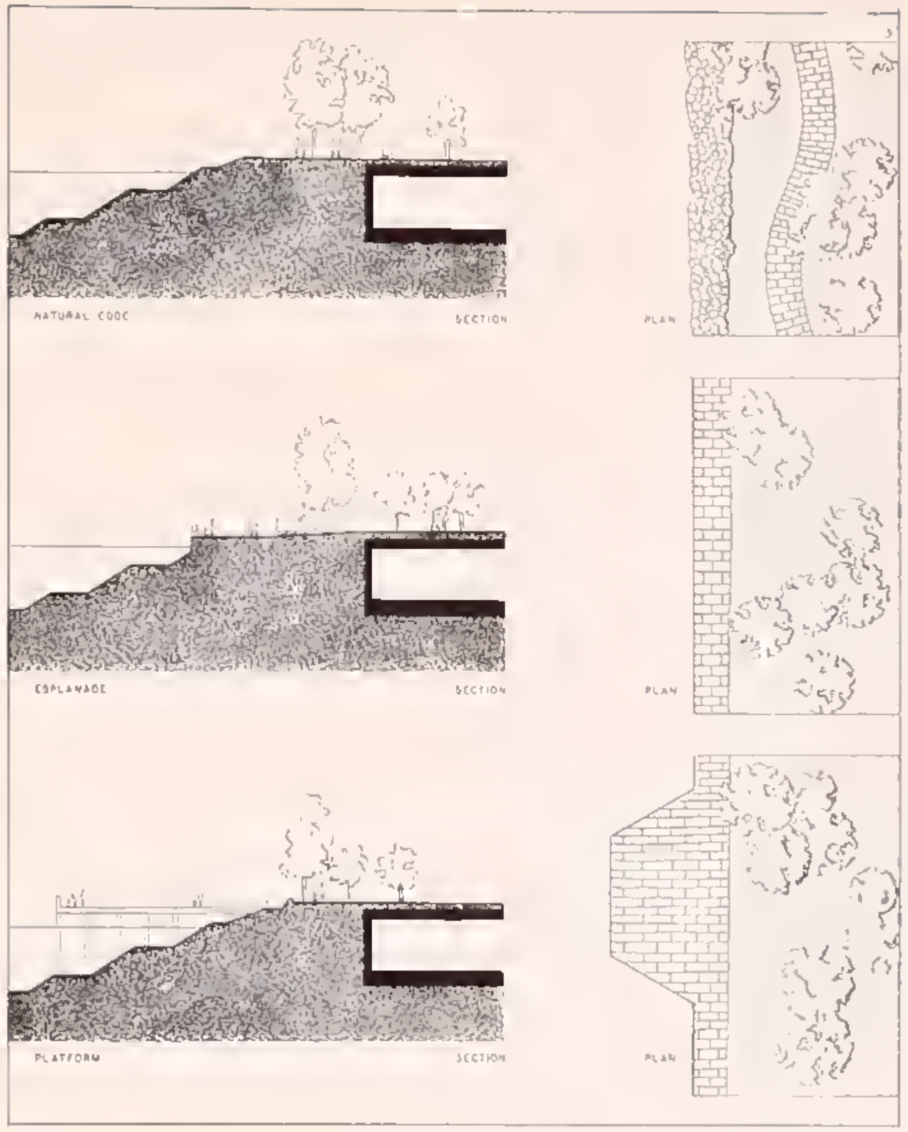


Illustration 4—17. Riveredge Design Options

By using appropriate plant materials in landfill sections, a natural wateredge landscape is developed. A combination of rock and earth provides a suitable landscape treatment for passive recreational activities offering the potential user the quiescent of an overview of the riverfront and the New Jersey shore.

Active recreational activities which may occur along the water are reflected in a more formal, hard edge treatment in the form of defined limits of the river and upland areas. An extended decked area over the landfill edge of the outboard alignment is a particular example of this possibility.

Vegetation opportunities at the wateredge permit only plantings compatible with brackish water conditions. (The variety of trees and plants listed in the species chart are considered suitable in such an environment.) Areas considered too restricted for plant materials will be stabilized with grasses and stone material to protect the top of embankment.

Treatment of West Street

Landscaping can be a major tool in minimizing negative impacts of West Street on existing land uses. The arrangement and density can be comparable to typical street planting type or, in a more architectural approach, might incorporate more urban forms of pavement and space delineation, separating areas by use of small retaining walls and bermed surfaces. Noise abatement of the visually improved West Street is an immediate gain.

In addition, the treatment of ground surfaces underneath elevated ramp structures, where they occur, has been considered, as it will have a major visual impact on pedestrians and local street users. It is unlikely that grass or ground covers can be grown under most structures so consideration has been given to a variety of pavements, including stone block, brick, exposed concrete aggregate, and bituminous concrete with a pebbled-treated surface.

Interchange-Infield Areas and Areas of Transition

Where the transportation facility transitions from depressed section to embankment and elevated structure, and where complex turning movements connect the facility with other major transportation routes, complex interchange conditions will create the final urban form in large areas that are visible from surrounding buildings and to the highway user as he travels in sequence. For the most part, pedestrian movement is physically precluded by ramps and interchange traffic volumes. These final urban geometric forms become areas of landscape concern. Just as important as signing will be the employment of landscaping elements such as retaining structures and bermed surfaces employing sympathetic paving and natural materials to help channelize and simplify driver decisions in complex interchange areas. (Illustrations 4-1 and 4-2.)

Although it is strongly recommended that natural earth embankment slopes have a minimum of a 1 on 3 slope ratio, and preferably flatter wherever possible for maintenance operations, areas of embankment within interchanges will be sloped 1 on 2 to 1 on 3 and will be stabilized with plant or sympathetic paving material to reduce maintenance of grass areas. The maintenance of such slopes is intended to be greatly reduced through the use of natural materials such as stone, brick, exposed concrete aggregate, and other sympathetic materials providing a clean appearance.

Infield and inaccessible areas bounded by ramps may receive park-like plantings (for example, The Holland Tunnel Interchange Plaza). Other infield areas will be treated with parkway-type plantings. All unpaved areas from edge of outside roadways out to the right-of-way lines will be landscaped. The Holland and Lincoln Tunnel Interchanges have been considered as Green Belt Areas and will be treated in a park-like manner with open grass or ground-covered areas and mass plantings. Screen and buffer plantings will be used where required to block or enhance views.

Over Structure Planting

In the area immediately over the facility, where landscaping and a pedestrian river view esplanade are proposed, earth fills 4 feet deep combined with top soil and mulch will support planting material such as red fescue and companion grasses. Location of trees is not restricted to the area immediately above the vertical supporting structure of the facility. Continuous planting throughout this cross section, will require special irrigation for plants above tunnel areas because of the relatively shallow soil depth.

An earth fill with a topsoil layer of 4 feet on the concrete slab over the facility will require an irrigation system for both the lawn area and the woody plant material if they are to live and thrive. However, since the depressed transportation facility is rolling, that is, of variable depth throughout its length, certain areas above the facility may even support deeper earth fill.

Assuming minimum irrigation, it will be possible to produce a sturdy drought resistant lawn throughout the corridor of the Modified Outboard Alternative.

Ground covers suggested to stabilize large tracts of new land provided by the Modified Outboard Alternative are red fescue, bluegrass, and ryegrass. These plant material provide quick establishment of earth stabilization while the areas in which they are employed are planned for further development by others. The prime consideration here is to protect new landfill areas from exposure to winds coming from the waterfront.

Care must be taken in new planting areas to ensure planting that does not dry out prior to its full establishment. In particularly dry and hot periods, hand watering may be required to prevent large losses of plant material. The post planting care is especially important in establishing the above-structure landscape.

Illustrations 4-18 and 4-19 relate planting areas of concern, with suggested species that will survive and thrive in such areas.

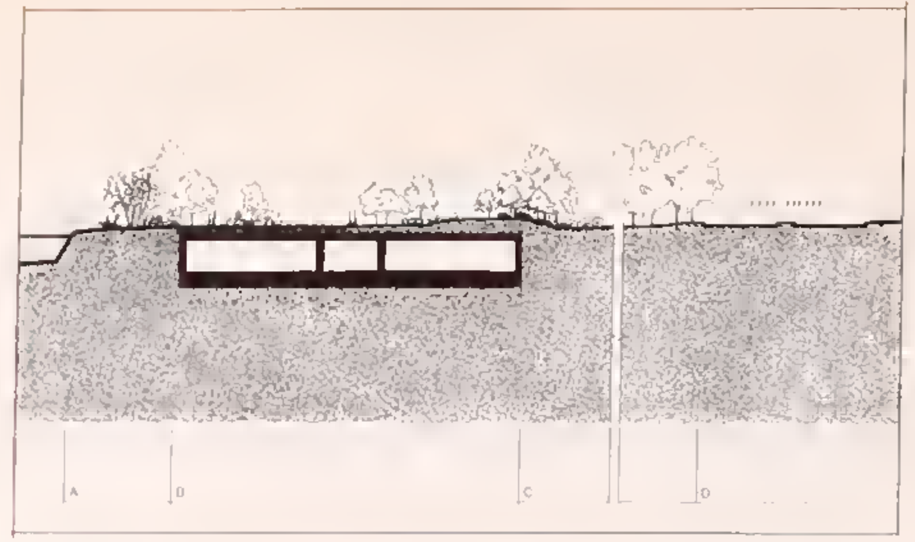


Illustration 4–18. Landscape and Ground Cover Options
Illustration 4–19. Species Chart

	Common Name	Mature Height	Type	Location
Trees				
Sophora japonica	Japanese Pagoda	40'	Deciduous	A, C, O
Platanus acerifolia	London Plane	70'	Deciduous	C, O
Ginkgo biloba	Maidenhair	50'	Deciduous	C, O
Tilia tomentosa	Silver Linden	50'	Deciduous	A, C, D
Acer pseudoplatanus	Sycamore Maple	80'	Deciduous	C, D
Gleditsia triacanthos	Thornless Honey-Locust	60'	Deciduous	C, D
Quercus phellos	Willow Oak	50'	Deciduous	A, C, O
Pinus strobus	Eastern White Pine	60'	Evergreen	A, C
Minor Trees				
Malus varieties	Crab Apple	25'	Deciduous	A, B, C
Amelanchier laevis	Downy Serviceberry	20'	Deciduous	A, B, C
Pinus thunbergi	Japanese Black Pine	25'	Evergreen	A, C
Salix pentandra	Laurel Willow	20'	Deciduous	A, B
Magnolia soulangeana	Saucer Magnolia	25'	Deciduous	B, C
Crataegus phaenopyrum	Washington Hawthorne	20'	Deciduous	A, B, C, O
Shrubs				
Ilex glabra	Ink Berry	5-6'	Evergreen	A, C
Rose wichuriana	Memorial Rose	1'	Half-Evergreen	A, B
Myrica carolinensis	Northern Bayberry	4-5'	Evergreen	A, C
Rose rugosa	Red Rugosa Rose	4-6'	Deciduous	A, C
Rosa nitida	Shining Rose	3-4'	Deciduous	A, C
Ground Cover				
Tripterygium regelia	Chinese Matrimony Vine	–	Perennial	A, B
Juniperus horizontalis	Creeping Juniper	–	Evergreen	A, B, C
Hedera helix	English Ivy	–	Evergreen	B

Section 5 - Selected Alternative

Introduction

In December 1971, the West Side Highway Project was established by a memorandum of understanding signed by Governor Nelson A. Rockefeller and Mayor John V. Lindsay.

The Federal Government designated the route from the Brooklyn Battery Tunnel to the Lincoln Tunnel as Interstate Route 478. Alternative alignments were developed during the first phase of this work. A Draft Environmental Impact Statement (DEIS), which detailed the environmental impacts of each of the alternatives, and a Design Report which showed the engineering details of each alternative, were then prepared. These documents were circulated, and in June 1974 and September 1974 public hearings were held. The comments at the public hearing and after the public hearing from both the private and public area were studied and evaluated. The results of this work were incorporated into the alternatives, and modifications were developed. A modification of the original outboard alternative is being recommended for approval.

Description of the Selected Alignment

The Modified Outboard Alternative, or Westway, as approved by Governor Hugh L. Carey and Mayor Abraham D. Beame, is a unique urban transportation facility carefully designed to improve transportation as well as economic and social conditions on the West Side of Manhattan as well as act as a catalyst for redevelopment. The Plan of the Modified Outboard Alternative is shown on Illustration S-1. The Modified Outboard Alternative is similar to the original Outboard Alternative contained in the Draft EIS and presented at public hearings. The combination of highway and West Street traffic lanes was scaled down from that of the original Outboard Alternative to provide six lanes of highway capacity with special design features to reserve two lanes for express buses and high-occupancy vehicles during peak periods. The separate transitway was eliminated from Midtown to the Battery. The size of West Street was reduced in Greenwich Village and Chelsea from six to four lanes, and the design characteristics were changed to discourage through-travel use. The amount of landfill was reduced from about 240 acres to about 180 acres, particularly in the area of the Greenwich Village waterfront. Also, the scale and size of major interchanges was reduced, particularly the two-corridor Holland Tunnel Interchange which was reduced in size to a one-corridor interchange.

The Modified Outboard Alternative consists of a new six-lane highway with special design features to provide for express transit bus and high-occupancy vehicle use of two lanes during peak periods, the removal of the elevated highway structure and the reconstruction of the old highway corridor into a local street designed to serve local traffic. Importantly, an integral part of the alternative is a land use policy for the land created by the project as well as the corridor areas directly affected by the reconstruction of the Highway.

The Modified Outboard Alternative is proposed for construction between the Battery in Lower Manhattan and 42nd Street in the Midtown area. However, in order to disclose fully the policy and plans for the entire highway corridor, the Final Environmental Impact Statement (FEIS) describes the intent of the City and State to rebuild the section of highway from 42nd to 72nd Streets and to repair and improve the safety of the section of the highway known as the Henry Hudson Parkway from 72nd Street to the Bronx-Westchester County line.

The selected alternative as presented here has been redesigned in accordance with decisions by the Governor and Mayor and more detailed instructions from the Project Working Committee and takes into account the many suggestions, comments, criticisms, criteria, guidelines, and requests made during the public hearings and as a result of the review of the DEIS. The Modified Outboard Alternative has been designed to meet these goals, objectives, and policies and has been tailored to the diverse mobility and environmental requirements of the West Side of Manhattan.

The new 4.2-mile highway will be located on a new alignment in waterfront landfill for a large part of its length between the Brooklyn-Battery Tunnel and 42nd Street. This alignment would be approximately midway between the Hudson River pierhead and bulkhead lines, except in Lower Manhattan where it would remain largely in the space now occupied by the existing West Side Highway and West Street.


PATH TUBES
HOLLAND TUNNEL
PATH TUBES
VENT. BLDG. NO. 1
VENT. BLDG. NO. 2
VENT. BLDG. NO. 3
BATTERY PARK CITY AREA
BROOKLYN BATTERY TUNNEL
WEST ST
GREENWICH ST
CHURCH ST
CHAMBERS ST.
CANAL ST.
W. BROADWAY
BROADWAY
AVE OF THE AMERICAS
HOUSTON ST.
14th ST.

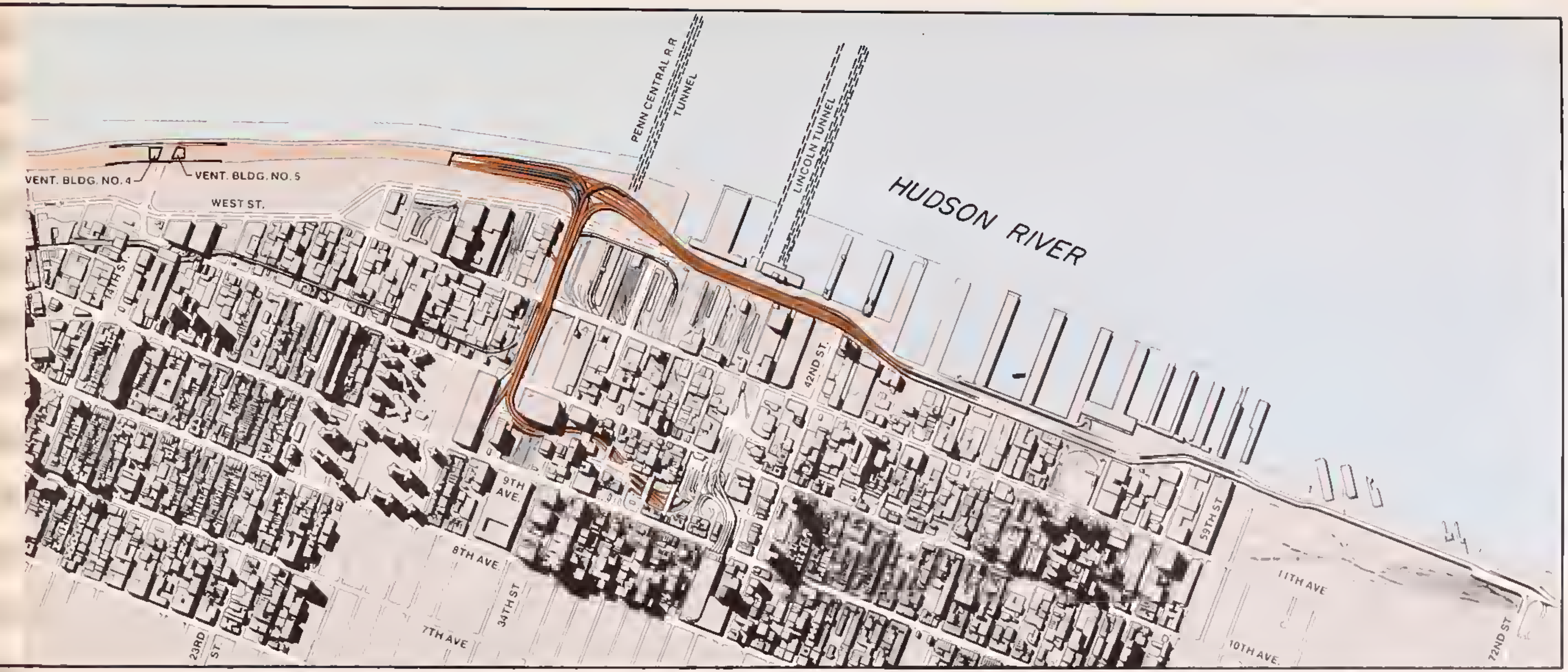


Illustration S-1 Selected Alternative

Highway (Open)

Highway (Closed)

Express Buses – High Occupancy Vehicle Ramps

North

Feet 550 0 1,100

Approximately 55 percent, or 2.6 miles, of the new highway would be below-grade in a covered section Open sections will occur at interchange areas, including the Canal and 30th Street areas where direct elevated ramp connections would be provided to the Holland and Lincoln Tunnels, and to the northbound highway lanes in Lower Manhattan This covered highway will provide a safe, efficient, express route along the perimeter of Manhattan for traffic that now used existing north-south avenues and local streets. Environmentally, the enclosed and mechanically ventilated tunnel will help alleviate the problems of noise pollution and traffic fumes in sensitive residential areas of the corridor In addition, investigations of noise impacts have resulted in including noise barriers in noise sensitive areas along the project

For its entire length the highway will have six moving lanes, three in each direction, in order to accommodate projected voulmes of auto, truck, express transit bus and high-occupancy vehicle traffic Access ramps to the highway will be located at key points within the corridor such as the Battery Park Underpass, the Lower Manhattan Business District, Canal Street, 14th Street and the Midtown Business District The highway also will have three direct Interstate connections to Brooklyn and Long Island via the Brooklyn-Battery Tunnel and to New Jersey at the Holland and Lincoln Tunnels

During the morning and evening rush hour periods, the inner lane of the highway in each direction will be designed to accommodate express buses and high-occupancy vehicles These highway lanes will be connected to other existing express bus lanes and facilities within the corridor In Midtown, bus ramps will be located within the Lincoln Tunnel Interchange with access to the Port Authority Bus Terminal 40th Street and a direct connection via the Lincoln Tunnel to the I-495 express bus lane to New Jersey. In Lower Manhattan, a two-way bus ramp would be provided at Laight Street, utilizing West Street between Battery Place and Laight Street for the collection and distribution of passengers in the financial district.

The final component of the Modified Outboard Alternative is a new West Street/Twelfth Avenue reconstructed in its present right-of-way The design and traffic-carrying capacity of this facility would vary according to the local needs of existing adjacent areas within the corridor and the requirements of proposed development on the new waterfront landfill In some sections such as the West Village and Chelsea, West Street will consist of four traffic lanes separated by a center median plus on-street parking space. In other areas, particularly Lower Manhattan, the facility will consist of six lanes Both physical design techniques and traffic control devices will be used to achieve the desired operating characteristics of each section.

Section 6 - Traffic

Introduction

Traffic volume estimates were developed utilizing advanced traffic forecasting methodology which included computerized traffic simulation processes. The volume estimates were used to assess traffic impacts and for environmental studies. The traffic estimates were also used to design weaving sections, ramp widths (one or two lanes), the streets affected by the ramps, and the Traffic Surveillance and Control System. The volume estimates played a limited role in the determination of the number of lanes on the mainline and West Street and the location of interchanges. The major interchange locations were fixed by the necessity of connecting the mainline to the Lincoln, Holland, and Brooklyn Battery Tunnels; the Interstate criteria regarding the spacing between ramps, and the Project's northern limit.

Incorporation of the Traffic Surveillance and Control System in the design is a significant advance which will permit maximum utilization of the Transportation System's capacity. The Control System will enable the operating agency to fix and implement policies regarding diversionary signing, variable speeds and ramp metering to ensure system efficiency and help prevent operational problems.

In this project it has been recognized that it is not possible to forecast precisely all the large-scale and local behavioral, technological, economic, and social factors that will affect day-by-day and hour-by-hour traffic movements. At the same time, however, it is also recognized that the the best possible estimates of probable usage in the design year are necessary to aid in determining whether the design of the selected alternative is efficient with respect to probable average or typical traffic needs.

Traffic estimates were prepared to indicate probable usage of the Modified Outboard Alternative in a way that allows evaluation of the service to be provided with regard to access and capacity, but without incorporating in the estimating procedure, the operations improvements that will result from use of the Traffic Surveillance and Control System. The estimates reflect interaction of vehicle movements with the travel conditions to be offered on the entire Manhattan street and highway network acting as an integrated system.

The specific volumes developed in this way could vary from those expected to occur in actual operations, because the operating agency will be able to utilize the Traffic Surveillance and Control System to implement policies regarding traffic diversion or access control to encourage optimum system operation, responding to traffic conditions on a real-time basis.

Modified Outboard Alternative

The Modified Outboard Alternative consists of a six-lane highway, with assignment of one lane for buses and high occupancy vehicles (HOVs) during peak periods. This lane will extend from the Lincoln Tunnel to just south of the Holland Tunnel in each direction of travel. Major interchanges occur with the Brooklyn Battery Tunnel, Holland Tunnel, 14th Street, and the Lincoln Tunnel prior to its connection with the existing West Side Highway at 42nd Street.

As described in the following paragraphs, a detailed, multistepped process was employed to develop trip tables for the design year 1995. These tables represent slight revisions in trip-end estimates from those presented in the Draft Environmental Impact Statement. The revisions to the 1995 land use and demographic factors for Manhattan represent the City's most current land use policies incorporating all the landfill projects associated with the new Highway.

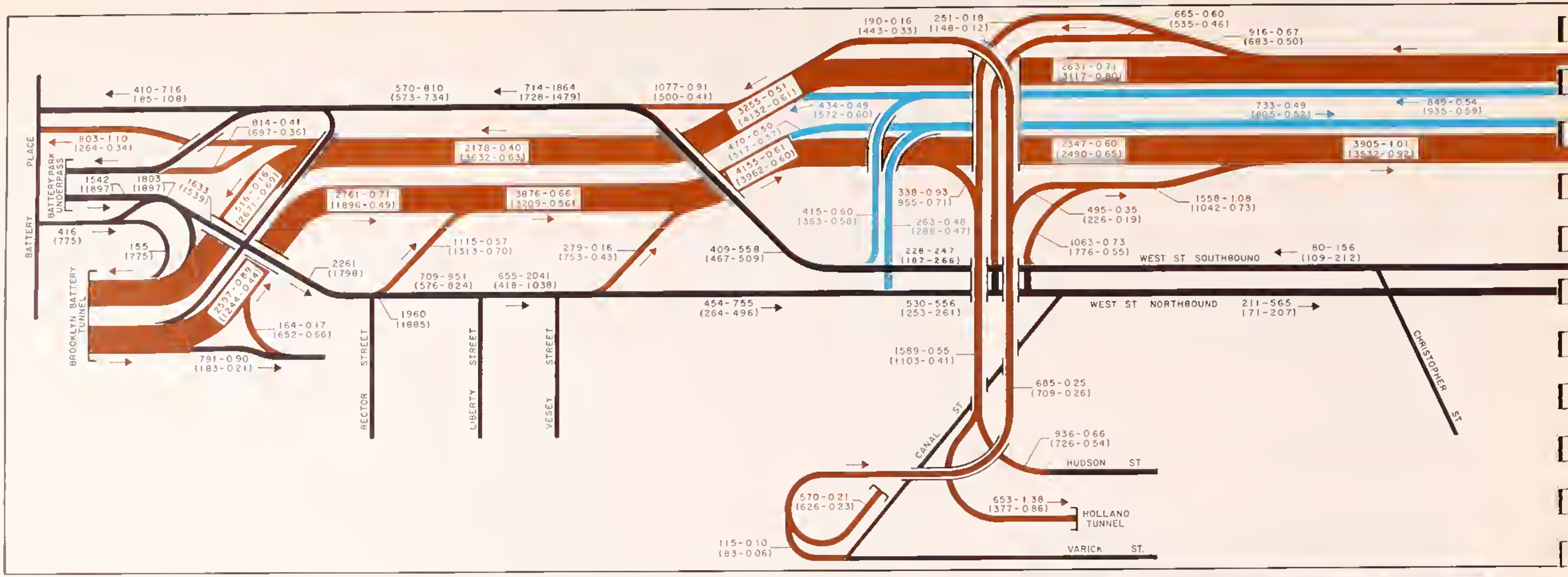
Traffic Forecasting Methodology

Traffic forecasting is a general term used to describe a multistep process that converts projections of population, employment, and general economic activity, along with land development plans, into estimates of future year volumes and speeds on individual links of the street and transit networks under study. The output from the process is used to compare alternative transportation plans in terms of their relative impact on the environment, their performance level (measured generally in terms of speed), and the benefits obtained from each of the plans relative to the cost of the plan. The process of travel forecasting is a highly complex methodology and set of procedures which make necessary the extensive use of computers and their capacity to process massive amounts of data.

The basic process involves gathering current data concerning the number of trips people make in the study area and the variables that affect where they go and why. Among the relevant variables are demographics (population, employment, office and residential floor space, automobiles available), travel time, the amount of available parking space, and the relative convenience or inconvenience of available modes of travel (automobiles, mass transit). From that data, mathematical equations describing the relationships among the variables can be developed and then applied to different sets of variables as they are predicted for the future.

The work program for the Project was directed toward the development of an objective process for estimating trip ends (both person trips and truck trips), and assigning vehicle trips to a highway and street network. The traffic simulation procedure included execution of the following basic steps:

1. The 1972 average weekday trip interchange table was generated, based on the 1963 Tri-State origin-destination surveys and estimates of 1972 trip destinations by vehicle type. Auto and truck AM, PM, and off-peak trip files were developed for assignment purposes.



2 Prepare a detailed description of the street and highway network which existed in 1972 in terms of traffic capacity, travel direction, travel speed, distance, turn prohibitions,traffic control devices, and truck prohibitions

3 Develop suitable traffic assignment procedures, assign the 1972 trip tables to the network, and adjust the procedure as necessary to produce assignment results which satisfactorily simulate the 1972 traffic counts Integrate a capacity restraint procedure into the assignment process to simulate actual driver reaction to traffic congestion to ensure realistic traffic assignment results

4 Develop trip tables for 1995 based on estimates of floor space, population, employment, and vehicle usage. These include AM,PM, and off-peak travel by autos and trucks separately.

5 Prepare detailed descriptions of the street and highway network that will exist in 1995 for the Alternatives.

6 Assign the 1995 AM and PM peak hours and off-peak hour trip tables to the alternative networks.

The results of the simulation process indicates how the Modified Outboard Alternative will influence traffic movements in the Impact Area upon its construction. It also provides for a detailed analysis of the traffic impacts and the resulting time and cost benefits which the new Highway would provide.

Traffic Estimates

The traffic estimates presented in Illustration 6-1 represent peak-hour volumes which include traffic volumes from the computer simulation process and estimated express bus and HOV (those with three or more persons) volumes. All volumes shown are given in total vehicles. Volumes are given for the highway mainline (both mixed traffic and express bus-HVO lanes), ramps and West Street/12th Avenue.

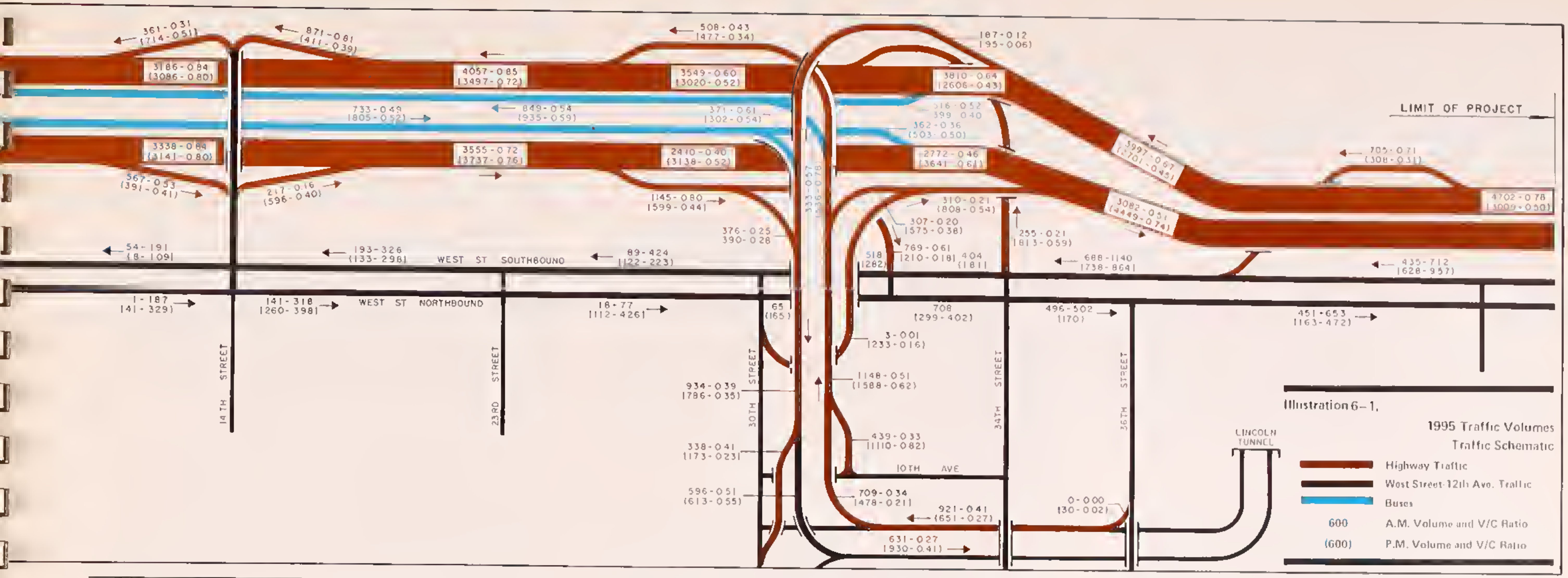


Illustration 6–1,

1995 Traffic Volumes
Traffic Schematic

Mainline Volumes

Analysis of the peak hour southbound volumes indicates two distinct patterns. In the morning peak hour the highest volumes are in the midtown area, decreasing in sections to the south. The opposite occurs in the afternoon, with lowest volumes in midtown increasing to the south.

For the AM peak hour, the southbound traffic volume starts at 4702 vehicles at the Project's northern limit and decreases to 3997 vehicles south of the 38th Street exit ramp. The volume increases slightly to 4065 vehicles between the Lincoln Tunnel on and off ramps immediately north of the HOV lane. At this point, 516 HOVs will exit the general traffic lanes to enter the express bus-HOV lane. A total of 508 vehicles will join the mainline from the Lincoln Tunnel ramp, resulting in a mainline volume of 4057 vehicles south of this ramp to the 14th Street interchange. Between the 14th Street and Holland Tunnel interchanges a volume of 3547 vehicles is estimated. This decreases to 3255 vehicles just north of the Battery Park City off ramp, which exits 1077 vehicles. A volume of 2178 vehicles will continue past the Battery Park City ramp to the Battery Park Underpass, Battery Place, and the Brooklyn Battery Tunnel exits. The southbound express bus-HOV lane will carry an estimated volume of 840 car-pool vehicles and buses during the AM peak hour.

Southbound volumes in the PM peak hour will be lower than the AM volumes for all roadway sections north of 14th Street. A volume of 3009 vehicles is projected north of the 38th Street exit, decreasing to 2701 vehicles north of the Lincoln Tunnel Interchange. An estimated volume of 3497 vehicles will use the general traffic lanes between 14th Street and the Lincoln Tunnel, increasing to 3800 vehicles south of 14th Street. The mainline volume will increase to 4132 vehicles south of the terminus of the express bus-HOV lane north of the Battery Park City exit. A total of 3632 vehicles will use the southbound lanes in the World Trade Center area. Of that total, 2671 vehicles will exit to the Brooklyn Battery Tunnel, with the remaining vehicles exiting at Battery Place and the Battery Park Underpass. During the PM peak hour, the southbound express bus-HOV lane will carry an estimated volume of 935 vehicles, which is slightly more than the AM volume.

A comparison of the northbound mainline estimates indicates generally higher volumes during the morning peak hour than during the afternoon peak hour between the Brooklyn Battery Tunnel and 14th Street. North of 14th Street to the northern limit at 42nd Street, the mainline volumes are greater during the afternoon peak hours.

Northbound in the AM peak hour, the volume south of Rector Street will be 2761 vehicles, which is higher than the PM peak-hour volume. A volume of 3876 vehicles will use the highway north of Rector Street, increasing to 4155 south of the Holland Tunnel Interchange and the start of the express bus-HOV northbound lane. Mainline volumes of 3905 and 3555 are estimated between the Holland Tunnel Interchange and 14th Street, and between 14th Street and the Lincoln Tunnel Interchange, respectively. Between the Lincoln Tunnel on and off ramps the volume is 2772 vehicles, which will increase to 3082 vehicles at the Project's northern limit. During the AM peak hour, the northbound express bus-HOV lane will accommodate 733 vehicles, which is somewhat lower than the PM volume.

Northbound traffic in the PM peak hour will be 1896 vehicles south of Rector Street, increasing to 3209 vehicles in the World Trade Center area due to 1313 vehicles entering via the Rector Street on ramp. The mainline volume will increase to 3962 vehicles south of the Holland Tunnel Interchange. North of the Holland Tunnel-Canal Street ramps, the volume on the two general traffic lanes will reach 3532 vehicles, increasing to 3737 vehicles north of 14th Street. Within the Lincoln Tunnel Interchange north of the terminus of the express bus-HOV lane, the mainline highway is estimated to carry 3641 vehicles, increasing to 4449 vehicles at 42nd Street. The express bus-HOV lane will serve an estimated 805 vehicles in the northbound direction during the PM peak hour.

West Street/12th Avenue

Under the Modified Outboard Alternative, reconstructed West Street was designed to serve only the local traffic in the mixed residential-industrial section between Canal and 23rd Streets. Both north and south of this section, West Street would have one more traffic lane, left-turn bays, and progressive signalization to serve different traffic needs.

The traffic volumes for West Street indicates a generally low level of activity along most of its length. Two sets of traffic figures are given to represent the low and high volumes estimated to occur between the major cross streets shown on the schematics. Peak-hour volumes along West Street will not exceed 600 vehicles in either direction from south of Canal Street to 30th Street. In the World Trade Center area, northbound volumes during the AM and PM peak hours are estimated to range between 500 and 1200 vehicles. In the southbound direction between Canal Street and Battery Place, the heaviest volume of 1864 vehicles is projected immediately south of the Battery Park City exit ramp during the AM peak hour. Other volumes in this section will range from 400 to 1500 vehicles.

Adequate capacity is provided along all sections of West Street during the peak periods in order to provide for efficient travel movements and operations.

Ramp Volumes

Wide ranges in volumes are estimated for the ramps comprising the Modified Outboard Alternative during the AM and PM peak hours. For example, over 1500 vehicles were assigned to the northbound on ramp at Holland Tunnel-Canal Street during the morning peak hour, while only 95 vehicles will use the southbound off ramp to the Lincoln Tunnel during the afternoon peak hour. A total of 1115 and 1313 vehicles will enter the highway at Rector Street during the AM and PM peak hours. Generally, a greater imbalance in volumes occurs between the peak hours such as the resulting assignment to the northbound off ramp to Lincoln Tunnel-30th Street. A volume of 1145 vehicles will exit at this location in the morning, while about 600 vehicles will use the ramp in the afternoon.

Over 1000 vehicles will use the northbound off ramp to the Holland Tunnel, the southbound off ramp to Battery Park City during the AM peak hour, and the northbound on ramp from the Holland Tunnel during the afternoon peak hour. High volumes are also expected at the four 14th Street ramps where volumes will range between 600 and 800 vehicles during the peak direction and peak hour.

The ramp volumes depicted above reflect fairly normal conditions for urban interchange movements. As described previously in this section, the traffic estimates were used to design ramp widths and the local streets affected by the ramps. Therefore, the volumes assigned to the on and off ramps are not expected to create extensive congestion on the local streets in the interchange areas.

Volume to Capacity Ratios

To measure the impact of the highway design on traffic flow conditions, two basic parameters are used—the volume-to-capacity ratio (V/C) and the travel speed. The volume is the number of vehicles, expressed in passenger car equivalents (PCEs), which use the road in a given 1-hour period. Capacity represents the average traffic volume in PCEs that can be accommodated under specific conditions of traffic flow. Good traffic flow is indicated by a low volume to capacity ratio and by a high travel speed.

Highway mainline and ramp capacities were generated, and volume to capacity ratio analyzed in consideration of the highway's urban location and the peak hour commuter patterns of traffic using it. A maximum capacity of 2000 PCEs per lane was assumed for the highway mainline. For the ramps, lower design speeds and capacities were used in consideration of their connection with the tunnels and local streets, adjusted for on and off ramps.

During peak periods, the capacity will vary for the different sections of the highway. South of the Holland Tunnel Interchange, all three lanes in each direction will be open to general traffic, and the maximum capacity will be about 6000 PCEs per hour in each direction. However, on the section between the Holland and Lincoln Tunnels, one lane will be reserved for express buses and HOVs, thereby reducing the capacity for general traffic to 4000 PCEs.

The highway's general traffic lanes will operate near capacity in both directions, in the section between the Lincoln and Holland Tunnel Interchanges, during peak periods when the one lane is reserved for buses and HOVs. Speeds in each direction on these lanes will vary between 15 and 25 mph, and conditions in this section will be approaching unstable flow. As shown in Tables 6-1 and 6-2, the mainline general traffic section between 14th Street and the Holland Tunnel will experience V/C ratios exceeding 0.90 in both directions for each peak hour. The V/C ratios for the section from 14th Street to the Lincoln Tunnel are estimated to range from 0.72 to 0.85, since some additional capacity exists in this section caused by the need of a merge lane in each direction.

The other portions of the Modified Outboard Alternative will experience stable flow with higher operating speeds. Travel speeds during each peak hour will be near 40 mph or greater on the section north of the Lincoln Tunnel Interchange and on the section south of Canal Street. These sections have three lanes for general traffic, and V/C ratios do not exceed 0.75 on these mainline sections during the peak periods. Speeds drop to about 30 mph near the entrance and exit to the Brooklyn Battery Tunnel because of the operating characteristics of the Tunnel, although V/C ratios remain relatively low. The express bus-HOV lanes will operate at speeds of 45 mph or greater for both peak periods in each direction, with resulting V/C ratios of less than 0.60.

Table 6-1

1995 SOUTHBOUND PEAK HOUR VOLUMES AND VOLUME/CAPACITY RATIOS BY MAINLINE SECTIONS AND BY RAMPS

Location		A.M. Peak Hour				P.M. Peak Hour			
		Autos and Light Trucks	Heavy Trucks and Buses	Total Vehicles in PCE's	V/C Ratio	Autos and Light Trucks	Heavy Trucks and Buses	Total Vehicles in PCE's	V/C Ratio
Mainlines – General Traffic Lanes:									
From	To								
44th Street	38th Street	4,702	0	4,702	0.78	3,009	0	3,009	0.50
38th Street	Lincoln Tunnel Off Ramp	3,997	0	3,997	0.67	2,701	0	2,701	0.45
Lincoln Tunnel Off Ramp	34th Street	3,810	0	3,810	0.64	2,606	0	2,606	0.43
34th Street	Lincoln Tunnel On Ramp	4,004	61	4,126	0.69	3,341	78	3,497	0.58
Lincoln Tunnel On Ramp	14th Street Off Ramp	3,857	200	4,257	0.85	3,384	113	3,610	0.72
14th Street Off Ramp	14th Street On Ramp	2,997	189	3,375	0.84	2,989	97	3,183	0.80
14th Street On Ramp	Holland Tunnel Off Ramp	3,251	296	3,843	0.96	3,649	151	3,951	0.99
Holland Tunnel Off Ramp	Holland Tunnel On Ramp	2,428	203	2,834	0.71	3,035	82	3,199	0.80
Holland Tunnel On Ramp	Battery Park City	2,948	307	3,562	0.51	3,968	164	4,296	0.61
Battery Park City	Battery Place Off Ramp	1,982	196	2,374	0.40	3,506	126	3,758	0.63
Battery Place Off Ramp	Brooklyn Battery Tunnel	465	96	657	0.16	2,572	99	2,770	0.69
Express Bus – H.O.V. Lane		612	237	1,086	0.54	692	243	1,178	0.59
Entrance Ramps:									
34th Street		194	61	316	0.21	735	78	891	0.59
Lincoln Tunnel		369	139	647	0.43	443	34	511	0.34
14th Street		254	107	468	0.31	659	55	769	0.51
Holland Tunnel		137	53	243	0.16	387	56	499	0.33
Exit Ramps:									
38th Street		705	0	705	0.71	308	0	308	0.31
Lincoln Tunnel		187	0	187	0.12	95	0	95	0.06
14th Street		860	11	882	0.81	394	17	428	0.39
Holland Tunnel-Canal Street		824	92	1,008	0.67	615	68	751	0.50
Battery Park City		965	112	1,189	0.91	462	38	538	0.41
Battery Place		712	91	894	1.10	253	11	275	0.34
Battery Park Underpass		807	7	821	0.41	683	14	711	0.36

Table 6-2

1995 NORTHBOUND PEAK HOUR VOLUMES AND VOLUME/CAPACITY RATIOS BY MAINLINE SECTIONS AND BY RAMPS

Location		A.M. Peak Hour				P.M. Peak Hour			
		Autos and Light Trucks	Heavy Trucks and Buses	Total Vehicles in PCE's	V/C Ratio	Autos and Light Trucks	Heavy Trucks and Buses	Total Vehicles in PCE's	V/C Ratio
Mainlines – General Traffic Lanes:									
From	To								
Greenwich Street	Rector Street	2,690	71	2,832	0.71	1,828	68	1,964	0.49
Rector Street	Murray Street	3,770	106	3,982	0.66	3,052	157	3,366	0.56
Murray Street	Holland Tunnel Off Ramp	4,009	146	4,301	0.61	3,701	261	4,223	0.60
Holland Tunnel Off Ramp	Holland Tunnel On Ramp	2,281	66	2,413	0.60	2,387	103	2,593	0.65
Holland Tunnel On Ramp	14th Street Off Ramp	3,781	124	4,029	1.01	3,369	163	3,695	0.02
14th Street Off Ramp	14th Street On Ramp	3,301	37	3,375	0.84	3,089	52	3,193	0.80
14th Street On Ramp	Lincoln Tunnel Off Ramp	3,500	55	3,610	0.72	3,681	56	3,793	0.76
Lincoln Tunnel Off Ramp	Lincoln Tunnel On Ramp	2,772	0	2,772	0.46	3,641	0	3,641	0.61
Lincoln Tunnel On Ramp	44th Street On Ramp	3,082	0	3,082	0.51	4,449	0	4,449	0.74
Express Bus – H.O.V. Lane		490	243	976	0.49	568	237	1,012	0.62
Entrance Ramps									
Greenwich Street		155	9	173	0.17	645	7	659	0.66
Rector Street		1,081	34	1,149	0.57	1,224	89	1,402	0.70
Murray Street		238	41	320	0.16	649	104	857	0.43
Holland Tunnel-Canal Street		1,500	58	1,616	1.08	982	60	1,102	0.73
14th Street		200	17	234	0.16	592	4	600	0.40
Lincoln Tunnel-30th Street		310	0	310	0.21	808	0	808	0.54
Exit Ramps									
Holland Tunnel		1,283	55	1,393	0.03	848	107	1,062	0.71
14th Street		481	86	653	0.53	281	110	501	0.41
Lincoln Tunnel-30th Street		1,090	55	1,200	0.80	543	56	655	0.44

Traffic Surveillance and Control System

A Traffic Surveillance and Control (TS&C) system has been planned for construction with the Modified Outboard Alternative. The system will provide corridor traffic surveillance and control consistent with operational policy directives and enhance preferential service to buses and HOVs. Such a system will consist of automated (tactical) and manual (management) control subsystems that are designed according to specified functional requirements for each of the five principal components of the selected alternative, namely: (1) mainline highway, (2) ramps, (3) West Street/12th Avenue, (4) local streets, and (5) public transit.

This design shall integrate the tactical and management control elements so that prudent transportation systems management is exercised and environmental impacts minimized. The benefits (safer highway conditions, reduced delays during incidents, reduced fuel consumption, etc.) to be realized using traffic surveillance and control should outweigh the total costs incurred during the lifetime of the system. The system is designed to be coordinated with the overall computer traffic control system being developed and installed for the island of Manhattan. It contributes to making the selected alternative an integral part of the city roadway system. Traffic on the mainline highway and on the express bus-HOV lanes will be controlled by the West Side Highway system, while West Street operations will be controlled by the New York City system.

The general structure of the Traffic Surveillance and Control system recommended for the Modified Outboard Alternative includes:

1. An electronic surveillance subsystem that would use a central computer for automatic (or tactical) control and identification of unusual conditions on the roadways.
2. Personnel whose function would be to implement a control strategy.
3. The System Management Center would implement actions beyond the capabilities of the Central Computer system.

Illustration 6-2 indicates how various traffic control hardware might be placed in the vicinity of the 14th Street interchange, assuming the Modified Outboard Alternative is implemented. The hardware elements would provide both local control for that area of the corridor and information to the Traffic Control Center for systemwide control strategy. The ramp-metering system, designated by an X in Illustration 6-2, is actually an aggregate of four types of control components. These include fixed signs, traffic signal lights, a local controller mechanism and a communications interface which would be linked to the computer facility. Details and locations of the equipment, technical procedures, analyses, and findings are contained in a separate technical report entitled, "Traffic Surveillance and Control System for the Modified Outboard Alternative", dated October 1976.

The design objectives of the Traffic Surveillance and Control System for the selected alternative are to provide corridor traffic surveillance and control consistent with operational policy directives, and to enhance preferential service to buses and HVOs. Accordingly, the functional design requirements are identified for each of the five major elements of the Modified Outboard Alternative outlined below.

Mainline Highway

1. Electronic detectors located in the highway pavement to monitor volume, speed, and density and linked to the control center.
2. TV surveillance with cameras placed at every quarter mile in each direction to permit visual observations of traffic conditions and to enable the operator to evaluate an incident on the highway.
3. Variable message signs near interchanges and along the highway to provide speed control, lane control, traffic, and alternate routing information and priority lane operation.
4. Emergency vehicles with towing capability and equipped to render first aid and mechanical assistance to motorists.
5. Motorists emergency-aid call boxes, located every quarter mile in each direction, to permit two-way communications to motorists in need of aid to call the control center.
6. Regulate and control operation of express bus-HOV lanes and provide for the enforcement of the lane operations by means of special overhead signing.
7. Special treatment given to the merge areas at both ends of the express bus-HOV lane in order to maximize safety conditions.

Highway Ramps

1. Entrance ramp control, consisting of electronic detectors, traffic signals, and fixed signs at all entrance ramps to the Highway, to provide traffic flow regulation.
2. Automatic barricades at entrance ramps connecting West Street/12th Avenue with the Highway to effect ramp closure.
3. Variable-message signing information at all entrance ramps to convey highway conditions, alternate routing, and ramp operation.
4. Merging control at the entrance ramps to the priority lanes to facilitate and increase the safety of the merging operations at these points.

West Street/12th Avenue

1. A traffic responsive signal system, consisting of detectors and controllers linked to a computer, which would monitor traffic conditions and progress traffic in compliance with the Westway policy directives recommended for West Street.
2. Various types of information signs in the vicinity of ramps leading to the Highway to advise motorists of traffic conditions and possible alternate routes.
3. TV surveillance at selected points to permit visual observation and verification of traffic conditions.
4. An Automatic Vehicle Identification (AVI) system to provide priority for buses at traffic signals and to identify buses as they exit or enter the highway at the special bus ramps.

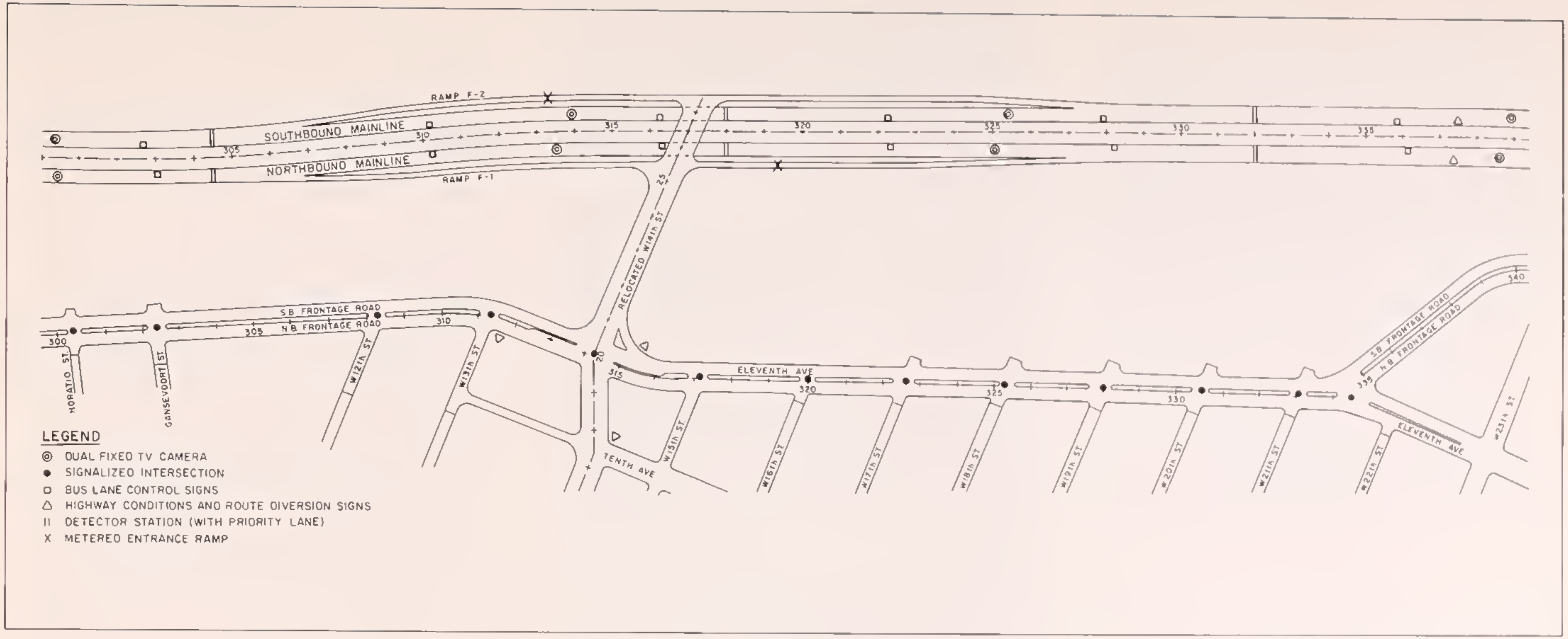


Illustration 6–2.

Traffic Surveillance and Control System

Sample Design

North

Adjacent Local Streets

1. It is assumed that the New York City Department of Traffic will operate this system and permit an interface with the planned computerized traffic control system which will supervise the street network controls adjacent to the impact area.
2. TV surveillance would permit visual observation and verification of an incident on major arterials
3. Information signs, advising motorists of maintine traffic conditions and alternate routes, would be installed at selected intersections on the local street system

Public Transit

1. Provide capability for the establishment of peak-hour preferential highway lanes along the mainline from just south of the Holland Tunnel to the Lincoln Tunnel for use by express buses and HOVs
2. Regulate and control the operation including enforcement of the preferential lanes by means of overhead variable-message signing
3. Regulate and control the merging areas to and from the express bus-HOV lanes to maximize safety
4. Provide the capability for exclusive bus lanes along West Street in lower Manhattan by means of pavement marking, overhead signing and bus priority traffic signals at certain intersections by use of special vehicle detectors to distinguish between buses and other vehicles

Traffic Control Center

The Traffic Control Center is where the street and Highway operating policy would be implemented. The Control Center would house the computer facility, TV monitors and other electronic elements, all computer peripheral devices, and an illuminated map display. The personnel in the Control Center would be able to monitor traffic conditions either visually or electronically. Based on the information provided by the system, management would determine the nature and magnitude of the control to be exerted based on existing conditions It is assumed that the Control Center will be located in the building now occupied by the New York City Department of Traffic.

Overall System Operation

Operation of the Traffic Control System as designed will integrate traffic movements on the Highway and West Street. Corridor traffic is directed to the Highway and away from West Street and other local streets Traffic not destined for the Corridor is discouraged from using the other streets in the Corridor As part of the system, traffic will be directed to highway ramps, encouraged to use major crosstown routes, and discouraged from using residential streets

Along West Street, the Traffic Control System is segmented into several operational portions Adjacent land uses and the density of development determine the design and operation of the system Traffic not destined for Greenwich Village or Chelsea is discouraged from using West Street in these residential areas. Speeds on West Street between Canal and 23rd Streets will be constrained by progressive traffic signal timing to be less than on adjacent north-south avenues and the Highway. West Street in the residential areas will become less attractive to through trips

South of Canal Street and north of 23rd Street, the design of the system responds to the areas' non-residential uses. Lower Manhattan has an intense concentration of office space. In the Midtown area, West Street is bordered by industrial uses including the 30th Street railroad yards. Traffic signal progression will accommodate traffic to these less sensitive land uses by permitting higher speeds and smoother flow.

Costs

The composite cost is defined as consisting of the one-time capital cost plus the present worth of the annual operating and maintenance costs The total cost for implementing the TSCS would approximate $11 million.

The cost of replacement parts and the salaries of maintenance personnel are included in the annual costs It is assumed that the present physical plant of the New York City Department of Traffic would take on this additional maintenance operation. Therefore, construction costs for a Control Center for the Traffic Surveillance and Control System have not been included in the above estimate Included in the annual costs of the Control Center is the payroll cost of the professional staff which would operate in the Center

Benefits

The benefits which would accrue to motorists as a result of a Traffic Surveillance and Control System in the West Side Highway corridor are safer operating conditions, lower average trip times, and better air quality.

1. Safer operating conditions would result from fast incident detection, response, and clearance of incidents on the Highway; and regulating the ramp entry rates to minimize the interference between the Highway and ramp traffic.
2. Lower average trip times would result from the control system alerting motorists to incidents on the Highway, and by integrating the signal control system for progression of the signals in the corridor so that it is responsive to unusual traffic loads created by incidents occuring elsewhere in the corridor.
3. Improved air quality would be obtained in the area from the increased average vehicle speeds and smooth flow conditions on the Highway and parallel street network, thus reducing motor fuel consumption.

Section 7 - Construction

Introduction

A construction schedule, maintenance of traffic procedure, and estimate of cost was developed for the recommended alignment. In addition to the above items, the construction impacts for the Modified Outboard Alternative with respect to traffic, air quality, noise and water quality are discussed in the Final Environmental Impact Statement. This section of the report, relating to construction schedules, maintenance of traffic and costs, is predicated on the assumption that the existing West Side Highway is closed to traffic and will be demolished.

Construction Schedules

The magnitude of the Modified Outboard alignment is so large, in both size and cost that it would not be feasible to build it with one construction contract. Therefore, a construction schedule was prepared showing the number of contracts anticipated and the years in which a particular contract will be under construction. Further, the following basic parameters were adopted:

1. The project should be completed within a minimum construction time consistent with a planned method of maintaining traffic.
2. The schedule should allow for orderly letting of construction contracts which would be reasonable in size and cost. The maximum cost of any single contract was established as approximately $100 million.
3. The construction shall begin at the southerly end of the project, since the landfill for Battery Park City will be in place at the time construction begins, permitting immediate construction of the Modified Outboard Alternative.

Illustration 7-1 delineates the detailed construction schedules for the Modified Outboard Alternative.

Maintenance of Traffic

Control of the vehicular traffic in the area of construction has been a major consideration of the project from the beginning of the planning process. In order to minimize the disruption of local traffic a detailed maintenance of traffic plan was developed with the following parameters as a guide:

1. A minimum of two lanes in each direction should be maintained for West Street and 12th Avenue traffic.
2. Staged construction should be used to minimize the impact on traffic during the construction in the area of the tunnel approaches.
3. Access to all properties along the construction route should be maintained.

Drawings detailing the maintenance of traffic during construction are shown in Section 8, Graphics.

Cost Estimates

A detailed construction and right-of-way cost estimate, using 1976 cost, was prepared for the Modified Outboard Alternative. The construction cost estimate was determined by estimating quantities of major items of work from plans and work sheets, and applying unit cost to these quantities. The right-of-way estimate was prepared by the New York State Department of Transportation. Based on these estimates, the total construction cost of the Modified Outboard Alternative will be $1,008.6 million and the right-of-way cost will be $147.0 million, in 1976 dollars. Table 7-1 shows the cost breakdown.

Table 7-1

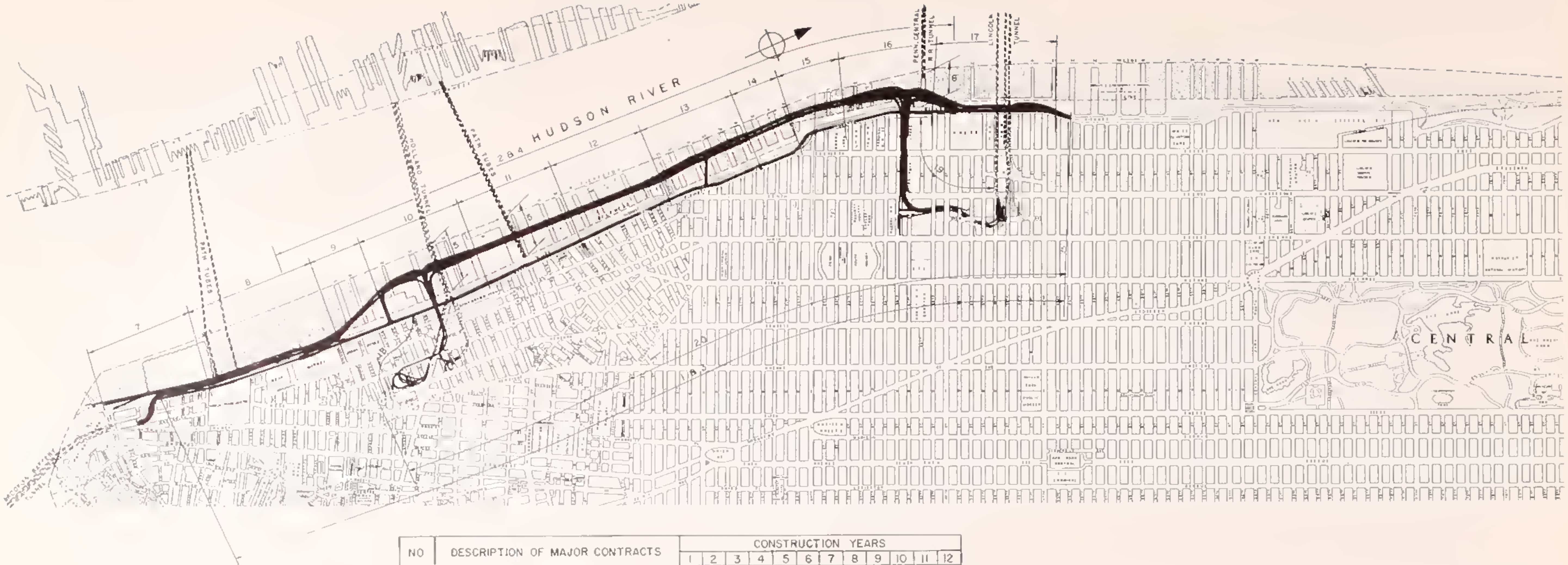
HIGHWAY CONSTRUCTION AND RIGHT-OF-WAY COSTS

(In Millions of Dollars)

	Construction Costs			Right of Way Costs [a]		
	Base Cost [a]	Miscellaneous [b]	Total	Market Value	Miscellaneous	Total
Modified Outboard Alternative	$877.0	$131.6	$1,008.0	$117.9	$29.1	$147.0

(a) Includes 4 percent for Survey and Mobilization

(b) Includes 15 percent for Engineering and Contingencies



NO	DESCRIPTION OF MAJOR CONTRACTS	CONSTRUCTION YEARS											
		1	2	3	4	5	6	7	8	9	10	11	12
1	UTILITY CONTRACTS	■	■	■									
2	DEMOLITION OF PIERS & HEADHOUSES	■	■	■									
3	DEMOLITION EXISTING W.S.H. VIADUCT	■	■	■									
4	LANDFILL OPERATION	■	■	■	■								
5	TUNNEL PROTECTION HOLLAND AND PATH	■	■										
6	TUNNEL PROTECTION CONRAIL (PENN) RAILROAD		■	■									
7	BROOKLYN BATTERY TUNNEL TO LIBERTY STREET		■	■	■	■	■	■	■				
8	LIBERTY STREET TO HARRISON STREET		■	■	■	■	■	■	■				
9	HARRISON STREET TO LAIGHT STREET			■	■	■	■						
10	LAIGHT STREET TO WEST HOUSTON STREET			■	■	■	■						
11	WEST HOUSTON STREET TO CHARLES STREET			■	■	■	■						
12	CHARLES STREET TO GANSEVOORT STREET				■	■	■	■					
13	GANSEVOORT STREET TO 18TH STREET				■	■	■	■					
14	18TH STREET TO 22ND STREET				■	■	■	■					
15	22ND STREET TO 26TH STREET					■	■	■	■				
16	26TH STREET TO 33RD STREET					■	■	■	■				
17	33RD STREET TO 42ND STREET					■	■	■	■				
18	HOLLAND TUNNEL INTERCHANGE-EAST OF WEST ST						■	■	■	■			
19	LINCOLN TUNNEL INTERCHANGE-EAST OF 12TH AVE					■	■	■	■	■			
20	WEST ST-12TH AVE & MISCELLANEOUS WORK						■	■	■	■	■		

Illustration 7–1. Construction Schedule
Modified Outboard Alternative

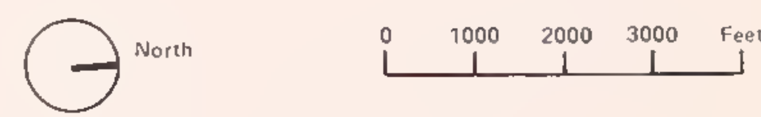


Table 7-2

ITEMS OF WORK ESTIMATED

Description	Unit	Description	Unit	Description	Unit
Clearing and grubbing	l.s.	Cement concrete pavement	sq. yd.	Structural steel	lbs.
Demolition of buildings	l.s.	Structure excavation	cu. yd.	Parapet	lin. ft.
Demolition of structures	l.s.	Sheet piling	sq. ft.	Bridge lighting	l.s.
Excavation	cu. yd.	Slurry wall in earth	sq. ft.	Underdeck lighting	l.s.
Dredging	cu. yd.	Slurry wall in rock	sq. ft.	Bridge drainage	l.s.
Embankment in place (under water)	cu. yd.	Dewatering	l.s.	Waterproofing and protection course	sq. yd.
Stone fill	cu. yd.	Pipe for drilled-in caissons	lin. ft.	Protection of existing tunnels	l.s.
Embankment in place (above water)	cu. yd.	Sockets for drilled-in caissons	each	Bus station	l.s.
Sand drains	lin. ft.	Steel H piles	lin. ft.	Underpinning	l.s.
Riprap	cu. yd.	Prestress, precast piles 54" O.D.	lin. ft.	Concrete topping	cu. yd.
Main line roadway pavement	sq. yd.	Prestress, precast piles 36" O.D.	lin. ft.	Tubular C.I.P. concrete piles	lin. ft.
Main line shoulder pavement	sq. yd.	Tie-down	lin. ft.	Municipal storm systems	l.s.
Ramp pavement	sq. yd.	Socket for tie-down	each	Municipal sanitary systems	l.s.
Street pavement	sq. yd.	Tremie concrete	cu. yd.	Municipal combined sewer systems	l.s.
Drainage	l.s.	Concrete for footings	cu. yd.	Municipal water supply systems	l.s.
Pumping station	l.s.	Concrete for piers and pier caps	cu. yd.	Other municipal utilities	l.s.
Signing	l.s.	Concrete for walls (above footings)	cu. yd.	Electrical distribution systems	l.s.
Lighting	l.s.	Concrete for bridge decks	cu. yd.	Telephone systems	l.s.
Fencing	lin. ft.	Concrete for tunnel roofs	cu. yd.	Fire alarm systems	l.s.
Traffic signal system	l.s.	Concrete for pile caps	cu. yd.	Telegraph systems	l.s.
Landscaping	l.s.	Prestressed concrete beams	cu. yd.	Police telephone systems	l.s.
Mobilization	l.s.	Wall finish	sq. ft.	Gas distribution systems	l.s.
Maintenance of traffic	l.s.	Ventilation (mechanical and electrical)	l.s.	Steam distribution systems	l.s.
Stake-out survey	l.s.	Ventilation buildings	l.s.	Pneumatic tubes distribution systems	l.s.
		Tunnel lighting	l.s.	Other private utilities	l.s.

The construction cost estimate was developed from a list of major standard and unusual work items, including work items normally used by the New York State Department of Transportation. Some items were combined after estimating the amounts of individual components

Quantities of major work items were prepared utilizing engineering study drawings, cross sections, and analysis of sizes and shapes of certain construction items Table 7-2 shows all the work items estimated. Table 7-3 shows quantities estimated for the major work items for the Modified Outboard Alternative.

Unit prices were developed for each of the items, based on the following information

1 The latest (1975) weighted average bid prices for contracts prepared by the New York State Department of Transportation The prices were adjusted to reflect 1976 prices

2 Construction bid prices for similar work in the New York City area by other agencies Several contracts were recently let for landfill required for Battery Park City The bid prices for this work were considered in establishing unit prices

3 The contractors and vendors familiar with special types of construction used in this project were also consulted and this information was used in developing the unit prices

4 All dredged material is to be placed inboard of the roadway embankment. There will be no ocean dumping of dredged material

The total construction cost was estimated by multiplying the unit prices by the quantities of each major work item Added to this cost was 4% for mobilization and surveys, and 15% for engineering and contingencies

Table 7-3

SUMMARY OF QUANTITIES OF CONSTRUCTION MATERIALS FOR MAJOR ITEMS OF WORK

Description	Unit	Quantity
Excavation	Cubic Yards	3,516,000
Dredging	Cubic Yards	3,690,000
Embankment	Cubic Yards	9,742,000
Stone Fill	Cubic Yards	1,583,000
Sand Drains for Highway	Linear Feet	4,290,000
Prestressed Precast Concrete Piles	Linear Feet	935,000
Concrete (all types)	Cubic Yards	1,497,000
Prestressed Concrete Beams	Cubic Yards	118,000
Structural Steel	Pounds	64,019,000

The right-of-way cost estimate was prepared by the Real Estate Division of the New York State Department of Transportation. The potential impact on affected properties was estimated, based upon plans for the Modified Outboard Alternative. The estimated cost was based upon present market value as established by recent sales of comparable commercial and residential property on the west side.

Several items were added to the market value of the impacted properties to arrive at a total estimated right-of-way cost. One major cost included in the estimate is $52 million for the functional replacement of the Gansevoort destructor plant and marine transfer station. Additional miscellaneous items were added to cover administrative costs of acquisition and relocation.

A construction schedule was also developed for the Modified Outboard Alternative. Table 7-4 shows the estimated annual base construction expenditures (not including engineering and contingencies) for each of the 10 years required to complete the project.

Table 7-4

APPROXIMATE ANNUAL CONSTRUCTION EXPENDITURES
(In Millions of Dollars)

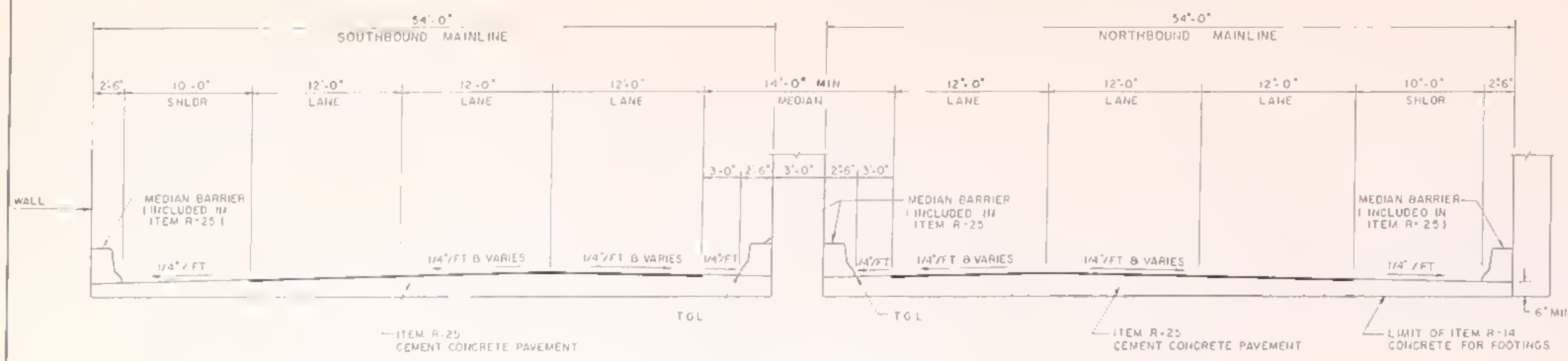
Construction Year	Annual Construction Cost
1	$ 49
2	83
3	106
4	120
5	139
6	139
7	116
8	78
9	41
10	6
Total	$877

Section 8 - Graphics

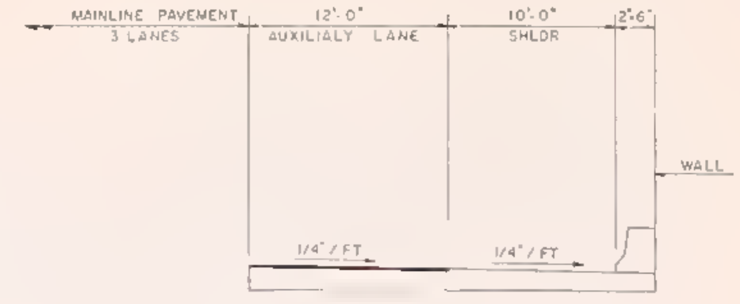
Index of Drawings

Modified Outboard Alternative
Key Plan

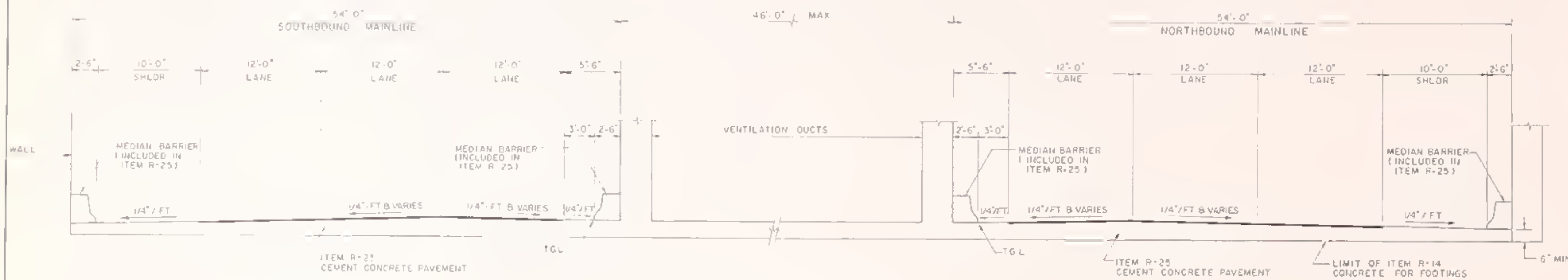
WEST SIDE HIGHWAY PROJECT



MAINLINE DEPRESSED SECTION
℄ STA 211 + 00± TO ℄ STA 236 + 00±
℄ STA 347 + 00± TO ℄ STA. 366 + 30±



TYPICAL AUXILIARY LANE



MAINLINE COVERED SECTION
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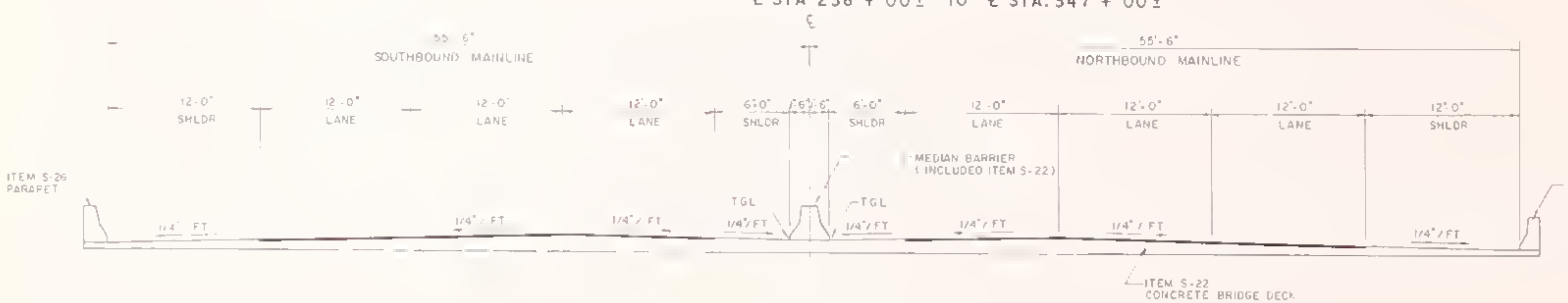
℄ STA 236 + 00± TO ℄ STA. 347 + 00±



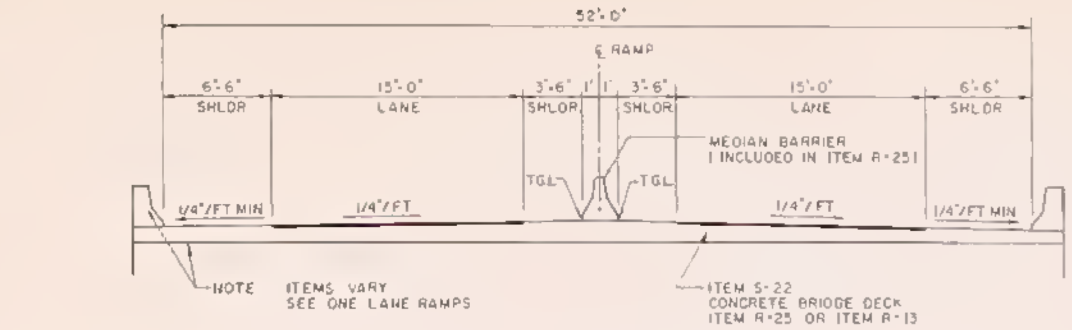
MAINLINE ELEVATED SECTION
℄ STA 366 + 30± TO ℄ STA 395 + 00±

Modified Outboard Alternative

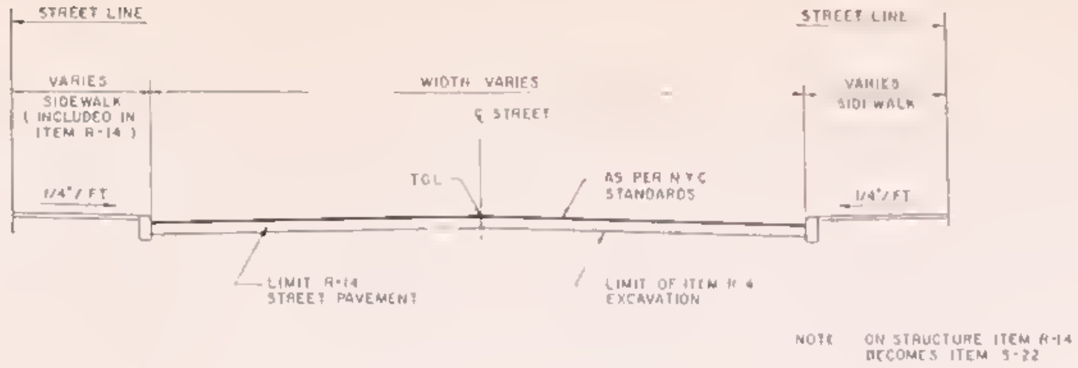
TYPICAL ROADWAY SECTIONS
MAINLINE

WEST SIDE HIGHWAY PROJECT

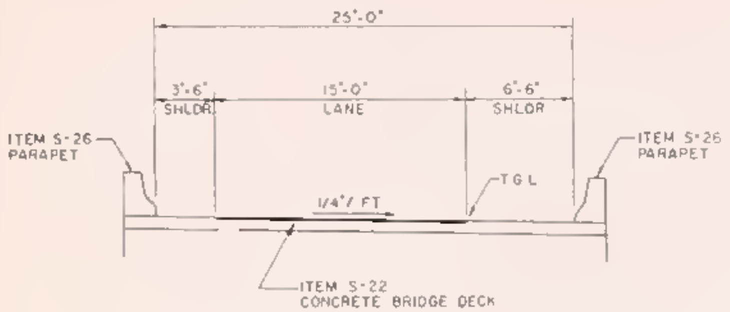
Feet 3 2 1 0 5



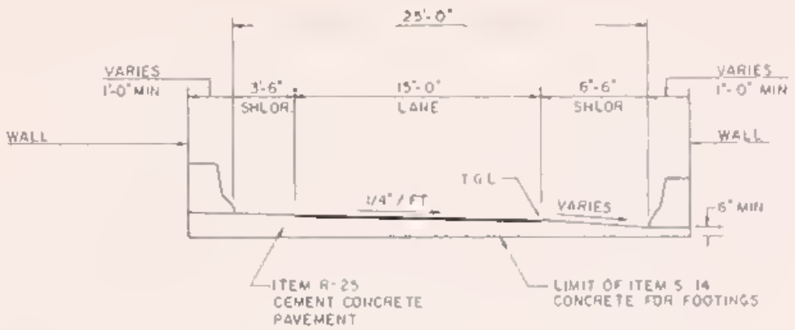
TWO LANE RAMP
(TWO WAY OPERATION)



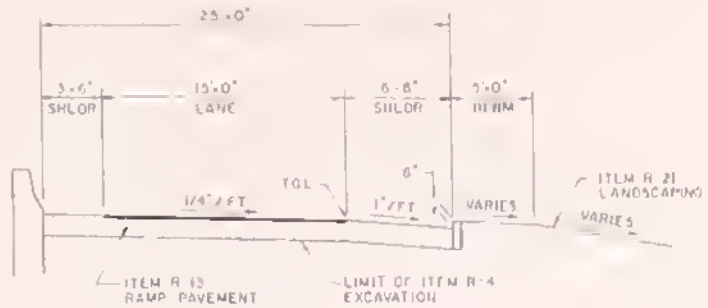
CITY STREET - SECTION GRADE



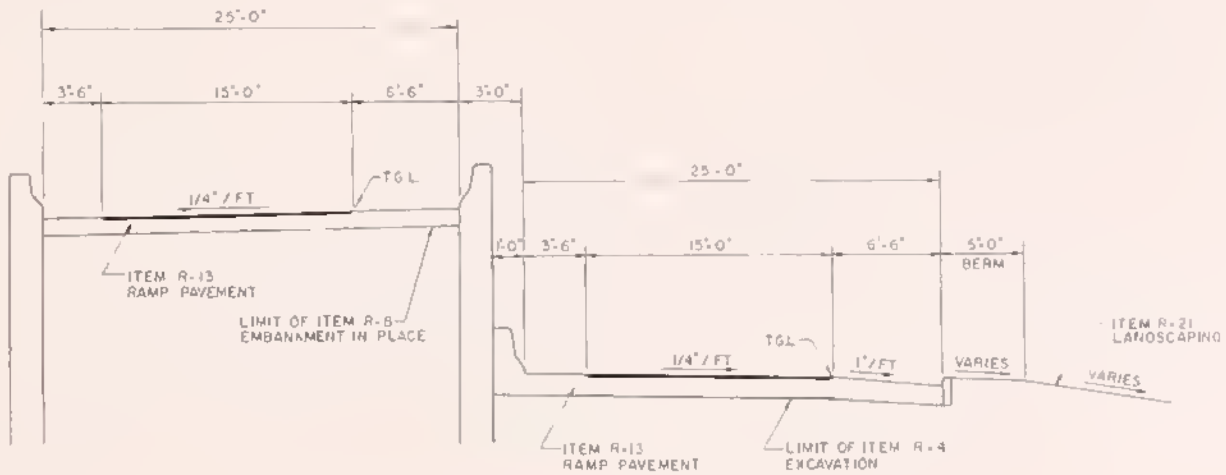
ONE LANE RAMP - ELEVATED SECTION



ONE LANE RAMP - DEPRESSED SECTION



ONE LANE RAMP ON EARTH

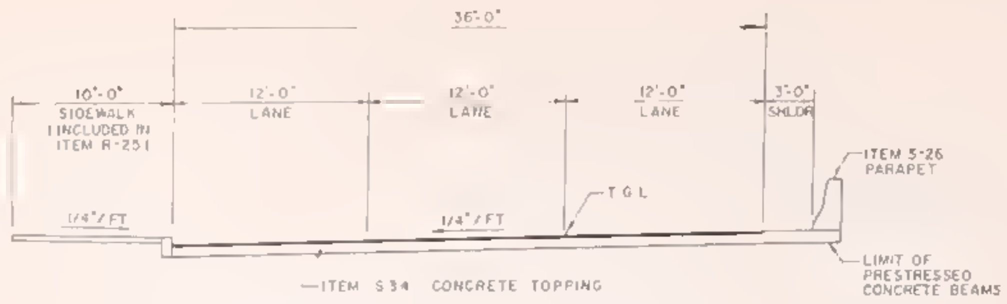


TWO LANE RAMP ONE WAY OPERATION
SEPARATE GRADE

Modified Outboard Alternative

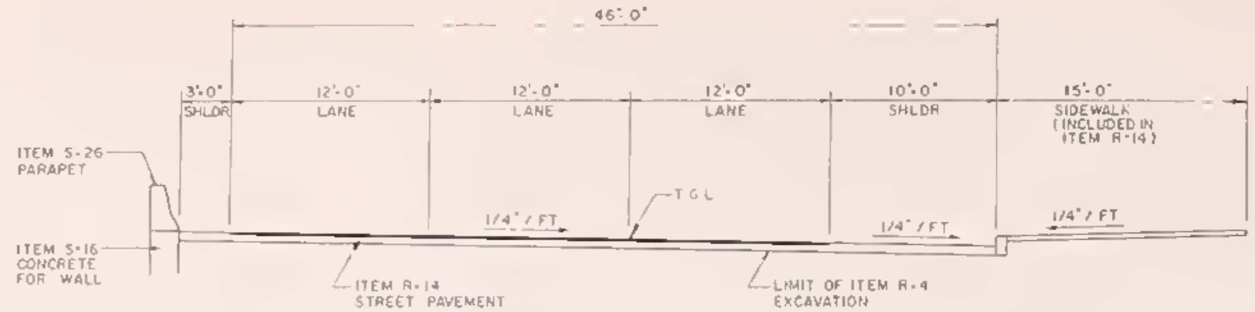
TYPICAL ROADWAY SECTIONS
RAMPS AND STREETS

WEST SIDE HIGHWAY PROJECT



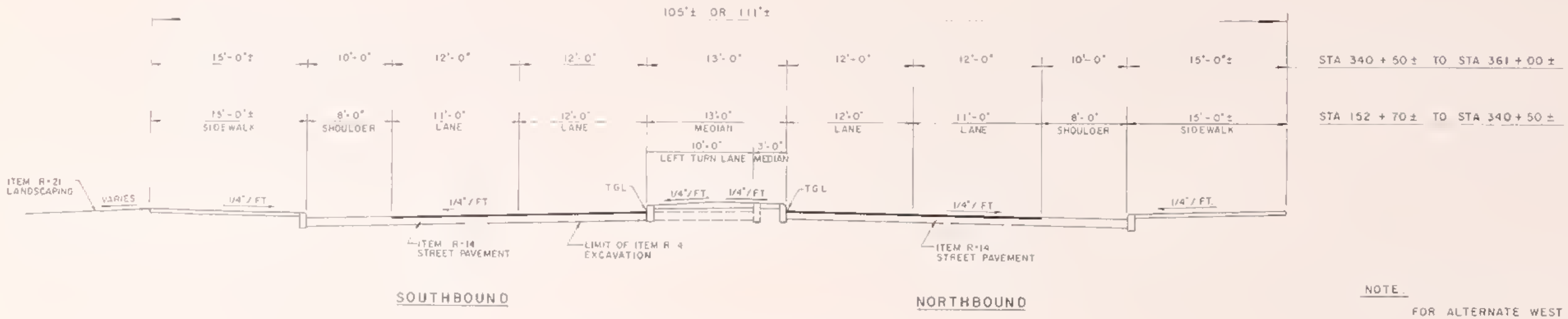
TYPICAL SOUTHBOUND FRONTAGE ROAD SECTION

STA 113 + 00± TO STA 145 + 00±



TYPICAL NORTHBOUND FRONTAGE ROAD SECTION

STA. 113 + 00± TO STA. 152 + 70±

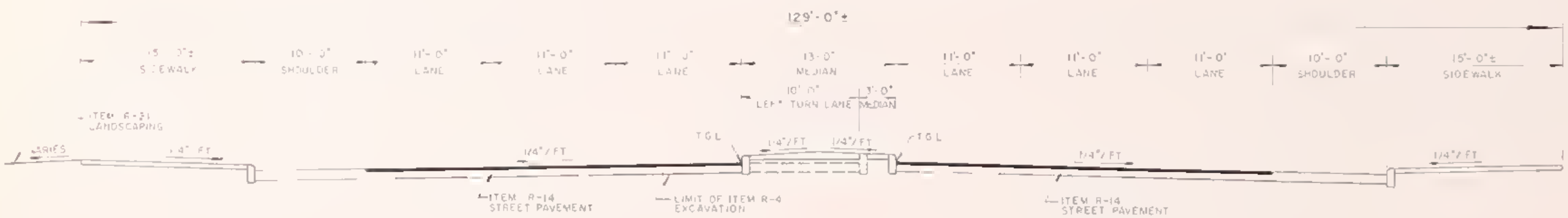


TYPICAL WEST STREET SECTION

STA. 152 + 70± TO STA 361 + 00±

NOTE.

FOR ALTERNATE WEST STREET SECTIONS SEE SHEET NO 8-56



SOUTHBOUND

NORTHBOUND

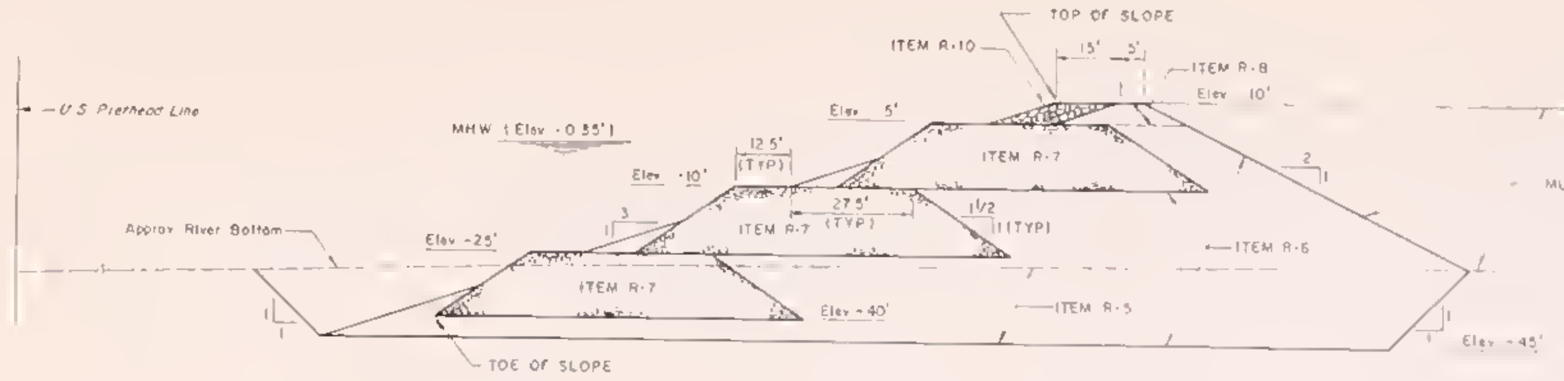
TYPICAL WEST STREET SECTION

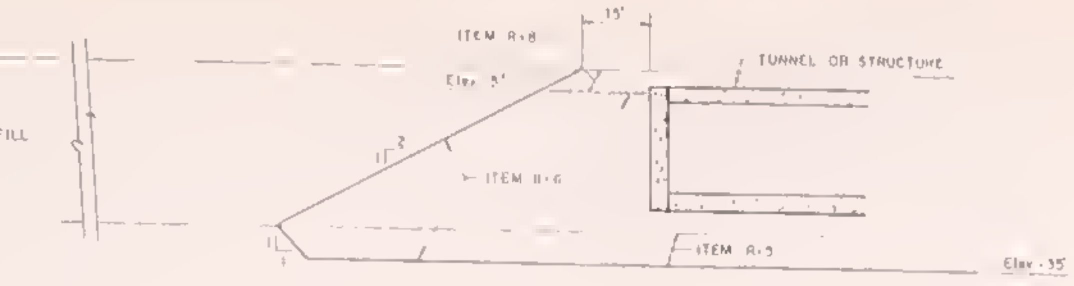
STA 361 + 00± TO STA 395 + 00±

Modified Outboard Alternative

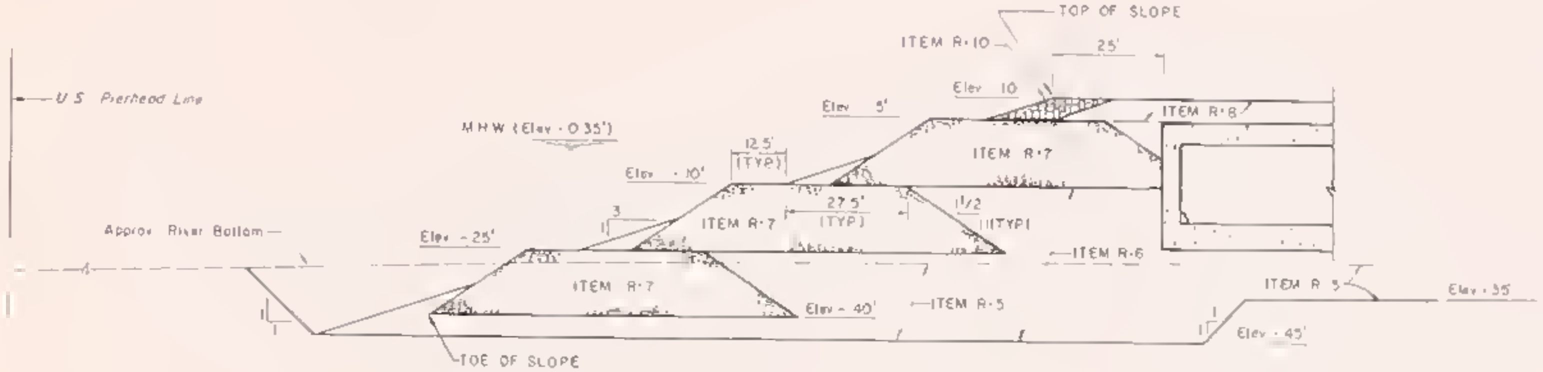
TYPICAL ROADWAY SECTIONS
FRONTAGE ROADS

WEST SIDE HIGHWAY PROJECT





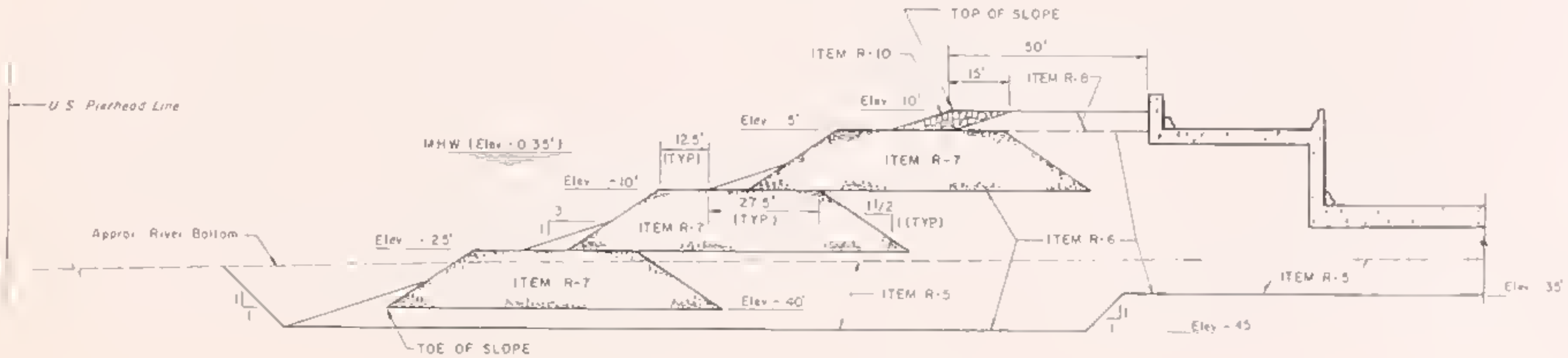
STONE FILL ADJACENT TO EMBANKMENT



STONE FILL ADJACENT TO TUNNEL

ITEM DESCRIPTION

ITEM R-5 DREDGING
ITEM R-6 EMBANKMENT IN PLACE (UNDER WATER)
ITEM R-7 STONE FILL
ITEM R-8 EMBANKMENT IN PLACE (ABOVE WATER)
ITEM R-10 RIP-RAP



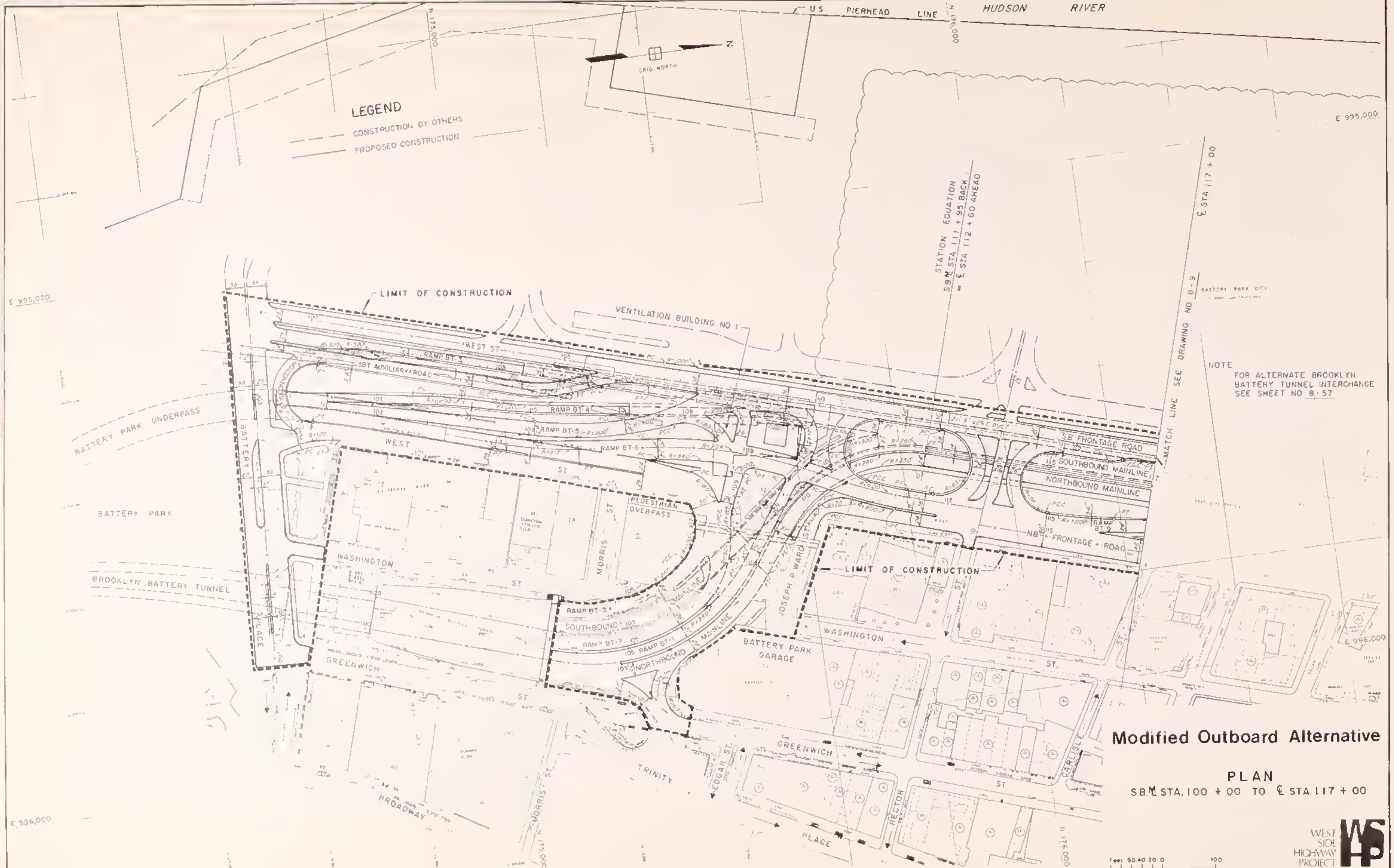
STONE FILL ADJACENT TO STRUCTURE

Modified Outboard Alternative

STONE FILL DETAILS

Feet 10 5 0 10

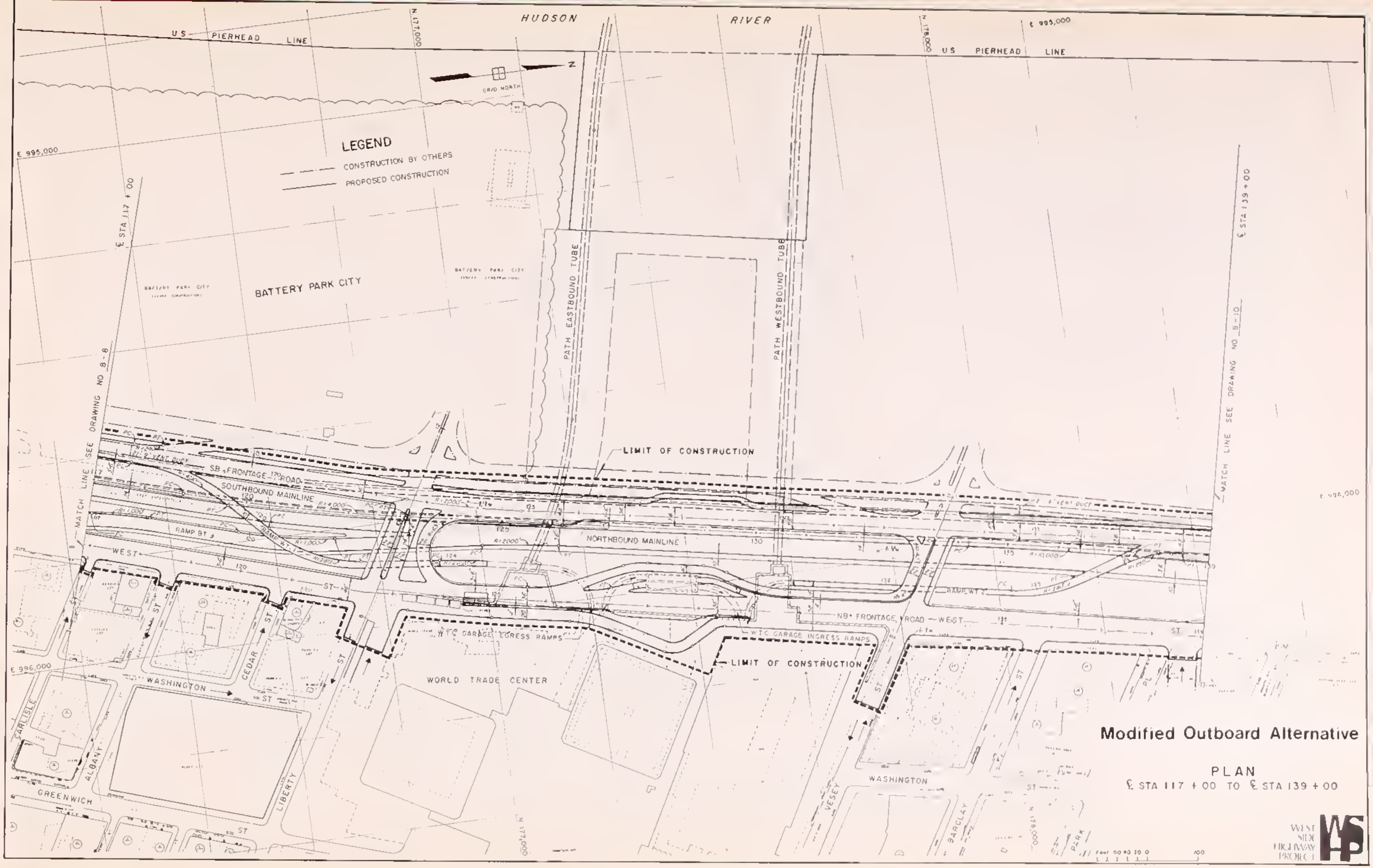
WEST SIDE HIGHWAY PROJECT



Modified Outboard Alternative

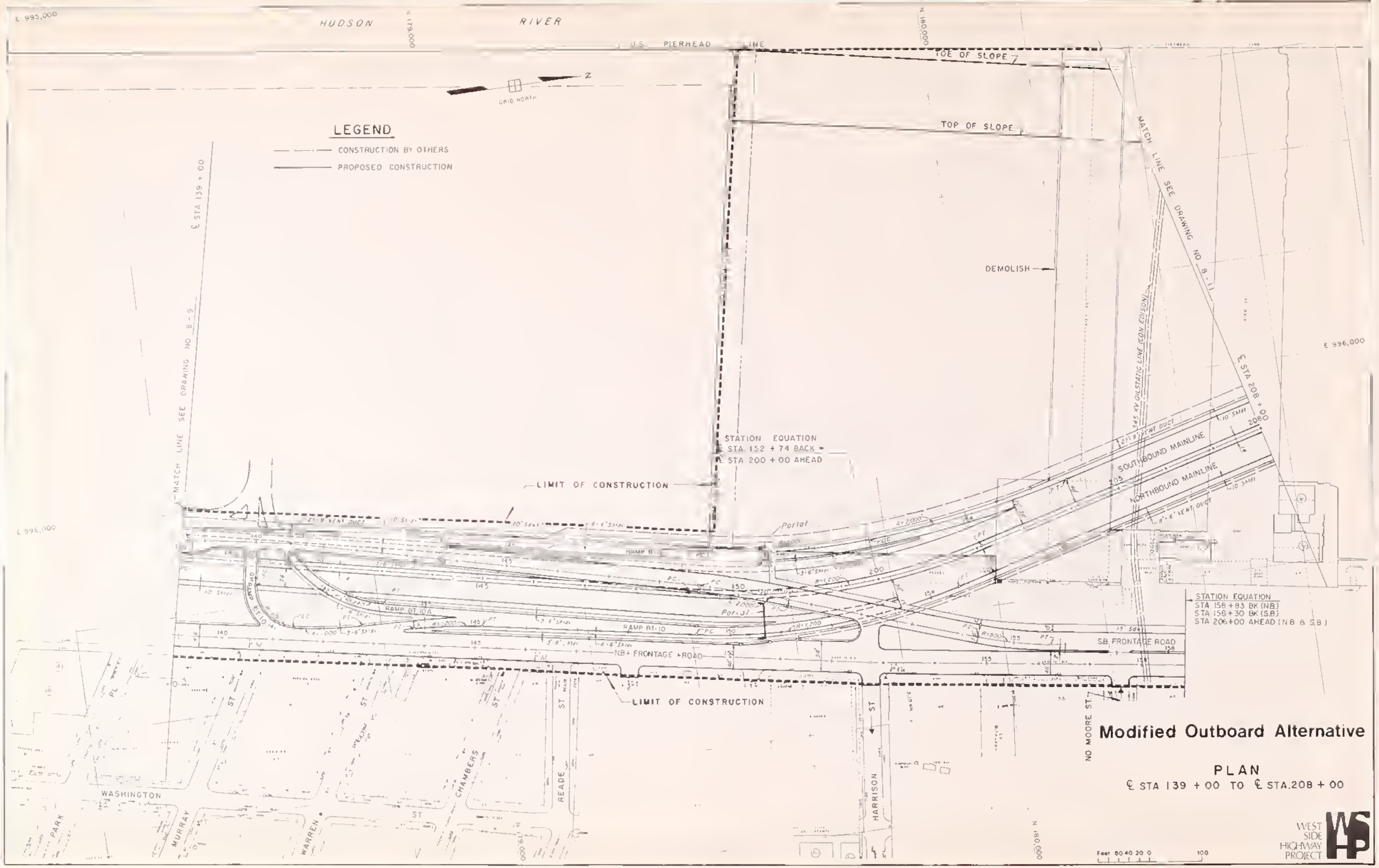
PLAN

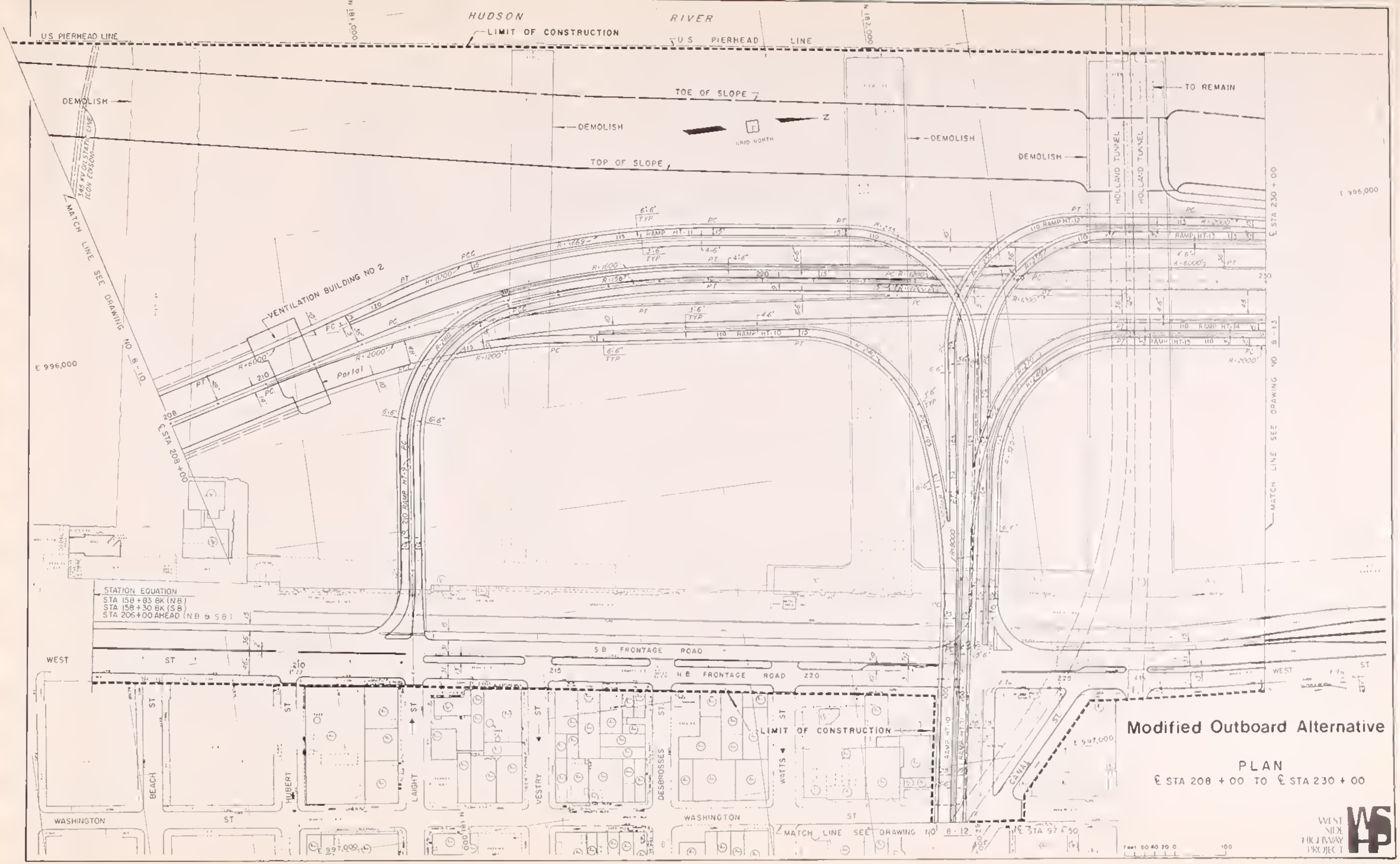
SB ℄ STA. 100 + 00 TO ℄ STA. 117 + 00



Modified Outboard Alternative

PLAN
℄ STA 117 + 00 TO ℄ STA 139 + 00

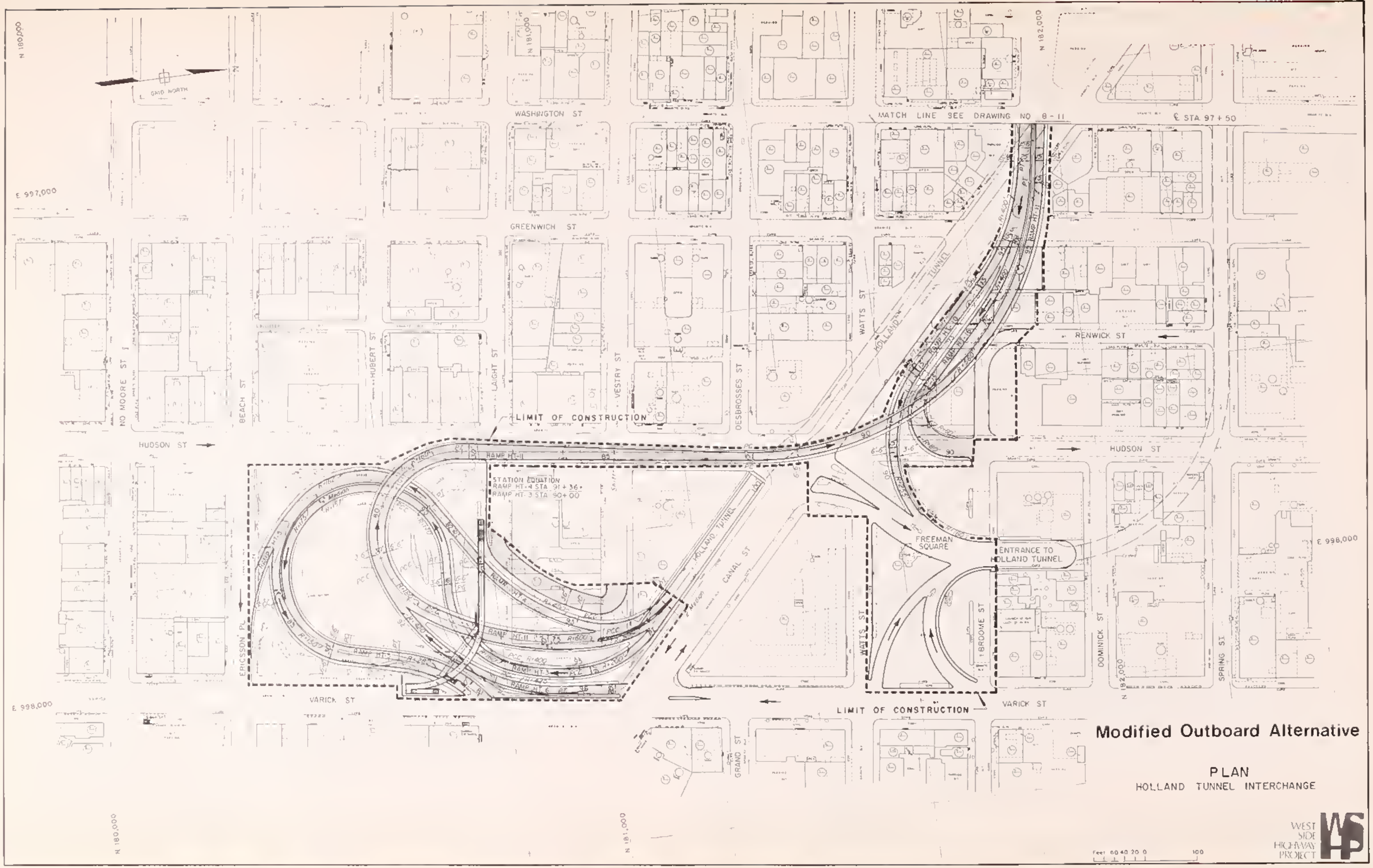

HUDSON RIVER
U.S. PIERHEAD LINE
TOE OF SLOPE
TOP OF SLOPE
GRID NORTH
LEGEND
CONSTRUCTION BY OTHERS
PROPOSED CONSTRUCTION
MATCH LINE SEE DRAWING NO 8-9
℄ STA 139 + 00
MATCH LINE SEE DRAWING NO 8-11
DEMOLISH
345 KV OILSTATIC LINE (CON EDISON)
℄ STA 208 + 00
STATION EQUATION
℄ STA 152 + 74 BACK =
℄ STA 200 + 00 AHEAD
LIMIT OF CONSTRUCTION
SOUTHBOUND MAINLINE
NORTHBOUND MAINLINE
Portal
RAMP BT-10A
RAMP BT-10
NB FRONTAGE ROAD
SB FRONTAGE ROAD
STATION EQUATION
STA 158 + 83 BK (NB)
STA 158 + 30 BK (S.B)
STA 206+00 AHEAD (NB & S.B)
LIMIT OF CONSTRUCTION
WASHINGTON
PARK PL
MURRAY ST
WARREN ST
CHAMBERS ST
READE ST
HARRISON ST
NO MOORE ST
Modified Outboard Alternative
PLAN
℄ STA 139 + 00 TO ℄ STA.208 + 00
WEST SIDE HIGHWAY PROJECT



Modified Outboard Alternative

PLAN

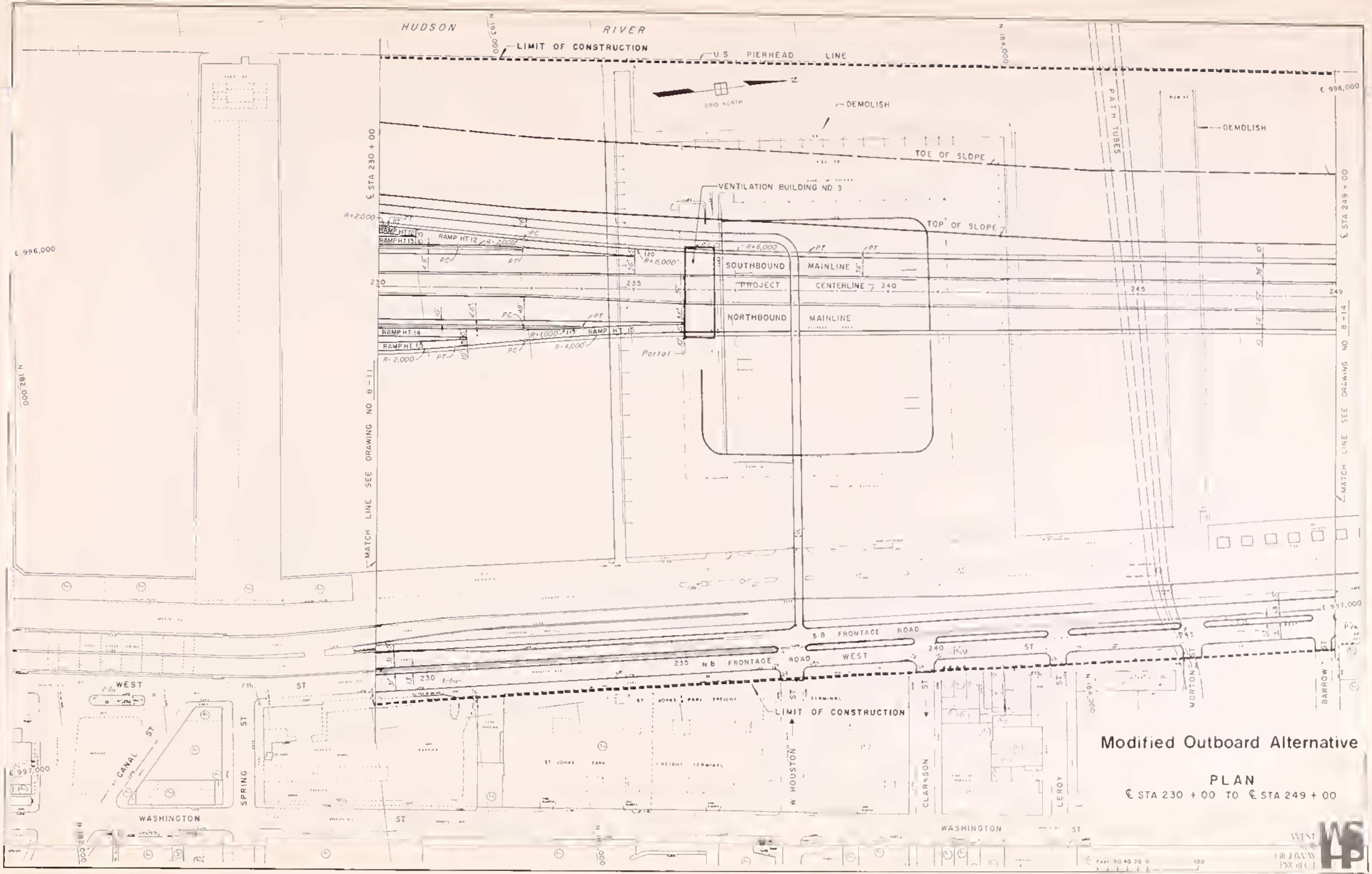
℄ STA 208 + 00 TO ℄ STA 230 + 00



Modified Outboard Alternative

PLAN
HOLLAND TUNNEL INTERCHANGE

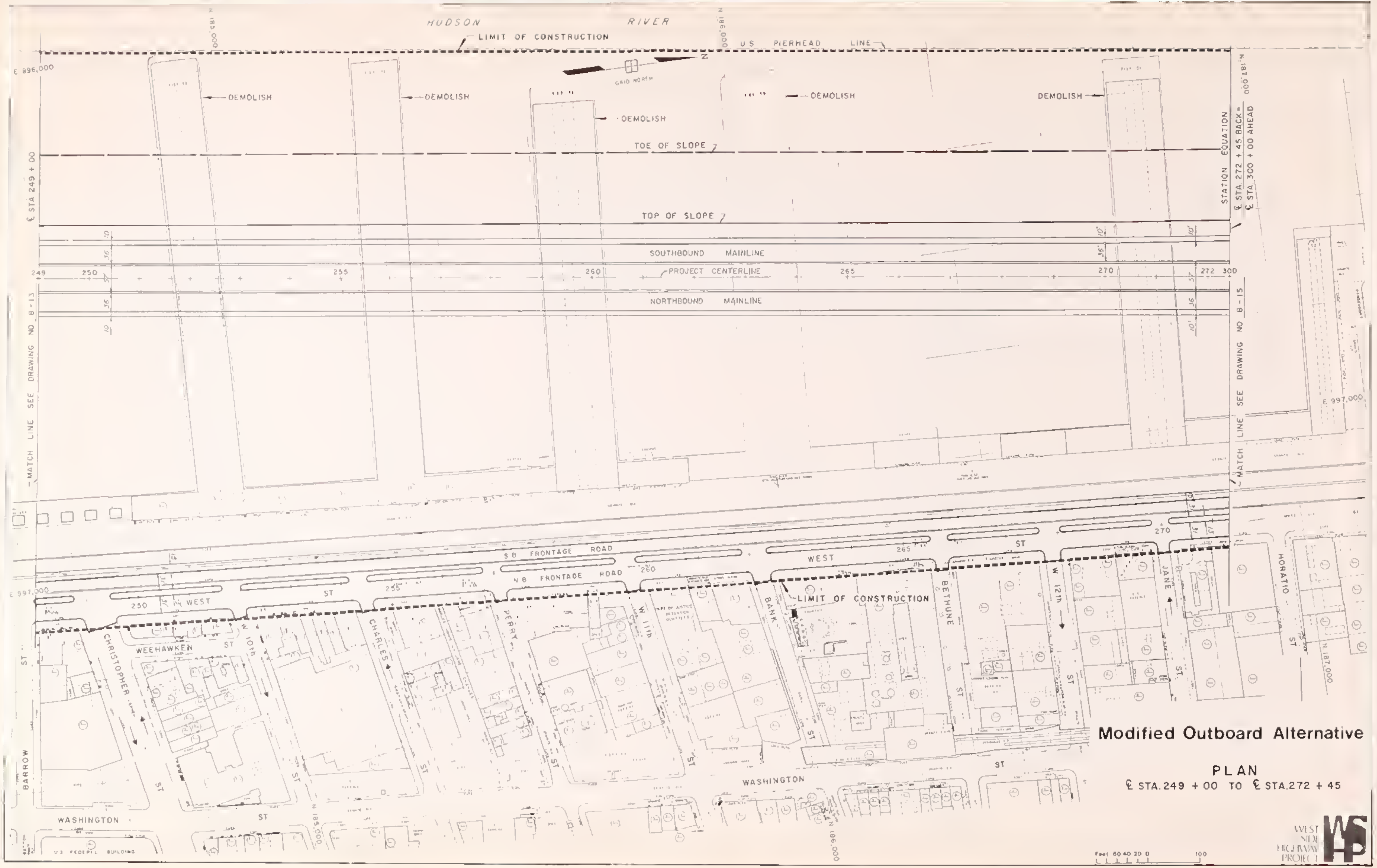
WEST SIDE HIGHWAY PROJECT



Modified Outboard Alternative

PLAN

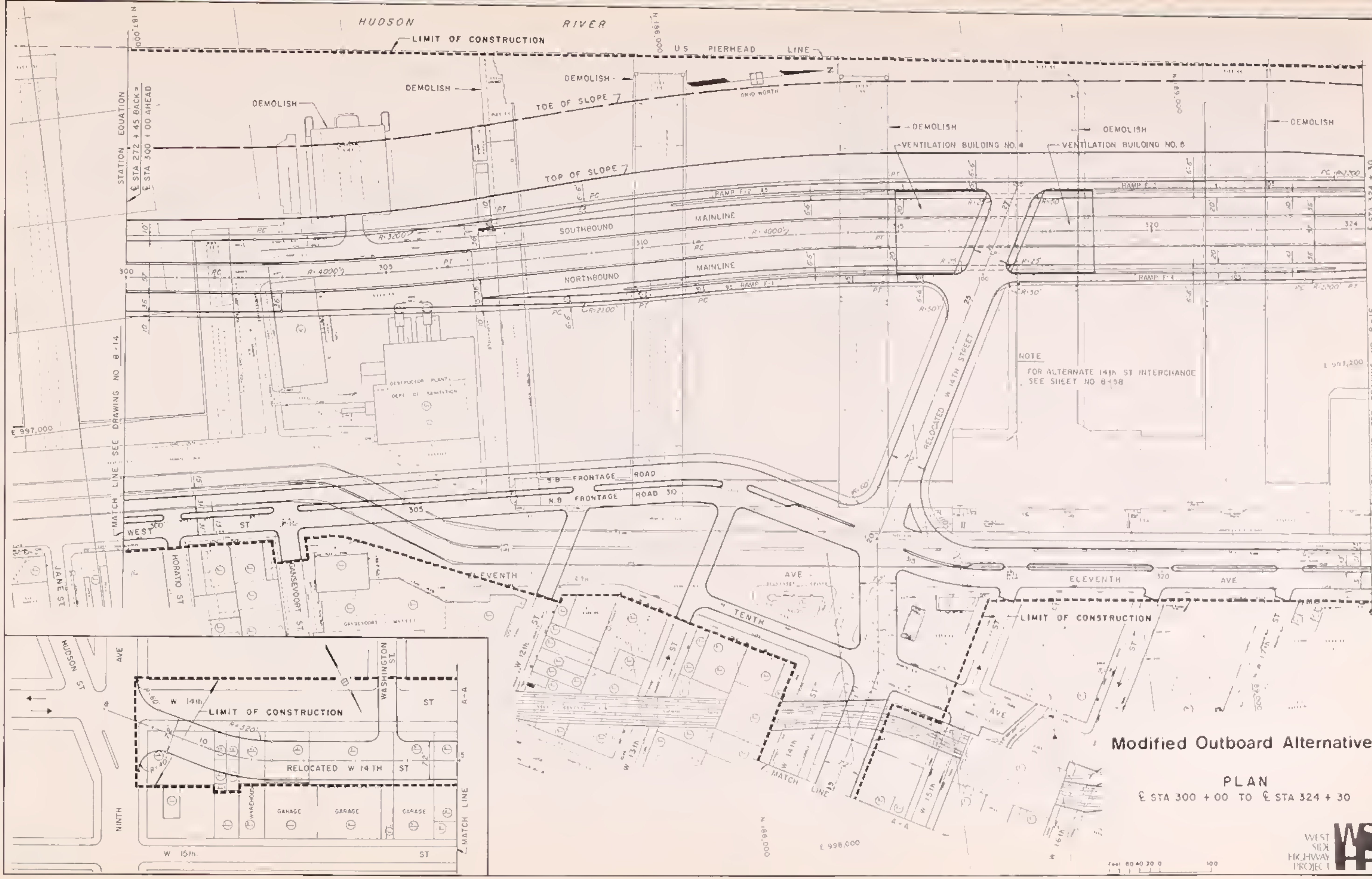
℄ STA 230 + 00 TO ℄ STA 249 + 00



Modified Outboard Alternative

PLAN

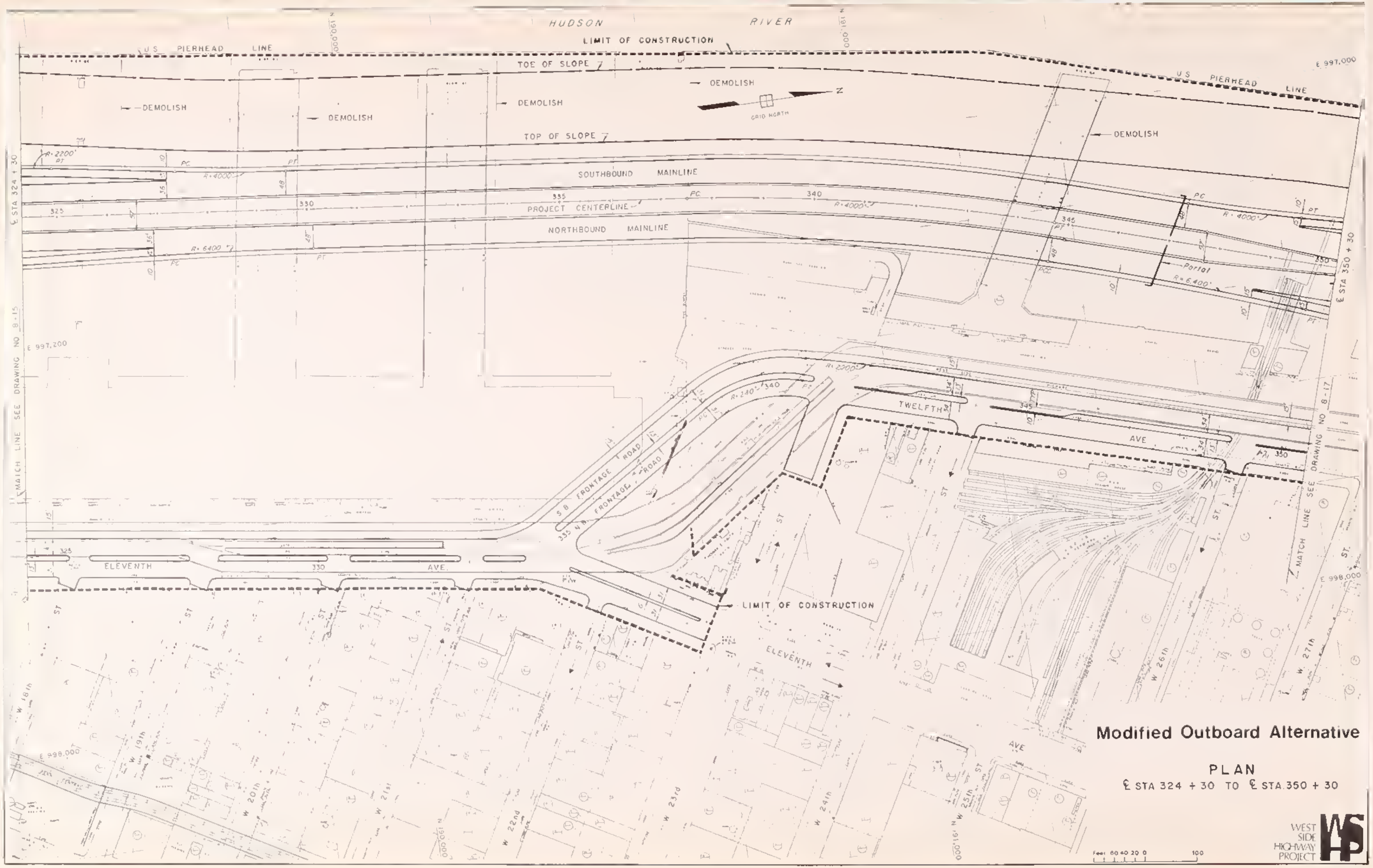
℄ STA.249 + 00 TO ℄ STA.272 + 45

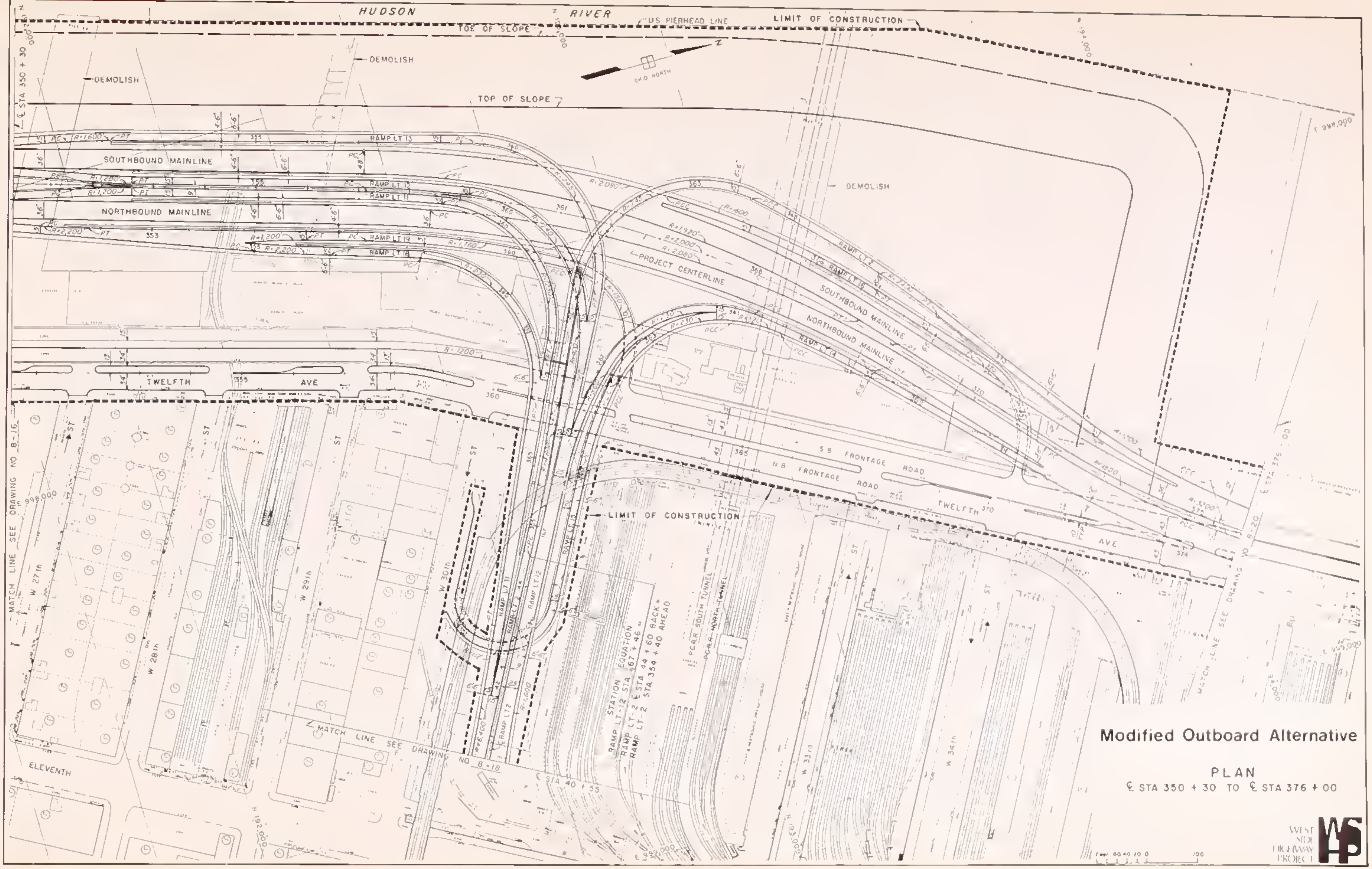


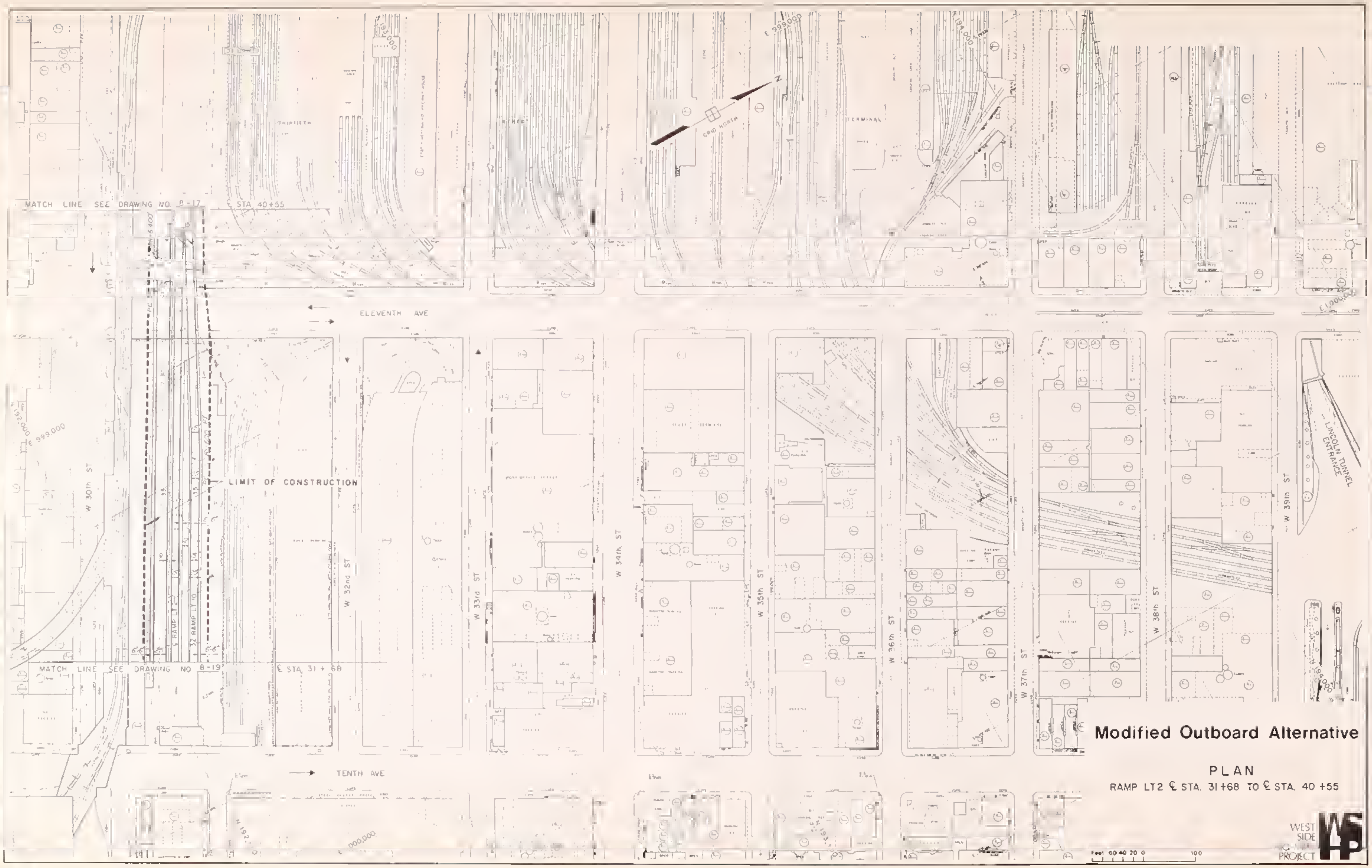
Modified Outboard Alternative

PLAN

℄ STA 300 + 00 TO ℄ STA 324 + 30


HUDSON RIVER
LIMIT OF CONSTRUCTION
U.S. PIERHEAD LINE
TOE OF SLOPE
DEMOLISH
DEMOLISH
DEMOLISH
DEMOLISH
DEMOLISH
GRID NORTH
N
TOP OF SLOPE
SOUTHBOUND MAINLINE
PROJECT CENTERLINE
NORTHBOUND MAINLINE
Portal
℄ STA 324 + 30
℄ STA 350 + 30
MATCH LINE SEE DRAWING NO. 8-15
MATCH LINE SEE DRAWING NO. 8-17
E 997,000
E 997,200
E 998,000
S.B. FRONTAGE ROAD
N.B. FRONTAGE ROAD
TWELFTH AVE
ELEVENTH AVE
ELEVENTH AVE
LIMIT OF CONSTRUCTION
W 18th ST
W 19th ST
W 20th ST
W 21st ST
W 22nd ST
W 23rd ST
W 24th ST
W 25th ST
W 26th ST
W 27th ST
Modified Outboard Alternative
PLAN
℄ STA 324 + 30 TO ℄ STA 350 + 30
WEST SIDE HIGHWAY PROJECT
Feet 60 40 20 0 100


HUDSON RIVER
US PIERHEAD LINE
LIMIT OF CONSTRUCTION
TOE OF SLOPE
TOP OF SLOPE
DEMOLISH
DEMOLISH
DEMOLISH
GRID NORTH
€ STA 350 + 30
SOUTHBOUND MAINLINE
NORTHBOUND MAINLINE
RAMP LT 13
RAMP LT 12
RAMP LT 11
RAMP LT 19
RAMP LT 18
RAMP LT 3
RAMP LT 16
RAMP LT 14
RAMP LT 2
PROJECT CENTERLINE
SOUTHBOUND MAINLINE
NORTHBOUND MAINLINE
TWELFTH AVE
SB FRONTAGE ROAD
NB FRONTAGE ROAD
TWELFTH AVE
LIMIT OF CONSTRUCTION
MATCH LINE SEE DRAWING NO 8-16
MATCH LINE SEE DRAWING NO 8-18
MATCH LINE SEE DRAWING NO 8-20
W 27th ST
W 28th ST
W 29th ST
W 30th ST
W 33rd ST
W 34th ST
ELEVENTH
STATION EQUATION
RAMP LT-12 STA 67 + 46 =
RAMP LT-2 € STA 44 + 60 BACK =
RAMP LT-2 STA 354 + 40 AHEAD
P.R.R. SOUTH TUNNEL
P.R.R. NORTH TUNNEL
€ STA 40 + 55
€ STA 376 + 00
Modified Outboard Alternative
PLAN
€ STA 350 + 30 TO € STA 376 + 00
WEST SIDE HIGHWAY PROJECT

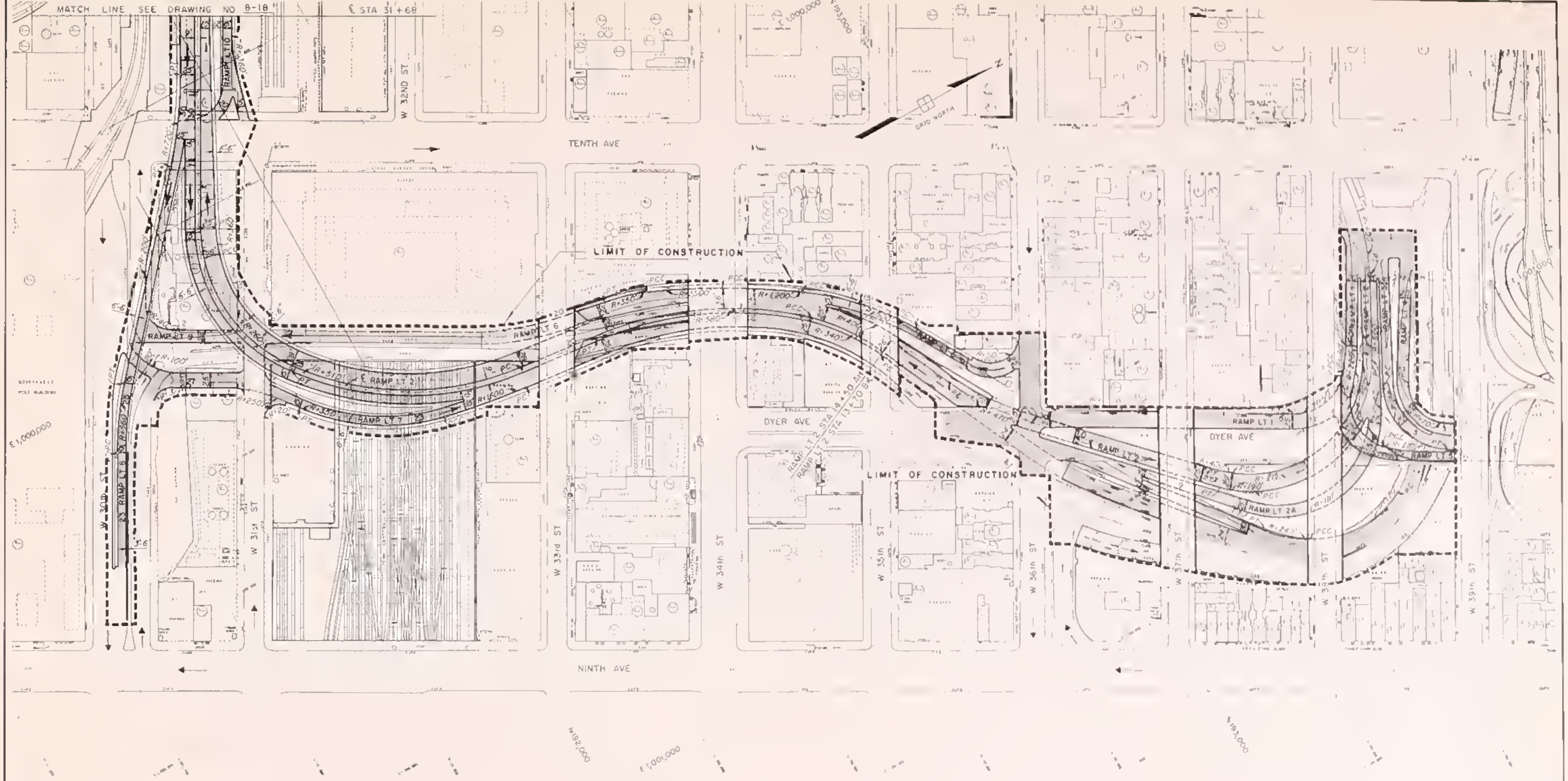


Modified Outboard Alternative

PLAN

RAMP LT2 ℄ STA. 31+68 TO ℄ STA. 40+55

WEST SIDE PROJECT

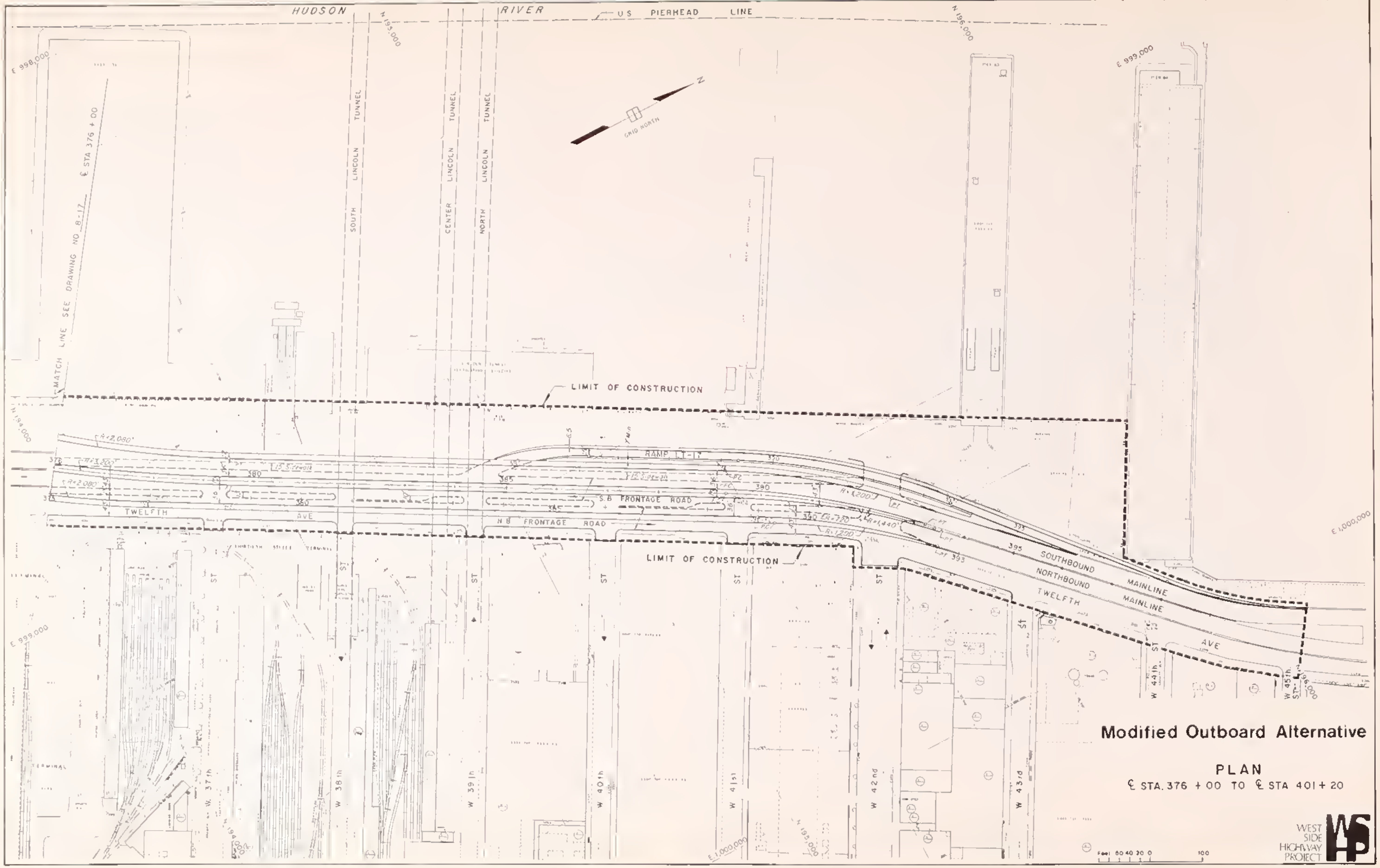


Modified Outboard Alternative

PLAN

RAMP LT2 ℄ STA 1+00 TO ℄ STA 31+68

WEST SIDE HIGHWAY PROJECT

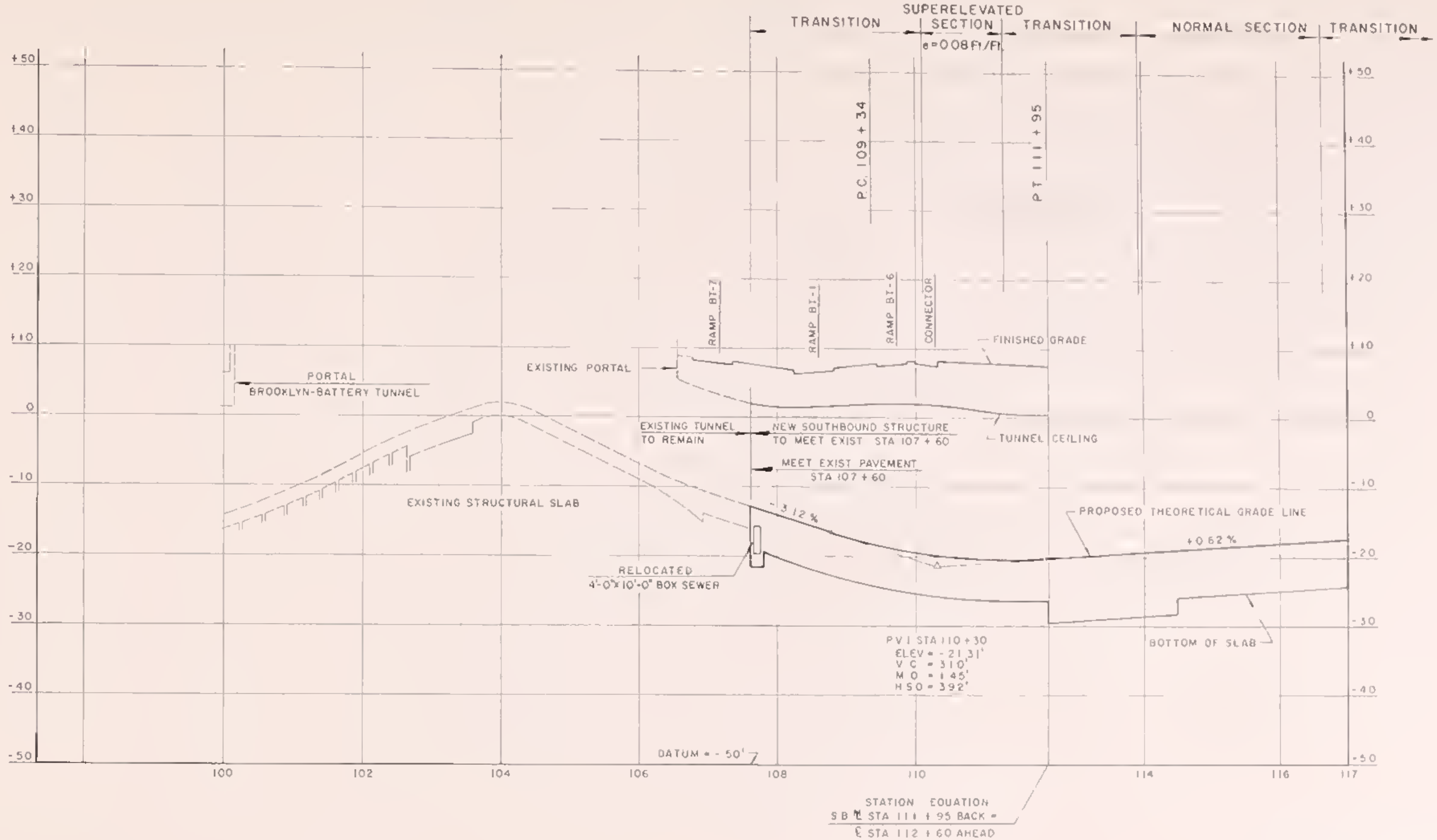


Modified Outboard Alternative

PLAN

℄ STA. 376 + 00 TO ℄ STA 401 + 20

WEST SIDE HIGHWAY PROJECT



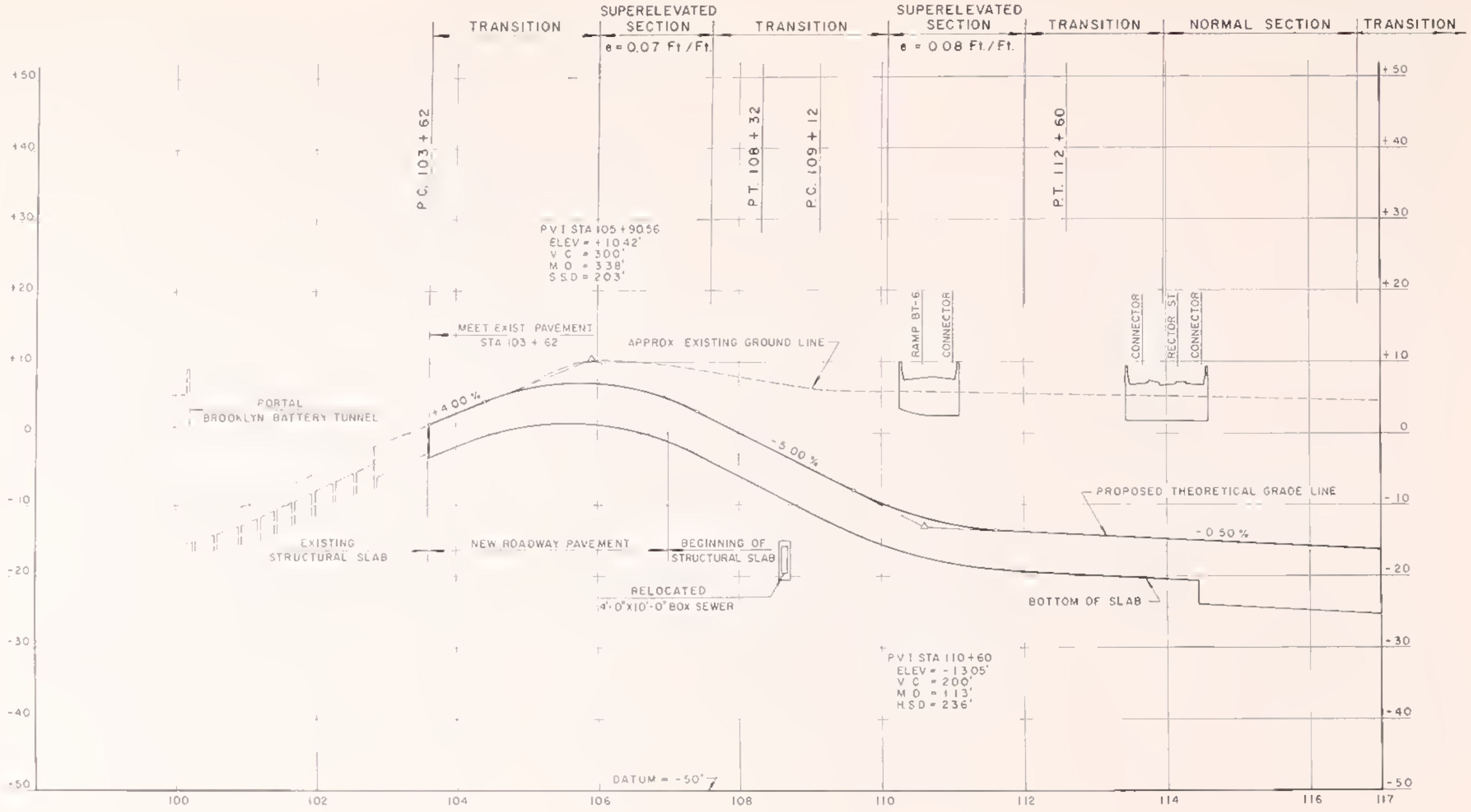
Modified Outboard Alternative

PROFILE

SB ℄ STA 100 + 00 TO ℄ STA 117 + 00

Feet 60 40 20 0 100

WEST SIDE HIGHWAY PROJECT

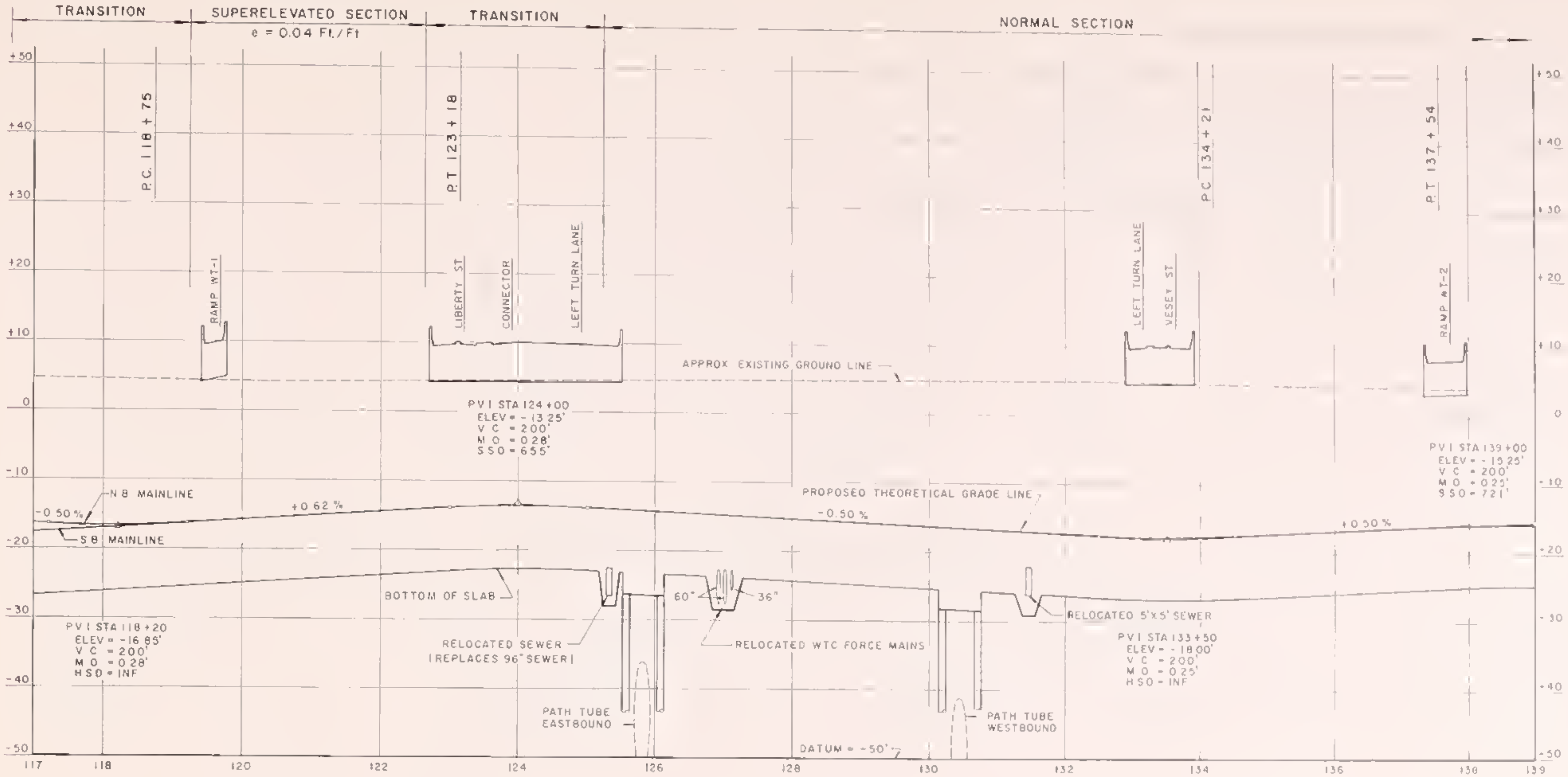


Modified Outboard Alternative

PROFILE
NB ℄ STA 100 + 00 TO ℄ STA 117 + 00

Feet 60 40 20 0 100

WEST SIDE HIGHWAY PROJECT

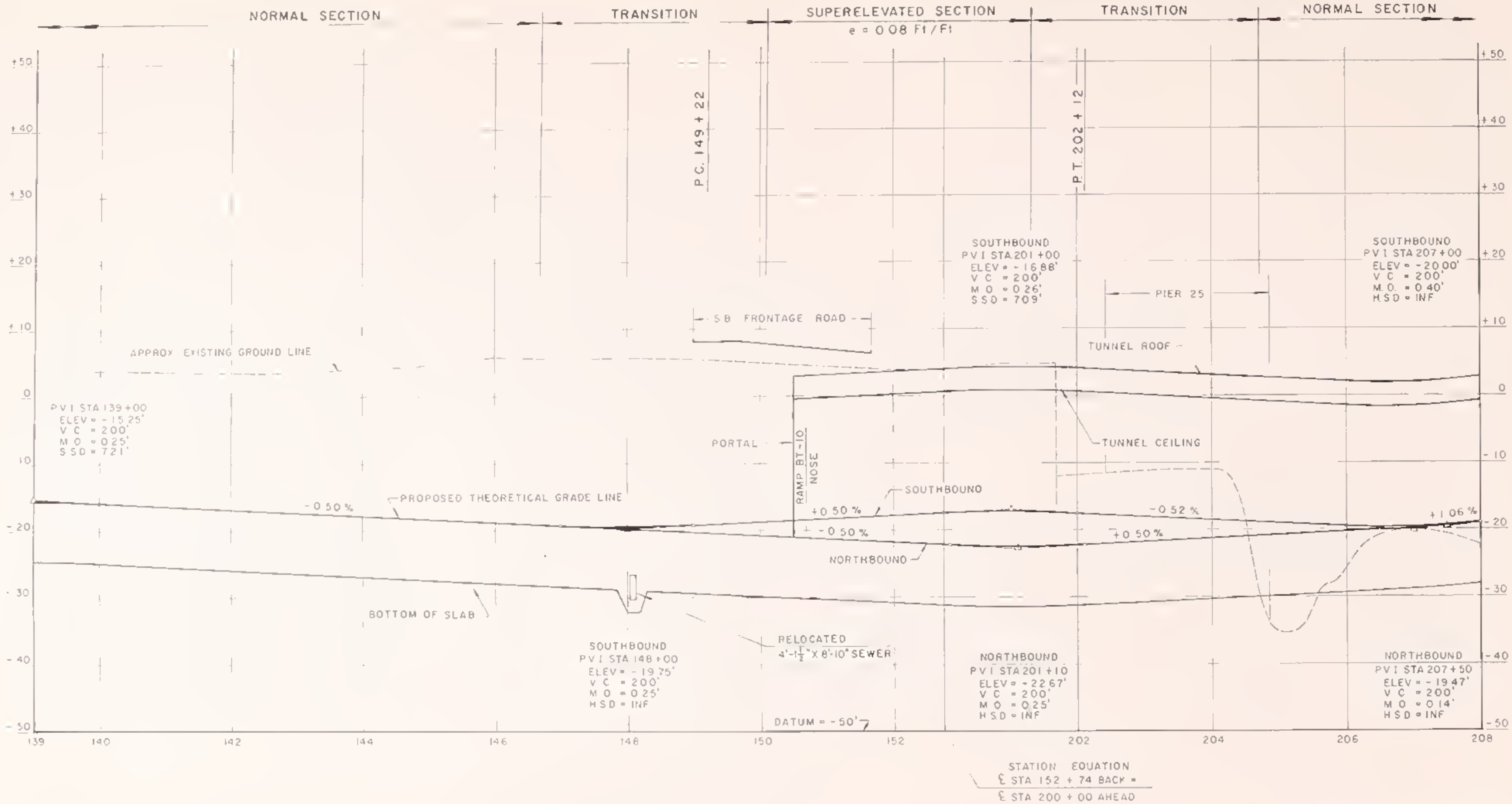


Modified Outboard Alternative

PROFILE

℄ STA 117 + 00 TO ℄ STA 139 + 00

WEST SIDE HIGHWAY PROJECT



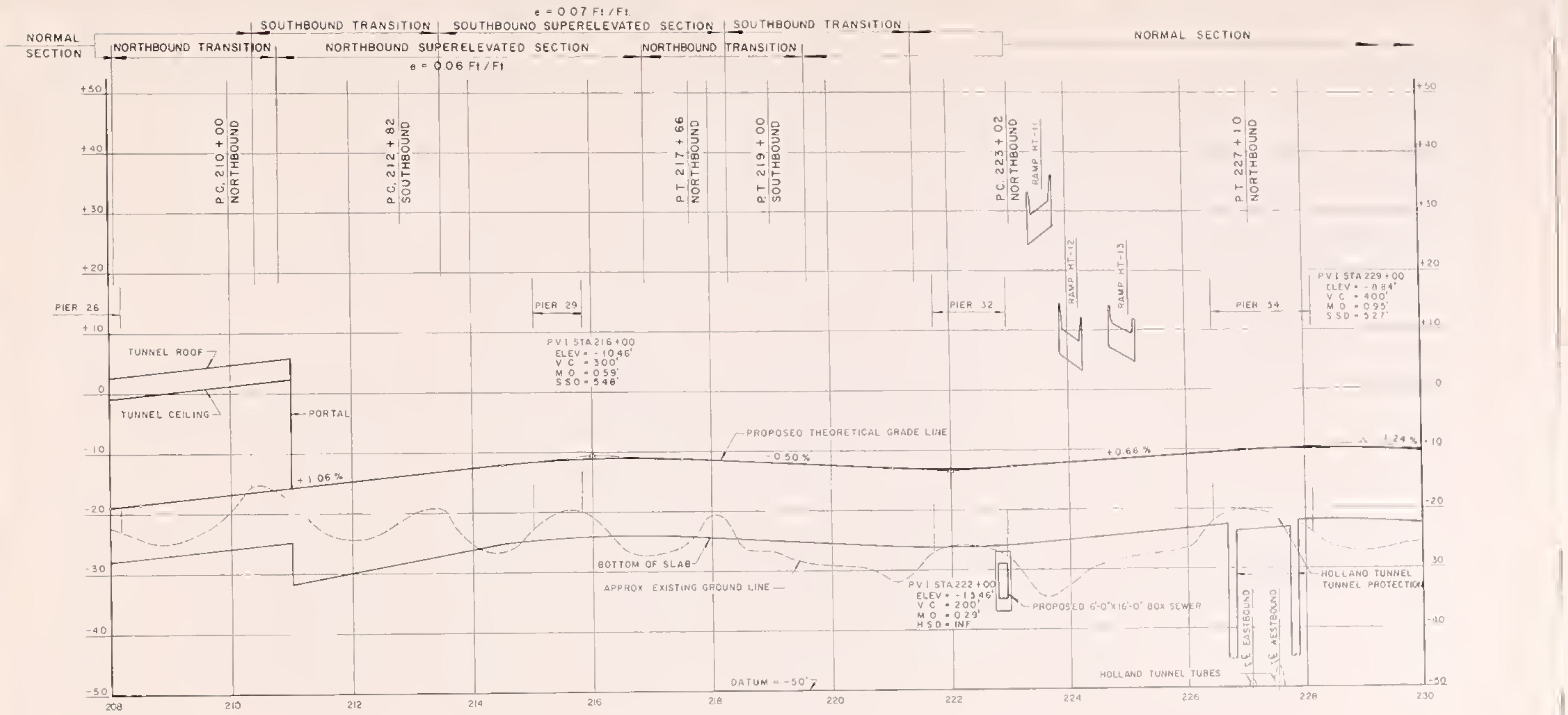
Modified Outboard Alternative

PROFILE

℄ STA. 139 + 00 TO ℄ STA. 208 + 00

Feet 60 40 20 0 100

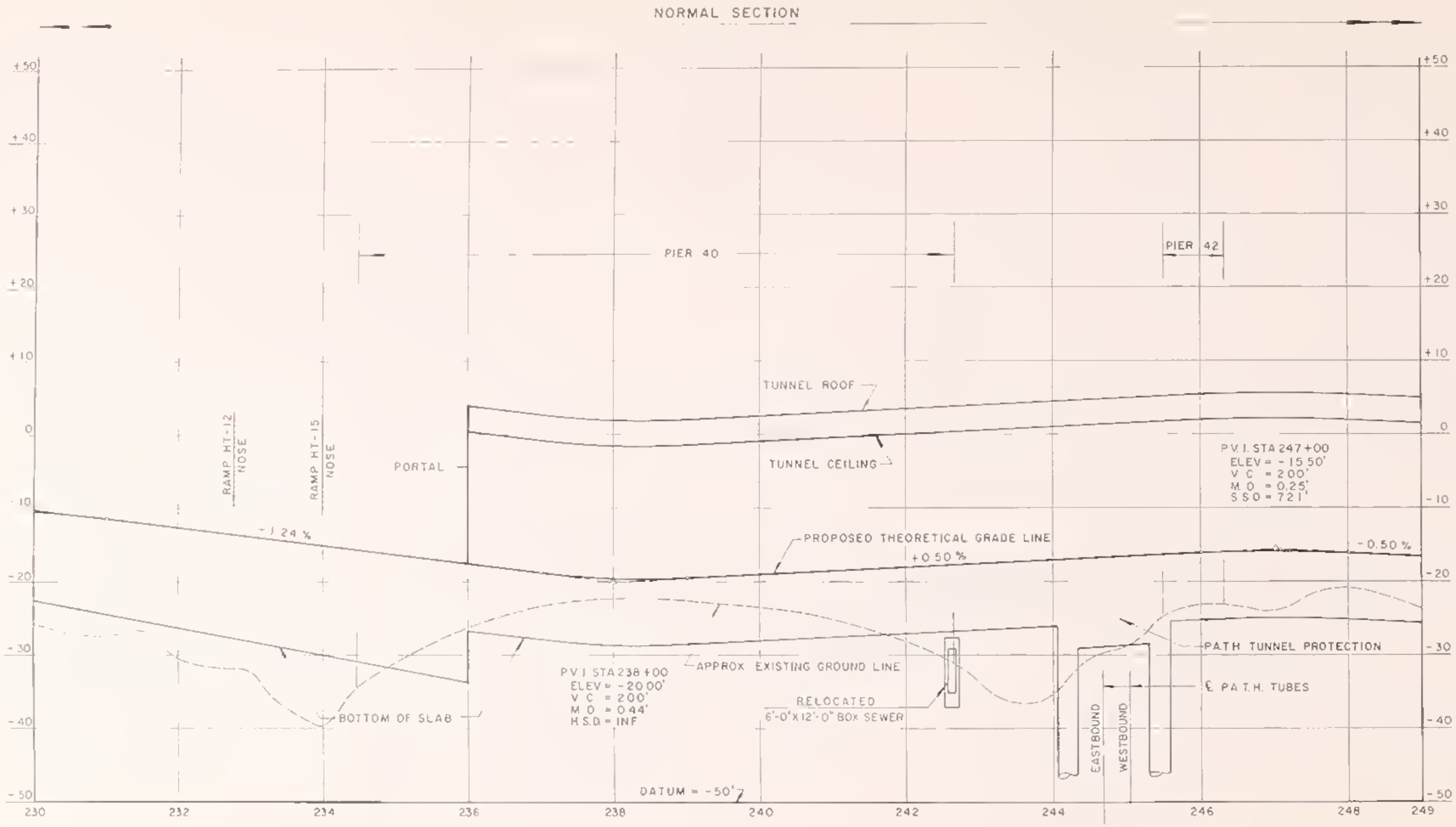
WEST SIDE HIGHWAY PROJECT



Modified Outboard Alternative

PROFILE
℄ STA 208 + 00 TO ℄ STA 230 + 00

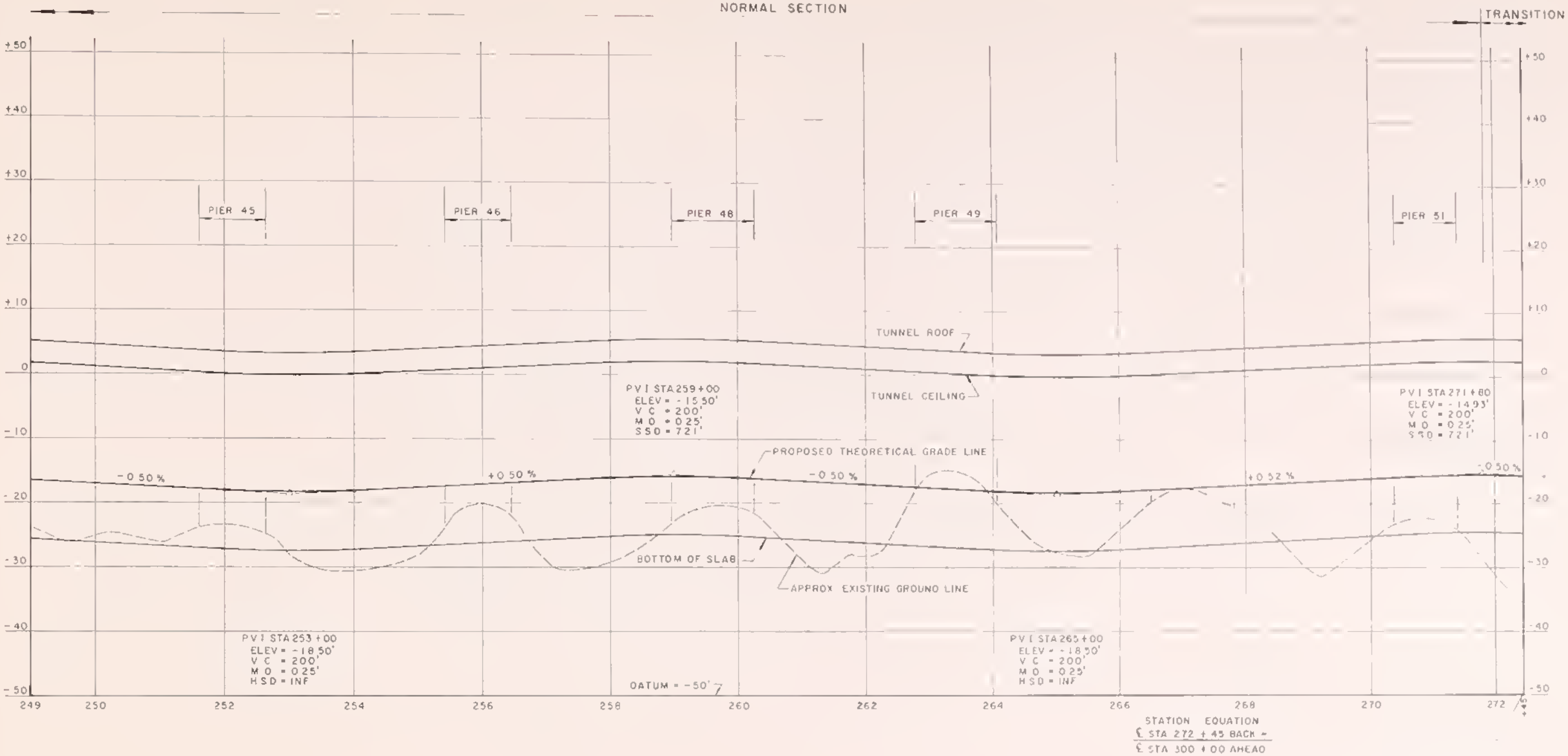
WEST SIDE HIGHWAY PROJECT



Modified Outboard Alternative

PROFILE
℄ STA. 230 + 00 TO ℄ STA 249 + 00

WEST SIDE HIGHWAY PROJECT

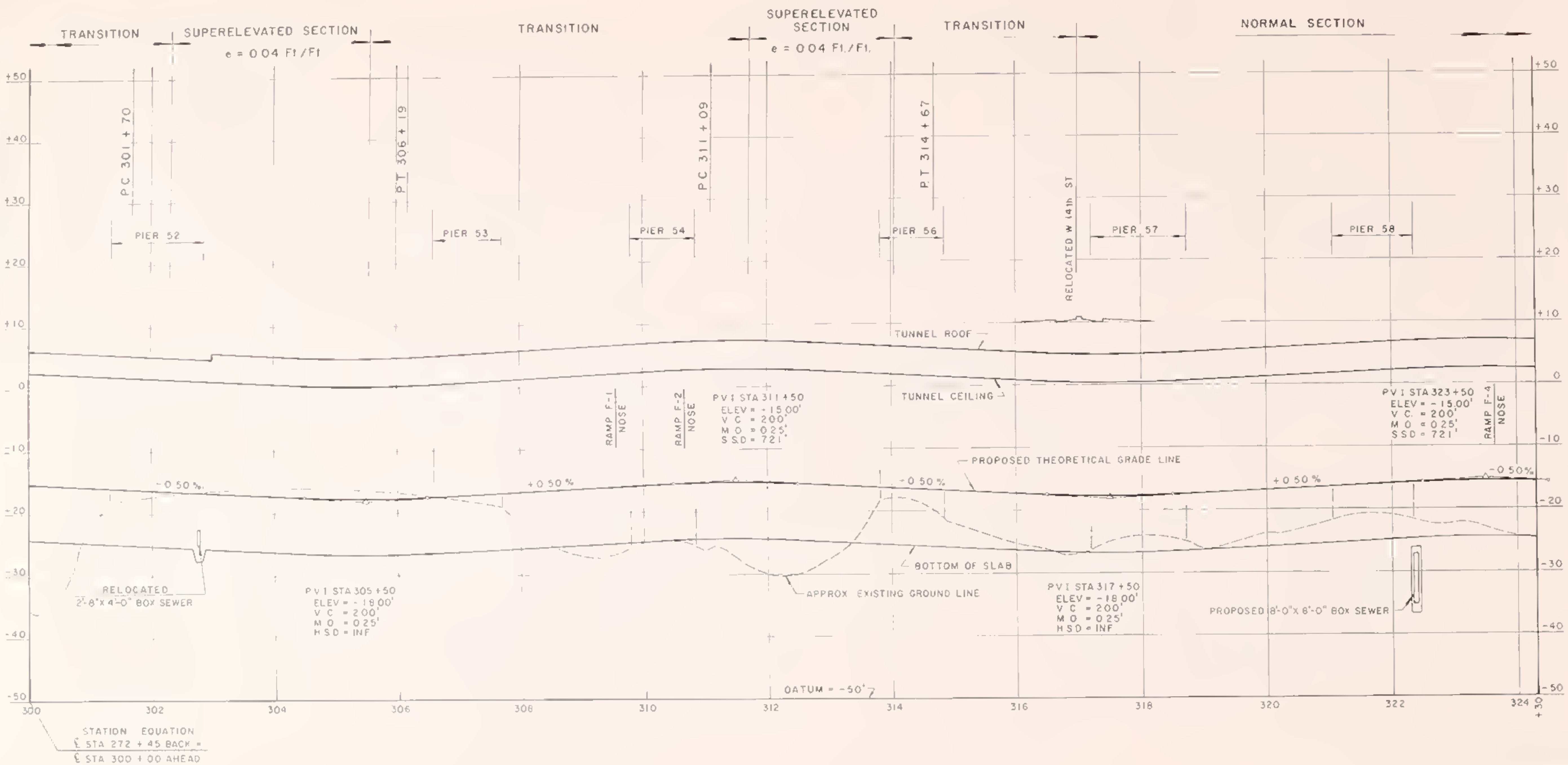


Modified Outboard Alternative

PROFILE

℄ STA 249 + 00 TO ℄ STA 272 + 45

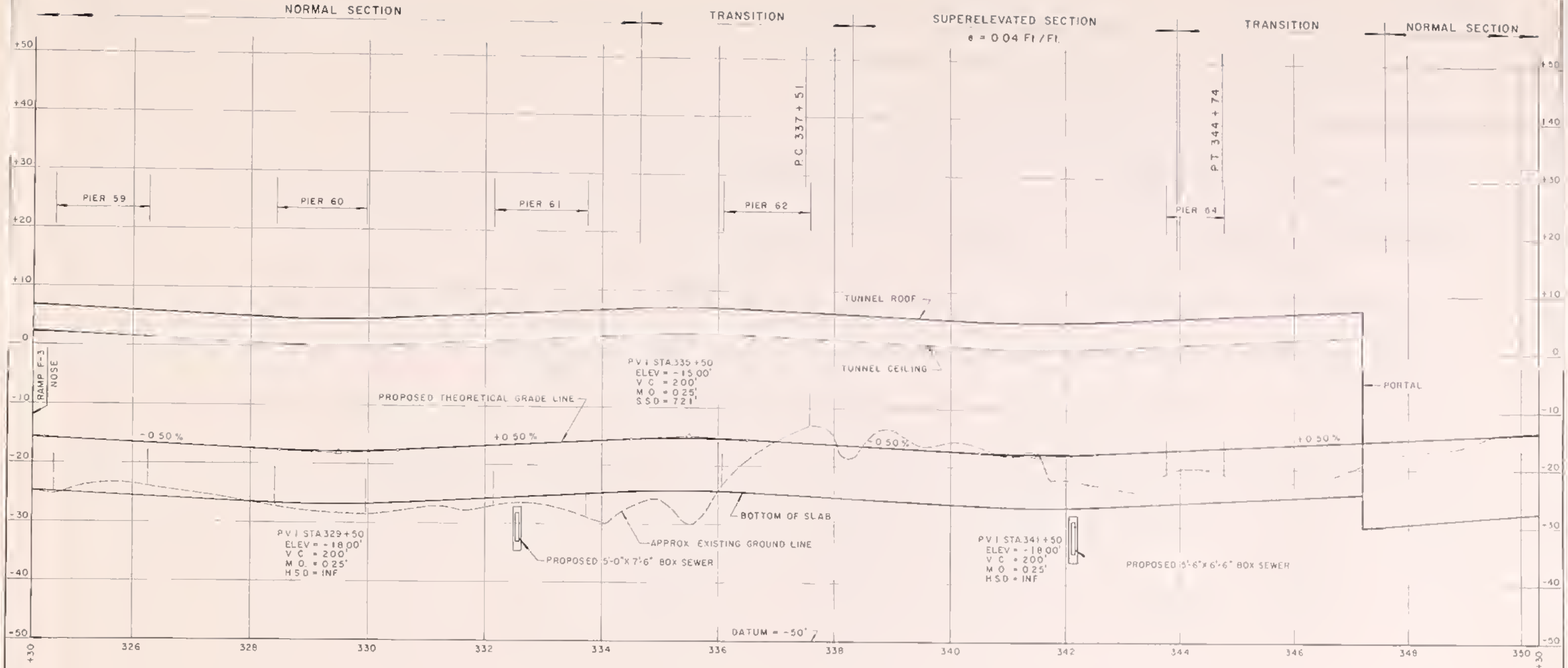
WEST SIDE HIGHWAY PROJECT



Modified Outboard Alternative

PROFILE
℄ STA 300 + 00 TO ℄ STA.324 + 30

WEST SIDE HIGHWAY PROJECT



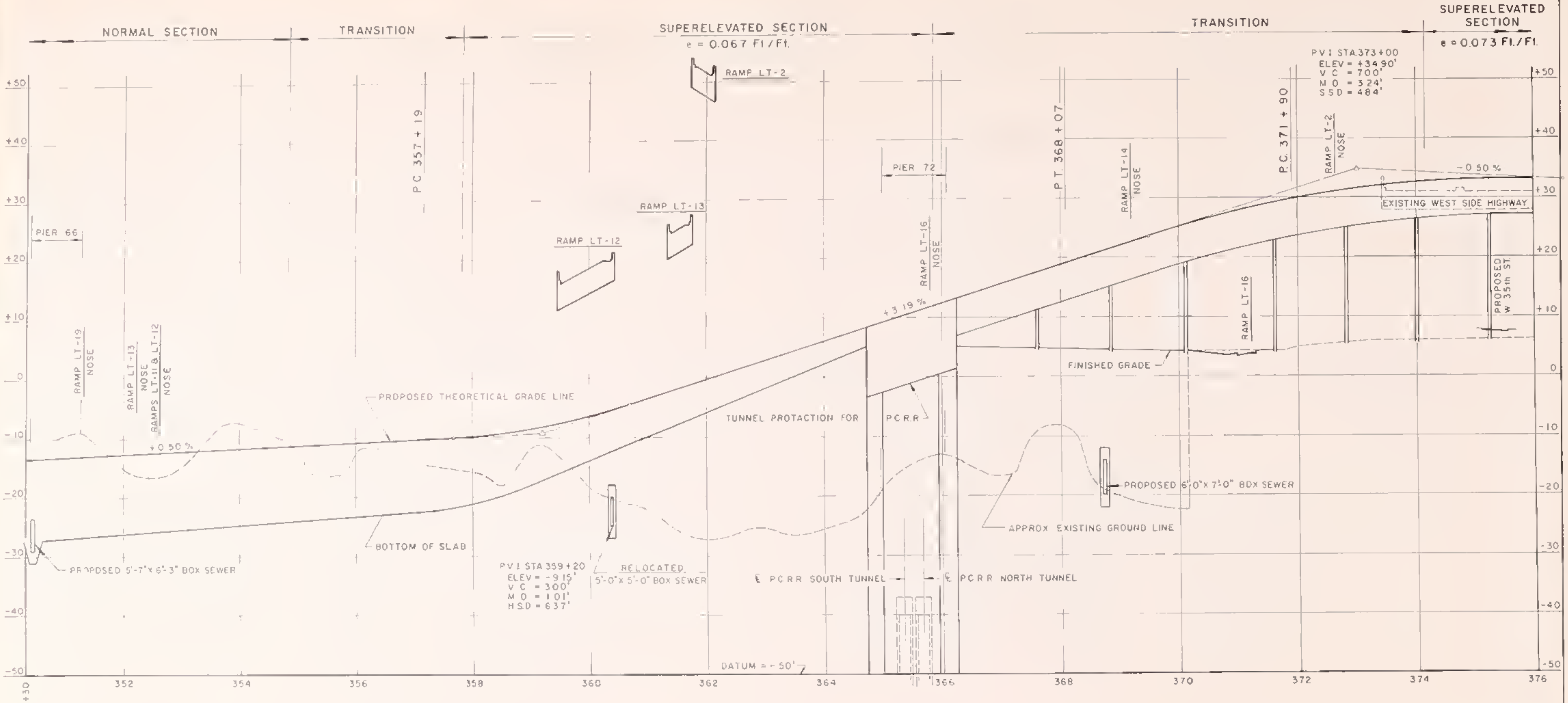
Modified Outboard Alternative

PROFILE

℄ STA 324 + 30 TO ℄ STA 350 + 30

Feet 60 40 20 0 100

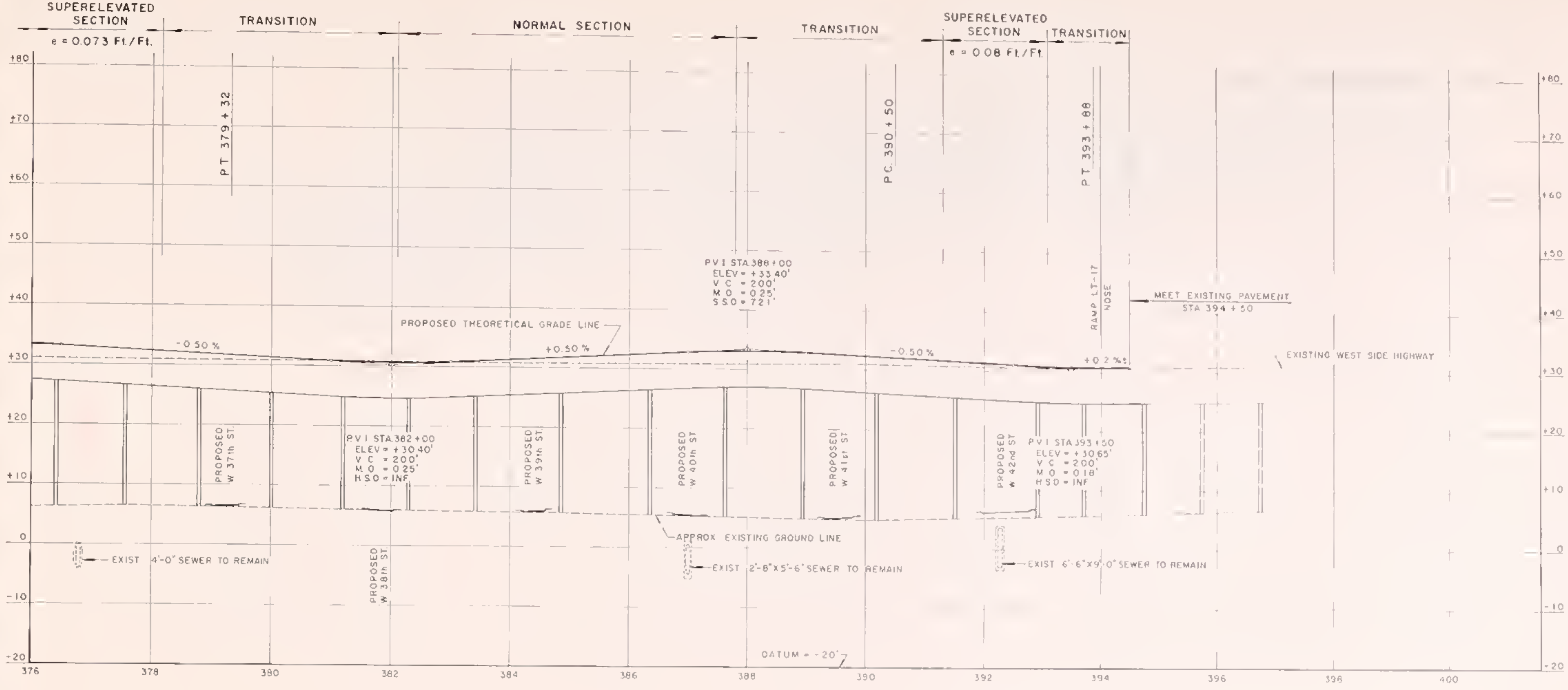
WEST SIDE HIGHWAY PROJECT



Modified Outboard Alternative

PROFILE
℄ STA 350 + 30 TO ℄ STA 376 + 00

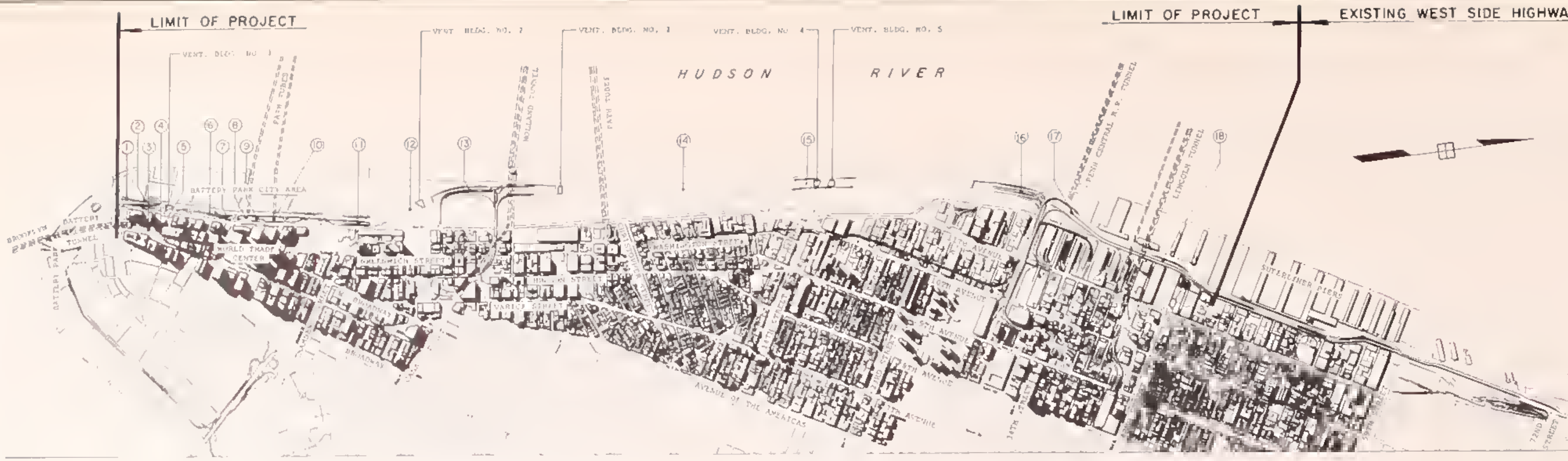
WEST SIDE HIGHWAY PROJECT



Modified Outboard Alternative

PROFILE
℄ STA 376 + 00 TO ℄ STA 394 + 50

WEST SIDE HIGHWAY PROJECT



KEY PLAN – CONTROL SECTIONS & VENTILATION BUILDINGS

INDEX OF DRAWINGS

KEY PLAN SECTION	CONTROL SECTION	DWG NOS
1	S F STA 100 + 20	8 - 33
2	S F STA 104 + 00	8 - 33
3	N B STA. 103 + 50	8 - 34
4	N B STA 106 + 30	8 - 34
5	N B STA 108 + 90	8 - 35
6	℄ STA 118 + 00	8 - 36
7	℄ STA 121 + 50	8 - 36
8	℄ STA 125 + 00	8 - 37
9	℄ STA 128 + 00	8 - 37
10	℄ STA 130 + 50	8 - 38
11	℄ STA 148 + 50	8 - 38
12	℄ STA. 208 + 00	8 - 39
13	℄ STA. 219 + 00	8 - 40
14	℄ STA 262 + 00	8 - 40
15	℄ STA 313 + 00	8 - 41
16	℄ STA 357 + 00	8 - 41
17	℄ STA 367 + 00	8 - 42
18	℄ STA 389 + 00	8 - 42

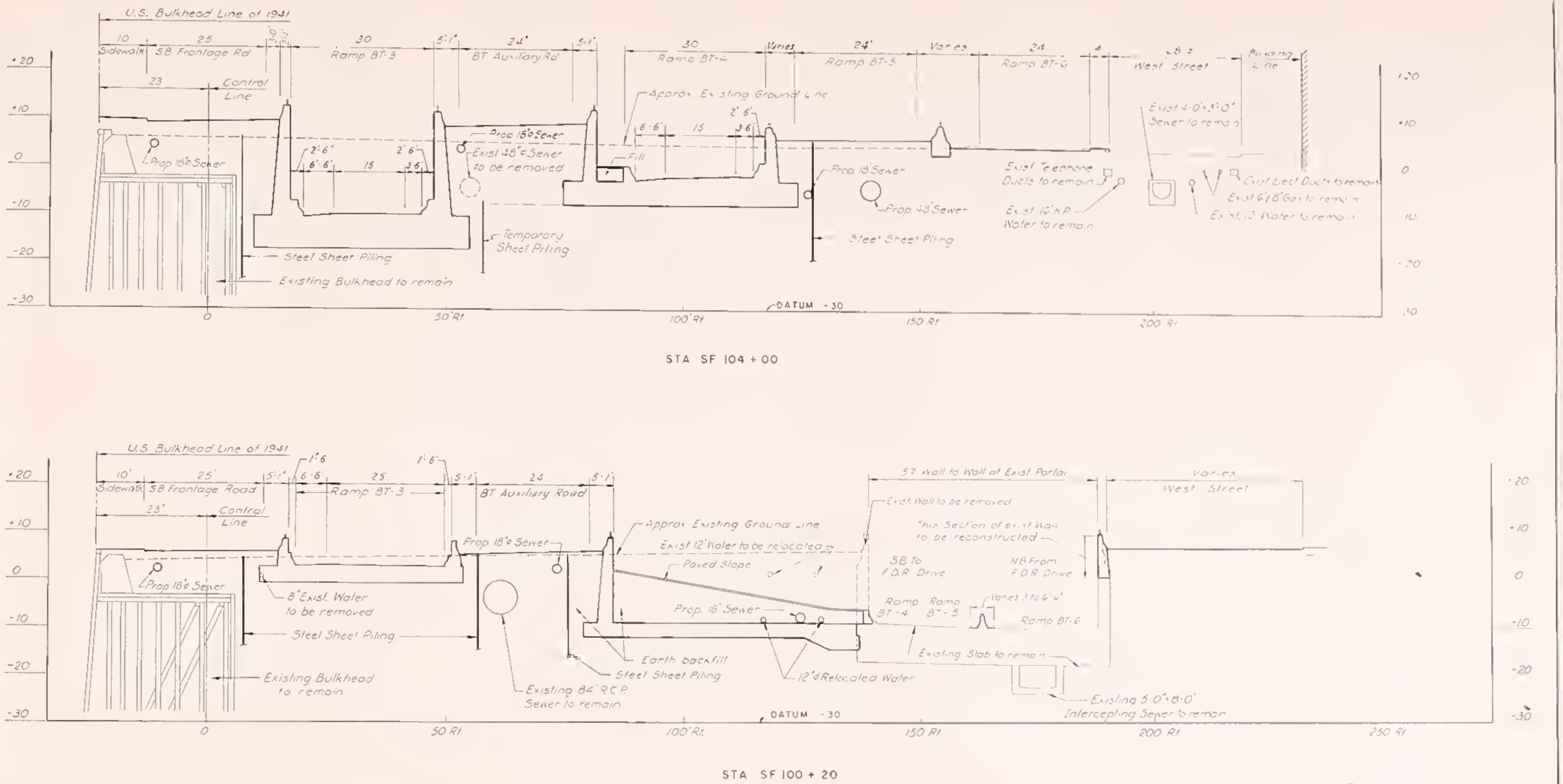
VENTILATION BUILDINGS	DWG NOS
NO 1	8 - 43
NO 2	8 - 44
NO 3	8 - 45
NO. 4	8 - 46
NO 5	8 - 47

Modified Outboard Alternative
Key Plan

CONTROL SECTIONS &
VENTILATION BUILDINGS

Feet 550 0 1100

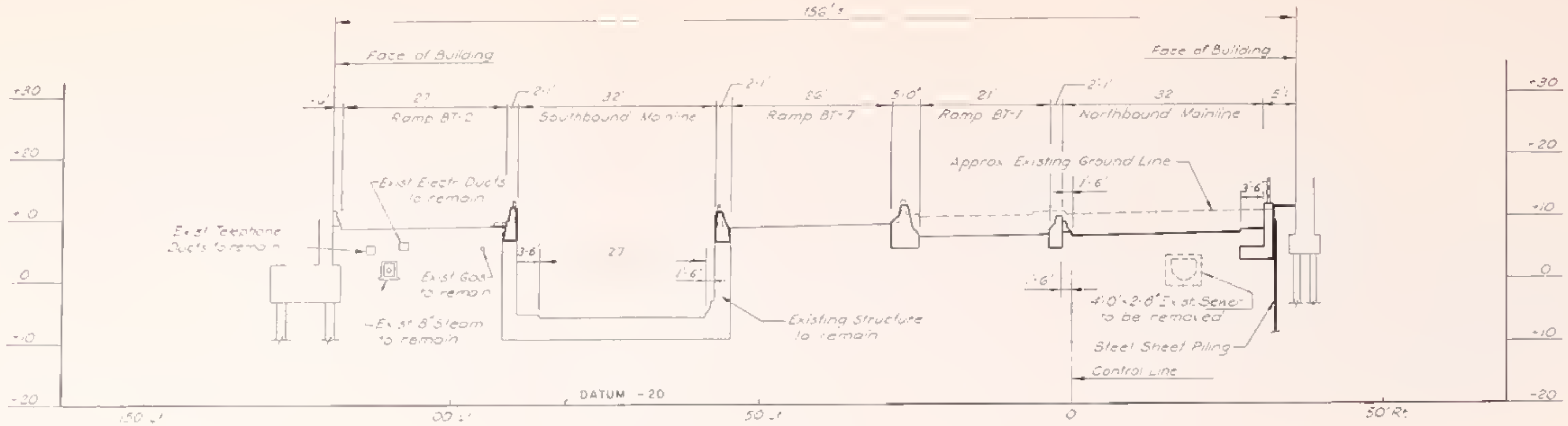
WEST SIDE HIGHWAY PROJECT



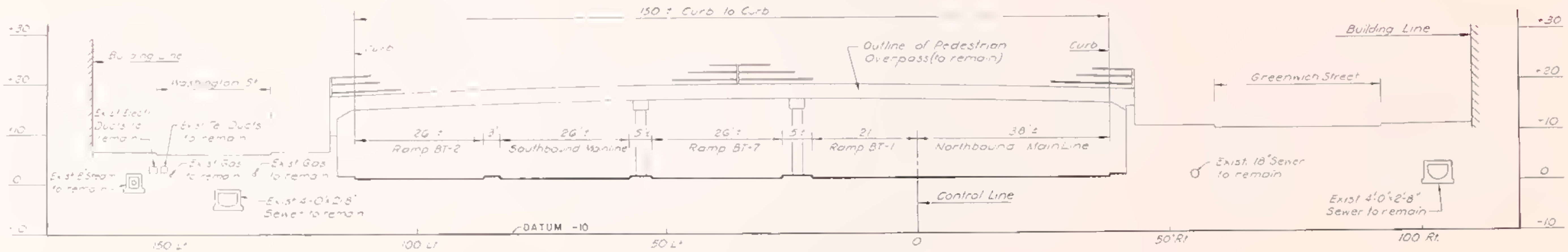
Modified Outboard Alternative

CONTROL SECTIONS
STA SF 100+20 AND STA SF 104+00

WEST SIDE HIGHWAY PROJECT



STA NB 106 + 30



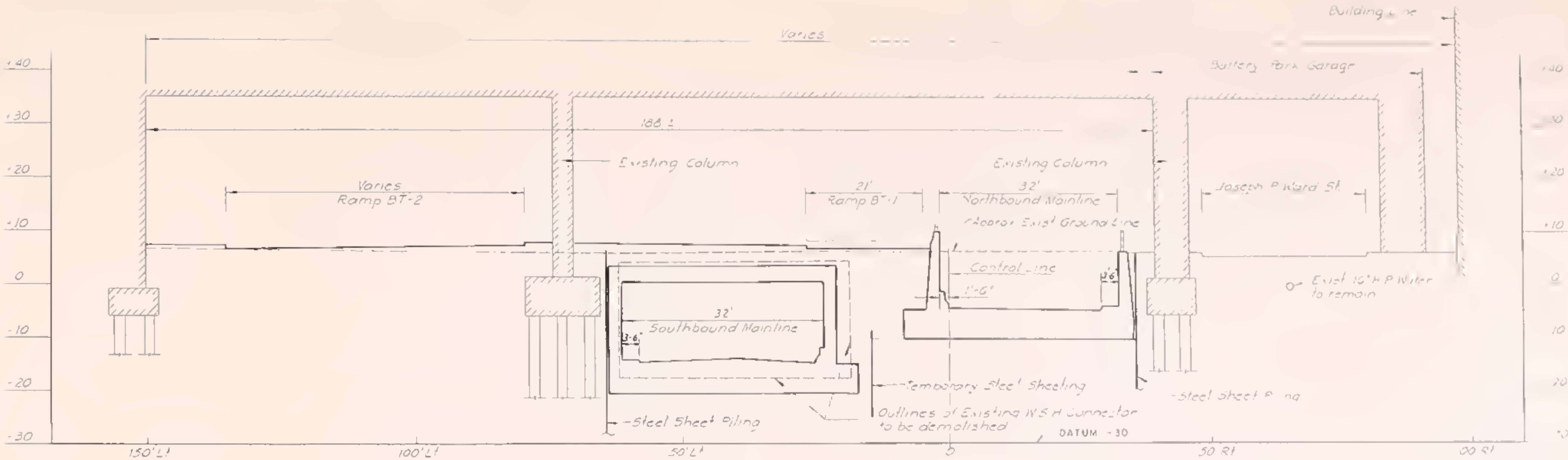
STA NB 103 + 50

Modified Outboard Alternative

CONTROL SECTIONS

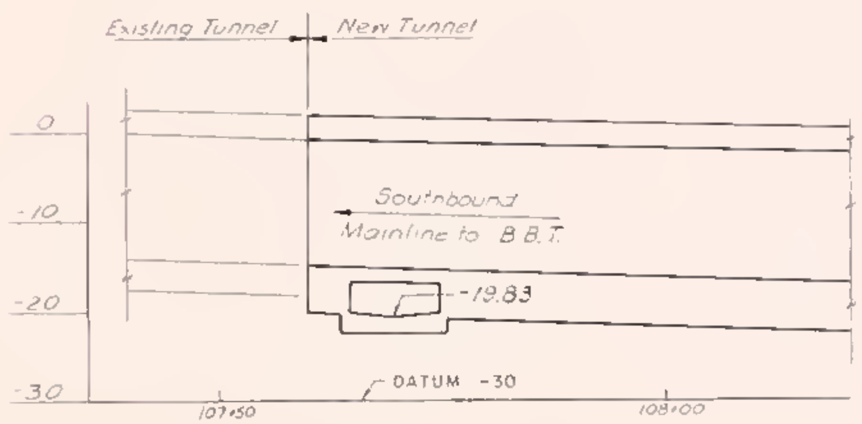
STA NB 103+50 AND STA NB 106+30

WEST SIDE HIGHWAY PROJECT



STA NB 108+90

(TAKEN PARALLEL TO WEST FACE OF GARAGE)

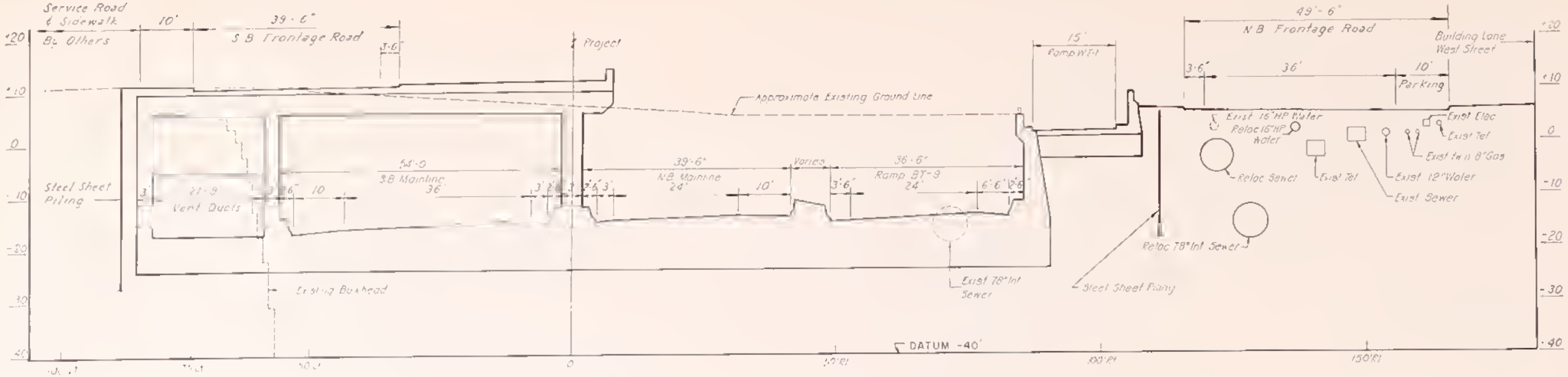


LONGITUDINAL SECTION
AT ℄ SB MAINLINE

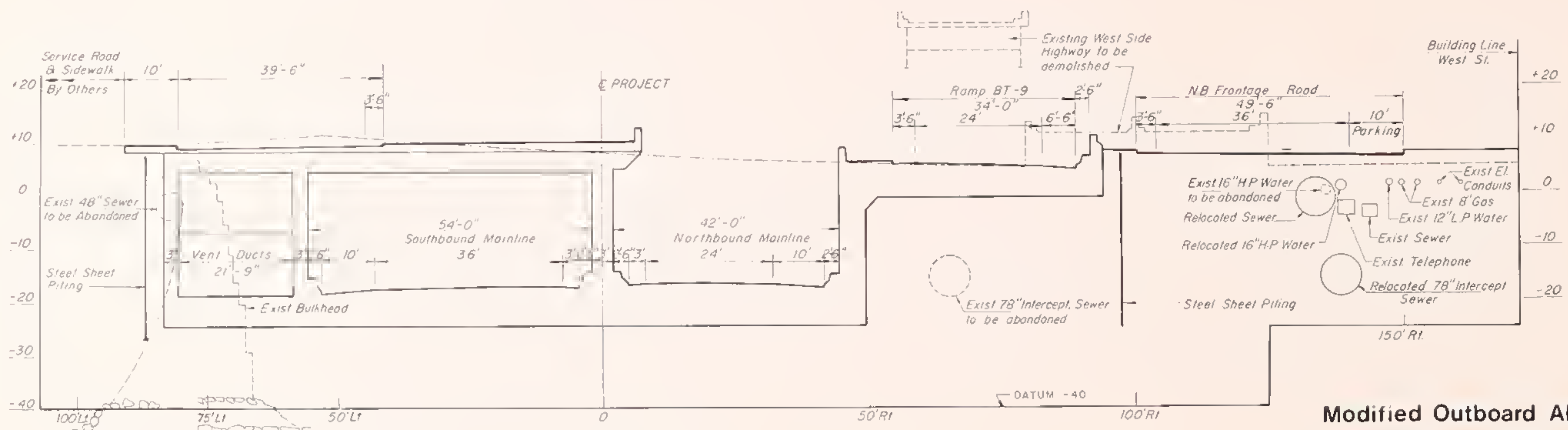
Modified Outboard Alternative

CONTROL SECTION
STA NB 108+90

WEST SIDE HIGHWAY PROJECT



℄ STA 121 + 50

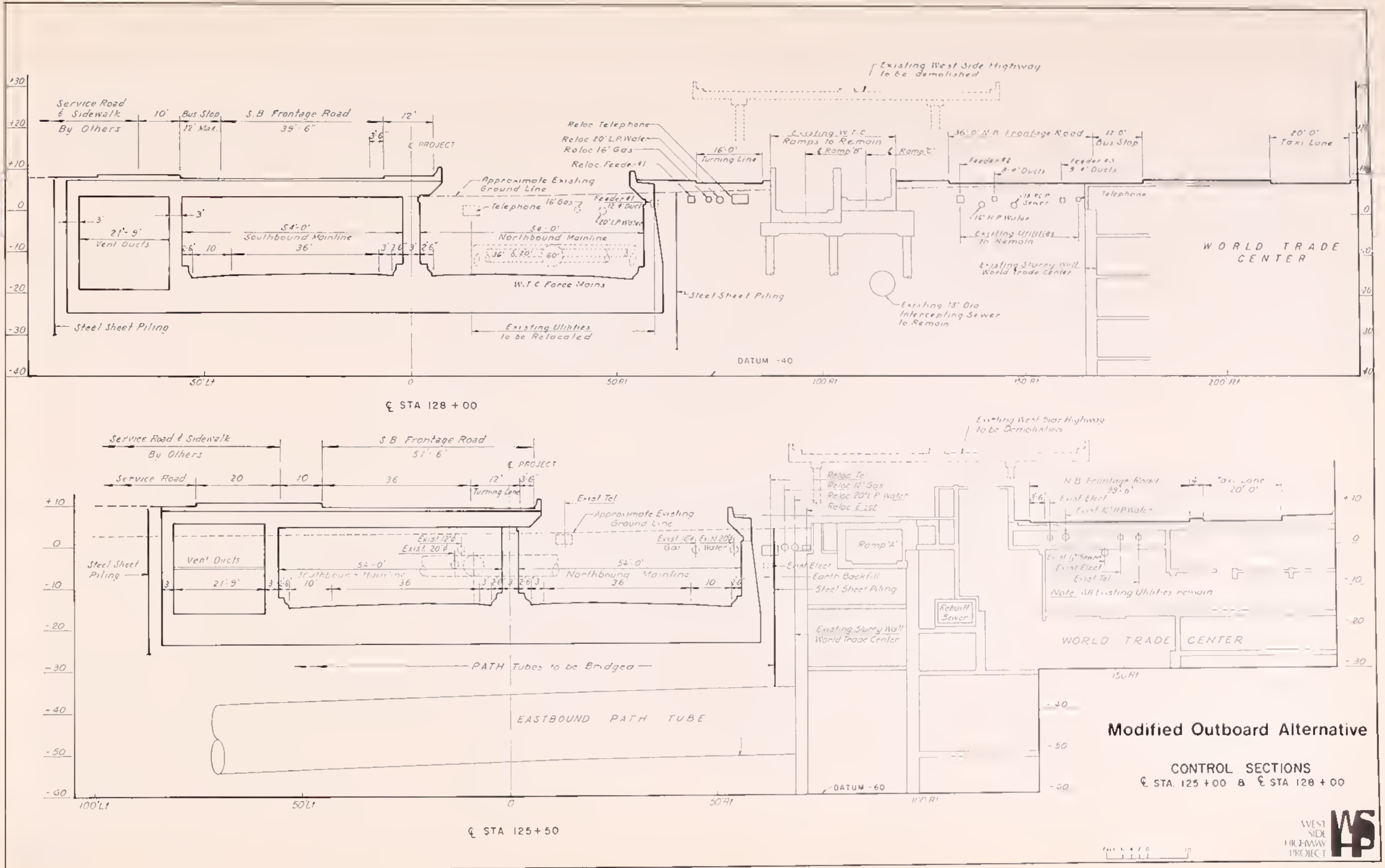


℄ STA 118 + 00

Modified Outboard Alternative

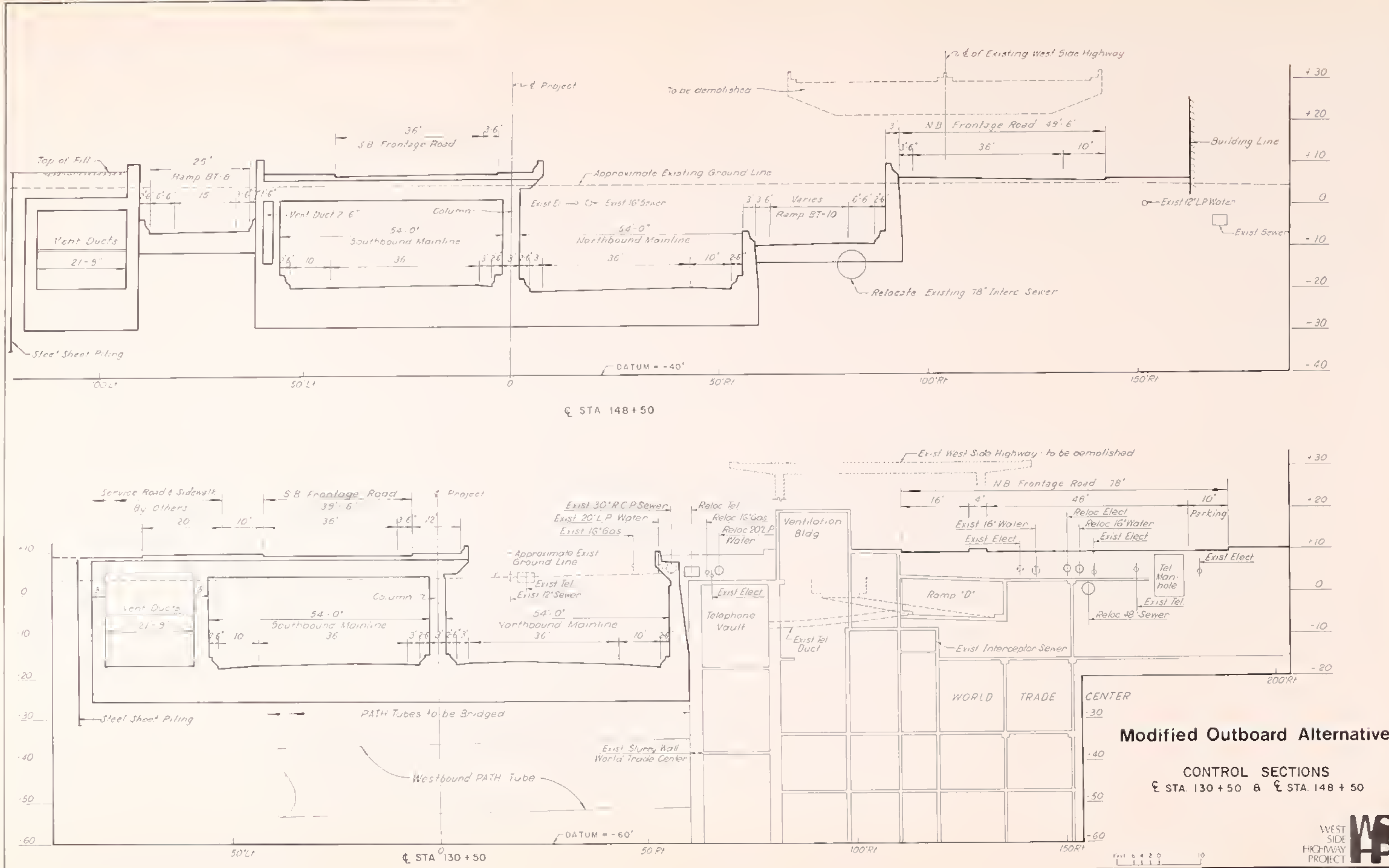
CONTROL SECTIONS
℄ STA 118 + 00 & ℄ STA 121 + 50

WEST SIDE HIGHWAY PROJECT



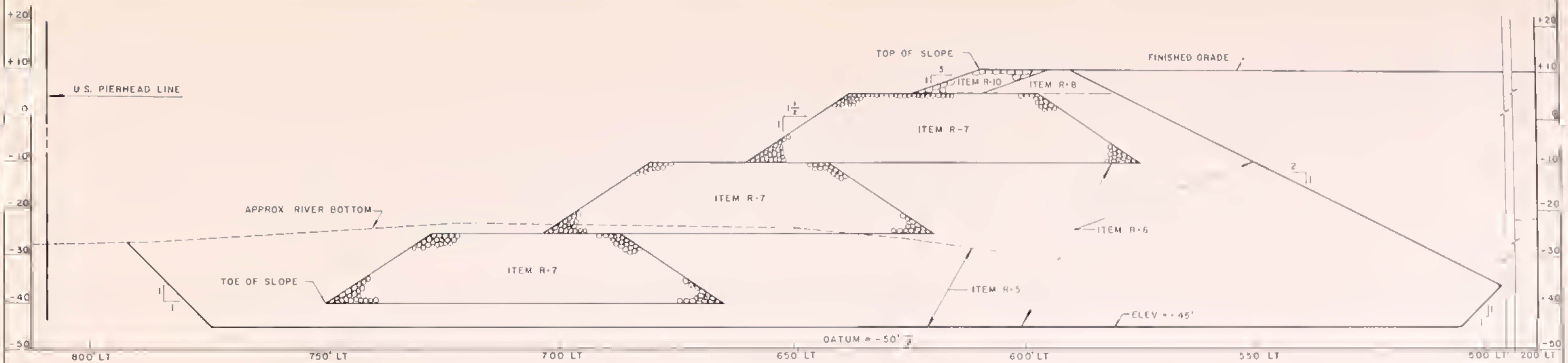
Modified Outboard Alternative

CONTROL SECTIONS
℄ STA. 125+00 & ℄ STA 128+00

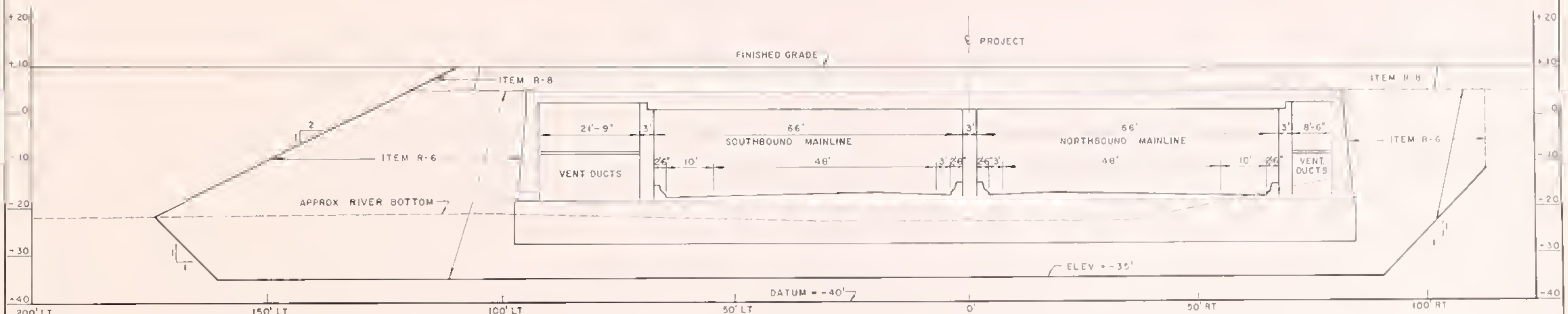


Modified Outboard Alternative

CONTROL SECTIONS
℄ STA. 130 + 50 & ℄ STA. 148 + 50



℄ STA 208 + 00



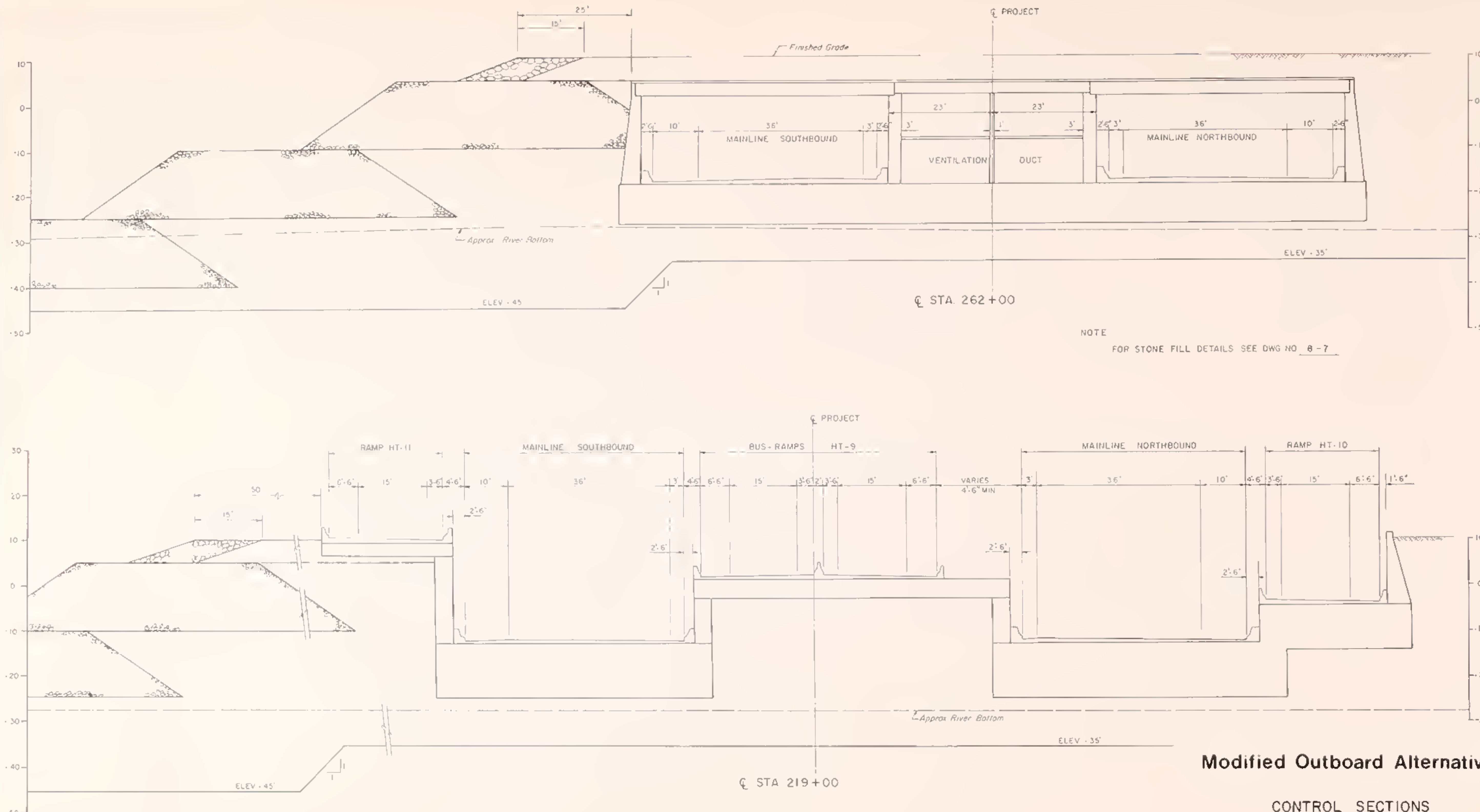
℄ STA 208 + 00

NOTE
FOR STONE FILL DETAILS
SEE DWG NO 8-7

Modified Outboard Alternative

CONTROL SECTION
℄ STA. 208 + 00

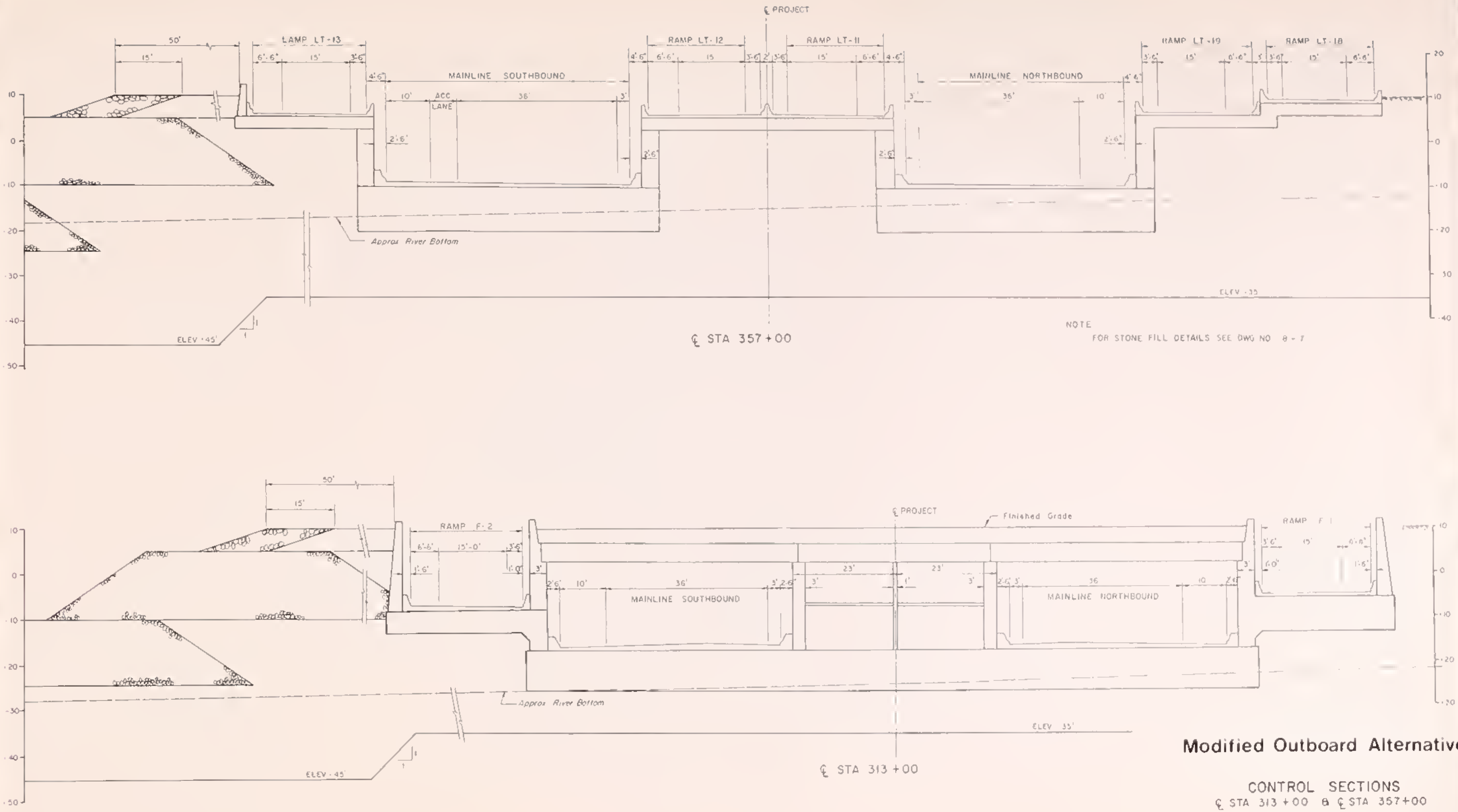
WEST SIDE HIGHWAY PROJECT



Modified Outboard Alternative

CONTROL SECTIONS
℄ STA 219+00 & ℄ STA. 262+00

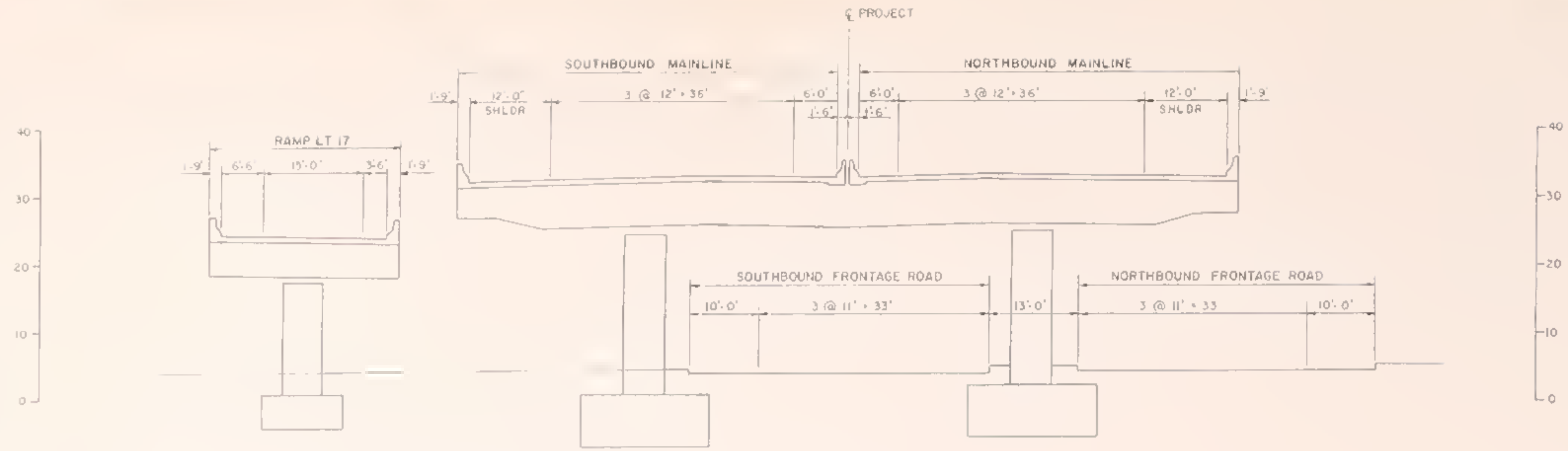
WEST SIDE HIGHWAY PROJECT



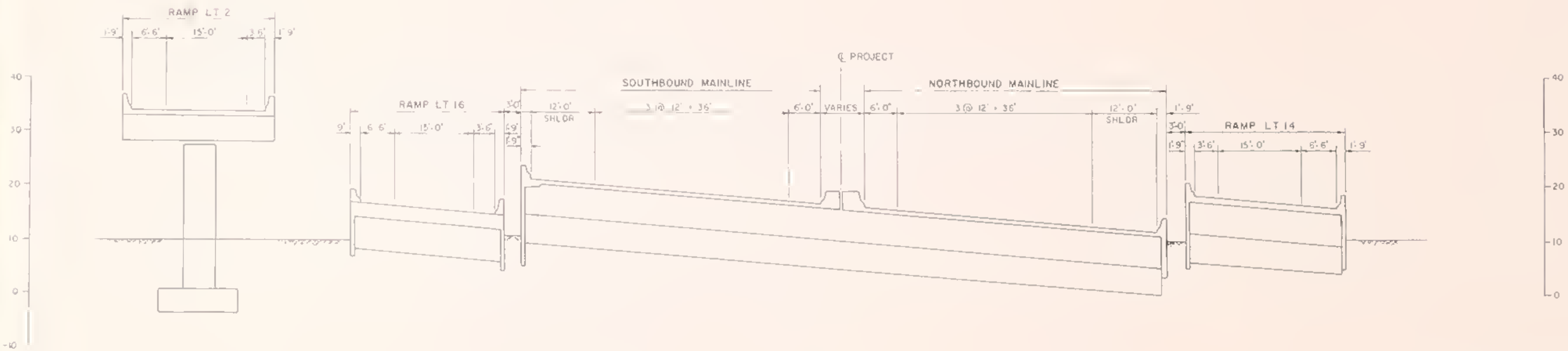
Modified Outboard Alternative

CONTROL SECTIONS
℄ STA 313+00 & ℄ STA 357+00

WEST SIDE HIGHWAY PROJECT



℄ STA. 389 +00

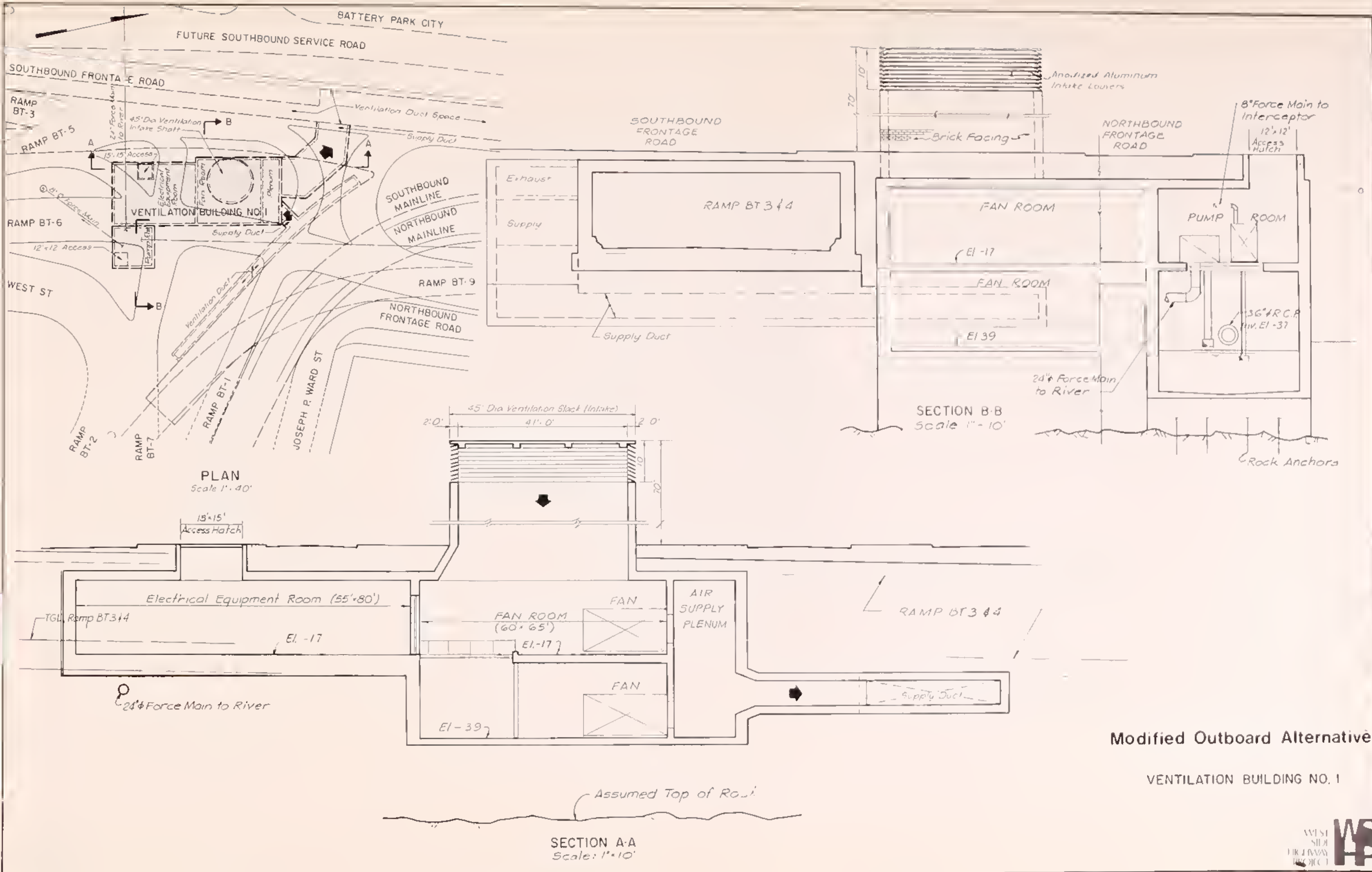


℄ STA. 367 +00

Modified Outboard Alternative

CONTROL SECTIONS
℄ STA 367 +00 & ℄ STA 389 +00

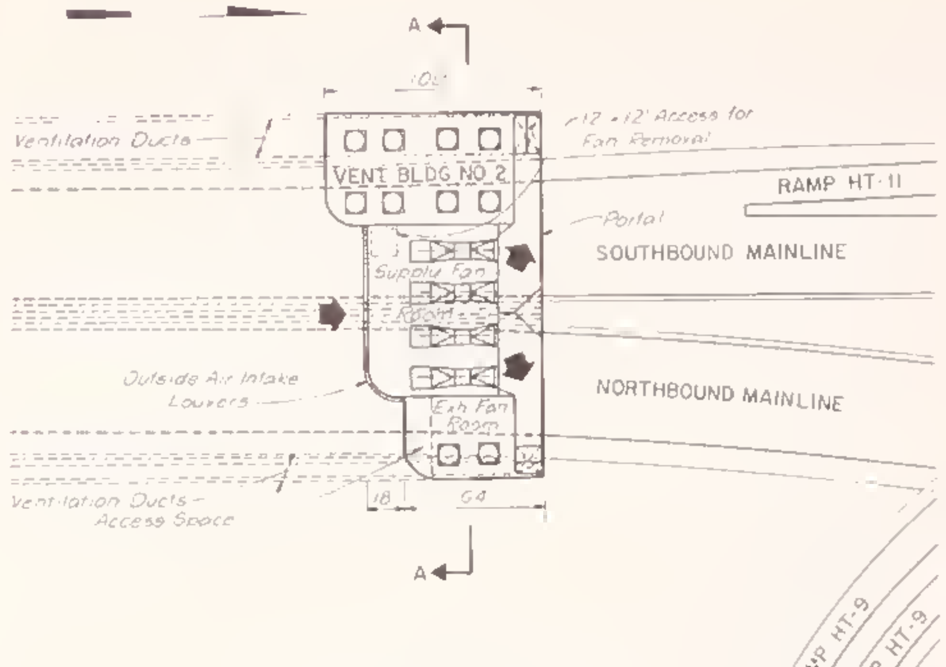
WEST SIDE HIGHWAY PROJECT



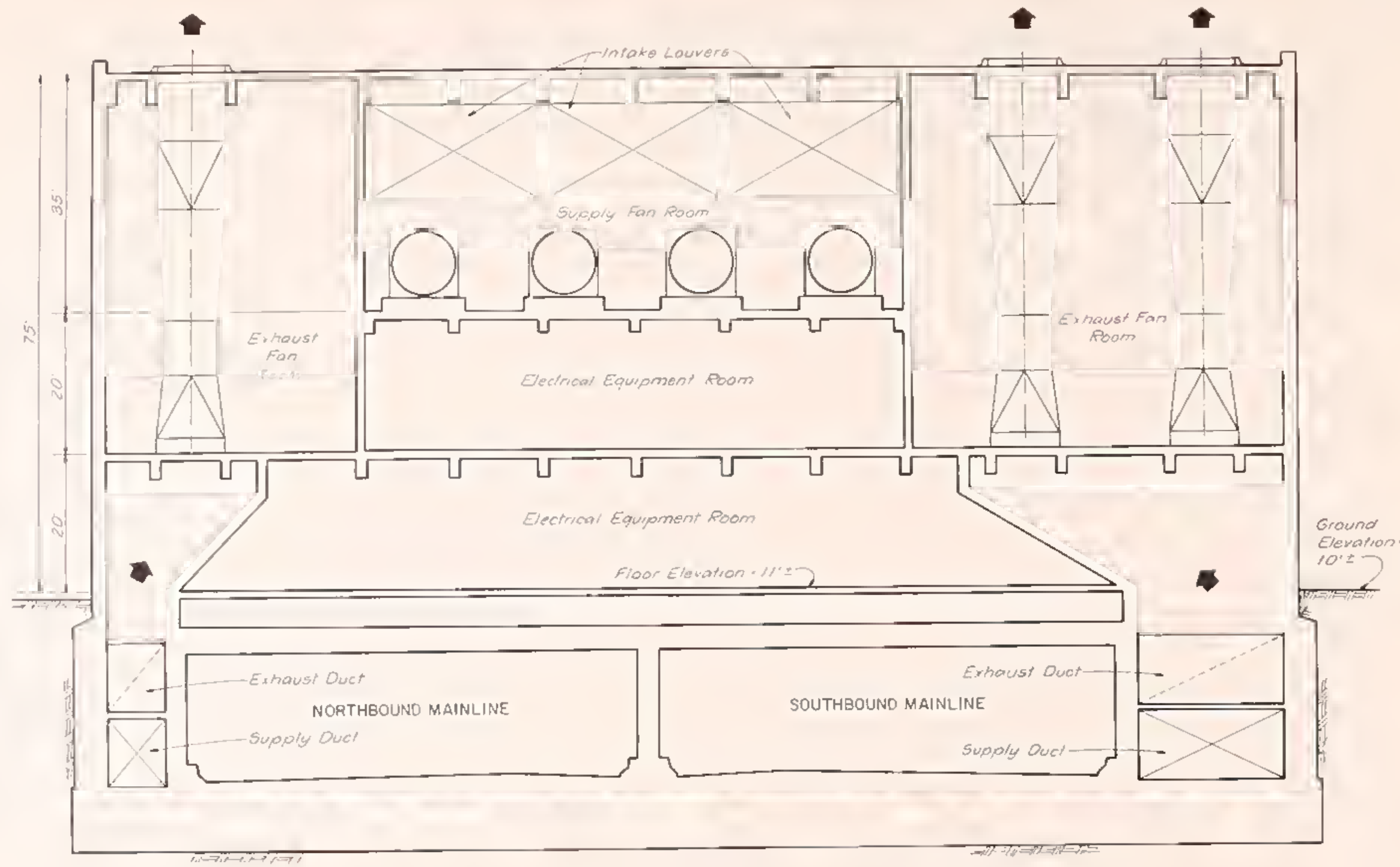
Modified Outboard Alternative

VENTILATION BUILDING NO. 1

WEST SIDE HIGHWAY PROJECT



FAN ROOM FLOOR PLAN
Scale 1"=40

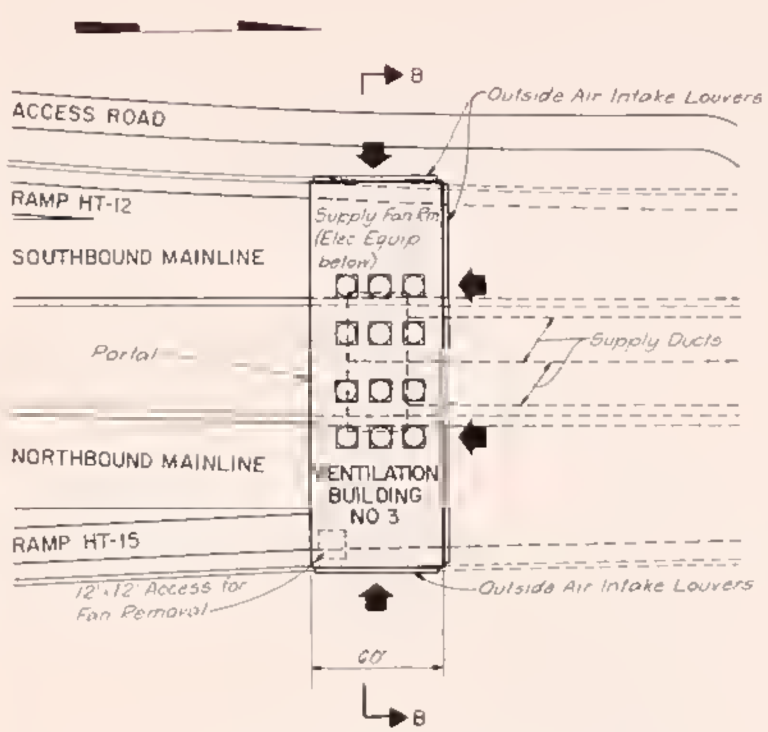


SECTION A-A
Scale 1"=10

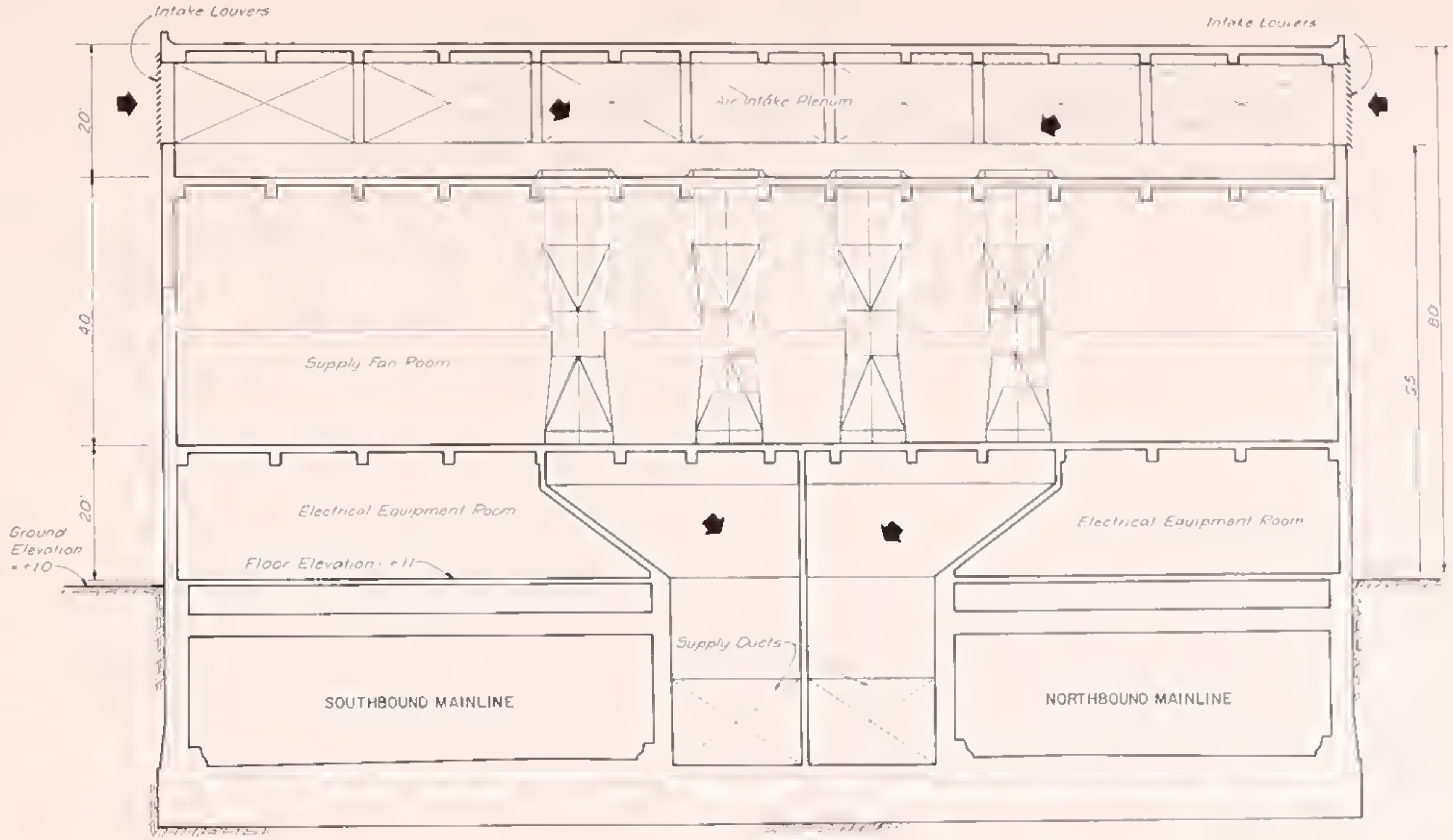
Modified Outboard Alternative

VENTILATION BUILDING NO. 2

WEST SIDE HIGHWAY PROJECT



FAN ROOM FLOOR PLAN
Scale 1"=40'

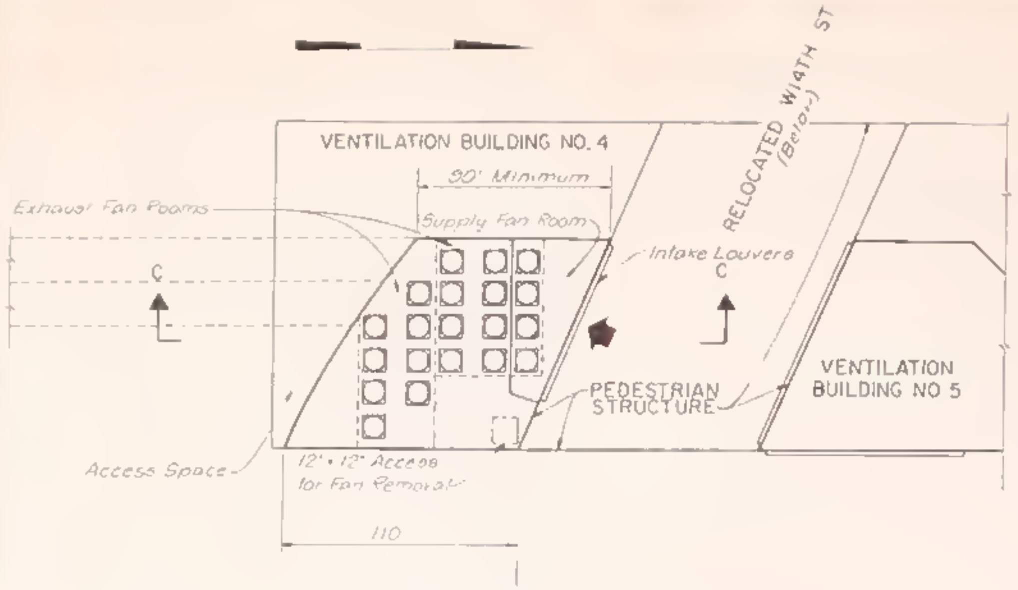


SECTION B-B
Scale 1"=10'

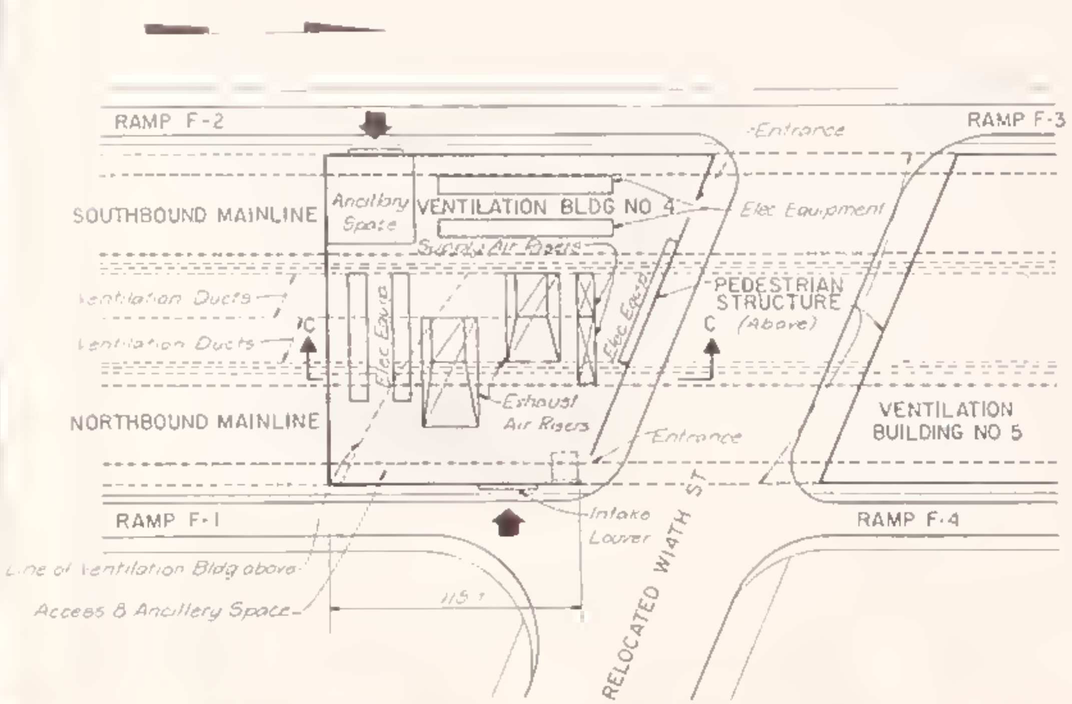
Modified Outboard Alternative

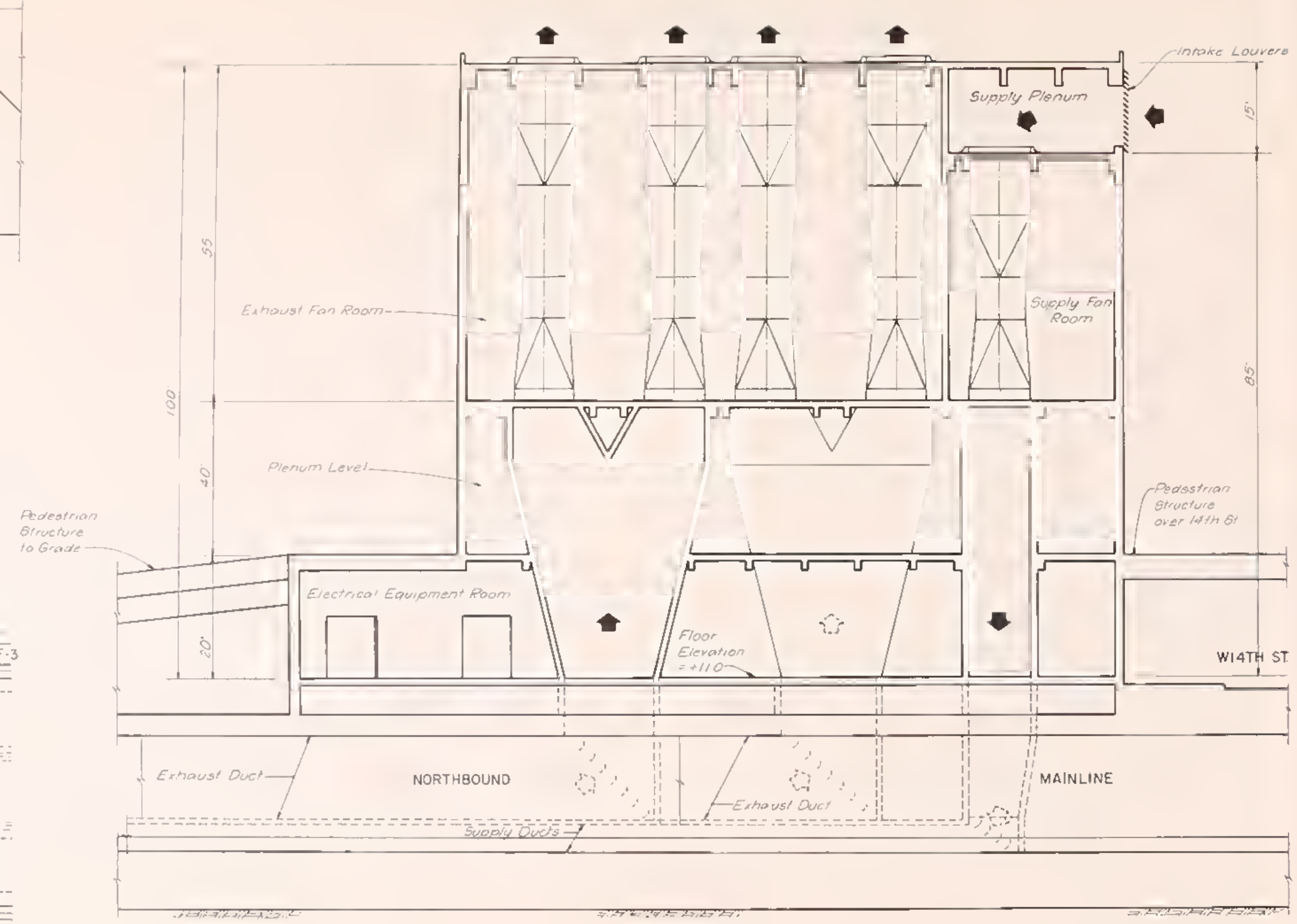
VENTILATION BUILDING NO. 3

WEST SIDE HIGHWAY PROJECT



FAN ROOM FLOOR PLAN
Scale 1"-40'





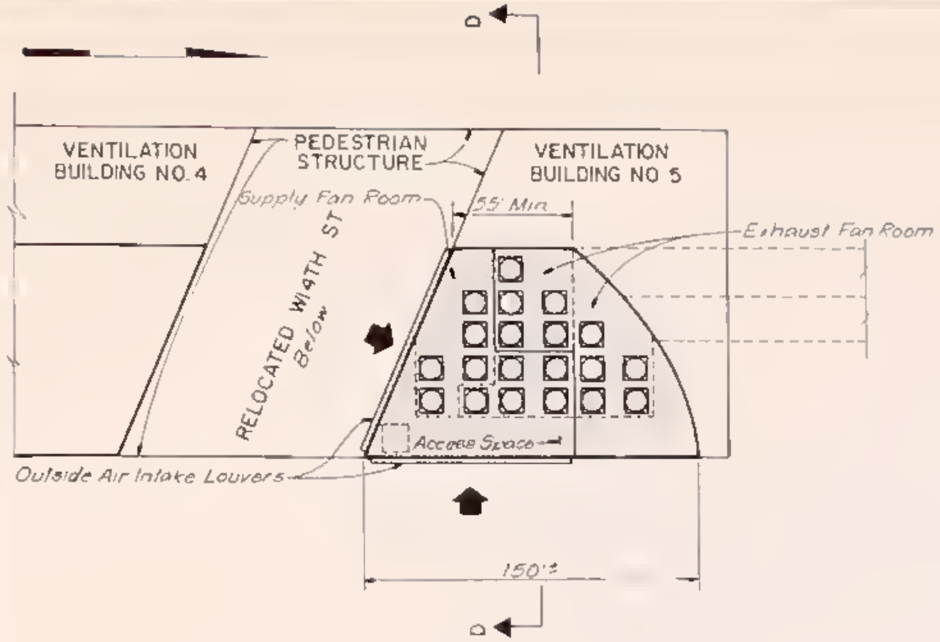
SECTION C-C
Scale 1"-10'

Modified Outboard Alternative

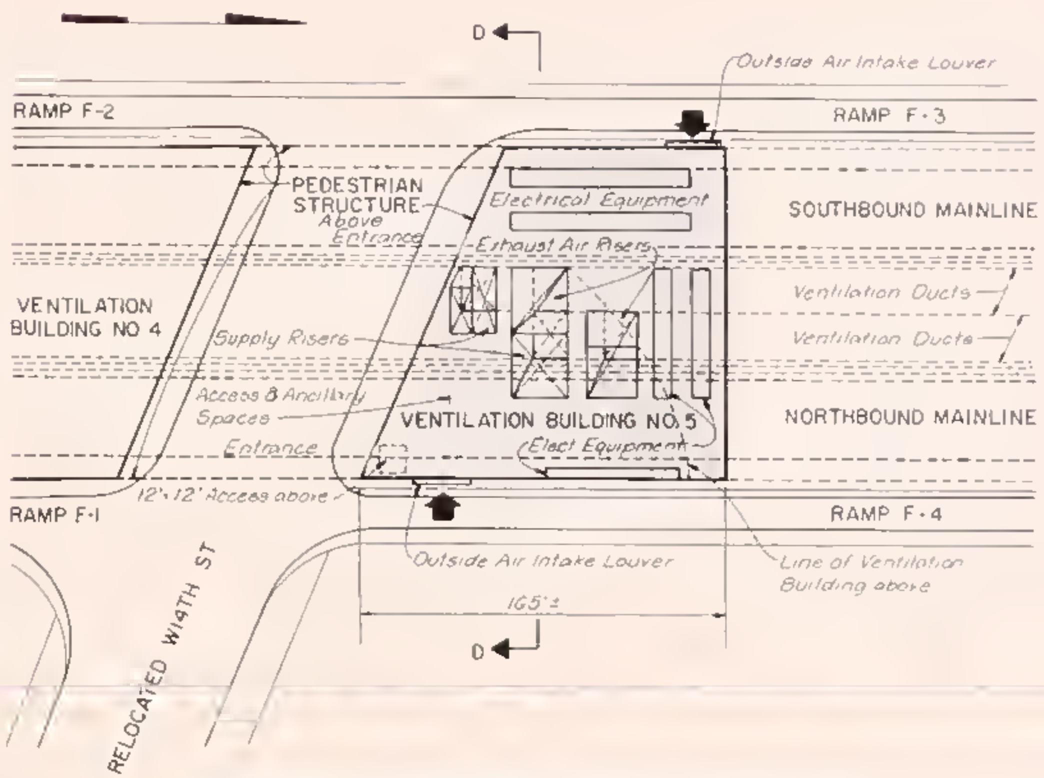
VENTILATION BUILDING NO. 4

ELECTRICAL EQUIPMENT ROOM FLOOR PLAN
Scale 1"-40'

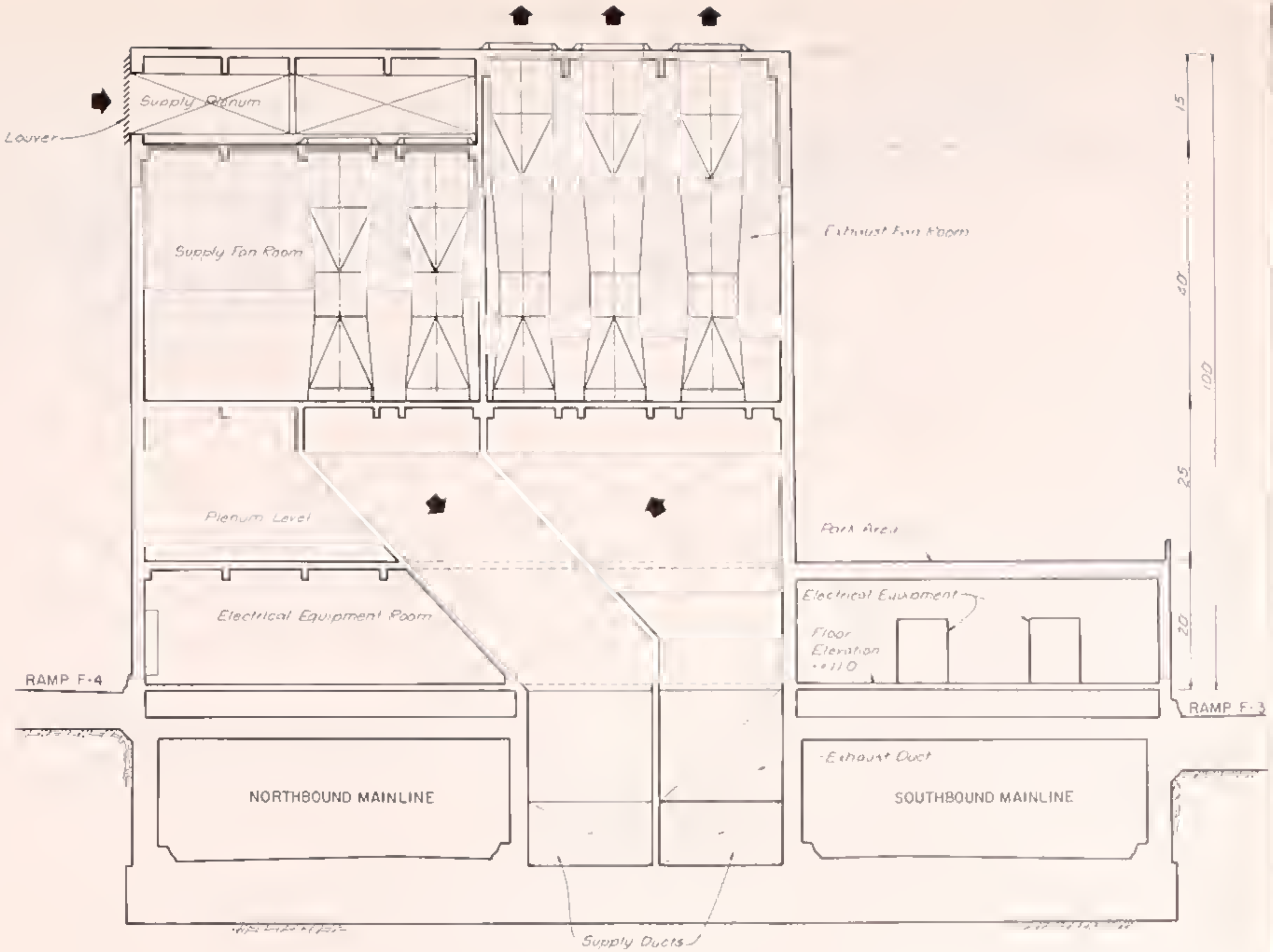
WEST SIDE HIGHWAY PROJECT



FAN ROOM FLOOR PLAN
Scale 1:40'



ELECTRICAL EQUIPMENT ROOM FLOOR PLAN
Scale 1"-40'



SECTION D-D
Scale 1":10'

Modified Outboard Alternative

VENTILATION BUILDING NO. 5

WEST SIDE HIGHWAY PROJECT

KEY PLAN - MAINTENANCE OF TRAFFIC

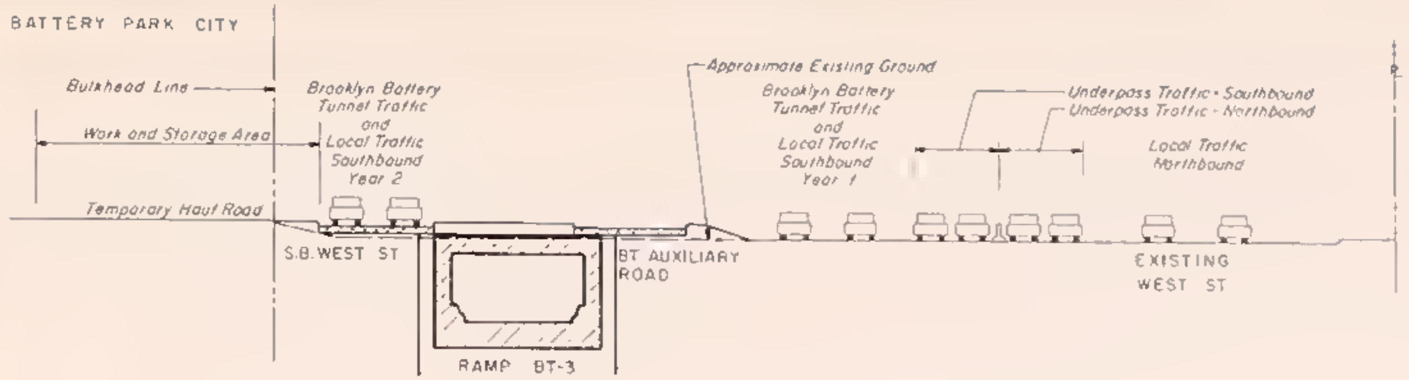
INDEX OF DRAWINGS

LOCATION	SECTION	DWG NOS
VICINITY OF BATTERY PLACE	(1-1)	8-49
VICINITY OF BATTERY TUNNEL APPROACH	(2-2)	8-50
VICINITY OF WORLD TRADE CENTER	(3-3)	8-51
℄ STA 220 + 00	(4-4)	8-52
℄ STA 250 + 00	(5-5)	8-53
HOLLAND TUNNEL INTERCHANGE	PLAN 1	8-54
LINCOLN TUNNEL INTERCHANGE	PLAN 2	8-55

Modified Outboard Alternative
Key Plan
MAINTENANCE OF TRAFFIC

Feet 550 0 1100

WEST SIDE HIGHWAY PROJECT



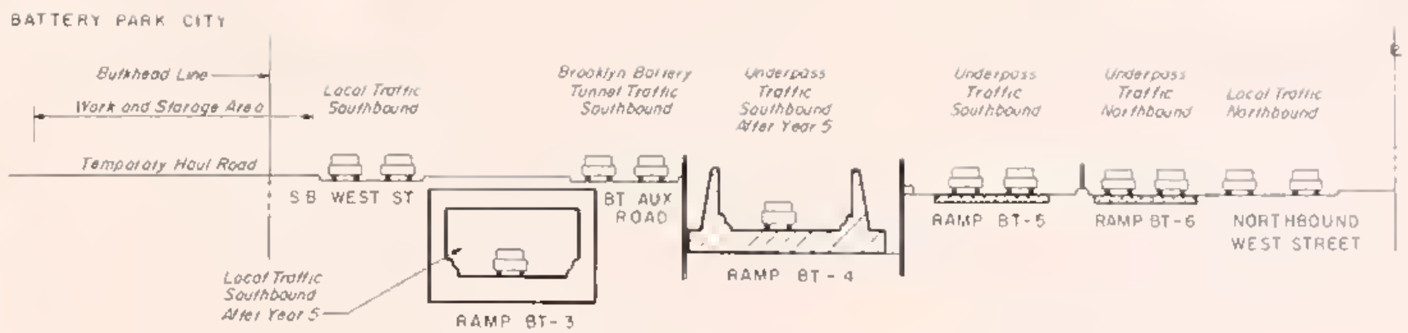
CONSTRUCTION PERIOD - YEARS 1 AND 2

MAINTENANCE OF TRAFFIC

MAINTAIN TRAFFIC ON EXISTING WEST STREET
MAINTAIN TRAFFIC INTO AND OUT OF BATTERY PARK UNDERPASS
MAINTAIN TRAFFIC ON SOUTHBOUND WEST STREET IN YEAR 2
DURING RELOCATION OF UTILITIES, TRAFFIC SHALL BE MAINTAINED AROUND CONSTRUCTION
MAINTAIN ACCESS TO BATTERY PARK CITY

SEQUENCE OF CONSTRUCTION

RELOCATE UTILITIES
CONSTRUCT TEMPORARY HAUL ROAD
CONSTRUCT RAMP BT-3
PAVE SOUTHBOUND WEST STREET
PAVE BT AUXILIARY ROAD



CONSTRUCTION PERIOD - YEARS 3 THROUGH 6

MAINTENANCE OF TRAFFIC

MAINTAIN TRAFFIC ON SOUTHBOUND WEST STREET, BT AUXILIARY ROAD AND NORTHBOUND WEST STREET
MAINTAIN AT LEAST ONE LANE OF TRAFFIC ON RAMP BT-6
MAINTAIN AT LEAST ONE LANE OF TRAFFIC ON RAMP BT-5
MAINTAIN ACCESS TO BATTERY PARK CITY
YEAR 6 - DETOUR ALL TRAFFIC TO FINAL TRAFFIC PATTERN

SEQUENCE OF CONSTRUCTION

CONSTRUCT RAMP BT-4
PAVE RAMP BT-6, ONE LANE AT A TIME
PAVE RAMP BT-5, ONE LANE AT A TIME

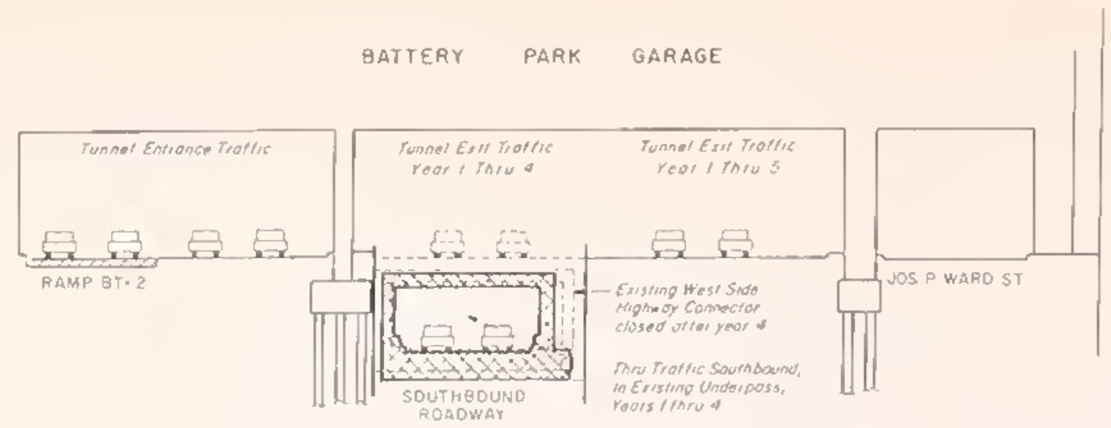
LEGEND

COMPLETED CONSTRUCTION PREVIOUS YEARS
EARLY STAGE CONSTRUCTION
LATTER STAGE CONSTRUCTION
DENOTES ROADWAY OPEN TO TRAFFIC DURING CONSTRUCTION

Modified Outboard Alternative

MAINTENANCE OF TRAFFIC
S.F. STATION 105 + 00±
VICINITY OF BATTERY PLACE

WEST SIDE HIGHWAY PROJECT



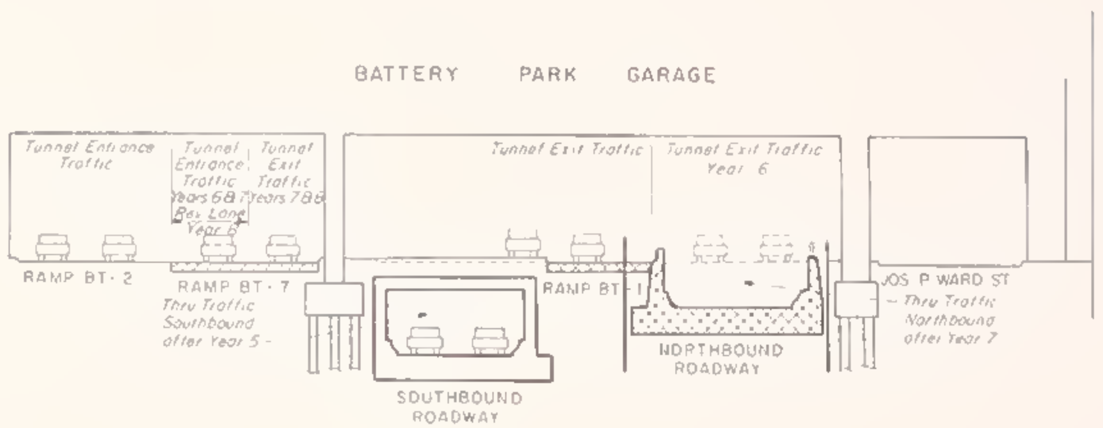
CONSTRUCTION PERIOD - YEARS 1 THROUGH 5

MAINTENANCE OF TRAFFIC

MAINTAIN TRAFFIC ON AT GRADE PAVEMENTS EXCEPT IN AREA OF SOUTHBOUND ROADWAY WHEN UNDER CONSTRUCTION
MAINTAIN AT LEAST ONE LANE OF TRAFFIC ON RAMP BT-2
MAINTAIN TUNNEL ENTRANCE TRAFFIC IN EXISTING WEST SIDE HIGHWAY CONNECTOR THRU YEAR 4
DURING RELOCATION OF UTILITIES TRAFFIC SHALL BE MAINTAINED AROUND CONSTRUCTION
MAINTAIN ACCESS TO BATTERY PARK CITY

SEQUENCE OF CONSTRUCTION

RELOCATE UTILITIES
CONSTRUCT VENTILATION BUILDING NO. 1
PAVE RAMP BT-2 ONE LA. AT A TIME
DEMOLISH WEST SIDE HIGHWAY CONNECTOR
CONSTRUCT PORTION OF SOUTHBOUND ROADWAY



CONSTRUCTION PERIOD - YEARS 6 THROUGH 8

MAINTENANCE OF TRAFFIC

MAINTAIN TRAFFIC ON AT GRADE PAVEMENTS EXCEPT IN AREA OF NORTHBOUND ROADWAY
MAINTAIN AT LEAST ONE LANE OF TRAFFIC ON RAMP BT-7 AND RAMP BT-1
MAINTAIN TUNNEL ENTRANCE TRAFFIC IN SOUTHBOUND ROADWAY
MAINTAIN ACCESS TO BATTERY PARK CITY
YEAR 9 - DETOUR ALL TRAFFIC TO FINAL TRAFFIC PATTERN

SEQUENCE OF CONSTRUCTION

PAVE RAMP BT-7, ONE LANE AT A TIME
CONSTRUCT NORTHBOUND ROADWAY
PAVE RAMP BT-1, ONE LINE AT A TIME

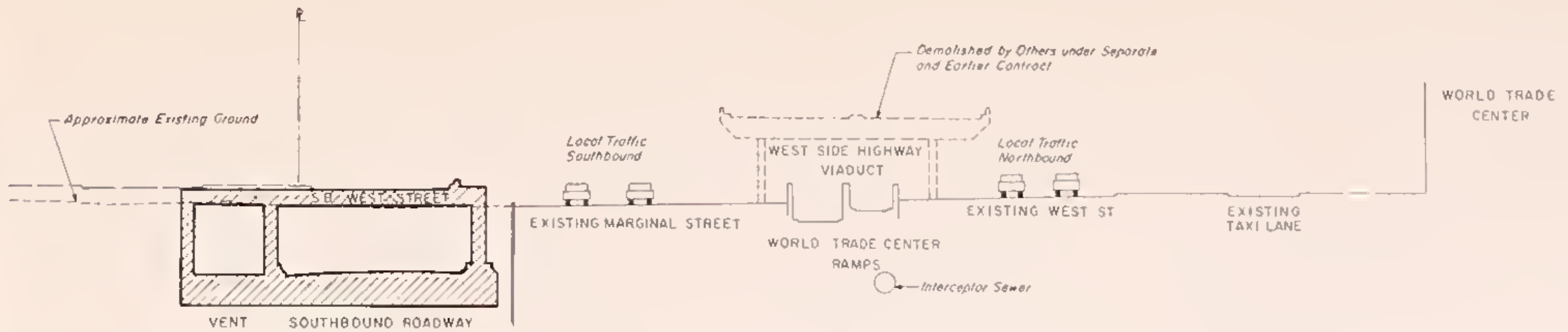
LEGEND

COMPLETED CONSTRUCTION PREVIOUS YEARS
EARLY STAGE CONSTRUCTION
LATTER STAGE CONSTRUCTION
DENOTES ROADWAY OPEN TO TRAFFIC DURING CONSTRUCTION

Modified Outboard Alternative

MAINTENANCE OF TRAFFIC
NB STATION 108 + 90±
VICINITY BATTERY TUNNEL APPROACH

WEST SIDE HIGHWAY PROJECT



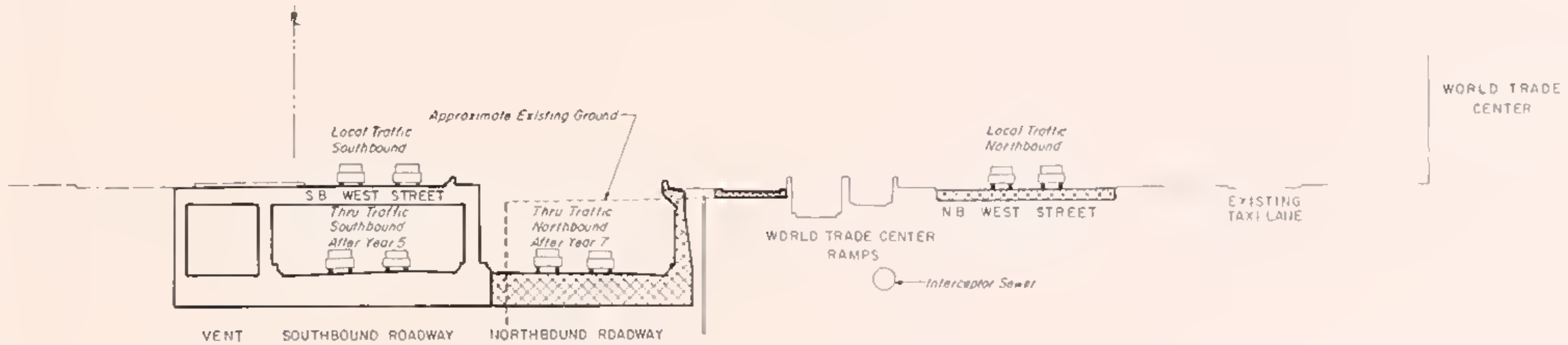
CONSTRUCTION PERIOD - YEARS 1 THROUGH 4

MAINTENANCE OF TRAFFIC

MAINTAIN EXISTING PATTERN ON WEST STREET AND MARGINAL STREET
DURING RELOCATION OF UTILITIES, TRAFFIC SHALL BE MAINTAINED AROUND CONSTRUCTION
MAINTAIN ACCESS TO BATTERY PARK CITY AND WORLD TRADE CENTER

SEQUENCE OF CONSTRUCTION

RELOCATE UTILITIES
CONSTRUCT PATH TUBE PROTECTION
CONSTRUCT SOUTHBOUND ROADWAY & VENTILATION DUCT
CONSTRUCT S B WEST STREET



CONSTRUCTION PERIOD - YEARS 5 THROUGH 8

MAINTENANCE OF TRAFFIC

MAINTAIN NORTHBOUND LOCAL TRAFFIC ON WEST STREET
DETOUR SOUTHBOUND LOCAL TRAFFIC TO NEWLY CONSTRUCTED SOUTHBOUND WEST STREET
MAINTAIN ACCESS TO BATTERY PARK CITY AND WORLD TRADE CENTER
YEAR 8 DETOUR TO FINAL TRAFFIC PATTERN

SEQUENCE OF CONSTRUCTION

CONSTRUCT NORTHBOUND ROADWAYS
PAVE NORTHBOUND WEST STREET UNDER TRAFFIC
CONSTRUCT WORLD TRADE CENTER ACCESS RAMPS

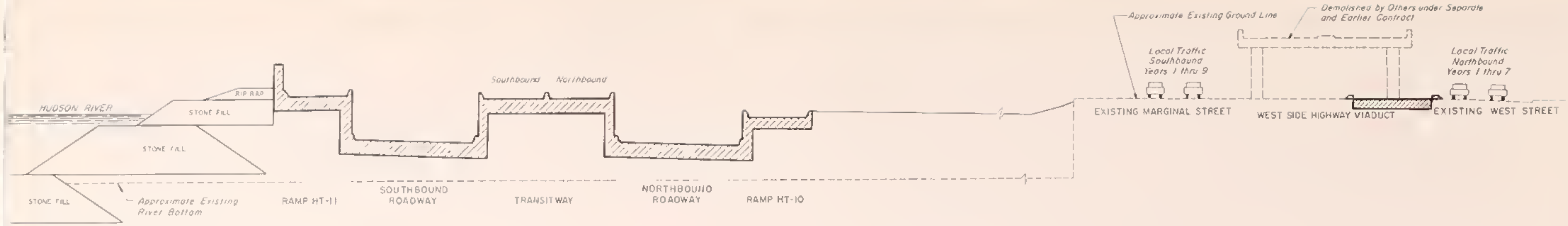
LEGEND

COMPLETED CONSTRUCTION PREVIOUS YEARS
EARLY STAGE CONSTRUCTION
LATTER STAGE CONSTRUCTION
DENOTES ROADWAY OPEN TO TRAFFIC DURING CONSTRUCTION

Modified Outboard Alternative

MAINTENANCE OF TRAFFIC
℄ STATION 128 + 00±
VICINITY WORLD TRADE CENTER

WEST SIDE HIGHWAY PROJECT



CONSTRUCTION PERIOD - YEARS 1 THROUGH 7

MAINTENANCE OF TRAFFIC

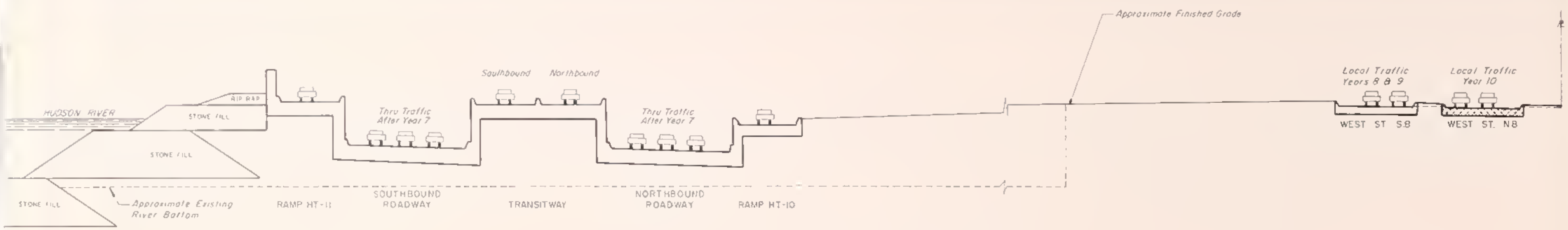
MAINTAIN SOUTHBOUND LOCAL TRAFFIC ON EXISTING MARGINAL STREET
MAINTAIN NORTHBOUND LOCAL TRAFFIC ON EXISTING WEST STREET

SEQUENCE OF CONSTRUCTION

CONSTRUCT HOLLAND TUNNEL PROTECTION
CONSTRUCT SOUTHBOUND AND NORTHBOUND ROADWAYS
CONSTRUCT TRANSITWAY
CONSTRUCT RAMPS HT-10 AND HT-11
CONSTRUCT SOUTHBOUND WEST STREET

LEGEND

COMPLETED CONSTRUCTION PREVIOUS YEARS
EARLY STAGE CONSTRUCTION
LATTER STAGE CONSTRUCTION
DENOTES ROADWAY OPEN TO TRAFFIC DURING CONSTRUCTION



CONSTRUCTION PERIOD - YEARS 8 THROUGH 10

MAINTENANCE OF TRAFFIC

DETOUR NORTHBOUND LOCAL TRAFFIC TO NEWLY CONSTRUCTED SOUTHBOUND WEST STREET
YEAR 10 - DETOUR ALL TRAFFIC TO FINAL PATTERN

SEQUENCE OF CONSTRUCTION

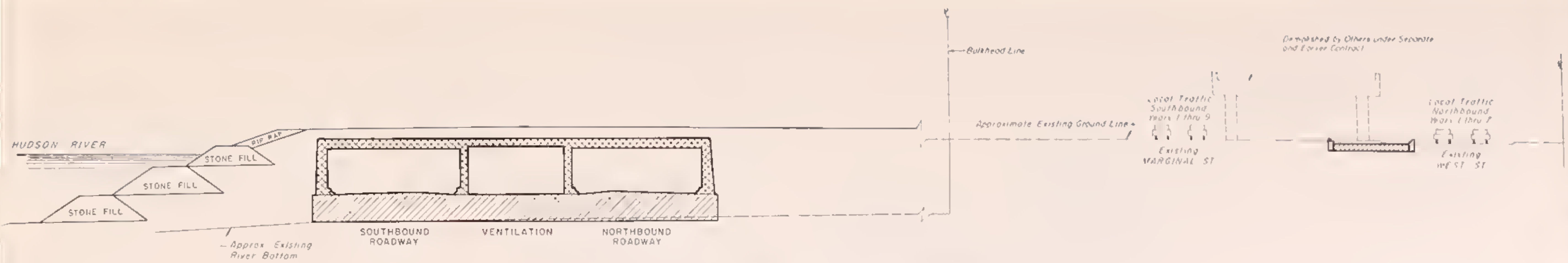
CONSTRUCT NORTHBOUND WEST STREET
COMPLETE MISCELLANEOUS WORK

Modified Outboard Alternative

MAINTENANCE OF TRAFFIC

℄ STA 220 + 00

WEST SIDE HIGHWAY PROJECT



CONSTRUCTION PERIOD - YEARS 1 THROUGH 7

MAINTENANCE OF TRAFFIC

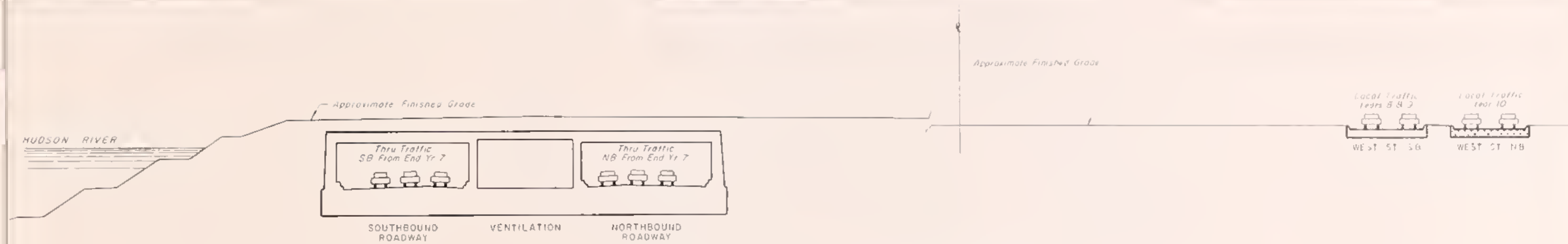
MAINTAIN EXISTING TRAFFIC PATTERN ON THE EXISTING MARGINAL STREET SOUTHBOUND, AND WEST STREET NORTHBOUND

SEQUENCE OF CONSTRUCTION

CONSTRUCT PROTECTION FOR PATH TUBE
CONSTRUCT SOUTHBOUND AND NORTHBOUND ROADWAYS
CONSTRUCT VENTILATION DUCTS & ACCESSORIES
CONSTRUCT SOUTHBOUND WEST STREET

LEGEND

COMPLETED CONSTRUCTION PREVIOUS YEARS
EARLY STAGE CONSTRUCTION
LATTER STAGE CONSTRUCTION
DENOTES ROADWAY OPEN TO TRAFFIC DURING CONSTRUCTION



CONSTRUCTION PERIOD - YEARS 8 THROUGH 10

MAINTENANCE OF TRAFFIC

DETOUR NORTHBOUND LOCAL TRAFFIC TO NEWLY CONSTRUCTED SOUTHBOUND WEST STREET
YEAR 10 - DETOUR ALL TRAFFIC TO FINAL PATTERN

SEQUENCE OF CONSTRUCTION

COMPLETE TOPSOILING & SEEDING AND COMPLETE ANY MISCELLANEOUS ROADWAY ITEMS

Modified Outboard Alternative

MAINTENANCE OF TRAFFIC
STA 250 + 00
VICINITY OF PIER 40

WEST SIDE HIGHWAY PROJECT

CONSTRUCTION PERIOO- YEARS 5 AND 6

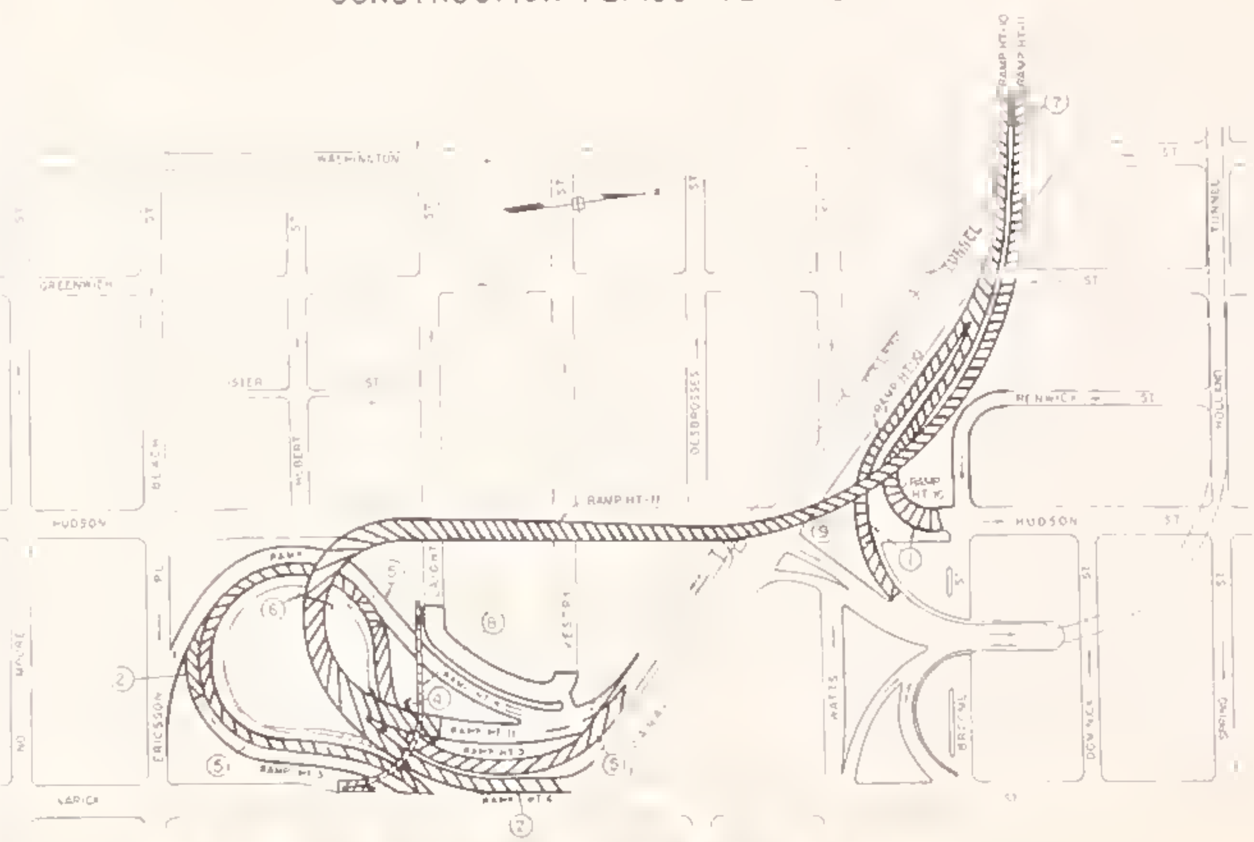
CONSTRUCTION PERIOD- YEARS 5 AND 6

SEQUENCE OF CONSTRUCTION

1. DEMOLISH BUILDINGS.
2. CONSTRUCT NEW CONNECTIONS BETWEEN VESTRY AND LAIGHT STREETS AND BETWEEN RENWICK AND HUDSON STREETS.
3. CONSTRUCT TEMPORARY PEDESTRIAN OVERPASS.
4. CONSTRUCT RAMPS WHERE CLEAR OF EXISTING TRAFFIC PATTERN IN EXIT INTERCHANGE.
5. BEGIN CONSTRUCTION RETAINING WALLS FOR ENTRANCE RAMPS HT-10 AND HT-16 TO HOLLAND TUNNEL.
6. CONSTRUCT CLOSURE PIECES OF RAMPS.

MAINTENANCE OF TRAFFIC

CLOSE RENWICK STREET FROM CANAL STREET TO BROOME STREET EXTENSION.
MAINTAIN TRAFFIC ON EXISTING CONNECTION BETWEEN VESTRY AND LAIGHT STREETS UNTIL NEW CONNECTION IS CONSTRUCTED.
MAINTAIN EXISTING BASIC TRAFFIC PATTERN IN EXIT INTERCHANGE WHILE CONSTRUCTING RAMPS HT-4 AND HT-3.
MAINTAIN HUDSON STREET TRAFFIC THRU YEAR 6



CONSTRUCTION PERIOD YEARS 7 AND 8

CONSTRUCTION PERIOD- YEARS 7 AND 8

SEQUENCE OF CONSTRUCTION

1. COMPLETE CONSTRUCTION FOR RAMPS HT 10 AND HT-16 AT HUDSON STREET
2. CONSTRUCT CLOSURE PIECE RAMP HT-3.
3. CONSTRUCT TEMPORARY PAVEMENT WIDENING
4. CONSTRUCT ABUTMENTS FOR RAMP HT-3 UNDERPASS.
5. CONSTRUCT RAMP HT-3.
6. CONSTRUCT ABUTMENT OF RAMP HT-11
7. CONSTRUCT RAMP HT-6 AND COMPLETE CONSTRUCTION OF RAMP HT-11
8. CONSTRUCT PEDESTRIAN OVERPASS.
9. COMPLETE LOCAL STREET REVISIONS.
10. COMPLETE MISCELLANEOUS WORK.

MAINTENANCE OF TRAFFIC

MAINTAIN TWO NORTH BOUND LANES IN HUDSON STREET FOR LOCAL TRAFFIC ONLY FROM HUBERT ST. TO CANAL ST
CLOSE HUDSON STREET FROM CANAL STREET TO BROOME STREET FROM YEAR 7
DIVERT HUDSON STREET THRU TRAFFIC TO AVENUE OF THE AMERICAS VIA CHAMBERS AND CHURCH STREETS OR FRANKLIN STREET
CLOSE EXISTING EXIT RAMPS TO LAIGHT AND HUDSON STREETS
DIVERT TWO LANES TUNNEL EXIT TRAFFIC TO RAMP HT-4
DIVERT TUNNEL EXIT TRAFFIC ONTO RAMPS HT-4 AND HT-3.
DIVERT PEDESTRIAN TRAFFIC TO PEDESTRIAN OVERPASS.

LEGEND

- EXISTING PAVEMENT
- PERMANENT CONSTRUCTION THIS STAGE
- PERMANENT CONSTRUCTION PREVIOUS STAGES
- TEMPORARY CONSTRUCTION THIS STAGE
- TEMPORARY CONSTRUCTION PREVIOUS STAGES
- TRAFFIC MAINTAINED IN THIS STAGE
- CROSS REFERENCE BETWEEN PLAN AND SEQUENCE OF CONSTRUCTION TEXT

Modified Outboard Alternative

MAINTENANCE OF TRAFFIC
HOLLAND TUNNEL INTERCHANGE

WEST SIDE HIGHWAY PROJECT

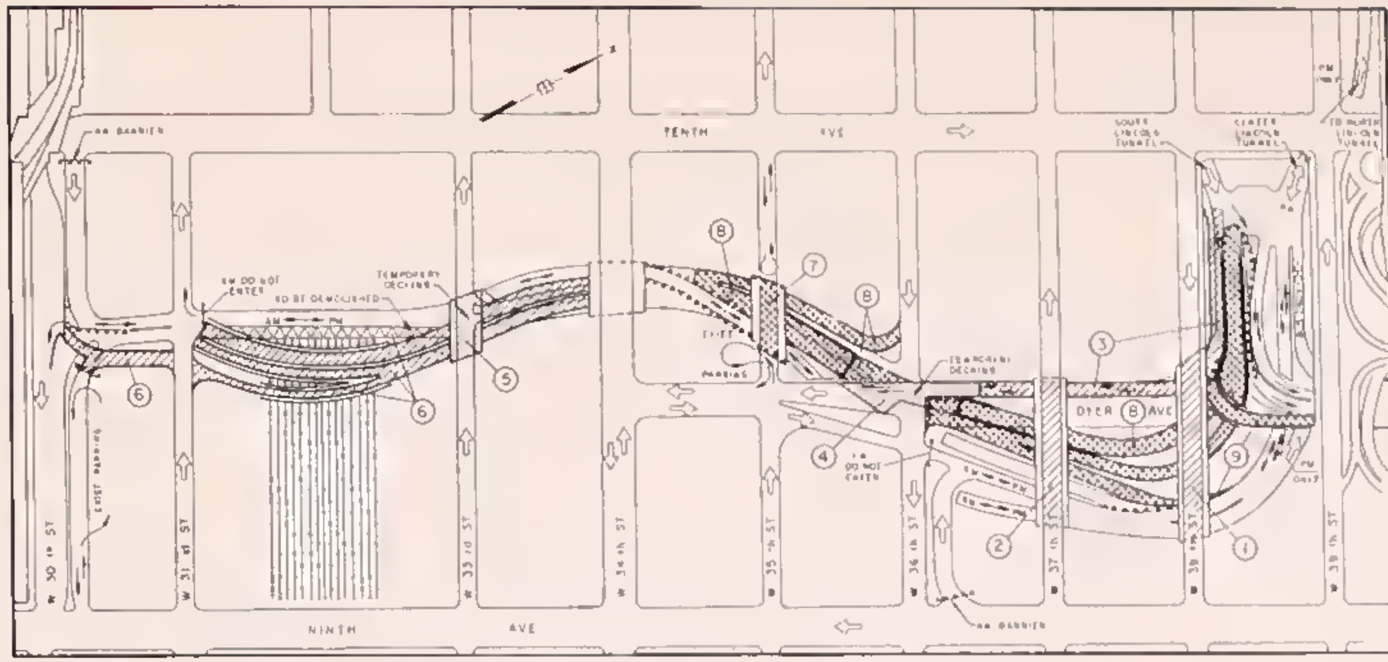
MAINTENANCE OF TRAFFIC

TRAFFIC FROM THE SOUTH LINCOLN TUNNEL HEADING SOUTH IS RESTRICTED TO TWO LANES WITH ACCESS TO WEST 34TH, WEST 35TH AND WEST 36TH STREETS VIA DYER AVENUE.

TRAFFIC MOVEMENTS TO AND FROM THE SOUTH USING THE CENTER LINCOLN TUNNEL ARE LIMITED TO A REVERSIBLE OPERATION INBOUND IN THE MORNING AND OUTBOUND IN THE EVENING WITH ONE LANE SERVING WEST 30TH AND 31ST STREETS AND ONE LANE FOR THE WEST 34TH AND WEST 36TH STREETS AREA.

WEST 35TH, WEST 37TH AND WEST 38TH STREETS WILL BE CLOSED TO THROUGH TRAFFIC DURING THE OVERPASS DEMOLITION AND RECONSTRUCTION OPERATIONS. HOWEVER, NOT MORE THAN ONE STREET SHALL BE CLOSED AT ONE TIME.

TRAFFIC SHALL BE MAINTAINED ON DYER AVENUE AND WEST 36TH STREET DURING THE CONSTRUCTION OF THE TEMPORARY DECKING. WEST 33RD STREET MAY BE CLOSED TO TRAFFIC DURING THE TEMPORARY DECKING CONSTRUCTION IF NO OTHER STREET IS CLOSED AT THE TIME.



CONSTRUCTION PERIOD - YEARS 6 AND 7

SEQUENCE OF CONSTRUCTION

1. DEMOLISH EXISTING WEST 38TH STREET OVERPASSES AND CONSTRUCT NEW OVERPASSES.
2. DEMOLISH EXISTING WEST 37TH STREET OVERPASSES AND CONSTRUCT NEW OVERPASSES.
3. CONSTRUCT RETAINING WALL AND PART OF RAMP LT1.
4. CONSTRUCT TEMPORARY DECKING AT DYER AVENUE AND WEST 36TH STREET.
5. CONSTRUCT TEMPORARY DECKING AT 33RD STREET
6. DEMOLISH EXISTING RAMP BETWEEN WEST 31ST STREET AND WEST 33RD STREET. CONSTRUCT RAMP LT2 FROM WEST 31ST STREET TO WEST 34TH STREET AND RAMP LT7.
7. DEMOLISH EXISTING WEST 35TH STREET OVERPASS AND CONSTRUCT NEW OVERPASS.
8. CONSTRUCT RAMP LT2 FROM THE LINCOLN TUNNEL THROUGH WEST 35TH STREET AND PART OF RAMP LT6.
9. CONSTRUCT RAMPS LT2A, LT5 AND EXIT RAMP TO DYER AVENUE.

MAINTENANCE OF TRAFFIC

TRAFFIC FROM THE SOUTH LINCOLN TUNNEL TO THE SOUTH WILL NOW HAVE A ONE-LANE EXIT TO THE WEST 34TH - WEST 36TH STREETS AREA AND AN AM ONLY ONE-LANE ACCESS TO THE WEST 30TH - WEST 31ST STREETS AREA. IF WARRANTED, AN ADDITIONAL LANE OF TRAFFIC CAN BE MAINTAINED TO DYER AVENUE DURING THE REMOVAL OF THE TEMPORARY DECKING AND THE REMAINING CONSTRUCTION OF RAMP LT1. (STEP 5)

TRAFFIC MOVEMENTS TO AND FROM THE CENTER TUBE TO THE SOUTH ARE STILL RESTRICTED TO AN AM-PM REVERSIBLE OPERATION. HOWEVER, ACCESS TO THE NORTH LINCOLN TUNNEL FROM THE WEST 34TH - WEST 36TH STREETS AREA IS NOW OPEN AT ALL TIMES.

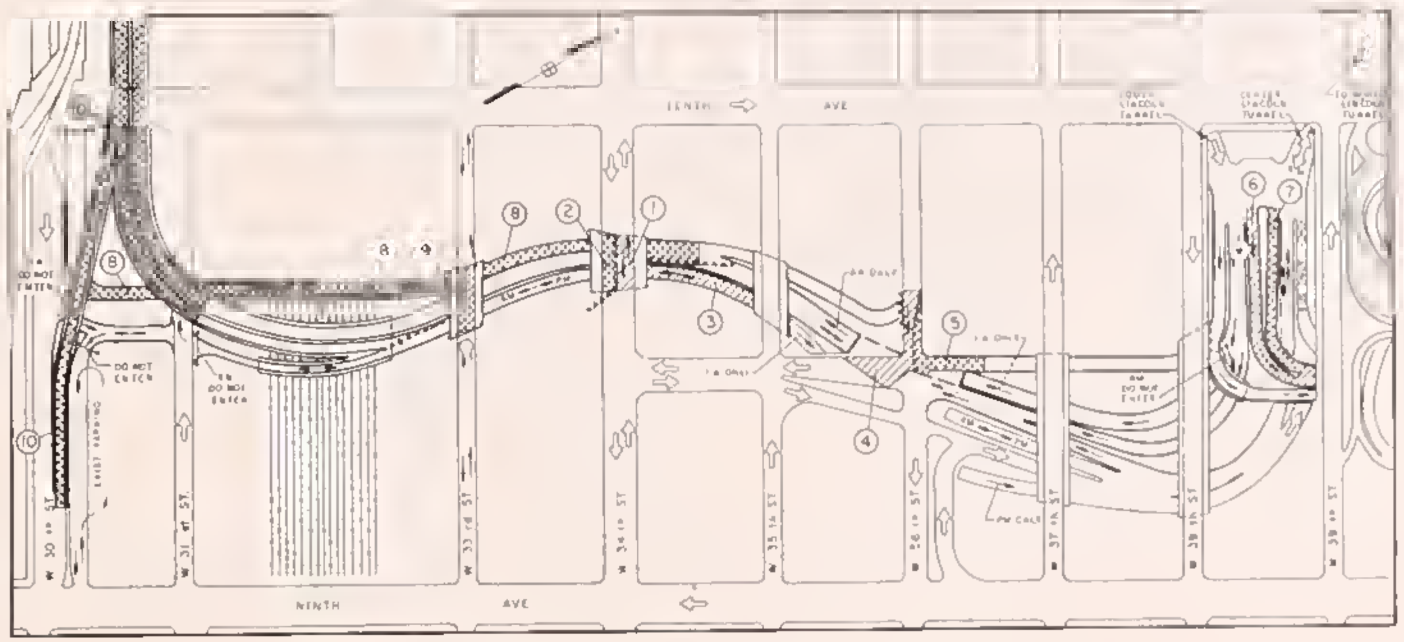
DEMOLITION AND RECONSTRUCTION OF THE WEST 34TH STREET OVERPASS SHALL BE DONE IN HALVES WHILE MAINTAINING ONE LANE OF TRAFFIC IN EACH DIRECTION.

WEST 33RD STREET CAN BE LEFT OPEN TO THROUGH TRAFFIC IF WARRANTED DURING THE REMOVAL OF THE TEMPORARY DECKING AND RECONSTRUCTION OF THE STREET. TRAFFIC ON DYER AVENUE AND WEST 36TH STREET SHALL BE MAINTAINED DURING THE REMOVAL OF THE TEMPORARY DECKING AND RECONSTRUCTION OF THE INTERSECTION.

TRAFFIC SHALL BE DIVERTED TO THE FINAL TRAFFIC PATTERN UPON COMPLETION OF THIS STAGE, INCLUDING DIRECT ACCESS TO AND FROM THE NEW WEST SIDE HIGHWAY.

SEQUENCE OF CONSTRUCTION

1. DEMOLISH HALF OF EXISTING WEST 34TH STREET OVERPASS AND CONSTRUCT NEW HALF
2. DEMOLISH REMAINDER OF EXISTING WEST 34TH STREET OVERPASS AND COMPLETE NEW CONSTRUCTION.
3. COMPLETE RAMP LT2 CONSTRUCTION IN THE 34TH STREET AREA.
4. REMOVE PART OF THE TEMPORARY DECKING AND RECONSTRUCT INTERSECTION UNDER TRAFFIC.
5. REMOVE TEMPORARY DECKING AND COMPLETE RAMP LT1 CONSTRUCTION.
6. CONSTRUCT RAMP LT3.
7. CONSTRUCT RAMP LT4.
8. CONSTRUCT RAMP LT9 AND COMPLETE RAMP LT6.
9. REMOVE TEMPORARY DECKING AND RECONSTRUCT WEST 33RD STREET.
10. CONSTRUCT RAMP LT8 AND COMPLETE RAMP LT12 CONSTRUCTION TO THE NORTH INCLUDING
11. NEW CONNECTIONS TO THE WEST SIDE HIGHWAY.



CONSTRUCTION PERIOD - YEARS 8 AND 9

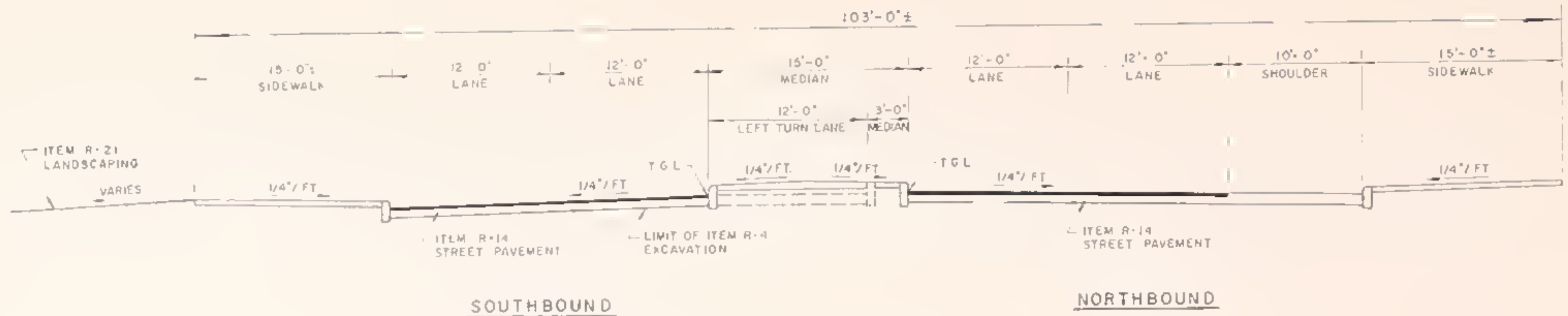
LEGEND

- EXISTING PAVEMENT
- EARLY STAGE CONSTRUCTION
- LATTER STAGE CONSTRUCTION
- PERMANENT CONSTRUCTION PREVIOUS STAGE
- EARLY STAGE CONSTRUCTION-COVERED ROADWAY
- LATTER STAGE CONSTRUCTION-COVERED ROADWAY
- PERMANENT CONSTRUCTION PREVIOUS STAGE-COVERED RDWY
- TEMPORARY CONSTRUCTION THIS STAGE
- TRAFFIC MAINTAINED IN THIS STAGE
- CROSS REFERENCE BETWEEN PLAN AND SEQUENCE OF CONSTRUCTION TEXT
- MOVABLE BARRICADES
- DENOTES EXISTING DIRECTIONAL STREET PATTERN

Modified Outboard Alternative

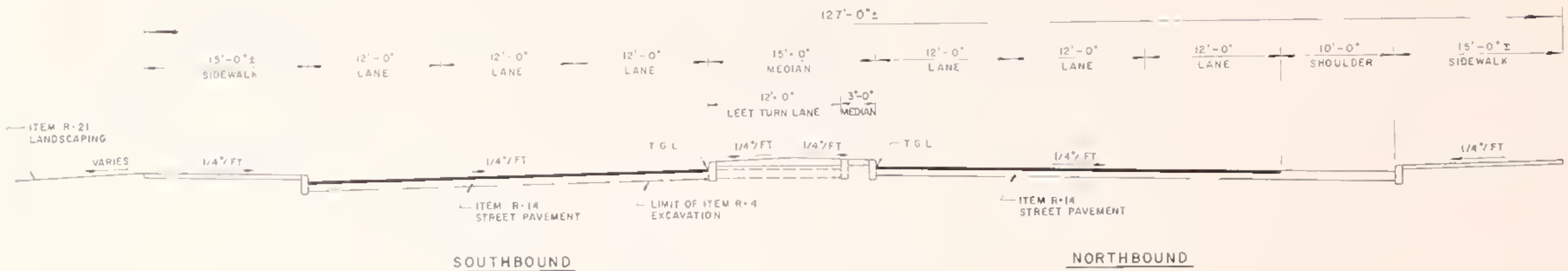
MAINTENANCE OF TRAFFIC
LINCOLN TUNNEL INTERCHANGE

WEST SIDE HIGHWAY PROJECT



ALTERNATE WEST STREET SECTION

STA 152 + 70± TO STA 361 + 00±



ALTERNATE WEST STREET SECTION

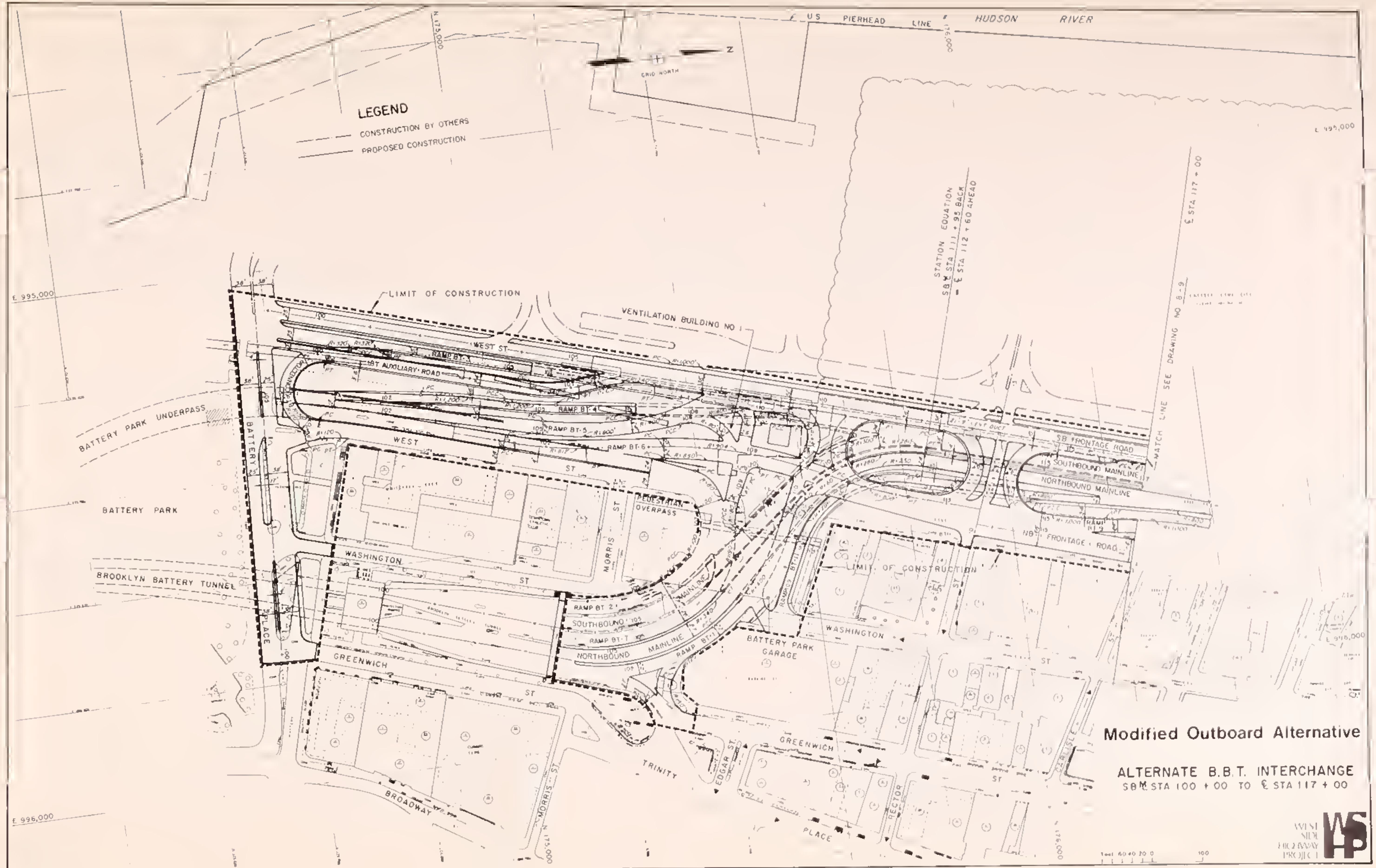
STA. 361 + 00± TO STA. 395 + 00±

Modified Outboard Alternative

ALTERNATE TYPICAL SECTIONS
WEST STREET

Feet 3 2 1 0 5

WEST SIDE HIGHWAY PROJECT

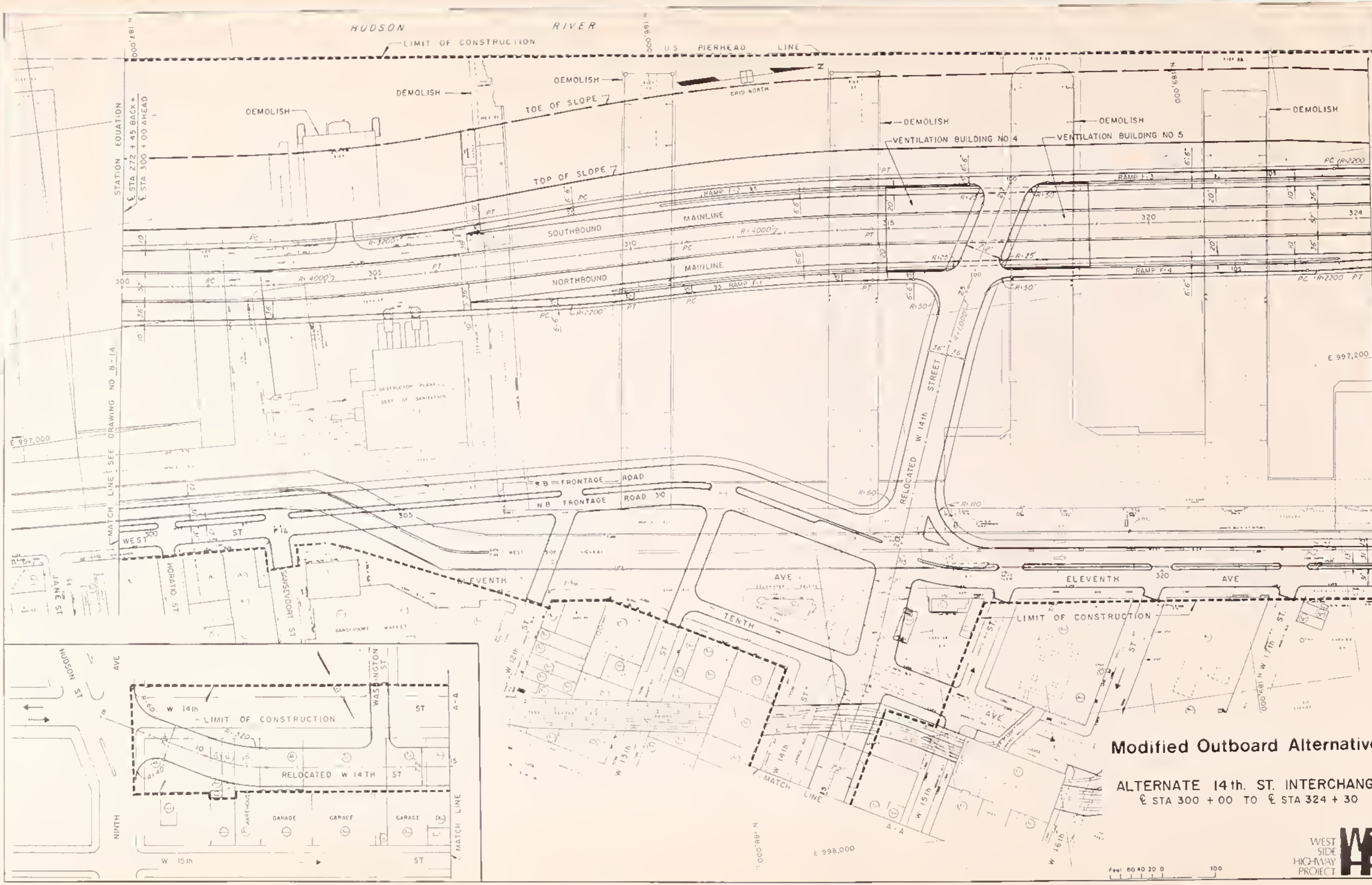


Modified Outboard Alternative

ALTERNATE B.B.T. INTERCHANGE

SB ℄ STA 100 + 00 TO ℄ STA 117 + 00

WEST SIDE HIGHWAY PROJECT


HUDSON RIVER
LIMIT OF CONSTRUCTION
U S PIERHEAD LINE
GRID NORTH
DEMOLISH
TOE OF SLOPE
TOP OF SLOPE
STATION EQUATION
℄ STA 272 + 45 BACK =
℄ STA 300 + 00 AHEAD
VENTILATION BUILDING NO 4
VENTILATION BUILDING NO 5
SOUTHBOUND MAINLINE
NORTHBOUND MAINLINE
RAMP F-1
RAMP F-2
RAMP F-3
RAMP F-4
℄ STA 324 + 30
MATCH LINE SEE DRAWING NO 8-14
MATCH LINE SEE DRAWING NO 8-16
E 997,000
E 997,200
E 998,000
RELOCATED W 14th STREET
S B FRONTAGE ROAD
N B FRONTAGE ROAD
WEST ST
ELEVENTH AVE
TENTH AVE
JANE ST
HORATIO ST
GANSEVOORT ST
W 12th ST
W 13th ST
W 14th ST
W 15th ST
W 16th ST
W 17th ST
MATCH LINE
A-A
HUDSON ST
NINTH AVE
WASHINGTON ST
W 14th
LIMIT OF CONSTRUCTION
RELOCATED W 14TH ST
W 15th ST
GARAGE
Modified Outboard Alternative
ALTERNATE 14th. ST. INTERCHANGE
℄ STA 300 + 00 TO ℄ STA 324 + 30
Feet 80 40 20 0 100
WEST SIDE HIGHWAY PROJECT
WSHP