Chapter 2: Project Alternatives

2-1 INTRODUCTION

The development and evaluation of project alternatives is central to the National Environmental Policy Act (NEPA) and State Environmental Quality Review (SEQRA) processes. This chapter describes the alternatives for the Tappan Zee Hudson River Crossing Project that are evaluated in this Environmental Impact Statement (EIS), as well as alternatives that were previously considered but were eliminated during the scoping process for this EIS and the reasons for their elimination.

This EIS considers two alternatives for the Tappan Zee Hudson River crossing as follows:

- ***No Build Alternative.*** The No Build Alternative would involve the continued operation of the existing seven-lane bridge with ongoing maintenance and measures necessary to keep the bridge in a state of good repair; and
- ***Replacement Bridge Alternative.*** The Replacement Bridge Alternative would replace the existing Tappan Zee Bridge with two new structures (one each for eastbound and westbound traffic) to the north of its existing location.

The location and general characteristics of the Replacement Bridge Alternative have been identified and are the basis of the impacts assessment in this EIS. However, to provide for flexibility in the final design of the Replacement Bridge Alternative, this EIS considers options for certain structural characteristics of the bridge (i.e., the distance between bridge piers and the type of bridge structure across the navigable channel). The Replacement Bridge Alternative options that are under consideration are described below.

A Rehabilitation, Tunnel, and Single Structure Alternative were also considered. As described below, the Rehabilitation, Tunnel, and Single Structure Alternatives are not prudent because they would not meet the project's goals and objectives. Therefore, this EIS does not assess a Rehabilitation, Tunnel, or Single Structure Alternative for the Tappan Zee Hudson River Crossing Project.

2-2 ALTERNATIVES ANALYZED IN THIS ENVIRONMENTAL IMPACT STATEMENT

The following describes the No Build and Replacement Bridge Alternatives, which are analyzed in detail in this EIS.

2-2-1 NO BUILD ALTERNATIVE

NEPA requires that an EIS consider a No Build Alternative. The No Build Alternative reflects the continuation of the existing Tappan Zee Hudson River Crossing and serves as the baseline condition against which the potential benefits and impacts of the Replacement Bridge Alternative are evaluated.

Under the No Build Alternative, the Tappan Zee Bridge would retain its current, seven-lane configuration. The New York State Thruway Authority (NYSTA) would continue maintenance of the bridge and would invest capital funds to keep it in a state of good repair. NYSTA estimates that it would spend $1.3 billion to maintain and repair over the next decade. Major work activities would include seismic upgrades to portions of the bridge, navigational safety improvements, steel and concrete repairs, and other miscellaneous work to continue to keep the bridge safe for the traveling public.

Extraordinary maintenance efforts and capital projects would ensure that the bridge continues to be safe to the traveling public, but these projects would not correct all of the structural, operational, safety, security, or mobility needs of the bridge as described in Chapter 1, "Purpose and Need." Therefore, given the age of the bridge and its vulnerabilities in extreme events, it is possible that under the No Build Alternative, the crossing could be closed altogether at some point in the future, resulting in the loss of a critical infrastructure element to an important transportation corridor.

As described in Chapter 1, "Purpose and Need," the New York Metropolitan Transportation Council (NYMTC) projects substantial population and employment growth in Westchester and Rockland Counties over the next 30 years. This growth is expected independent of alternatives for the Tappan Zee Hudson River Crossing and is the baseline for evaluating the potential impacts of the project alternatives. In addition to the growth projected by NYMTC, there are specific projects that will be undertaken independent of the project alternatives for the Tappan Zee Hudson River Crossing. These projects are shown in **Tables 2-1 and 2-2**.

Table 2-1
Planned Developments Within the Study Area

Jurisdiction	Development Name	Development Description	Status
Tarrytown	Crescent Associates	60,000-square-foot, 3-story office building, with accessory parking to join two existing office buildings; located opposite Interstate 87/287 ramps at 155 White Plains Road	Approved
Tarrytown	Jewish Community Center on the Hudson (JCC)	The JCC purchased the adjacent property, the former GM Training Center at 425 South Broadway, and plans to expand with the creation of a new campus on the two properties (approximately 75,000 square feet on 6.6 acres). The campus is located 500 feet south of the New York State Interstate 87/287 on Route 9.	Approved
Tarrytown	Jardim Estates	Subdivision of up to 50 single family residences	In approvals process

Table 2-2
Notable Transportation Improvement Program (TIP) Projects in the Study Area

Agency	Project Number	Project Description
Rockland County Department of Transportation [1]	882300	Tappan Zee Express bus expansion
Town of Orangetown [2]	875967	Traffic signal improvements: at 28 intersections in Orangetown
NYSDOT [2]	810322	Reconstruction of Route 9/Route 119 (Executive Boulevard) as a four-lane divided roadway with left-turn bays and new sidewalks
Village of Tarrytown [2]	875976	Traffic signal improvements at five intersections along Route 9 in Tarrytown
Town of Greenburgh [2]	878012	1 mile of trail to link Lyndhurst and Sunnyside historic sites
NYSDOT [1]	882161	Orange-Westchester Link (OWL): peak-hour commuter between Route 17 (I-86) corridor to Westchester County with connections to other services (Tappan Zee Express, I-bus & local service).

Sources:
[1] New York Metropolitan Transportation Council (NYMTC) Transportation Improvement Program (TIP) Federal Fiscal Years 2008-2012, Adopted October 29, 2007, and last revised September 7, 2011.
[2] Draft Federal Fiscal Years 2011-15 Transportation Improvement Program, June 2011.

The assessment of the No Build Alternative in this EIS accounts for background growth, which includes the specific projects described above.

2-2-2 REPLACEMENT BRIDGE ALTERNATIVE

The Replacement Bridge Alternative would result in a new bridge crossing of the Hudson River between Rockland and Westchester Counties.

2-2-2-1 DESIGN PARAMETERS

A number of design parameters have been considered to develop the location and general configuration of the Replacement Bridge Alternative. However, to provide for flexibility in the final design of the Replacement Bridge Alternative, this EIS considers options for certain structural characteristics of the bridge. The following describes the preferred location, the general characteristics, and the design options for the Replacement Bridge Alternative.

Location

The planning for the Replacement Bridge Alternative considered a footprint that would maximize the use of existing NYSTA right-of-way while minimizing effects on existing highway infrastructure in Rockland and Westchester Counties. Replacement bridge alignments both north and south of the existing Tappan Zee Bridge were considered.

There is available NYSTA right-of-way to the north of the existing highway on both sides of the Hudson River to accommodate construction of a new crossing. Sufficient

right-of-way is not available on the south side of the existing highway at the Rockland landing. A southern alignment would require cutting into the hill in Rockland and displacement of approximately 30 properties and potential implications of up to 20 others properties to stabilize the hill.

A north alignment also allows for a straight approach to the Westchester toll plaza. A south alignment would result in a conflict between the new crossing's horizontal curvature and the approach to the toll plaza, which would not meet design and safety standards. Because of the offset in the highway the extent of the works would reach back through Interchange 10 which would need to be reconstructed to provide the curvatures necessary to meet design speeds. On the Westchester the required horizontal curvature would be less than the minimum required for the required design speed and would be unacceptable. In addition, a temporary toll plaza to the south of that existing would be required during construction and would impact properties south of the existing NYSTA right-of-way.

Therefore, a replacement bridge to the north of the existing Tappan Zee Bridge is preferred and is being proposed.

General Configuration

Chapter 1, "Purpose and Need," identified structural, safety, operational, and mobility deficiencies of the existing Tappan Zee Bridge. To address these deficiencies and with consideration of the project's goals and objectives, the following design parameters have been incorporated into the general configuration of the Replacement Bridge Alternative.

Redundancy

Redundancy is a key consideration for the structural integrity and operational flexibility of a replacement bridge.

Structural redundancy (member redundancy, load path redundancy, and hardening and dispersion) would provide the bridge with the design capacity to withstand extreme events such as earthquakes, hurricanes, vessel collision, and fires. It would be achieved through a design that would include vertical and horizontal bridge elements that complement and support each other. In this way, the bridge would maintain its structural redundancy throughout the superstructure even if a single member should fail. Structural redundancy would be accomplished through a new bridge that meets current seismic structural and safety design standards.

Service redundancy would provide the bridge with the ability to maintain traffic flow during routine maintenance and extreme events. As described in Chapter 1, "Purpose and Need," the Tappan Zee Hudson River crossing is a vital link between Rockland and Westchester Counties for 138,000 vehicles per day and is the only interstate crossing for a 48-mile stretch of the Hudson River. A full closure of the bridge would result in major disruption to traffic, long detours, and potentially an hour or more increase in travel time. To that end, the Replacement Bridge Alternative must include provisions to ensure that the crossing is not subject to full closure to the maximum extent feasible.

Twin bridge structures would provide superior service redundancy as compared with a single structure. In the event that an incident or extreme event would require the closure

of one structure, the second structure could remain open to traffic. At the same time, this redundancy would provide for flexibility in bridge inspection and maintenance. With a single structure, NYSTA would need to carefully plan and stage inspection and maintenance activities to retain open lanes across the bridge. As a result, repairs would take longer, cost more, and be more limited in scope than if a temporary closure could be implemented. With two separate structures, NYSTA would have much greater flexibility in planning for the bridge's inspection, long-term maintenance, and future contract work, and therefore would ensure the structural and operational integrity of this vital link over a longer timeframe. This configuration would also provide for safer work zones for inspection, maintenance, and repair crews.

For these reasons, the Replacement Bridge Alternative would include two separate structures across the Hudson River.

Minimum Width

NYSTA would maintain traffic flow across the Hudson River to the maximum extent feasible, even if one of the two structures must be closed. To provide adequate capacity for such short-term traffic operations, each of two road decks would need a minimum width of 87 feet to provide for a minimum of seven temporary highway lanes, shoulders, and an adequate buffer for two-way traffic operations in the event that one structure would be inoperable.

At present, bicycles and pedestrians are prohibited on the Tappan Zee Hudson River crossing, although there are existing multi-use trails near the bridge on both sides of the river. To maximize the public investment in a new crossing, a shared-use (bicycle/pedestrian) path would be provided across one of the spans of the replacement bridge. To meet current design standards for the path and to provide adequate separation from traffic lanes, the Replacement Bridge Alternative must provide a minimum of 12 feet of additional width for the shared-use path.

To meet these requirements, the Replacement Bridge Alternative's structure that includes a shared-use path would be 96 feet wide. The Replacement Bridge Alternative's structure that does not include a shared-use path would be 87 feet wide.

Gap

To provide adequate clearance to inspect and maintain the superstructure and piers of each of the new bridge structures, the New York State Department of Transportation (NYSDOT) prefers a minimum gap of 16-foot between parallel bridge structures.

The gap between the two structures would affect the manner in which potential future transit modes could be provided in the corridor. As described in the Chapter 1, "Purpose and Need," one of the project's objectives is to provide a crossing that "does not preclude future trans-Hudson transit services" in the corridor. The following are options that would not preclude future transit on this corridor:

1) Allow for the incorporation of future transit on the new highway structures without reducing the number of general traffic lanes;

2) Provide for future transit across a third parallel bridge that would be constructed at a later date and that would serve as an exclusive transit right-of-way; or

3) Provide additional structural support within the new highway structures as well as a gap between the new highway structures to allow for future transit modes to operate on a new deck that would span the gap at a later date.

These options are illustrated in **Figure 2-1**.

The implementation of any of these options for future transit modes would require a separate and independent environmental review process when and if a proposal for transit services is foreseeable and financing is available.

Option 1 would allow for exclusive bus lanes within the left shoulders of the replacement bridge, but infrastructure to support the upland connections to these bus lanes would be needed in Rockland and Westchester Counties.

Option 2 could provide for a new exclusive or combined bus or commuter rail bridge across the Hudson River. However, Option 2 would be costly ($2 billion to $3 billion) and would result in work in the Hudson River (i.e., dredging and pile driving) for additional foundations to support piers for the new structure that could be avoided with implementation of either Option 1 or Option 3.

Option 3 would allow for either or both bus and commuter rail service across the Hudson River; however, additional strengthening of the new bridge would be required to support the additional loads from any potential transit service within the gap between the new structures. The additional current cost for strengthening the replacement bridge under Option 3, to allow for any future transit service within the gap between structures, would be approximately $200 to $300 million. Should implementation of transit occur in the future, an additional approximately $500 to $700 million (in 2012 dollars) would be required to implement the future transit infrastructure across the bridge. In total, the cost for transit service within the gap would be $700 million to $1 billion. In comparison, a new, exclusive transit bridge across the river (i.e., Option 2) would cost between $2 billion and $3 billion. In short, Option 3 would save between $1 billion and $2 billion as compared to Option 2.

Consistent with and in furtherance of the project's goal to "maximize the public investment in a new trans-Hudson crossing," planning for additional strengthening and a gap between the two new structures to facilitate Option 3 for transit service is considered prudent at this time. Therefore, a 40-foot gap would be provided between the highway structures at the main span towers. The gap would narrow as it approaches the Rockland County landing, but the transit structure and its connections could be provided at a lower elevation (i.e., below the highway deck) at this location.

It should be noted that any option for future transit service would require an additional funds as well as land for construction of upland transit infrastructure (i.e., right-of-way, stations, parking, and ancillary facilities). A bus rapid transit service along this corridor between Suffern and Port Chester would cost an additional $4 to $5 billion (in 2012 dollars). The additional cost of commuter rail service between Suffern and the Metro-North Hudson Line in Tarrytown would cost approximately $7.5 billion (in 2012 dollars). The combined cost for both commuter rail and bus rapid transit services would be approximately $10.1 billion (in 2012 dollars) (see **Appendix A** for further information regarding the cost of transit options).

1) Provide the infrastructure for future transit on the new highway bridges without reducing the number of general traffic lanes;

2) Provide the infrastructure for future transit across a third parallel bridge that would be constructed at a later date and would serve as an exclusive right-of-way;

3) Span the gap between the two new highway bridge structures at a later date to provide the infrastructure for future transit modes.

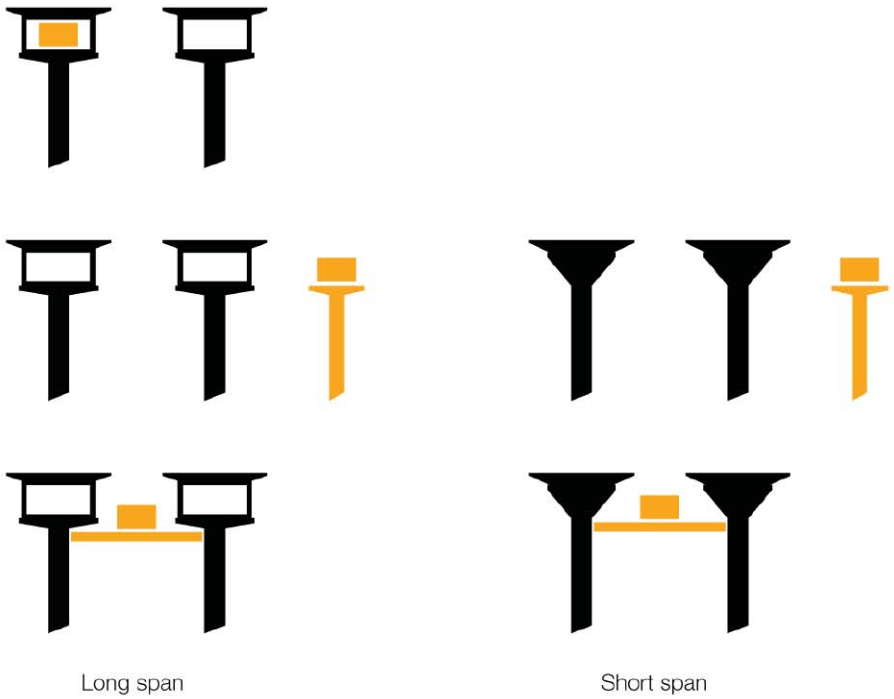

Figure 2-1
Options That Would Not Preclude Transit

Summary

The design parameters described above identify the location and general characteristics of the Replacement Bridge Alternative. In summary, the Replacement Bridge Alternative would:

- Be located to the north of the existing Tappan Zee Bridge;
- Include two separate spans to provide service redundancy;
- Have a 96-foot-wide deck for the superstructure that includes a shared-use path;
- Have a 87-foot-wide deck for the superstructure that does not include a shared-use path;
- Have a gap between the two bridge structures; and
- Provide additional strengthening as not to preclude transit.

These design parameters have been incorporated into the following description of the Replacement Bridge Alternative. **Appendix A** provides the design criteria for the Replacement Bridge Alternative.

2-2-2-2 DESCRIPTION OF THE REPLACEMENT BRIDGE ALTERNATIVE

Pursuant to New York State legislation passed in December 2011, NYSDOT and NYSTA anticipate that this project would be advanced under a Design-Build contract. With this approach, NYSDOT and NYSTA would select a single Design-Builder to both complete the design and construct the Replacement Bridge Alternative. The selection of the Design-Builder would be accomplished through a two-step approach—first a Request for Qualifications (RFQ) would be used to develop a short-list of qualified firms, followed by a Request for Proposals (RFP). The RFP would specify basic design and planning guidelines, environmental performance commitments and any additional mitigation required based on the analysis presented in this Draft EIS (DEIS).

As specified in 23 CFR § 636.109, a Design-Build process must be coordinated with review under NEPA. The design options presented in this DEIS provide an envelope for the possible final design of the Replacement Bridge Alternative (see **Figure 2-2**). The options presented in the EIS represent the extent of work that is expected to be reflected in the proposals that are received out of the design build process, thereby enabling the team to identify and analyze the potential impacts and mitigation measures necessary relevant to the resources in the project area. While preliminary designs are identified in this DEIS, the Design-Builder has the option to propose alternative design concepts that are consistent with the Final EIS (FEIS), Record of Decision and criteria of the RFP Contract Documents. The Design-Build process enables the Design-Builder to use innovation to further avoid, minimize and mitigate environmental effects and promote efficiency in cost and construction duration.

The design options presented in this DEIS provide an envelope for the possible final design of the Replacement Bridge Alternative. The options presented in the EIS represent the extent of work that is expected to be reflected in the proposals that are received out of the design build process, thereby enabling the team to identify and analyze the potential impacts and mitigation measures necessary relevant to the resources in the project area. While preliminary designs are identified in this DEIS, the Design-Builder has the option to propose alternative design concepts that are

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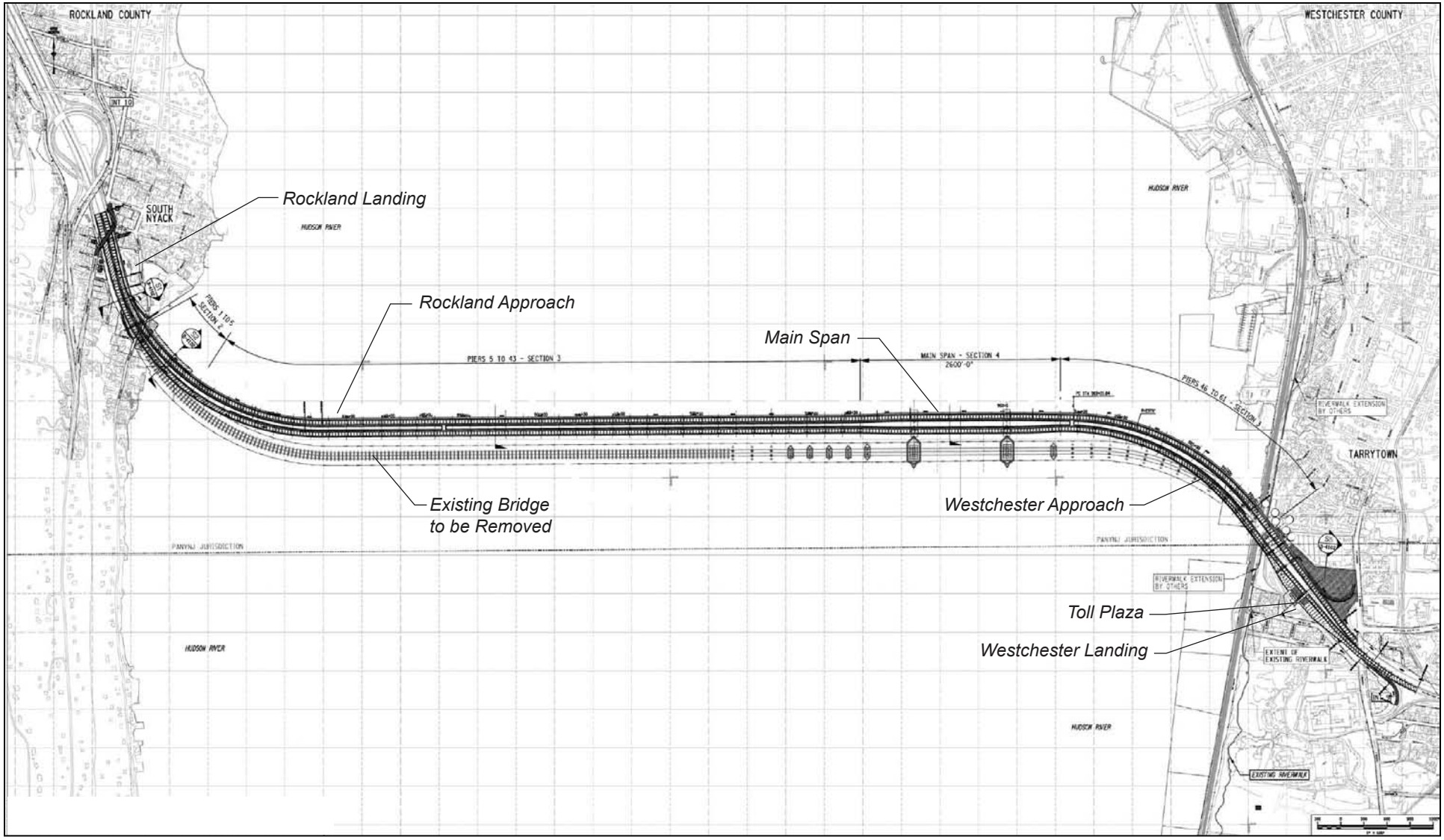

TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Figure 2-2
Replacement Bridge Alternative

consistent with the FEIS, Record of Decision, and criteria of the RFP Contract Documents.

Landings

In Rockland and Westchester Counties, Interstate 87/287 would be shifted slightly northward to meet the new abutments of the Replacement Bridge Alternative.

Rockland County

Figure 2-3 shows a plan for the Rockland Landing. As will be described below, there are two options for the Replacement Bridge Alternative's approach spans (Short Span and Long Span Options), which would result in somewhat different configurations of the Rockland County landing. Where notable differences between the Short Span and Long Span Options would occur at the landings, they are described below. **Figure 2-3** reflects the Rockland County landing for the Short Span Option.

Approximately 150 feet west of the South Broadway Bridge, the roadway would begin to shift northward from its existing centerline. The highway would continue to operate with 10 lanes: 8 general traffic lanes (4 eastbound and 4 westbound); 1 eastbound acceleration lane from Interchange 10 (Route 9W); and 1 westbound deceleration lane to Interchange 10 (Route 9W)[1]. Left and right shoulders would be provided in both directions. The eastbound acceleration lane and the westbound deceleration lane would end approximately 300 feet west of River Road, and as it approaches the bridge, the roadway would consist of 8 general traffic lanes with left and right shoulders.

The new bridge abutment would be located approximately 75 feet west of River Road[2]. At the point where it meets the approach spans of the new bridge, the northern boundary of the highway would be approximately 100 feet north of its existing boundary. The highway would exit Rockland County at an elevation of between 16 and 23 feet above River Road.

Reconfiguration of the Rockland Landing would require reconstruction of the South Broadway Bridge slightly east of its existing location. The reconfigured highway would also require that new eastbound and westbound maintenance ramps be constructed from Interstate 87/287 to River Road.[1] For the Long Span Option, the eastbound maintenance ramp would extend about 100 feet further inland than in the Short Span Option. The longer maintenance ramp is required to meet the higher elevation of the highway in the Long Span Option.

Westchester County

Figure 2-4 shows the Westchester County landing. The new bridge would enter Westchester County with 60 feet of clearance above the Metro-North Railroad (MNR) Hudson line. The new bridge structures would straddle the centerline of the existing bridge, and the new alignment would extend approximately 100 feet to the north and

[1] Interstate 87 is signed as a north-south highway, and therefore, traffic is generally described as northbound and southbound. However, the highway has an east-west orientation through the Tappan Zee Hudson River crossing.

[2] The measurement is from the middle of the abutment to River Road. River Road curves inward from the shoreline as it travels north. Thus, the north limit of the abutment is much closer to River Road than the south end of the abutment.

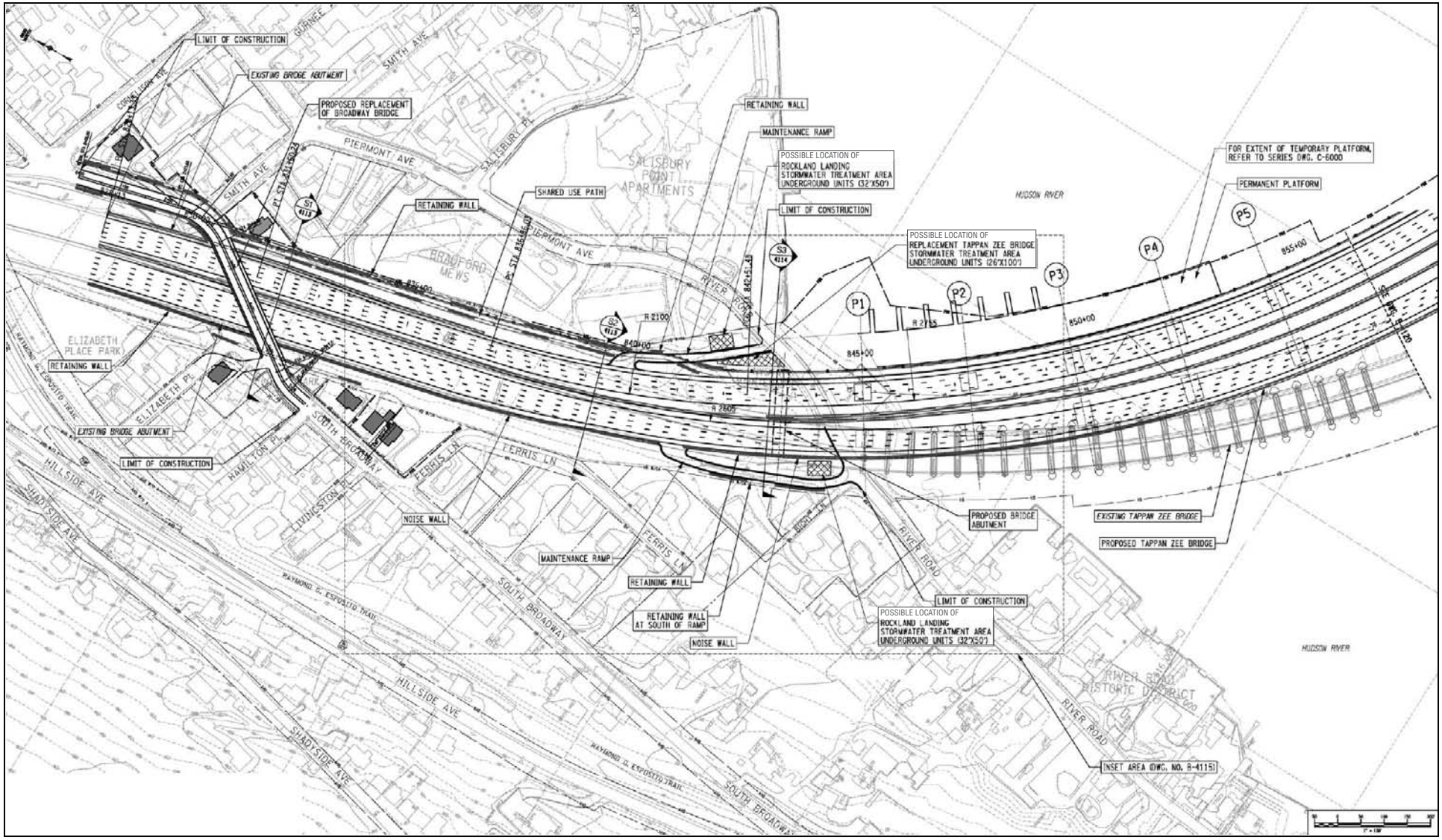

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Figure 2-3
Rockland Landing

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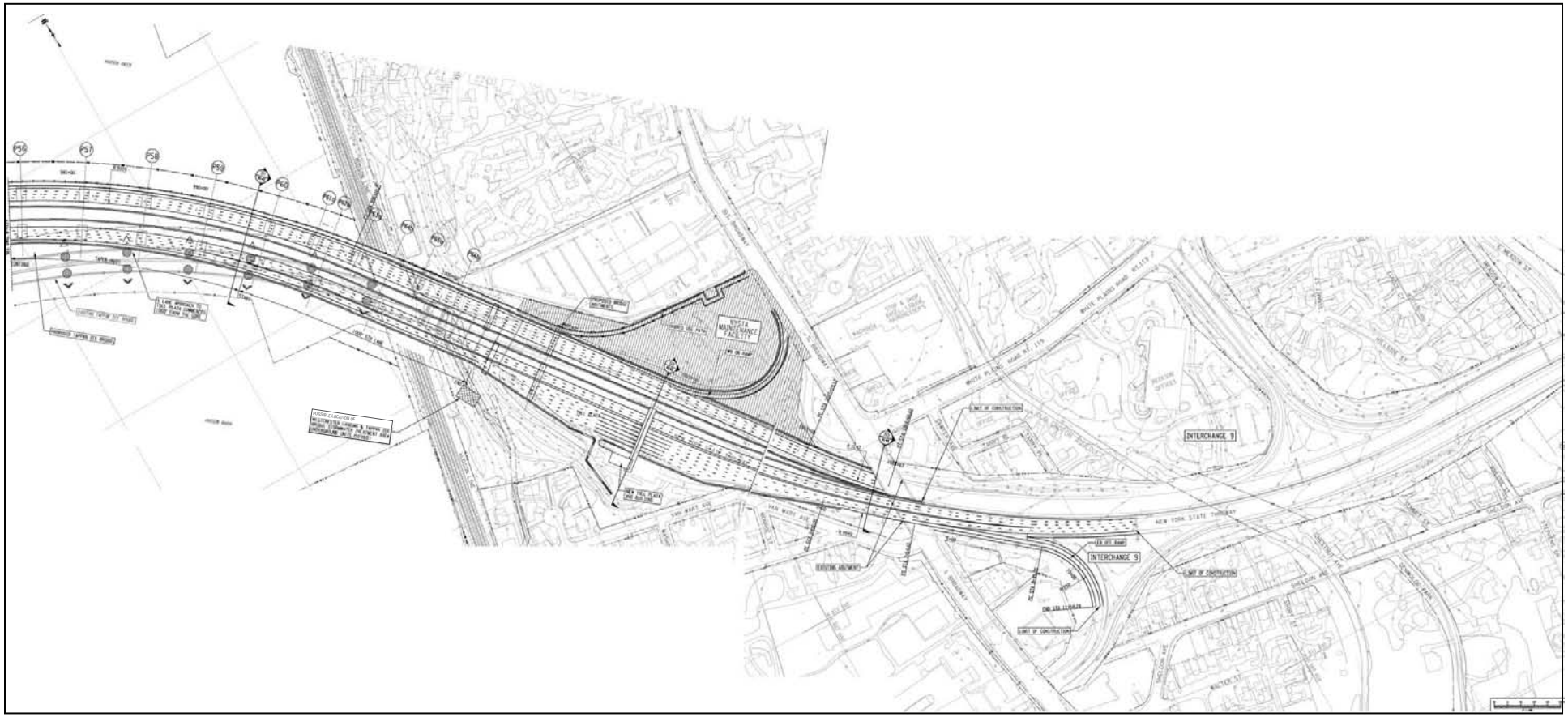

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Figure 2-4
Westchester Landing

100 feet to the south of the existing bridge. The new bridge abutments would be located approximately 200 feet inland of the Hudson line.

In the eastbound direction, the modified Westchester landing would extend from approximately 1,000 feet west of the Westchester County bridge abutments to approximately 400 feet east of the Broadway Bridge (Route 9). Approximately 1,000 feet west of the Westchester County abutments, eastbound Interstate 87/287 would widen from four to five lanes. The three inner lanes would serve as highway-speed E-ZPass lanes through the Westchester County toll plaza. The right two lanes would serve cash/E-ZPass customers, and these two lanes would widen to seven cash/E-ZPass lanes through the toll plaza. In total, the highway would carry 10 lanes through the Westchester County toll plaza.

East of the toll plaza, the highway would narrow to six eastbound lanes, five general traffic lanes and one deceleration lane to Interchange 9 (Route 9). The highway-speed E-ZPass lanes would remain separated from the cash/E-ZPass to a point approximately 200 feet east of the Broadway Bridge (Route 9). Therefore, motorists that would exit at Interchange 9 (Route 9) would use the cash/E-ZPass lanes. Between the Broadway Bridge (Route 9) and a point approximately 400 feet to its east, the highway would narrow from five to four lanes and would resume its existing alignment.

In the westbound direction, the modified Westchester landing would extend from the Broadway Bridge (Route 9) to about 100 feet west of the shoreline. The westbound highway would consist of four lanes as it would pass beneath the Broadway Bridge (Route 9). West of the Broadway Bridge, the westbound Interchange 9 (Route 9) on-ramp would join the highway, and an acceleration lane would be provided for approximately 750 feet. The acceleration lane would end approximately 100 west of the shoreline, and the highway would continue as four westbound lanes as it cross the Hudson River.

The modified Westchester landing would include 12-foot traffic lanes, a left shoulder, and a right shoulder in both the eastbound and westbound directions. There would be additional median space in the eastbound direction between the highway-speed E-ZPass lanes and the cash/E-ZPass lanes.

The modifications to the Westchester landing would require reconstruction of the toll plaza, the westbound on-ramp from Interchange 9 (Route 9), and the existing New York State Thruway maintenance facility at Interchange 9 (Route 9).

Approach Spans

There are two options for the approach spans that provide a framework for the evaluation of impacts in the DEIS. The approach spans link the landings with the main spans over the navigable channel. These options—Short Span and Long Span—differ in terms of the type of structure as well as the number of and distance between bridge piers. Both approach span options would include eight travel lanes (four eastbound and four westbound) with inside and outside shoulders on both structures. The north structure of each approach span option would also include a shared-use path.

Short Span Option

The Short Span Option would consist of two parallel bridge structures that would have a typical highway design with a road deck supported by girders and piers (see **Figure 2-5**). The parallel structures would be separated by a gap that would vary in dimension across the approach spans. The following describes the general characteristics of the Rockland County and Westchester County approach spans for the Short Span Option:

- The Rockland County approach spans would extend 4,125 feet between the abutments and the main spans, and each would consist of 43 sections. The average distance between the piers of Rockland County approach spans would be 230 feet[1]. There would be no gap between the parallel highway decks at the abutments. The gap between the highway decks would widen to 70 feet as the main spans.
- The Westchester County approach spans would extend 1,800 feet between the main spans and the abutments, and each would consist of 16 sections with an average distance between the piers of approximately 230 feet[1]. The gap between the parallel highway decks would range from 70 feet at the main spans to 40 feet at abutments.

As the approach spans meet the main span, the road deck would be at an elevation of 175 feet above the Hudson River's mean high-tide level.

Long Span Option

The Long Span Option would also consist of two parallel bridges structures. Each structure would have a truss supported by piers (see **Figure 2-5**). The road deck would be located on top of the trusses. The parallel structures would be separated by a gap that would vary in dimension across the approach spans. The following describes the general characteristics of the Rockland County and Westchester County approach spans for the Long Span Option:

- The Rockland County approach spans would extend 4,125 feet between the abutments and the main spans, and each would consist of 23 sections. The average distance between the piers of Rockland County approach spans would be about 430 feet.[1] There would be no gap between the parallel highway decks at the abutments. The gap between the highway decks would widen to 70 feet as the main spans.
- The Westchester County approach spans would extend 1,800 feet between the main spans and the abutments, and each would consist of 10 sections with an average distance between the piers of 430 feet[1]. The gap between the parallel highway decks would range from 70 feet at the main spans to 40 feet at abutments.

As the approach spans meet the main span, the road deck would be at an elevation of 195 feet above the Hudson River's mean high-tide level.

[1] This dimension is provided for illustrative purposes only. It should be noted that the piers may be located closer together near the abutments and shorelines but may be farther apart over water.

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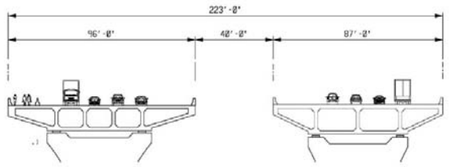
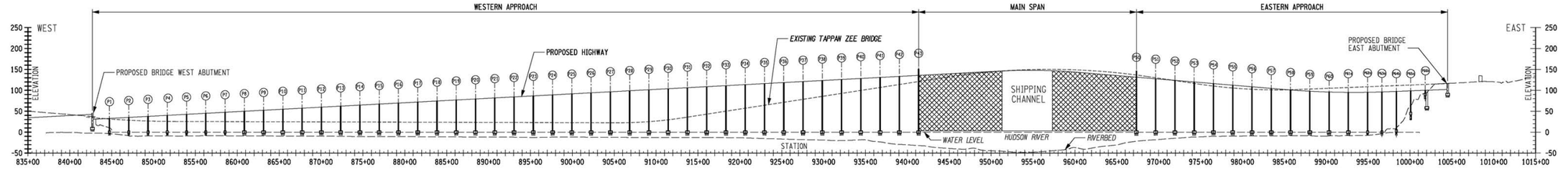
Short Span Option

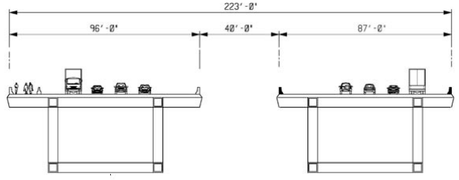


Short Span Cross-Section

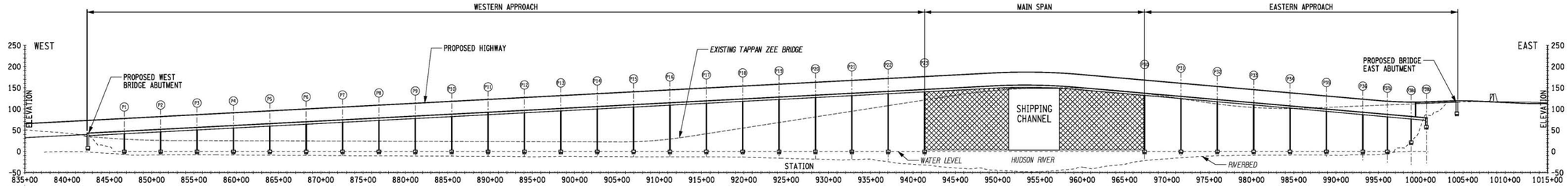


Short Span Plan View

Long Span Option



Long Span Cross-Section



Long Span Plan View

Figure 2-5
Approach Spans Options

Main Spans

The main spans, i.e., the portions of the bridge that cross the navigable channel of the Hudson River, would provide adequate vertical and horizontal clearance for marine transport.

- The horizontal clearance affects the width of the Hudson River's navigable channel for water craft and must be clear of bridge piers and other bridge infrastructure. The width of the Federally-mapped navigation channel is 600 feet through the Tappan Zee crossing. However, a minimum clearance of 1,042 feet is preferred to provide a safety buffer for through the channel.
- The vertical clearance affects the height of the bridge as well as the hull-to-mast height of marine vessels that navigate under the bridge. The Replacement Bridge Alternative would provide for a minimum vertical clearance of 139 at mean high water to maintain the existing maximum hull-to-mast height of vessels that travel beneath the Tappan Zee crossing.

This EIS considers two options for the bridge's main spans over the navigable channel—Cable-stayed and Arch (see **Figure 2-6**)[1]. These main span options represent potential designs for spanning the main span navigational channel. However, the Design Builder may consider design options that are within the parameters of these designs. Both options would result in a horizontal clearance of at least 1,042 feet and a vertical clearance of at least 139 feet over the navigable channel at mean high water. Both main span options would include eight travel lanes (four eastbound and four westbound) with inside and outside shoulders on both structures. The north structure of each main span option would also include a shared-use path.

Smaller vessels (i.e., smaller commercial craft, sailboats, power boats, and kayaks) could use the backspan channels beneath the approach spans closest to the navigable channel. With the Long Span Option, the backspan channels would provide a horizontal clearance of 380 feet and a vertical clearance of 123 feet. With the Short Span Option, the backspan channels would provide a horizontal clearance of 180 feet and a vertical clearance of 123 feet.

Cable-stayed Option

The Cable-stayed Span Option would result in two spans each supported by two towers and cables connected to towers. The four towers (two towers per span) would rise about 400 feet above the road deck and would be set approximately 300 feet outward from the limits of the navigable channel. Cables would extend from each of the towers to various points on the road deck, in effect holding it up from above. The cables would support the entirety of the main spans between the approach structures. The cables would extend both eastward and westward from each tower tying into the road deck as much as 300 feet away from the towers. The cables would be anchored to the ground

[1] Figure 2-5 shows the Oresund Bridge (a single Cable-stayed bridge across the Oresund Straight in Denmark and Sweden) and the Lake Champlain Bridge (a single Arch bridge across Lake Champlain in New York and Vermont). The Cable-stayed and Arch Options for the Replacement Bridge Alternative would consist of two separate structures across the Hudson River's navigable channel.

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Example of Cable-Stayed Option (Oresund Bridge, Denmark/Sweden)

Example of Arch Option (Lake Champlain Bridge, New York/Vermont)

Figure 2-6

Main Spans Options

through the tower foundations. Each section of the road deck would be connected to the towers by multiple cables.

Arch Option

This option would consist of two structures each supported by steel arches. Each structure would have two steel arches that would extend eastward and westward from the main spans' piers. The main spans' piers would be located about 500 feet outward from the limits of the navigable channel. The supports would curve upward and support the road deck from below. On either side of the navigable channel, the curved supports would extend above the road deck and meet in the middle forming the arch. The top of the arch would be about 200 to 300 feet above the road deck. Suspender cables would extend vertically from the arch structure to support the road deck.

Operations

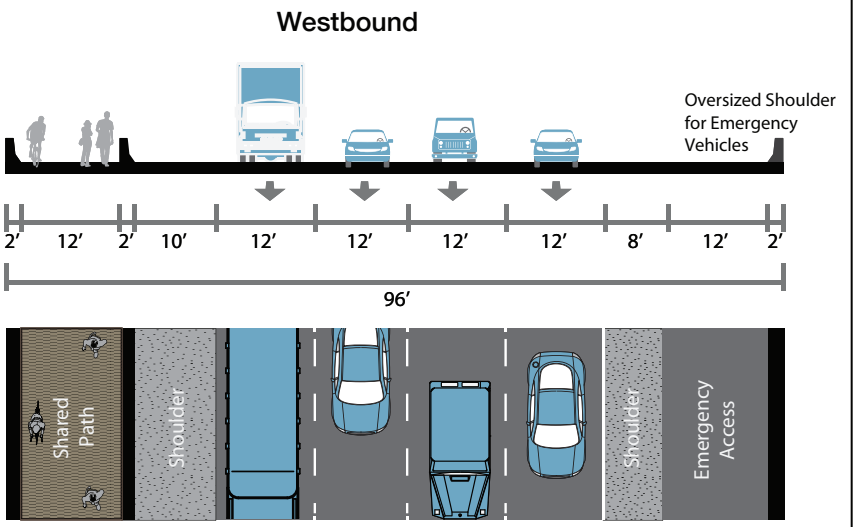
Figure 2-7 is a cross-section of the proposed road decks of the Replacement Bridge Alternative. Each deck would include four 12-foot traffic lanes, a 10-foot right shoulder, a 20-foot left shoulder and emergency access, and 2-foot barriers along the decks' edges. The left and right shoulders would serve as disabled vehicle lanes. The left shoulder would also provide emergency vehicle access. The extra-wide, left shoulders would be provided only on the bridge itself and would narrow at the abutments to the Westchester or Rockland County landings.

A shared-use (bicycle and pedestrian) path would be provided along the northern edge of the Replacement Bridge Alternative's north superstructure. The path would serve both eastbound and westbound cyclists and pedestrians. The path would be 12 feet wide with a two-foot buffer between the path and the traffic lanes (14 feet total). In Rockland County, the shared-use path would connect to Esposito Trail via the South Broadway Bridge in South Nyack, following the westbound lanes of Interstate 87/287 from the abutment to the South Broadway Bridge. In Westchester County, the shared-use path would be connected to Route 9 (South Broadway), following the westbound lanes of Interstate 87/287 from the abutment to the westbound on-ramp at Interchange 9. It would meet Route 9 at the bottom of the westbound on-ramp.

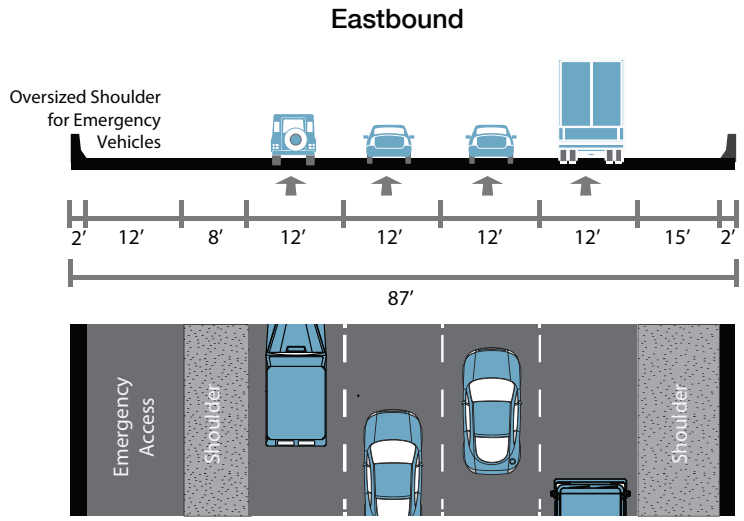
Ancillary Facilities

The NYSTA maintenance facility and the New York State Police barracks on the north side of Interstate 87/287 at Interchange 9 (Route 9) would be relocated during construction to use this space for a contractor staging area. Upon completion of the Replacement Bridge Alternative, a new maintenance facility and New York State Police barracks would be constructed at approximately the same location within the existing NYSTA right-of-way.

The Replacement Bridge Alternative would relocate the bridge maintenance ramps in Rockland County to meet the new alignment of the Replacement Bridge Alternative. These ramps would begin at River Road and rise to the grade of Interstate 87/287 east of the South Broadway Bridge in South Nyack. Because the Long Span Option would be at a higher elevation than the Short Span Option, its maintenance ramps would extend further west of River Road.



North Structure



South Structure

Figure 2-7

Replacement Bridge Alternative: Roadway Configuration

Permanent stormwater controls will be designed and constructed in accordance with the New York State Department of Environmental Conservation (NYSDEC) *Stormwater Design Manual*, NYSDOT *Highway Design Manual*, NYSDOT *The Environmental Manual*, and NYSTA engineering guidance. The permanent controls would be developed as part of the Stormwater Pollution Prevention Plan for the Replacement Bridge Alternative. Locations for the facilities would be determined as the final design for the Replacement Bridge Alternative is developed. Chapter 15, "Water Resources," includes a discussion of the potential stormwater systems and locations for permanent controls under consideration for the project.

Security

The Replacement Bridge would include design features and systems to protect the bridge from man-made events. Its design would incorporate offsets and clearances to limit access to key structure features. Surveillance and detection systems would be installed on the bridge, and a central command center would be located at NYSTA's maintenance facility to provide 24-hour monitoring of the bridge.

Property Acquisition

Construction of the Replacement Bridge Alternative would require both temporary (construction-period) and permanent property acquisitions and easements. The properties and purpose of the required acquisitions or easements are described in Chapter 6, "Land Acquisition, Displacement, and Relocation."

Construction Duration and Cost

Depending on the outcome of the Design Build process, construction of the Replacement Bridge Alternative is estimated to take between 3 and 5½ years. For purposes of analysis in this EIS, the duration of construction is assumed to be 4½- to 5½-year period. The various stages of construction are described in more detail Chapter 18, "Construction Impacts."

Depending on the outcome of the Design Build process, the construction cost is expected to range between $3.5 and $5 billion. The Design Build project delivery method would introduce innovation and may reduce construction time, cost and environmental impacts. For purposes of analysis in this EIS, the cost of the Replacement Bridge Alternative is assumed to be $4.64 billion (in 2012 dollars).

To assist in the preliminary engineering investigations, cost estimates, and development of potential environmental performance commitments during construction, NYSDOT and NYSTA will undertake a Pile Installation and Demonstration Program (PIDP) and geotechnical borings. NYSDOT and NYSTA have secured the necessary permits and approvals for the PIDP and geotechnical borings and work is expected to begin in the winter or early spring of 2012. As part of that program, NYSDOT and NYSTA will test the structural performance of a number of piles of varying diameters and monitor the efficacy of various noise attenuation measures. Any relevant data from these test programs will be incorporated into the Final Environmental Impact Statement for the Tappan Zee Hudson River Crossing Project.

2-3 ALTERNATIVES CONSIDERED AND ELIMINATED

2-3-1 REHABILITATION ALTERNATIVE

The *Alternatives Analysis for Rehabilitation and Replacement of the Tappan Zee Bridge Report* (March 2009) identified four rehabilitation options to enhance the structural integrity and operation of the existing Tappan Zee Bridge. Four rehabilitation options were considered:

1) Replacement Causeway and Rehabilitated Main Span;

2) Replacement Causeway and Widened Main Span;

3) Replacement Causeway, Rehabilitated Main Span, and Single Level Supplemental Bridge; and

4) Replacement Causeway, Rehabilitated Main Span, and Dual Level Supplemental Bridge.

The Alternatives Analysis for Rehabilitation and Replacement of the Tappan Zee Bridge Report (March 2009) was part of the Scoping Summary Report for the Tappan Zee Bridge/I-287 Corridor Project. It was widely distributed and became the subject of intensive public and agency review and comment. The findings of this report were reviewed in the context of the goals and objectives for the current project (see Chapter 1, "Purpose and Need"). This review concluded that the Rehabilitation Alternative is not considered prudent for the reasons described below.

The Rehabilitation Alternative would fail to meet the project goal of "ensuring the long-term vitality of this Hudson River crossing" for the following reasons:

- The Rehabilitation Alternative would be designed to comply with seismic criteria, which are based on strength. However, the Rehabilitation Alternative would lack ductility, which allows bridge members to endure changes in shape without breaking. The structural elements of the existing bridge that would not be replaced would not behave in a ductile manner in extreme seismic events. A replacement bridge would be designed to have ductile characteristics that would provide reserve capacity for even those extreme events that are in excess of code requirements.
- Therefore, the Rehabilitation Alternative would be vulnerable during an extremely long or intensive earthquake.
- The Rehabilitation Alternative options that have a single structure would lack service redundancy. If the bridge were heavily damaged by a natural or man-made event, it could be closed for repairs. If the bridge were closed, there would be no alternative routing for traffic at this location along the Hudson River.

The Rehabilitation Alternative would fail to meet the project goal of "improving transportation operations and safety on the crossing" for the following reasons:

- The Rehabilitation Alternative would lack alternative load path redundancy (i.e., the ability of bridge members to be supported by multiple means such as a deck supported both by a deck truss and by a bridge cable). As such, the Rehabilitation Alternative would not adequately address security or operational concerns since a fire, vessel allision, or other man-made event could more easily cause severe

damage to the structure and require its closure. Its closure would severely affect traffic operations, freight movement, and economic conditions across the region.

The Rehabilitation Alternative would fail to meet the project goal of "maximizing the public investment in a new Hudson River crossing" for the following reasons:

- The life span of bridge components retained in the Rehabilitation Alternative would be shorter than those of a new bridge. To maximize the public investment in a new Tappan Zee Hudson River crossing, the desired life span of the new structure is at least 100 years before major maintenance or rehabilitation is needed. However, components of the Rehabilitation Alternative would need major maintenance or replacement in as few as 50 years.
- The construction duration for the Rehabilitation Alternative would be one year longer than for a replacement bridge.
- There is much uncertainty associated with rehabilitation projects in that the extent of damage to certain bridge components may not be fully known until they are actually replaced. This uncertainty would have the potential to substantially increase the construction cost and duration of the Rehabilitation Alternative.
- The Rehabilitation Alternative would involve both upland and in-water construction activities and would be expected to result in many of the same environmental impacts of a replacement bridge.
- The Rehabilitation Alternative with two bridges would cost $2.5 to $2.7 billion more than the Replacement Bridge Alternative. It would also result in more in-water work and would have the same deficiencies described above in terms of life cycle and vulnerabilities.

Given these considerations, the Rehabilitation Alternative would not meet the project's purpose and need and was eliminated from further consideration in this EIS.

2-3-2 TUNNEL ALTERNATIVE

A newly bored or immersed tunnel between Rockland and Westchester Counties was previously studied (*Alternatives Analysis for Hudson River Highway Crossing*, July 2007). The findings of the previous study were reviewed in the context of the goals and objectives for the current project (see Chapter 1, "Purpose and Need"). This review concluded that the Tunnel Alternative is not considered prudent for the reasons described below.

The Tunnel Alternative would consist of five separate tubes with two lanes each or an immersed tunnel with two chambers. To provide for a maximum desired highway grade and to accommodate the topography of the affected area, the bored tunnel would stretch seven miles from Interchange 12 (NY 303/Palisades Center Drive) in Rockland County to east of Interchange 10 (Route 9) in Westchester County. In contrast, the immersed tunnel would be shallower and would come to surface closer to the shoreline. However, it would require extensive shoreline and in-water work.

Compared to the Replacement Bridge Alternative, the Tunnel Alternative would take longer to construct and would entail a higher cost ($8 billion as compared with $4.6 billion). The Tunnel Alternative would require acquisition of substantial rights-of-way for

its approach structures, portals, and ventilation structures. The tunnel's construction would substantially impact the Talleyrand Swamp and the Rockland and Westchester County shoreline of the Hudson River where its ventilation structures would be sited.

The Tunnel Alternative would offer less operational flexibility than a bridge. Traffic would be separated into two or five tubes, resulting in less flexibility to maintain traffic flow through the tunnel and difficult traffic control at the portals. The tunnel would have a 3 percent grade over a long distance, making speed control difficult for trucks. The separation of highway operations into separated tubes or chambers over a long distance would make emergency response more challenging than for a bridge. Furthermore, a bored tunnel would result in the removal of Interchanges 9 (Route 9), 10 (Route 9W), and 11 (Route 9W), and connectivity to Interstate 87 and 287 from local roads in eastern Rockland County would be lost.

While the Tunnel Alternative would meet some of the goals and objectives of the project, it would fail to meet the goal of "maximizing the public investment in a new Hudson River crossing" for the following reasons:

- The Tunnel Alternative would require higher construction costs and a longer duration of construction activities than a replacement bridge. As such, this alternative would not be cost-effective or yield maximum benefit in relation to its financial investment.
- The Tunnel Alternative would result in greater disruption to surrounding land uses than a replacement bridge, as extensive construction would be required outside of the existing New York State Thruway right-of-way, thereby requiring greater land acquisition.
- The Tunnel Alternative would not provide an opportunity to implement a shared-use pathway for cyclists and pedestrians.

Given these considerations, the Tunnel Alternative would not meet the project's goal to maximize the public investment in this Hudson River crossing. Thus, the Tunnel Alternative was eliminated from further consideration in this EIS.

2-3-3 SINGLE STRUCTURE ALTERNATIVE

Comments received during the scoping process for the Tappan Zee Bridge Hudson River Crossing Project called for examination of a Single Structural Alternative. The Single Span Alternative would involve the replacement of the existing Tappan Zee Bridge with a new eight-lane crossing on a single structure, whereas the Replacement Bridge Alternative would include two structures.

As noted above, this critical crossing requires service redundancy. In the event that a man-made or natural event would severely damage the bridge, the entire crossing would be subject to closure. Also, NYSTA would be more limited in its ability to maintain a single structure since it must remain open to traffic during repairs.

The constructability of the Single Structure Alternative is more difficult than for the Replacement Bridge Alternative. The Single Span Alternative would be a wide structure, which would likely be need to be constructed in multiple phases to maintain a proper transition between the bridge and landings without impeding traffic flow. Furthermore, construction of the second or third phase of a single structure would be

difficult if traffic were operating across the first phase, and it is likely that the Single Span Alternative would require that the existing bridge remain in use for a longer period. There would also be more property needed at the landings, and there would be piers in the river during construction.

Given these considerations, the Single Structure Alternative would not meet the project's goals to improve transportation operations and safety on the crossing and to maximize the public investment in this Hudson River crossing. Thus, the Single Span Alternative was eliminated from further consideration in this EIS.