PORTAL BRIDGE
CAPACITY ENHANCEMENT

Environmental Impact Statement
Alternatives Screening Report

July 2007

U.S. Department of Transportation
Federal Railroad Administration

NJ TRANSIT
The Way To Go.

PORTAL BRIDGE CAPACITY ENHANCEMENT PROJECT ALTERNATIVES SCREENING REPORT

A. INTRODUCTION

The National Railroad Passenger Corporation (Amtrak) and the New Jersey Transit Corporation (NJ TRANSIT) are proposing to enhance the capacity and improve the operation of the Portal Bridge, a rail crossing over the Hackensack River. The existing Portal Bridge is a two-track, moveable swing-span rail bridge completed in 1910 between the City of Kearny and the City of Secaucus in Hudson County, New Jersey. The Portal Bridge is located at Milepost 6.1 along the heavily used “High Line” portion of Amtrak’s Northeast Corridor, which connects Newark, NJ and New York, NY. The aging Portal Bridge is a bottleneck along the Northeast Corridor that conflicts with marine traffic and impedes efficient and reliable passenger rail service. The Portal Bridge Capacity Enhancement Project will examine alternatives to improving existing operations and ensure passenger safety.

The National Environmental Policy Act of 1969 (NEPA) requires federal agencies to consider the environmental effects of their proposed actions. As such, an Environmental Impact Statement (EIS) will be prepared for the Portal Bridge Capacity Enhancement Project. The Federal Railroad Administration (FRA), which oversees Amtrak’s capital programs, is the lead federal agency for the environmental review. The Federal Transit Administration (FTA), United States Coast Guard (USCG) and United States Environmental Protection Agency (USEPA) are cooperating agencies for the environmental review. They will contribute information for which they have special expertise and ensure the EIS is prepared in compliance with their environmental regulations. Other cooperating agencies may be identified during the EIS process.

The first steps in the preparation of an EIS are the issuance of a Notice of Intent and initiation of the public scoping process. A Notice of Intent was issued in the Federal Register on December 12, 2006. The Scoping Document was also issued in December 2006, followed by agency and public scoping meetings to solicit comments. The comment period for the Scoping Document officially closed on January 31, 2007.

As part of the scoping process, potential project alternatives have been developed and evaluated. This report has been prepared to describe the development of the alternatives and evaluation performed to date. The project purpose and need and the project goals are described below. These are followed by a description of the sequential screening process used for the alternatives evaluation. The first step includes identification of all feasible project alternatives in conjunction with a fatal flaw screening that was used to eliminate alternatives that were not feasible. The second step includes a screening of all the feasible project alternatives based on further operational, engineering, and environmental considerations.

This report concludes with a list of project alternatives recommended for further consideration and detailed analysis in the Draft EIS. It should be noted, however, that as the EIS process continues and the analysis evolves, alternatives may be revised, discarded, or added.

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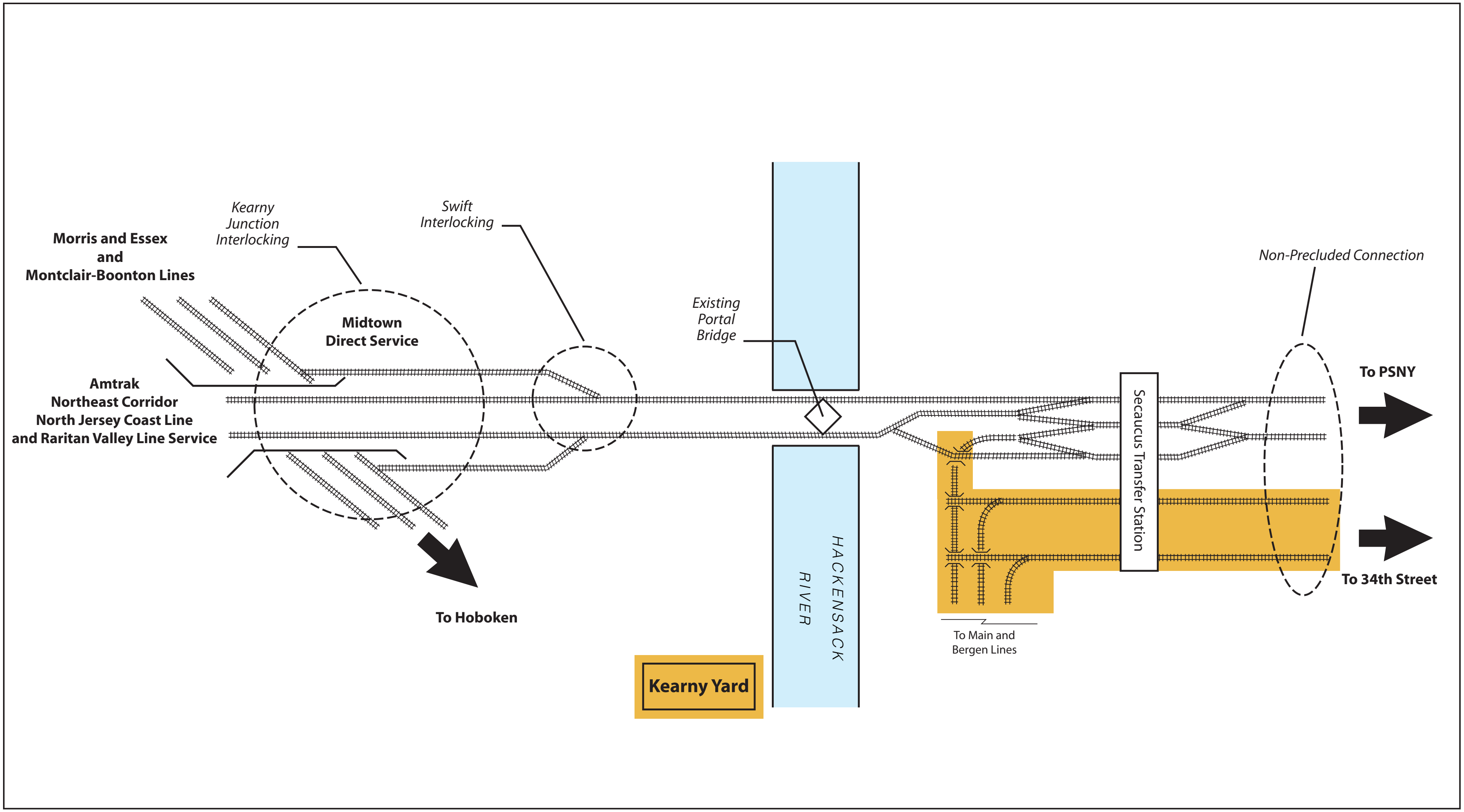

ARC Improvements

NJ TRANSIT
PORTAL BRIDGE CAPACITY
ENHANCEMENT PROJECT

Portal Bridge Boundary Conditions
Figure 1

B. ACCESS TO THE REGION'S CORE AND THE 2030 OPERATING PLAN

The alternatives evaluation process for the Portal Bridge project must consider the Access to the Region's Core (ARC) Project as well as NJ TRANSIT and Amtrak's 2030 Operating Plan (collectively referred to as "the 2030 Operating Plan"). These two initiatives, being undertaken in tandem with the Portal Bridge project, formulate some of the defining characteristics of the planned infrastructure with which the new Hackensack River crossing must be compatible.

ARC includes the construction of a new passenger rail tunnel underneath the Hudson River, an expansion of the existing New York's Pennsylvania Station (PSNY) beneath 34th Street in Midtown Manhattan, a rail storage yard in Kearny, and other track connections. The Portal Bridge project must provide connectivity to the planned ARC project elements—included in this connectivity is the construction of lead tracks between the proposed Kearny Yard and the proposed ARC tracks leading to the New York Penn Station Expansion (NYPSE). On the eastern side of the Hackensack River, the Portal Bridge project elements must connect with three existing tracks that extend westward from the existing Secaucus Transfer Station (two of which continue to the PSNY), and two tracks at ARC's planned southern "island"-type platform at Secaucus Transfer Station (see Figure 1). The two southern tracks will continue to the planned NYPSE in New York City. There is no planned connection east of the Hackensack River between the tracks servicing NYPSE and PSNY; however, ARC's current design does include provisions for a set of switches in the vicinity of existing Allied Interlocking (east of Secaucus Transfer Station) that could be constructed in the future and would allow trains on the southern tracks to access PSNY via the North River Tunnels. For issues related to operations, such "non-precluded" future crossovers would be for emergencies and potentially to support maintenance activities. With the opening of NYPSE in New York as part of the ARC project, the 2030 Operating Plan assumes the following terminal split between the four stations in New York City and New Jersey (see Table 1).

In the 2030 Operating Plan, NJ TRANSIT will continue to operate all of its Northeast Corridor trains into PSNY. Selected Raritan Valley Line trains will be extended to New York City from their current terminus at Newark Penn Station. As currently planned, NJ TRANSIT's Midtown Direct service and Raritan Valley Line service will operate to the planned NYPSE, while Northeast Corridor and most North Jersey Coast Line service will continue to operate to PSNY. The 2030 Operating Plan includes provisions for growth in the number of Amtrak trains on the Northeast Corridor, which will continue to operate all trains to, from, and via PSNY. With the current design for the ARC project, the Portal Bridge project now includes the construction of a connection from the west end of the Kearny Yard to the tracks leading to NYPSE, allowing for non-revenue movements in the early afternoon.

Table 1
2030 Operating Plan Terminal Station

Line	PSNY	NYPSE	Hoboken Station	Newark Penn Station
Amtrak	X			
NJT Northeast Corridor	X			
Morris & Essex and Montclair-Boonton Lines (including Midtown Direct service)		X	X	
Raritan Valley		X		X
North Jersey Coast Line	X	X	X	X

C. PURPOSE AND NEED

The current Portal Bridge opened in 1910 and was part of a larger project that extended rail service to Penn Station New York from New Jersey. The Portal Bridge is part of the Northeast Corridor and a critical infrastructure element for both Amtrak and NJ TRANSIT, enabling movement between east-of-Hudson and west-of-Hudson destinations. The existing bridge, however, poses reliability concerns, capacity constraints, and operational inflexibility. The problems associated with the existing Portal Bridge are discussed below.

AGING AND LIMITING INFRASTRUCTURE

Design standards for steel railroad bridges anticipate a typical lifespan of 100 years. Given the age of the Portal Bridge, it is likely nearing the end of its economic life. Rider safety is a top priority for both Amtrak and NJ TRANSIT. One of Amtrak's stated goals in its Strategic Reform Initiatives and FY06 Grant Requests (April 2005) is the return of the Northeast Corridor infrastructure to a "state of good repair and operational reliability." NJ TRANSIT also strives to maintain the infrastructure in a "state of good repair," which is achieved when infrastructure components are replaced on a schedule consistent with their life expectancy.

Special rail connections, known as miter rails, allow the rails to disengage and the bridge to open and close. These connections are mechanically separated and automatically controlled for the swing span to open and then are realigned and re-joined after it is closed. Depending on the reliability of this process, the period of time the bridge is closed to train traffic may be adversely affected, resulting in train delays. Additional delays can occur to mariners if the bridge becomes stuck and cannot open for them to pass underneath. Due to these issues, older swing span bridges are being replaced by other types of moveable bridges such as vertical lift and single-span bascule bridges—especially if there is heavy rail traffic, as in this case. The miter rail connections have been an ongoing problem since the Portal Bridge was constructed, and have been replaced numerous times. They are vulnerable to maladjustment and negatively affected by temperature changes. The rate of wear on the miter rails is worsened with higher train speeds and frequencies. As a result, while trains can operate at 90 miles per hour (mph) on adjacent portions of the Northeast Corridor, speeds over the Portal Bridge are restricted to 60 mph. As discussed in more detail below, the Hackensack River is a navigable waterway and marine traffic requires frequent bridge openings. These openings increase the likelihood of mechanical malfunctions, which have in the past caused Amtrak (the owner) to make repeated unscheduled repairs—a trend that has been accelerating over time.

CAPACITY CONSTRAINTS AND OPERATIONAL INFLEXIBILITY

The two-track configuration of the Portal Bridge, and the speed restrictions discussed above, limit the number of trains that can cross the Hackensack River, which is especially problematic during peak hours. Service enhancements over the past decade or more, such as the implementation of NJ TRANSIT's Midtown Direct service—which allows a limited number of Morris & Essex (M&E) Line trains (including the Morristown Line and Gladstone Branch) and Montclair-Boonton Line trains to merge onto the Northeast Corridor west of Portal Bridge for direct access to midtown Manhattan—have increased the total number of daily trains traveling over this already congested section of rail line. The merging and diverging of these popular trains onto and off of the Northeast Corridor somewhat reduces capacity for other Amtrak and NJ TRANSIT trains. This congestion will worsen with the implementation of the 2030 Operating Plan, which will: increase the number of Morris & Essex Line and Montclair-Boonton

Line trains (including Midtown Direct service), introduce direct service to Manhattan for NJ TRANSIT's customers on the Raritan Valley, Main/Bergen and Pascack Valley Lines, and support natural ridership growth on NJ TRANSIT's existing routes and services.

The Northeast Corridor has two tracks between Swift Interlocking (the point where Midtown Direct trains which diverged off of the Morris & Essex Line tracks merge onto the Northeast Corridor) and Portal Interlocking situated just west of the Secaucus Transfer Station. This current configuration creates two bottlenecks: (1) eastbound trains must merge from four tracks to two tracks at Swift Interlocking, and (2) westbound trains must merge from four tracks to three tracks and finally to two tracks between the Secaucus Transfer Station and Portal Interlocking. Because multiple rail lines are merging onto a two-track river crossing, the window of opportunity for each train is reduced. This operational inflexibility means that a delay on one rail line can cascade to other rail lines.

Frequent bridge openings exacerbate the current operational inflexibility. Bridge openings for mariners must be requested at certain time periods, during which times trains cannot operate over the Portal Bridge. Since several rail lines use the bridge, mechanical malfunctions during bridge closing cause a ripple effect throughout the rail corridor.

CONFLICTS WITH MARITIME USES

The Hackensack River is a navigable waterway governed by USCG. The existing Portal Bridge has only 23 feet of clearance between mean high water (MHW) and the lowest steel elevation of the bridge. As a result, marine traffic along this segment of the Hackensack River requires the frequent opening of the Portal Bridge and disruption of Northeast Corridor train traffic. This conflict is currently managed by restricting the times during which the bridge is permitted to open. Nonetheless, the lengthy time that is required to open and close the Portal Bridge for marine traffic continues to be disruptive to efficient rail operations.

D. PROJECT GOALS

A project's goals are the foundation of its purpose and need under NEPA. They are used as the basis for developing the criteria and screening methodology for evaluating the project alternatives. Six goals have been established for the Portal Bridge Capacity Enhancement Project, relating to capacity, reliability, safety, compatibility, cost-effectiveness, and environmental considerations. The alternatives screening and evaluation performed herein consider the project goals on a qualitative level appropriate for the long list alternatives. Objectives will be developed for each goal during the EIS process to provide specific and measurable means by which to evaluate and compare the remaining project alternatives. That level of evaluation will be commensurate with the more specific engineering, operational, and environmental details that will be available at that time. The six project goals are as follows:

GOAL 1: Enhance capacity to meet current and future demand—including new service—along the Northeast Corridor.

GOAL 2: Improve service reliability and operational flexibility.

GOAL 3: Provide a redundant Hackensack River crossing to enhance passenger safety and security.

GOAL 4: Minimize conflicts with maritime traffic.

GOAL 5: Optimize existing infrastructure and planned improvements.

GOAL 6: Minimize impacts on the surrounding environment.

E. FATAL FLAW SCREENING AND ALTERNATIVES DEVELOPMENT

Based on the project goals identified above, potential build alternatives were identified for the Portal Bridge Capacity Enhancement Project. Several meetings and workshops were held with Amtrak, NJ TRANSIT, agencies, stakeholders, members of the public, and the project team to develop and discuss a "long list" of potential alternatives. Previous studies of the Portal Bridge were considered in the development of the long list. FRA (as lead federal agency) and FTA, USCG, and USEPA (as cooperating agencies) also participated in the discussion of potential alternatives. As described below, agency and public input was solicited in development of the long list.

FATAL FLAW CRITERIA

A wide range of potential alternatives was considered for the long list. To ensure a meaningful alternatives analysis and environmental review, NEPA requires consideration of project alternatives that are considered reasonable and feasible. Four basic feasibility criteria were established for this project to eliminate non-viable alternatives. The four feasibility criteria, or "fatal flaw" criteria, are presented below:

LOGICAL TERMINI

Per NEPA, a proposed transportation improvement project must include in its definition rational end points. The logical termini for this project are the Kearny Junction Interlocking to the west and ARC's planned infrastructure at Secaucus Transfer Station to the east. This ensures that the project would include not only the new river crossing(s), but sufficient additional tracks to connect to the existing Northeast Corridor infrastructure. The logical termini also ensure that the project would consider all existing infrastructure and maximize its continued use where practical, thereby minimizing costly changes to such existing infrastructure.

In the 2030 Operating Plan, which was described above, all Midtown Direct service would use the planned NYPSE as its terminus. These trains currently merge onto the Northeast Corridor from the northwest via Swift Interlockings. To access the new station in New York, these trains will need to get across the Northeast Corridor to the proposed southern tracks connecting with NYPSE. This could be accomplished via running tracks underneath, or over, the Northeast Corridor tracks. Merging and diverging NJ TRANSIT's Midtown Direct trains directly across the Northeast Corridor "at grade" would adversely affect the capacity and efficiency of the Northeast Corridor because those train movements would be in conflict with dense existing and future Northeast Corridor traffic operating between Newark Penn Station and PSNY.

It would be preferable to construct this "flyover/duck-under" west of the Hackensack River, adjacent to, or at, the site of existing Swift Interlocking. This would allow the project to capitalize on the existing and anticipated future horizontal and vertical profiles of the railroad in crossing the tracks from NYPSE going to the Morris & Essex Line tracks over or under the Northeast Corridor. The construction of these tracks would be required and is assumed for all Portal Bridge project alternatives to optimize existing and planned infrastructure. Specifications for the flyover/duck-under will be refined during preliminary engineering.

Given that one of the goals of the Portal Bridge project is to minimize impacts on the surrounding environment, the project team looked only at Kearny Yard leads which would not cross the Belleville Turnpike and impact the existing warehousing uses on the other side. Crossing the Belleville Turnpike with the proposed track connection would require relocation of existing businesses as well as the modification of the existing Belleville Turnpike and potentially its interchange with the Newark and Jersey City Turnpike.

Restricting the yard lead connection to the area east of the Belleville Turnpike limits the potential height of the tracks it connects to. As the distance between the Hackensack River and the Belleville Turnpike is less than 2,000 feet, connecting the yard lead to tracks going over the river at 50 feet would result in a grade of over two percent—a fatal flaw which would adversely impact railroad operations (the existing "ruling grade" or maximum grade on this section of the Northeast Corridor is 1.97 percent). Any tracks which connect with the yard lead would need to be at a lower height in order to achieve a desirable grade for operations. Given the desire of NJ TRANSIT and Amtrak to segregate railroad operations (between trains going to PSNY and NYPSE), and all of the constraints listed above, the project team decided to examine the construction of two bridges over the Hackensack River, with the requirement that the bridge to which the Kearny Yard lead tracks connect to be at a low enough height so as to maintain a suitable grade for operations, but high enough to minimize conflicts with marine users.

CONSTRUCTABILITY REQUIREMENTS

Because the Northeast Corridor is a critical link in the region's transportation network, to be feasible an alternative must provide for continued operation of the Northeast Corridor during construction. Additionally, feasible project alternatives must be able to be constructed in a timely manner to ensure sufficient capacity for future projects, including ARC. As discussed in the Scoping Document, NJ TRANSIT has prepared a Draft EIS and has entered preliminary engineering for ARC, which includes an evaluation of a new two-track tunnel under the Hudson River and an expanded rail terminal in Manhattan under 34th Street and adjacent to the existing Penn Station. ARC will also include construction of Kearny Yard, a proposed rail storage yard (and potential inspection/servicing facility) south of the Northeast Corridor. NJ TRANSIT needs to complete the Portal Bridge project in time to accommodate future commuter train operations as well as the connection between Kearny Yard and the Northeast Corridor.

NAVIGABILITY REQUIREMENTS

The Hackensack River is a navigable waterway. The clearance from MHW to the bottom of steel on the existing Portal Bridge is 23 feet. The existing bridge must open frequently to permit maritime vessels to navigate the river. Any potential build alternative must also allow for waterborne traffic per the requirements of USCG. Based on preliminary discussions with USCG, either a moveable or a fixed bridge would be considered feasible for the project. A new bridge below a certain height would, however, need to be moveable in order to accommodate maritime traffic. Any alternative that would include a fixed bridge at a height less than 50 feet above MHW was deemed fatally flawed since it would introduce a new restriction to navigation on the Hackensack River, and it would be highly unlikely that USCG permits for such an action could be obtained. A new moveable bridge at a lower level would be feasible; however, the number of bridge openings would need to be minimized to ensure operational reliability. Based on existing data regarding marine vessel heights and the number of bridge openings required for the existing Portal Bridge, any new moveable bridge would need to be at least about 40 feet above MHW to minimize bridge openings.

TRACK REQUIREMENTS

Given the current and planned train operations for the Northeast Corridor, the existing two-track Portal Bridge will not be sufficient to support all of the service that is contemplated by the 2030 Operating Plan, in addition to existing Amtrak intercity train services and anticipated growth in those services. Preliminary analysis of this plan indicates that a minimum of four tracks would be needed to support existing and projected service, including organic ridership growth on existing NJ TRANSIT and Amtrak services. A potential build alternative could therefore include removal of the existing Portal Bridge and construction of two new two-track bridges. An alternative consisting of removal of the existing Portal Bridge plus construction of a single new three-track bridge would be considered fatally flawed due to insufficient capacity. It was also surmised based on engineering expertise that any alternative with more than five tracks in total would provide more capacity than needed to meet the project purpose and need and would provide more capacity than the planned connecting infrastructure could deliver. Hence, any alternative proposing fewer than four tracks or greater than five tracks at this crossing was not considered reasonable.

DEVELOPMENT OF LONG LIST OF ALTERNATIVES

Using these four fatal-flaw screening criteria, a long list was developed of potentially feasible project alternatives. Alternatives varied based on the following fundamental characteristics: reuse of the existing Portal Bridge; number of new bridges to be constructed; number of tracks per bridge; type of bridge (fixed or moveable); and bridge alignment relevant to the existing alignment. While the proposed alternatives could be further refined by additional characteristics such as bridge construction materials (steel versus concrete), bridge approach type (structure versus embankment), and new bridge alignment (north or south of the existing structure), these elements are more appropriately explored for those alternatives that are analyzed in the Draft EIS. As required by NEPA, a No Action Alternative will also be considered in addition to the build alternatives. The No Action Alternative will be carried forward to the EIS to serve as a baseline to evaluate the potential environmental effects of the build alternatives.

In total, 30 build alternatives passed the fatal-flaw screening. The long list was grouped into the following categories:

- *Alternatives That Would Retain the Existing Portal Bridge*—These alternatives would keep the existing Portal Bridge. It would be rehabilitated and reconditioned on its existing center pier and bridge abutments, and the existing top-of-rail elevation would be maintained. One new bridge would also be constructed.
- *Alternatives That Would Replace the Portal Bridge on a New Alignment*—These alternatives would include decommissioning of the existing Portal Bridge. Two new bridges would be constructed along alignment(s) different than the existing bridge’s alignment.
- *Alternatives That Would Modify the Existing Portal Bridge*—These alternatives would involve modification of the existing Portal Bridge. This could include raising the existing bridge structure to a higher elevation to reduce the number of bridge openings required for maritime traffic. One new bridge would also be constructed.
- *Alternatives That Would Replace the Portal Bridge on the Existing Alignment*—These alternatives would include removal of the existing Portal Bridge. Two new bridges would be

constructed. One would be built in the same location as the existing bridge; the other would be constructed on a new alignment.

Figure 2 shows these groups of alternatives and how individual alternatives were developed. The 30 long list of alternatives are listed in Table 2. Due to the alignment and location, it was assumed that any alternative re-using the existing Portal Bridge would reuse it for the southern bridge (leading to the planned NYPSE).

Table 2
Long List of Alternatives

Alternative No.	Bridge 1 (Southern bridge to NYPSE)	Bridge 2 (Northern bridge to PSNY)
Alternatives that Would Retain Existing Portal Bridge		
1.1	Existing Portal Bridge (2-Track Moveable)	2-Track Fixed
1.2	Existing Portal Bridge (2-Track Moveable)	3-Track Fixed
1.3	Existing Portal Bridge (2-Track Moveable)	2-Track Moveable
1.4	Existing Portal Bridge (2-Track Moveable)	3-Track Moveable
Alternatives that Would Replace Portal Bridge on New Alignment		
2.1	New 2-Track Fixed Bridge	2-Track Fixed
2.2	New 2-Track Fixed Bridge	3-Track Fixed
2.3	New 3-Track Fixed Bridge	3-Track Fixed
2.4	New 2-Track Moveable Bridge	2-Track Fixed
2.5	New 2-Track Moveable Bridge	3-Track Fixed
2.6	New 3-Track Moveable Bridge	2-Track Fixed
2.7	New 2-Track Moveable Bridge	2-Track Moveable
2.8	New 2-Track Moveable Bridge	3-Track Moveable
2.9	New 3-Track Moveable Bridge	3-Track Moveable
Alternatives that Would Modify Existing Portal Bridge		
3.1	Raise Existing Portal Bridge (2-Track Fixed)	2-Track Fixed
3.2	Raise Existing Portal Bridge (2-Track Fixed)	3-Track Fixed
3.3	Raise Existing Portal Bridge (2-Track Fixed)	2-Track Moveable
3.4	Raise Existing Portal Bridge (2-Track Fixed)	3-Track Moveable
3.5	Raise Existing Portal Bridge (2-Track Moveable)	3-Track Moveable
3.6	Raise Existing Portal Bridge (2-Track Moveable)	2-Track Moveable
3.7	Raise Existing Portal Bridge (2-Track Moveable)	3-Track Fixed
3.8	Raise Existing Portal Bridge (2-Track Moveable)	2-Track Fixed
Alternatives that Would Replace the Portal Bridge on the Existing Alignment		
4.1	New 2-Track Fixed Bridge	2-Track Fixed
4.2	New 2-Track Fixed Bridge	3-Track Fixed
4.3	New 3-Track Fixed Bridge	3-Track Fixed
4.4	New 2-Track Moveable Bridge	2-Track Fixed
4.5	New 2-Track Moveable Bridge	3-Track Fixed
4.6	New 3-Track Moveable Bridge	2-Track Fixed
4.7	New 2-Track Moveable Bridge	2-Track Moveable
4.8	New 2-Track Moveable Bridget	3-Track Moveable
4.9	New 3-Track Moveable Bridget	3-Track Moveable

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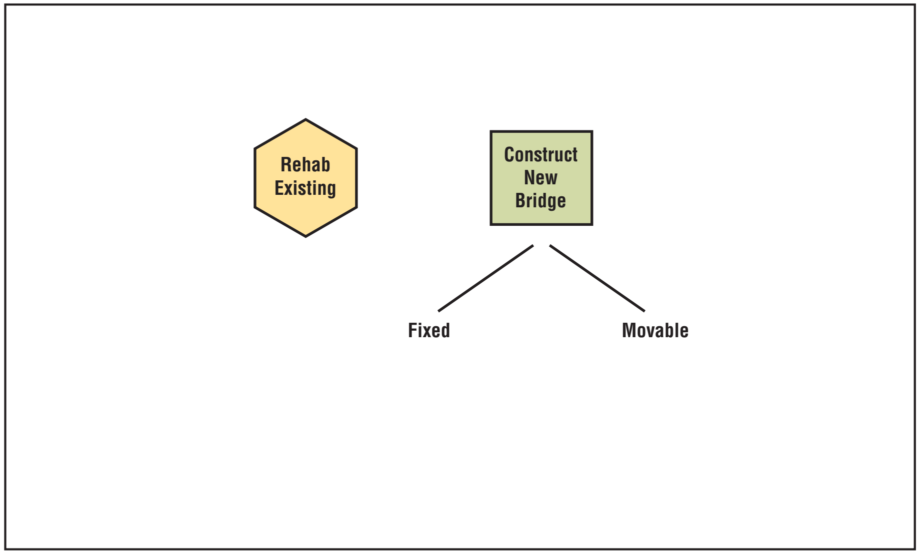
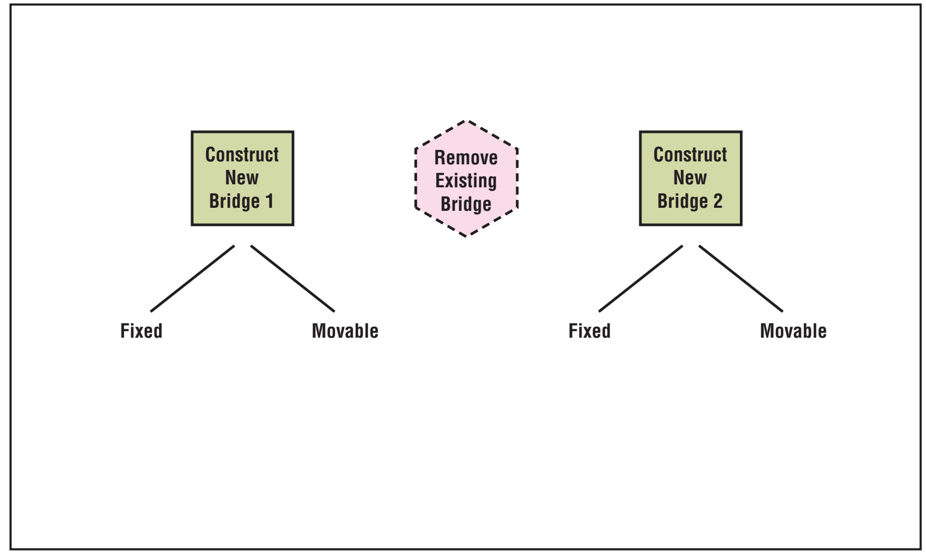
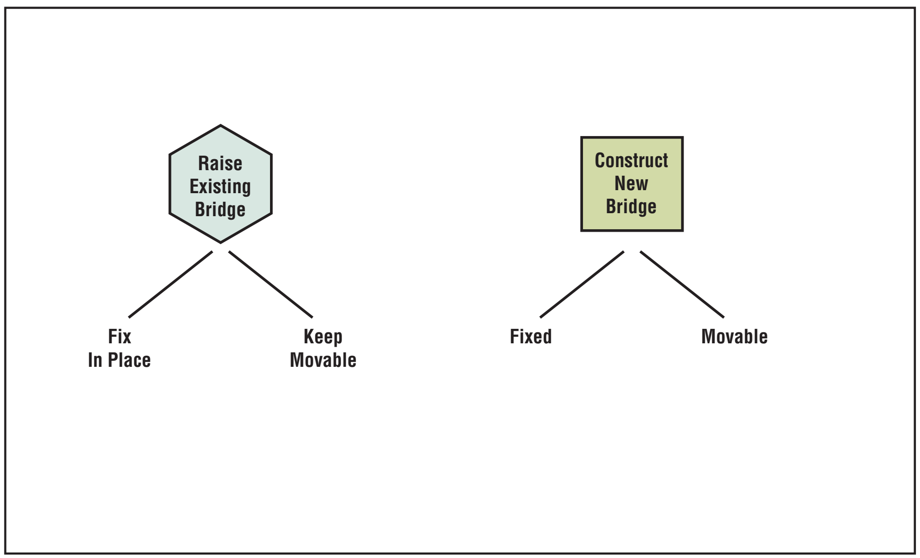


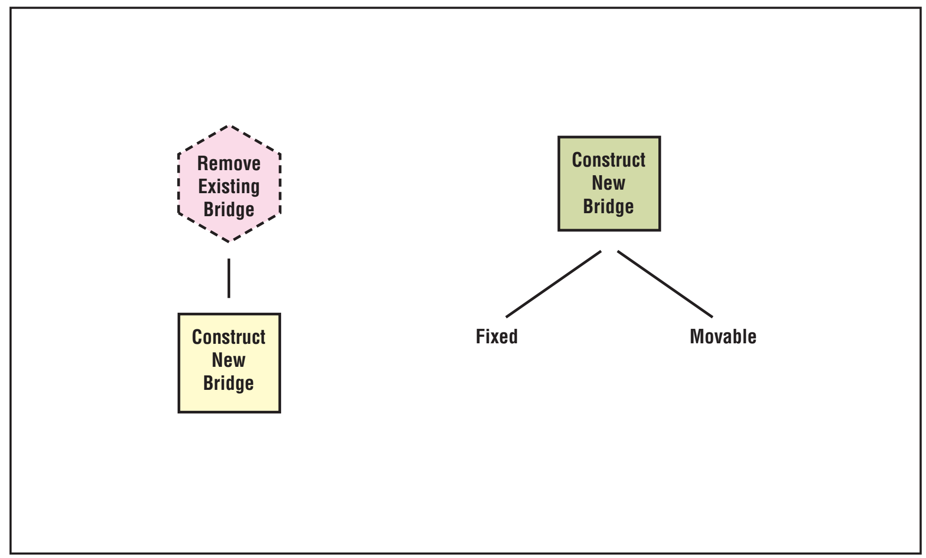
Rehabilitation Alternatives



Replace Bridge on New Alignment Alternatives



Modify the Existing Alternatives



Replace Portal Bridge using Existing Alignment Alternatives

Portal Bridge Alternative Groups

Figure 2

The four categories of build alternatives were described in the Scoping Document (dated December 2006), and the long list of alternatives was further explained during the agency scoping meeting, public scoping meeting, and the initial Regional Citizens' Liaison Committee meeting. Comments received during this time did not result in modifications to the long list. Rather, the comments generally requested further clarification, supported a particular alternative or alternative group, or questioned the practicality of modifying the existing Portal Bridge structure. Several project alternatives not on the long list were suggested during the scoping process; however, these alternatives were not incorporated into the long list since they were fatally flawed and/or beyond the scope of the project. Hence, these 30 build alternatives were carried forward to the second screening step.

F. SECOND-STEP SCREENING AND ALTERNATIVES EVALUATION

The second screening step involved evaluating each of the long list alternatives for their ability to satisfy certain requirements posed by FRA, Amtrak, and NJ TRANSIT. Three second step screening criteria were established, as follows:

- Engineering Considerations
- Practical Capacity
- Environmental Impacts and Property Acquisitions

The "Alternatives Evaluation" section below discusses these screening criteria as they relate to each of the long list alternatives. Similar to the fatal-flaw screening, this is not a detailed comparison of each alternative against the project goals. Rather, it is a preliminary evaluation to screen out undesirable alternatives and reduce the long list to a reasonable range of practical build alternatives that can be further described and analyzed in the Draft EIS. Similarly, the cost-effectiveness of each alternative is considered in tandem with the second step screening criteria.

ENGINEERING CONSIDERATIONS

A preliminary engineering evaluation was performed to assess the feasibility of the alternatives on the long list. The alternative groups that would remove the existing Portal Bridge and include construction of two new bridges would be feasible from an engineering perspective. Based on engineering judgment and comments received during the scoping process, the alternative group that would modify and raise the height of the existing Portal Bridge was evaluated for deficiencies that would deem it infeasible or eliminate it from further consideration.

As explained above, this group of alternatives would include construction of a new bridge parallel to the existing Portal Bridge. The existing bridge would then be rehabilitated and raised in height to reduce the number of bridge openings required. The height to which the existing bridge would be raised would depend on whether it would be fixed or moveable. The new bridge could consist of two or three tracks and be fixed or moveable. If the existing bridge would remain a moveable swing bridge, then the centerline of the new bridge would be positioned roughly 175 to 190 feet from the centerline of the existing bridge to allow room for the swing span to operate.

Other design assumptions were made for purposes of this preliminary engineering evaluation, as follows:

- The rehabilitation of the existing bridge would be sufficient to provide an additional 75 years of service life;
- To satisfy the navigable waterway requirements discussed above, the existing bridge would be raised a minimum of 17 feet (i.e., to 40 feet above MHW) if it would remain moveable, or 27 feet (i.e., to 50 feet above MHW) if it would become fixed.
- For a fixed bridge, the entire existing bridge would be ballasted. Only the approach spans would be ballasted if it would remain moveable.
- The existing bridge would remain a two-track bridge.
- If a moveable bridge were chosen, the new bridge would be a vertical lift bridge.

An additional analysis was performed to determine the feasibility of constructing either a fixed or a moveable bridge on the southern alignment, assuming that a connection must be made with the western edge of the proposed Kearny Yard.

EVALUATION OF ALTERNATIVES THAT WOULD RAISE THE EXISTING BRIDGE

The group of alternatives that would include raising the existing bridge would pose substantial engineering concerns, mostly associated with the reuse of the existing bridge. The primary concerns are discussed individually below, and include:

- Structural deficiencies of the existing substructure
- Remaining fatigue life of the existing superstructure
- Miter rail joints in a swing span
- Reliability of the existing structure
- Cost Effectiveness

Structural Deficiencies of the Existing Substructure

The existing pivot pier and approach piers are constructed of un-reinforced masonry and were constructed in an era when seismic loading was not considered during design. This type of construction is not well suited to resist the high lateral loads that would be experienced during a seismic event. The American Railway Engineering and Maintenance-of-Way Association (AREMA) bases the seismic analysis of bridges on a combination of the geographic location of the bridge and the structure importance classification. The geographic location determines the predicted maximum intensity of the design motions over a specified time period. The existing Portal Bridge is located in the most seismically vulnerable region on the east coast.

The structure importance classification is determined from factors such as the bridge’s role in the immediate safety of the surrounding communities, the immediate value of the structure based on the railroads utilization of the structure, and the replacement value based upon the complexity and level of difficulty associated with replacing the bridge should a seismic event occur that would cause failure. The Portal Bridge has a high ranking in these classifications due to its high level of importance to both the railroad and the surrounding communities.

AREMA indicates that existing bridges located in areas where the 500-year-peak acceleration exceeds 10 percent of gravity should be reviewed for resistance to seismic forces. The acceleration for the Portal Bridge is 17 percent of gravity; therefore, a preliminary seismic analysis of the existing substructures was performed. Previous studies to raise the existing bridge indicate that the pivot pier and rest piers would require extensive modification to raise the bridge and resist increased seismic and wind loads. In addition, this preliminary evaluation investigated the need for retrofit of the existing approach piers. The results indicate that the approach piers would also require retrofit to resist seismic loading when the bridge is raised. The piers would likely require seismic retrofit to resist seismic loads with the bridge at its current elevation. Raising the bridge and adding a ballasted deck would worsen the effects on the substructure. Modifying the existing piers would likely be difficult and expensive. Additional piles or drilled shafts would be needed, a reinforced concrete jacket would be required around the perimeter of the pier, and cofferdams would be required to perform the construction.

Remaining Fatigue Life of the Existing Superstructure

Portal Bridge was put into service in 1910 and has been in operation for almost 100 years, which consumes the intended service life for this structure. Fatigue design has been part of the AREMA code since 1910, but the design of the Portal Bridge was prior to that year. Therefore, fatigue life was likely not considered as part of the original design. The Portal Bridge has several fatigue sensitive details such as eyebar heads and riveted connections. Bridges of that era frequently receive welded repairs, which introduce additional fatigue sensitive details. The swing span experiences cyclic loading from opening and closing the bridge in addition to the typical live load cyclic loading that a fixed span experiences. The combination of these cycles and their respective induced stress range act to consume the fatigue life of the bridge.

An analysis was performed to determine the Portal Bridge's remaining fatigue life based on current AREMA fatigue design provisions. The analysis determined that only a handful of members satisfy the current fatigue design provisions using the design train recommended in AREMA (Cooper E-80). In order to meet the current fatigue design criteria, the loading on the bridge would have to be limited to a train no greater than a Cooper E-31.[1]

Miter Rail Joints in a Swing Span

The miter rail joints have been problematic for the Portal Bridge since it was put into service. Several different types of miter rail joints have been used on this bridge over its life but none have delivered the reliable service required for this location. Removing the mitered rail joint and installing a bolted, removeable section of rail has been considered as a permanent fix to the mitered rail problems. This would require a work crew to physically remove a section of rail from each track at both ends of the bridge and reinstall it each time the bridge needs to open for marine traffic. Mariners would be required to give significant advance notice prior to their need to pass through the Portal Bridge and would be restricted to off-peak railroad times (i.e., very early morning, late evening/night and possibly midday hours) due to the longer period the bridge could be out of service for rail traffic. Additionally the USCG would need to approve these restrictions. This fix could result in a more reliable joint but would continue to be an additional operating cost.

Reliability of the Existing Structure

As expected, the Portal Bridge has become less reliable with age. Reliability was measured based upon the number of days between failure events over an 11-year period for which data was available. During the period beginning December 1995 and ending September 2006, 192

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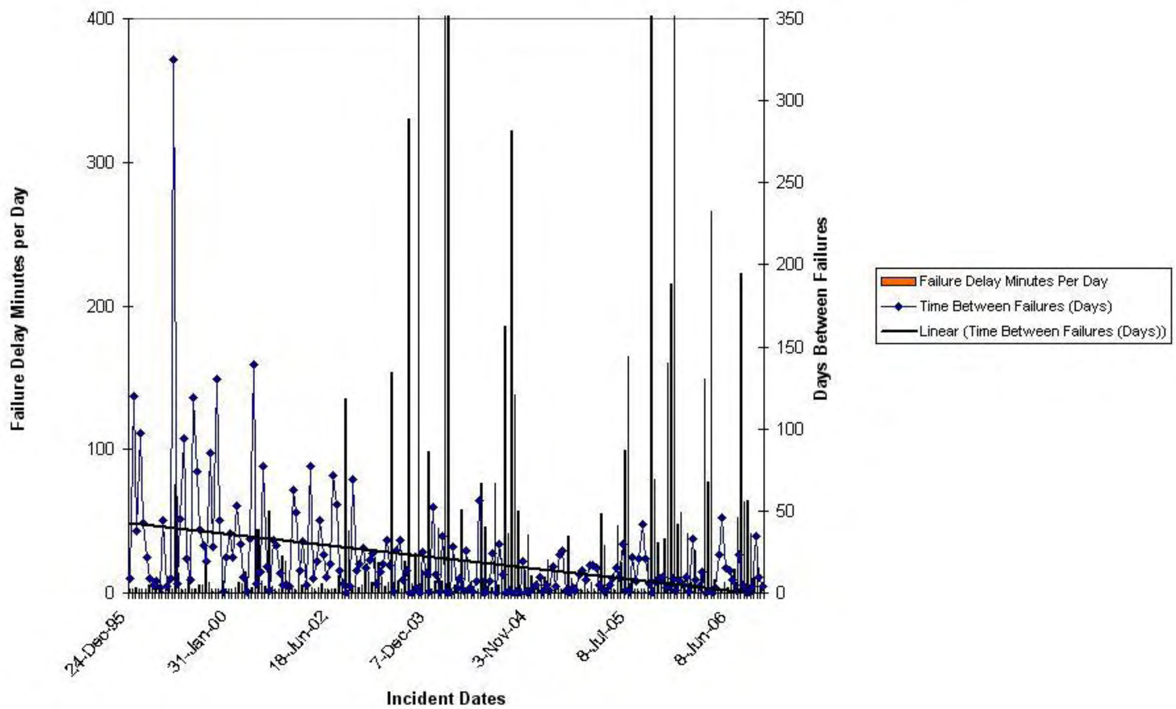
[1] A Cooper E loading is an engineering design standard that reflects the weight of the train per axle, along with other factors such as impact, sideways imbalances, longitudinal forces, multiple tracks, different values for reaction, and shear & moment that all differ depending on span length. Generally, the higher the Cooper E loading, the heavier the train (assuming an equal number of axles).

failures and inspections were recorded. The number of days between failures ranged from 0 (i.e., more than one failure occurred on the same day) to 325 days. The 11-year average was one failure every 20.8 days. A graph of the failure events and inspection data is shown below. A linear interpolation of the data shows that the number of days between failures has been decreasing steadily. The bridge's reliability would likely increase after a rehabilitation but would unlikely be as reliable as a new vertical lift or fixed bridge. After rehabilitation was completed, there would still be some 100-year-old components in service. As those components continue to wear, the trend of increased failure frequency would also continue. It would be very difficult to rehabilitate the existing bridge to achieve the level of reliability that a new vertical lift bridge or a new fixed bridge could provide.



Graph of Portal Bridge Failure Events and Inspections from 12/24/95 to 9/29/06

Cost Effectiveness

While detailed construction costs have not yet been developed, it is anticipated that the cost of raising the existing Portal Bridge would be comparable to the cost of constructing a new bridge. If the bridge would remain a swing span bridge, then all of the electrical and mechanical components would need to be replaced. Based on past experience with similar railroad bridges, the floor system would likely need to be replaced. Due to the construction activities required to retrofit the existing pivot pier and rest piers, the fender systems would need to be removed and replaced. New foundation elements and substructure strengthening would be required at all of the piers (see previous discussion on Structural Deficiencies of the Existing Substructure). This would require the use of expensive cofferdams. The existing swing span superstructure would also require some rehabilitation work and the existing approach girder spans would likely be replaced.

Recommendations

For the reasons given above, it is recommended that no further consideration be given to the group of alternatives that would raise the existing Portal Bridge. This group has many disadvantages when compared to some of the other long list alternatives. It would force a design within the geometric constraints of the existing structure, whereas other alternatives would allow an opportunity to evaluate the most economical superstructure, substructure, and number of spans. A new structure should provide the level of reliability and minimal maintenance that is required for this location. Some of the engineering concerns presented above, especially those regarding fatigue life, would also apply to the group of alternatives that would include rehabilitation of the existing Portal Bridge.

ALIGNMENT CONSIDERATIONS

Railroad design typically considers a "ruling grade" which is the maximum grade present on a section of track. In engineering a railroad, it is not preferable to create a higher ruling grade as this would adversely effect operations. Grades, which are expressed in terms of percentages, reflect the vertical rise relative to the amount of horizontal distance used to elevate the tracks.

An analysis was conducted using potential alignments for the northern, existing and southern alignments to determine whether or not a fixed bridge at 50 feet or a moveable bridge at 40 feet would be feasible for each alignment from and engineering perspective.

Northern Alignment

In order to avoid fouling the existing Portal Bridge's swing span during construction, a northern bridge would have to be located at least 180 feet from the existing alignment. This northern alignment would result in a horizontal distance of at least 3,500 feet available for the elevation of the Northeast Corridor tracks to the height of the bridge and makes the resulting grade, even for a 50-foot fixed bridge, feasible and below the current ruling grade of the existing Northeast Corridor.

Existing Alignment

The horizontal length necessary to climb to the needed elevation of the fixed 50-foot bridge would be 2,800 feet from the existing Swift Interlocking if the existing alignment is used. This length is considerably shorter and therefore substantially steeper than the option of a proposed alignment north of the existing structure due to the fact that the Hackensack River is angled relative to the existing Northeast Corridor and not perpendicular.

For comparison, the 40-foot movable bridge, on the existing alignment, would result in a 1.6 percent grade for the westerly approach which, while not optimal, is negotiable and falls below the Ruling Grade of 1.97 percent. By contrast, the 50-foot fixed bridge, along the existing alignment and from the existing Swift Interlocking, results in a westerly approach grade of 2.4 percent, greater than the existing ruling grade, and not conducive to operations, making a fixed bridge on the existing alignment not preferred. With the jump-over or duck-under realignments and crossovers involved in alternate designs that allow for non-conflicting operations of Amtrak and New Jersey Transit, the grade to achieve a 50-foot fixed bridge on the existing alignment would exceed 2.50 percent.

Southern Alignment

Finally, any elevated profile to a 50-foot fixed bridge on a parallel alignment to the south of the existing alignment would exacerbate the grade due to the swing of the river and navigable channel moving closer to the west approach. Therefore a fixed bridge to the south can be eliminated and it can be assumed that only a moveable bridge will be constructed to the south.

Recommendations

Due to issues of grade that are discussed above, it is recommended that a moveable bridge only be considered for the existing or southern alignment. As a fixed bridge on the northern alignment would not present any issues with grades, it is recommended that a moveable bridge be eliminated for the northern alignment in order to provide the maximum operational flexibility for the project.

PRACTICAL CAPACITY ANALYSIS CONSIDERATIONS

The long list of alternatives was evaluated to screen out those alternatives with insufficient or excess track capacity. As stated above, the build alternatives to be considered in the EIS must have sufficient track capacity to accommodate future capacity improvements and train services planned by Amtrak and NJ TRANSIT, including the ARC project. The fatal-flaw screening identified a minimum number of tracks needed to satisfy the project purpose and need. The practical capacity analysis was performed to determine if the requirements for the river crossing could be further defined.

The first step in the practical capacity analysis is calculating the total number of trains that could be accommodated by each alternative in a given hour. Depending on the exact location, the practical capacity of the High Line segment of the Northeast Corridor between Newark and New York is 23 to 25 trains per hour, based on: the existing mix of Amtrak and NJ TRANSIT trains, existing equipment, existing operating speeds, and the existing train control system (the High-Density Interlocking System, or HDIS).

If a higher volume of train traffic is attempted, some trains will experience signal delays and will be forced to operate below the maximum speed that is otherwise permitted for that type of train. The duration and severity of these signal delays would depend on the extent to which traffic exceeded the “clear signals” capacity of the railroad in a given time and on other factors such as relative train performance and train spacing.

Where tracks merge and/or diverge, an interlocking must be established to govern the movement of trains that operate through the track junction to prevent trains from operating on conflicting routes simultaneously, and from following each other too closely. Merging and diverging movements always reduce the practical capacity of the track because time is required to release and re-establish a route through the track junction, including switchpoint movement time and signal propagation time from the control center to the field and back to the control center. The more frequently the established route through the junction is changed in a given time period, the more the capacity is degraded. A rule-of-thumb in the industry is to assume that theoretical capacity is reduced 25 percent at an actively utilized track junction. It has therefore been assumed that 25 percent of the nominal capacity of 25 TPH would be lost when non-revenue deadhead trains are merging onto the Northeast Corridor or the proposed southern alignment from the proposed Kearny Yard during the mid-to-late afternoon. Hence, a capacity of 18 TPH[1] was assumed for tracks that would be so affected, especially during the afternoon/evening period. For the three- and four-track alternatives, a capacity of 18 TPH was assumed for the southernmost track. Importantly, it has been assumed that the merging speed of non-revenue trains entering the main line from Kearny Yard would be much lower than the Maximum Authorized Speed (MAS) of the main track, probably no more than 45 miles per hour (mph). It is possible that the merging speed could be as low as 30 mph. For these reasons, the assumed practical eastbound capacity during the evening peak period has been reduced by 25 percent. As stated above, there would be no physical connection between tracks serving NYPSE and PSNY east of the Hackensack River (although a connection just east of the Secaucus Transfer Station could potentially be built in the future). Practical capacity was therefore analyzed for two bridges separately, based on the proposed service to PSNY and NYPSE.

EVALUATION OF ALTERNATIVES THAT WOULD REUSE THE EXISTING PORTAL BRIDGE

Given the current plans for ARC the two proposed main tracks on the proposed southern alignment would serve the planned NYPSE exclusively, and would carry all of the Midtown Direct service and Raritan Valley service and a portion of the North Jersey Coast Line service. In addition, they would carry any NJ TRANSIT services operating to or from points west on the Northeast Corridor that might terminate at NYPSE instead of the existing PSNY, either upon completion of the ARC project, or at a future date in time. The southernmost of the two tracks, would normally support eastbound traffic to NYPSE while the northernmost of the tracks would normally support westbound traffic departing the same terminal. The proposed northern bridge would carry all of NJ TRANSIT's Northeast Corridor service, most of its North Jersey Coast Line service, as well as all of Amtrak's Northeast Corridor service, including its Regional, Acela, and Long Distance trains. Either Hackensack River crossing that carries service to these two stations would therefore not be a "secondary" crossing but would be equally important.

An important requirement for an alternative retaining the existing Portal Bridge structure itself, in situ or raised, is that a parallel, newly constructed fixed bridge or higher moveable bridge must support all of the rail traffic operating in this corridor in the event of a short-term problem with opening or closing the existing bridge. With the proposed segregation of rail traffic destined for PSNY and NYPSE east of the Hackensack River, the reuse of the existing Portal Bridge would require rail traffic to one of these stations to rely entirely on this bridge—diminishing the reliability of rail service to that station.

Recommendation

The Portal Bridge project should include the construction of two new bridges, each of which must be robust in terms of operational availability. The reuse of the existing Portal Bridge has been eliminated as being operationally infeasible.

SOUTHERN BRIDGE (TO NYPSE)

In terms of capacity, given the 2030 Operating Plan, a two-track railroad on the proposed southern alignment with a reasonably robust "HDIS-like" train control system, similar to the one in service today between Hudson Interlocking and PSNY, is likely to provide sufficient capacity

[1] 25 percent reduction from 25 TPH is 18.75 TPH, but is rounded down since a fractional remainder is not meaningful.

across the river, even accounting for trains that will merge onto extensions of these tracks near the Seacucus Transfer Station to the east of the river crossing and beyond the project limits. Also, based on preliminary analysis of anticipated train volumes, it is likely that these two tracks could also support off-peak and shoulder-peak operation of non-revenue ("deadhead") trains operating to or from proposed Kearny Yard or other remote points. Finally, since long-distance (intercity) trains will not use this southern infrastructure, practical capacity can be predicted with greater certainty because there will be less variability in train performance characteristics for scheduled trains operating over this alignment.

NORTHERN BRIDGE (TO PSNY)

It is anticipated that all NJ TRANSIT Midtown Direct service, as well as certain other NJ TRANSIT trains, will be programmed to operate on a southern two-track alignment. Therefore, those trains would not operate on the NEC east of Swift Interlocking. Given this proposal, a two-track northerly river crossing might be regarded as consistent with today's NEC in this location. However, all Amtrak trains and a still-significant number of NJ TRANSIT trains (up to 19 trains per hour in the peak direction during the two-hour AM peak period and up to 20 trains per hour in the peak direction during the two-hour PM peak period) would still operate across the proposed northerly bridge structure (or structures). Existing well-understood capacity pinch-points, or "bottlenecks," approaching PSNY from the west and approaching Dock Interlocking from the east might still exist and are outside the scope of this project; however, any new/relocated Northeast Corridor Hackensack River crossing should anticipate that future projects or programmed retirements of older equipment with less-aggressive braking capabilities might address and incrementally improve or remediate these pinch-points. Some of these capacity constraints will be addressed by the construction of the non-precluded Track 4 between Dock and Swift Interlockings. In addition, the Northeast Corridor infrastructure must accommodate a wider range of train performance capabilities than the proposed southern crossing because it must—unlike the southern bridge—carry high-speed intercity express trains such as today's Acela Express and long-distance trains such as today's Amtrak "Silver" services that generally represent the longest and heaviest trains operating over this line segment. Variability in train operating characteristics demands more capacity than homogeneous operating characteristics that are more typical of heavy-rail rapid transit systems such as (for example) PATH. This is an operating reality that cannot be avoided or eliminated even with the most rigorous attention to maintenance and operating discipline.

The total projected AM peak-period, peak-direction train volume programmed to remain on the NEC and thus utilize a proposed northerly (NEC) bridge crossing over the Hackensack is 22 trains per hour (combined Amtrak and NJ TRANSIT train operations). This is identical to today's (2007) maximum peak-direction traffic volume and very similar to the existing "mix" of traffic types (Amtrak long-distance, Amtrak Acela Express, Amtrak Regional, and NJ TRANSIT). The total projected PM peak-period, peak-direction train volume is even greater: up to 29 NJ TRANSIT and Amtrak trains per hour. This exceeds the existing and anticipated practical capacity of any one track. The anticipated peak-direction NEC train traffic would significantly stress a two-track northerly (NEC) river crossing that must be available without interruption or exception each working weekday. Assuming today's train control technology, each track would have a nominal clear-signals capacity of approximately 24 to 25 trains per hour (TPH).

In the AM reverse-peak direction (i.e., westbound), a peak of 15 trains per hour, which includes four Amtrak trains, are programmed to operate on the NEC via the northerly Hackensack River crossing. Similarly, during the PM peak period—when the reverse-peak direction is eastbound—a maximum of 12 reverse-peak trains per hour are programmed across this segment of the NEC. These figures are both well within the practical capacity of one track equipped with a train control system similar or identical to today's HDIS.

Traffic merges and diverges at Swift Interlocking (including the merging of six additional westbound trains in the AM peak-period) will unavoidably reduce the capacity of the railroad in both directions. This is because, under real-world conditions and given the projected peak-period traffic density, the timing precision that would be required to achieve few or no signal delays due to traffic merges is not achievable except under carefully choreographed conditions that are outside the practical realities of railroad operations, even with highly reliable fixed plant and equipment. Therefore, although it is possible that a two-track northerly crossing could be adequate, it also is possible that a three-track northerly (NEC) Hackensack River crossing would most likely be necessary, prudent, and justified by projected traffic volumes.

Analysis, including network simulations, will determine whether a third track is justified by the 2030 Operating Plan and should therefore be built immediately, or if it will be sufficient to build and commission only two NEC tracks across the Hackensack but not preclude a third main track that could be commissioned at a later date. This could suggest that the anticipated bridge structure be built to accommodate all three tracks, even if proposed NEC Track 4 is not actually constructed and put into service until a later date. Additional cost estimating, construction staging analysis and environmental analysis, will identify the merits of a three-track vs. two-track bridge structure if the third track is not immediately constructed and operational.

Finally, daytime maintenance activities that require temporarily removing a track from service would be more difficult to schedule (as they are today) with a two-track crossing compared with a three-track crossing. A redundant track for this purpose alone is unlikely to be deemed cost effective even with the anticipated traffic density at this site; but, if justified by other metrics, the added versatility to address scheduled (programmed) and unscheduled maintenance and repair activities would be another benefit realized by constructing a three-track railroad.

ENVIRONMENTAL IMPACT AND PROPERTY ACQUISTION CONSIDERATIONS

One of the project's goals is to minimize the adverse impacts to the surrounding environment. Amtrak owns the right-of-way along the Northeast Corridor. The right-of-way provides a buffer beyond the existing Portal Bridge and the lead tracks, but is not sufficiently wide to allow for construction of a new bridge that would not interfere with the operability of the existing Portal Bridge swing span. Property acquisition may, therefore, be required for any of the feasible alternatives. It was confirmed through available land use information that the area beyond the existing rail right-of-way includes private property, ecologically sensitive areas, and contaminated properties. Each alternative group was qualitatively assessed for its potential for adverse environmental impacts and property acquisition.

Replacing the existing bridge on the existing alignment would require construction of a new bridge on a new alignment. This alternative would require property acquisition and construction beyond the right-of-way. The alternative group that would remove the existing bridge and construct two new bridges on two new alignments may require twice as much property acquisition and construction beyond the right-of-way. Conceptual designs of the project alternatives will be prepared to delineate the area required for construction and for permanent use. At the current time, however, it can be concluded that the alternative group involving two new bridges on new alignments would have much greater adverse impacts on ecologically sensitive land and/or contaminated property than the other alternatives. This alternatives group would, however, have an advantage in terms of construction duration; namely, one new bridge could be constructed on either side of the existing Portal Bridge simultaneously. The alternatives group that would build a new bridge on the existing alignment would need to be constructed using a more lengthy phased approach (the first new bridge would be constructed on a new alignment, then the existing Portal Bridge would be removed, and finally the second new bridge would be constructed on that same alignment). Construction duration is only critical in that any alternative that could not be completed by ARC's opening year would not be advanced. As both the phased and non-phased approaches offer different advantages and disadvantages that are worth investigating further, these two alternative groupings will be advanced to the Draft EIS to be analyzed fully.

G. CONCLUSION

All of the alternatives that would retain the existing bridge (either at its existing height or at a raised height) have been eliminated due to operational and engineering concerns. The remaining alternatives (which do not include reuse of the existing bridge) were evaluated based on the conclusions of the second-tier screening discussed above, specifically:

- Since the northern alignment is the only alignment for which a fixed bridge at 50 feet above MHW would be feasible, any bridge constructed to the north must be fixed to maximize the operational benefits of the project;
- Due to both the inclusion of a connection with the Kearny Yard to the tracks destined for NYPSE, and the limited distance between Swift Interlocking and the western bank of the Hackensack River, it would not be possible to construct a fixed bridge on the existing or southern alignment; therefore, a moveable bridge must be constructed on these two alignments;
- With projected AM peak period eastbound traffic expected to be 22 TPH, and projected PM peak period westbound traffic expected to be 29 TPH, the northern bridge would most likely consist of three tracks to adequately accommodate all projected PSNY traffic; and,
- Two tracks would provide sufficient capacity for the projected NYPSE traffic.

As presented in Table 3, two alternatives remain at the completion of the second-step screening. These two alternatives are:

Alternative 1—Construction of a two-track moveable bridge on the southern alignment and construction of a three-track fixed bridge on the northern alignment.

Alternative 2—Construction of a two-track moveable bridge on the existing Portal Bridge alignment and construction of a three-track fixed bridge on the northern alignment.

These two alternatives will be advanced to the Draft EIS for further analysis.

Table 3
Second-Step Screening

Alternative	Bridge 1 (Southern Bridge)	Bridge 2 (Northern Bridge)	Reason for Elimination			
			Fixed Northern Bridge	3-Track Northern Bridge*	Moveable Southern Bridge	2-Track Southern Bridge
Alternatives that Would Replace Portal Bridge on New Alignment						
2.1	2-Track Fixed	2-Track Fixed		X	X	
2.2	2-Track Fixed	3-Track Fixed			X	
2.3	3-Track Fixed	3-Track Fixed			X	X
2.4	2-Track Moveable	2-Track Fixed		X		
2.5	2-Track Moveable	3-Track Fixed	*Advanced to DEIS as Alternative 1*			
2.6	3-Track Moveable	2-Track Fixed		X		X
2.7	2-Track Moveable	2-Track Moveable	X	X		
2.8	2-Track Moveable	3-Track Moveable	X			
2.9	3-Track Moveable	3-Track Moveable	X			X
Alternatives that Would Replace the Portal Bridge on the Existing Alignment						
4.1	2-Track Fixed	2-Track Fixed		X	X	
4.2	2-Track Fixed	3-Track Fixed			X	
4.3	3-Track Fixed	3-Track Fixed			X	X
4.4	2-Track Moveable	2-Track Fixed		X		
4.5	2-Track Moveable	3-Track Fixed	*Advanced to DEIS as Alternative 2*			
4.6	3-Track Moveable	2-Track Fixed		X		X
4.7	2-Track Moveable	2-Track Moveable	X	X		
4.8	2-Track Moveable	3-Track Moveable	X			
4.9	3-Track Moveable	3-Track Moveable	X			X

Notes: * It is expected that three tracks will be necessary for the northern bridge. This will be evaluated in the DEIS based on operational simulations.

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