Doubling Trans-Hudson Train Capacity at Penn Station

An Engineering Feasibility Study of Alternatives Within the Existing Station Footprint

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FINAL — October 2024

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Acronyms and Abbreviations

AHJ	Authority Having Jurisdiction
ARC	Access to the Region's Core
ATC	Automatic Train Control
BOH	Back-of-house
CE, CatEx	Categorical Exclusion
cfm	Cubic feet per minute
CP	Control Point
EA	Environmental Assessment
EIS	Environmental Impact Statement
ENR	Engineering News-Record
ERY	Eastern Rail Yard
ESD	Empire State Development
FONSI	Finding of No Significant Impact
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HVAC	Heating Ventilation and Air Conditioning
HYCC	Hudson Yards Concrete Casing
IND	Independent Subway System, or MTA Subway B Division
IRT	Interborough Rapid Transit, or MTA Subway A Division
LIRR	Long Island Rail Road
MAS	Maximum Authorized Speed
MEP	Mechanical, electrical, and plumbing
MNR	Metro-North Railroad
MTA	Metropolitan Transportation Authority
MU	Multiple unit
NEC	Northeast Corridor
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NJ	New Jersey
NORAC	Northeast Operating Rules Advisory Committee
NTP	Notice to Proceed
NY	New York
NYCDEP	New York City Department of Environmental Protection
NYCT	New York City Transit
Penn Station	New York Penn Station (also referred to as NYP, NYPS, and NY Penn Station in other publications)
OCS	Overhead catenary systems
OSHA	Occupational Safety and Health Administration
PATH	Port Authority Trans-Hudson
PPDS	Primary Power Distribution System
ROD	Record of Decision
S & I	Service and Inspection
SCADA	Supervisory Control and Data Acquisition
SEM	Sequential excavation method
SOE	Support of excavation
TBM	Tunnel boring machine
tph	Trains per hour
USDOT	United States Department of Transportation
VCE	Vertical circulation elements
WRY	Western Rail Yard

Executive Summary

Amtrak, the Metropolitan Transportation Authority (MTA), and NJ TRANSIT (together, the Partners) are considering alternatives to at a minimum double the trans-Hudson train capacity of New York Penn Station (Penn Station), an effort called the Penn Station Capacity Expansion Project (Penn Capacity Expansion). Some of the options being evaluated by the Partners adapt the station to add capacity within the existing station footprint, while others expand the station boundaries. This report assesses the technical feasibility of two different alternatives for adapting Penn Station to add capacity within the existing station footprint. A separate, future analysis will evaluate alternatives that expand the station boundaries.

The current Penn Station and its operational infrastructure, which includes the tunnels under the Hudson and East Rivers and the interlockings on either side of the station, are functioning above capacity. Greater train capacity at Penn Station is urgently needed to accommodate existing and anticipated passenger demand between New Jersey and New York and to enable Penn Station to provide direct service to a larger network of branch lines than it does today. Long-overdue infrastructure improvements along the Northeast Corridor (NEC), including a new two-track tunnel beneath the Hudson River and rehabilitation of the existing tunnel, will create the capacity to at least double trans-Hudson train service from New Jersey and points west and south. Steady ridership growth along the NEC and population growth within communities in the New York metropolitan region have created demand for utilizing that new capacity. As a result, increasing train capacity and expanding service at Penn Station to accommodate both current and projected future demand will bolster sustainable transportation options and access to economic opportunity in the heart of the New York metropolitan region for decades to come.

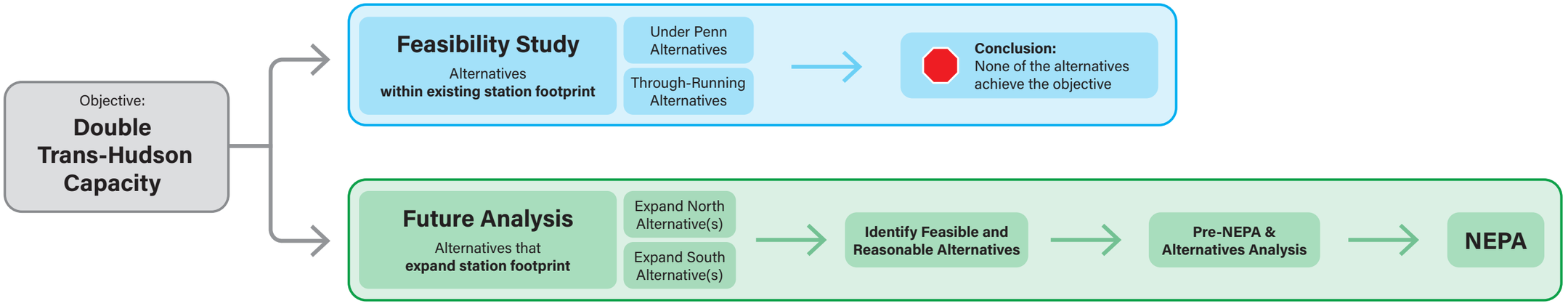
The Partners commissioned the WSP/FXC Team to develop and evaluate potential alternatives for at least doubling the trans-Hudson train capacity of Penn Station. This report documents alternatives that adapt the existing station footprint; alternatives that expand the station footprint will be documented in a separate, future analysis. Federal grant money from the U.S. Department of Transportation (USDOT) will be sought by the Partners for the project. As such, it is subject to environmental review under the National Environmental Policy Act (NEPA), which requires that reasonable alternatives be considered for any federal action. Implementing regulations define "reasonable alternatives" as "a reasonable range of alternatives that are technically and economically feasible, meet the purpose and need for the proposed action, and, where applicable, meet the goals of the applicant."

Contributing to the body of knowledge surrounding the Penn Station Capacity Expansion Project, the primary purpose of this study was to determine if the capacity requirements of the Gateway Program (described in the next section) — a minimum 48 trans-Hudson trains per hour (tph) — could be met within the station footprint. The report documents the process by which potential alternatives within the footprint of Penn Station were identified and details reasons why any alternative not recommended for further study was deemed infeasible.

A second goal of this feasibility study is to better understand the ability of these alternatives to support potential future cross-regional rail service.

Planning Context

The modernization of Penn Station and at a minimum doubling its trans-Hudson rail capacity are integral components of a larger program of regional rail infrastructure improvements centered on the NEC. A 457-mile-long rail corridor from Boston to Washington, D.C., the NEC is the busiest rail corridor in the country, the railroad spine of the East Coast, and an essential platform for metropolitan commuter networks along its length, including those in the New York metropolitan region. Penn Station, located at the midpoint of the NEC, is the busiest and most important station for Amtrak (the owner of the station) and for MTA Long Island Rail Road (LIRR) and NJ TRANSIT (the busiest and third-busiest commuter railroads in the country, respectively), both of which use the station under lease agreements with Amtrak. LIRR operates service on 10 branch lines that feed Penn Station, and NJ TRANSIT runs service on the NEC from Trenton to Penn Station and operates service on four other branches that merge into the NEC before running into New York, carrying over 80% of the ridership on this section of the NEC.



"The 'grow' vision prioritizes and embraces an advanced rail service that seamlessly integrates operations and services of Regional and Intercity operators and incorporates a new corridor-wide Metropolitan service to reach and connect local stations with hub and terminal stations. The vision incorporates operational efficiencies, including common ticketing and integrated planning, with the ability to transform the passenger experience by greatly enhancing convenience, reliability, travel-time savings, and travel choices. The seamlessly integrated rail services possible with operational efficiencies will make more effective use of public investments in infrastructure and will create greater transportation and economic benefits than continuing conventional separate operations."

— NEC FUTURE Tier 1 Final EIS Volume 1 (Preferred Alternative), page 4-24

NEC FUTURE

NEC FUTURE is a long-term investment plan for the entire NEC that aims to expand both intercity and regional commuter rail service throughout the corridor; increase reliability, connectivity, performance, and resiliency; promote equitable development; and bring NEC infrastructure to a state of good repair. Begun in 2012, the Federal Railroad Administration (FRA), an agency within USDOT, developed NEC FUTURE in collaboration with the eight states plus the District of Columbia along the corridor through their transportation agencies and metropolitan planning bodies; Amtrak; and the eight commuter railroads and six freight railroads that use the NEC.

FRA prepared a programmatic environmental impact statement (EIS) for this investment program under NEPA. Called a Tier 1 EIS, it assessed the corridor-wide environmental implications of three levels of expanded rail service across the NEC. The EIS process included extensive public outreach, with 2,500 public comments from 800 organizations and individuals received and responded to. The Record of Decision (ROD), issued in 2017, adopted a Selected Alternative that will grow rail service along the NEC and bring its infrastructure to a state of good repair to achieve modern, efficient passenger rail service for travelers.

The various infrastructure improvements for the New York metropolitan region identified in NEC FUTURE to meet the program goals fall into two groups:

1. At least doubling trans-Hudson rail service by adding two new tracks in a new tunnel below the Hudson River; rehabilitating the existing tunnel and tracks; expanding rail capacity at Penn Station; and numerous supporting infrastructure improvements in New Jersey.
2. Enabling cross-regional service at Penn Station in the longer term by adding two new tracks in a tunnel below Manhattan and the East River to Queens; rehabilitating the existing tunnels; and supporting infrastructure improvements in Queens and the Bronx.

The Tier 1 EIS is intended to be followed by project-specific environmental studies for the identified infrastructure improvements as planning and engineering for each one progresses. These are called Tier 2 studies. Implementing regulations provide for this tiered approach for programs like NEC FUTURE that are too large for a single environmental study to be practical.

Gateway Program

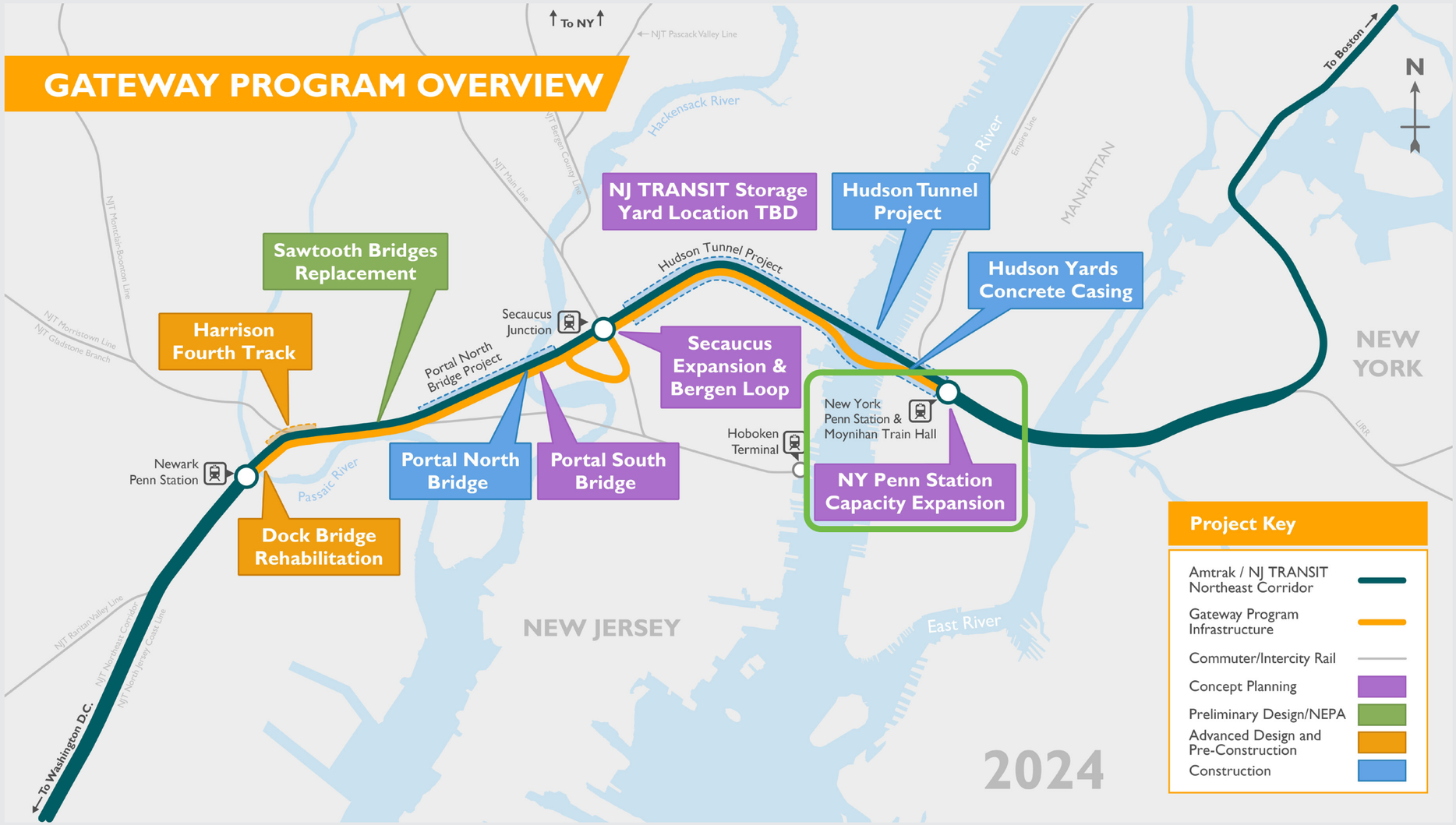
The Gateway Program is a subset of the infrastructure improvements identified in NEC FUTURE, specifically those needed to at least double trans-Hudson rail capacity and service. It is a comprehensive rail investment program to increase capacity and improve reliability, resiliency, and redundancy on the critical ten-mile section of the NEC between Newark Penn Station and New York Penn Station. It includes:

- Building the new two-track Hudson River Tunnel;
- Rehabilitating the existing two-track Hudson River tunnel (known by its original name, the North River Tunnel);
- Constructing concrete casings below Hudson Yards to preserve the Gateway right-of-way into Penn Station;
- Building, rehabilitating, or expanding trackage, bridges, connections, grade separations, and a rail yard in New Jersey; and
- At least doubling trans-Hudson rail capacity to support additional trains from New Jersey.

Figure E-1 illustrates the key components of the Gateway Program.

> **To achieve the NEC FUTURE vision for the New York metropolitan region, all of the Gateway projects, including at least doubling the trans-Hudson train capacity of Penn Station and the construction of the new Hudson River Tunnel, must be completed.**

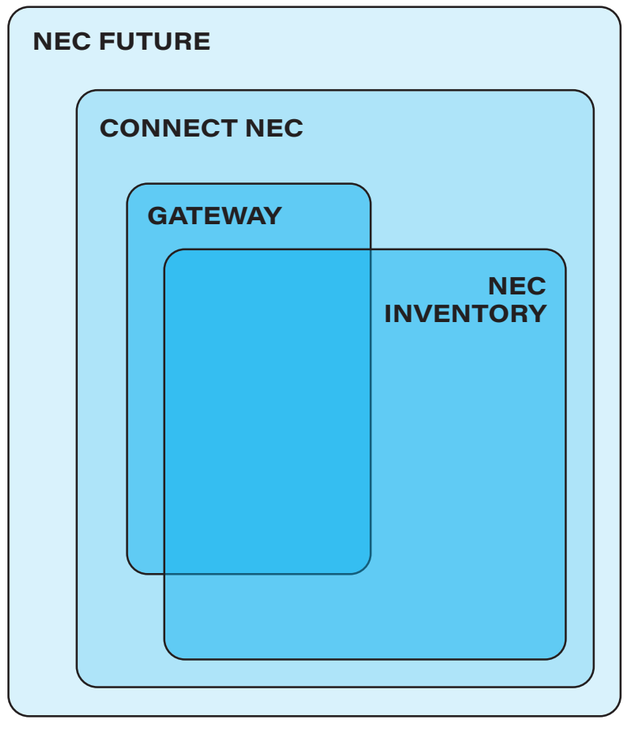
Figure E-1
Gateway Program Overview



Some environmental studies for Gateway projects have already been completed and approved, including EISs for the Hudson Tunnel Project, which is currently in procurement of major construction packages, and the Portal North Bridge in New Jersey, which is already in construction.

CONNECT NEC

The Northeast Corridor Commission (NECC) was established by Congress in 2008 to develop coordinated strategies to improve the Northeast's core rail network. It comprises representatives from each of the NEC states, Amtrak, and the USDOT. In 2021, the NECC published CONNECT NEC 2035 (C35), a 15-year service development plan and infrastructure planning process for the Northeast Corridor as the first phase of NEC FUTURE, identifying 173 potential rail infrastructure projects for implementation. In 2023, the NECC released CONNECT NEC 2037 (C37) as an update to this plan, defining in much greater detail the specific capital investments needed to achieve the service goals laid out in C35 and providing additional analysis of constraints and funding needs. Among the many projects proposed in CONNECT NEC is the expansion of track capacity Penn Station.



NEC Inventory

In 2022, FRA prepared the NEC Project Inventory, prioritizing 68 projects identified in C35 to compete for federal funding made available by the Bipartisan Infrastructure Law between 2022 and 2026. The Gateway projects — including the proposed expansion of Penn Station — are included in the NEC Inventory, as is the proposed modernization of Penn Station concourses. FRA has awarded funding to some projects on the Inventory and continues to allocate funds through the Federal-State Partnership for Intercity Passenger Rail and other grant programs.

Cross-Regional Rail Service and Through-Running

Cross-regional rail service, another major goal of NEC FUTURE for the region, is a general term for any system providing service that connects communities and business centers to an urban center and to each other in a greater metropolitan region. Its focus is on providing regular, all-day bi-directional service among multiple origins and destinations, serving multiple travel purposes.

Regional metro is a specific service concept for cross-regional rail, characterized by frequent, transit-style service (headways of 15 minutes or less) connecting urban and inner-suburban communities to each other, as well as to a city center. Regional metro systems rely on "through running" trains through major stations in urban centers to connect communities on opposite sides of the urban center to each other. This type of service supplements conventional intercity and commuter service on an inner portion of a regional rail network that is configured to accommodate it, and where markets can support it, but does not replace the conventional intercity and longer-haul commuter services that are essential to their regional economies. Regional metro service has been implemented successfully in various cities around the world.

The NEC FUTURE vision for achieving both increased train capacity and cross-regional service mirrors international best practices. At Penn Station, new tunnels and an expansion of the existing station are envisioned, which is a typical solution where regional metro service has been introduced.

In cities where regional metro service has been added to existing commuter and intercity service, such as London, Paris, Madrid, Sydney, Berlin, Munich, and Zurich, and where it is being planned and implemented now, the portion of the regional rail network converted to regional metro service is limited to a smaller number and shorter length of branch lines than we have in the New York metropolitan region. In all cases, new tunnels have been built and major stations have been expanded so that the new regional metro service can run on tracks and platforms that are separate from intercity and commuter service, which run on different headways and which have different operating characteristics and require longer station dwell times at major city center stations. If the services were mixed on the same tracks in major stations, the regional metro service would not be able to achieve the transit-style close spacing of trains that makes it successful.

Cross-regional rail in the New York metropolitan area requires investment across the rail network where the service would be provided. It requires an integrated long-range plan for the entire regional rail network, which does not exist at the present time. There is no single entity with responsibility for rail transportation planning, investment, and operations at the scale of the multi-state region.

While not identified for immediate funding and implementation in Connect 2035 or the NEC Inventory, the

NEC FUTURE vision for cross-regional rail service through New York Penn Station includes through-running regional metro, in addition to maintaining longer-distance suburban commuter service and increasing intercity rail service. Supporting these three service types requires doubling trans-Hudson rail capacity at the station. The intent of the Penn Station Capacity Expansion Project is to achieve that doubling of trans-Hudson rail capacity while simultaneously laying the groundwork for the future implementation of cross-regional service once funding is available and railroads and planning bodies have reached agreement on how best to realize a regional metro network right-sized for our region.

Description of the Alternatives

This study begins with FRA's long-term vision to grow NEC rail service as laid out in NEC FUTURE. Although international practice favors delivery of high-density cross-regional rail service through construction of separate, purpose-built infrastructure through the center of the urban core, local stakeholders have expressed considerable interest in the feasibility of converting Penn Station to all through-running as an alternative to expanding the station footprint and as the basis for cross-regional service. Responding to the interest of stakeholders, and with the goal of applying real-world knowledge to otherwise conceptual ideas, the Partners identified two potential alternatives for doubling trans-Hudson rail capacity at Penn Station by adapting the station within its existing footprint (**Figure E-2**).

While each alternative has many potential variations, the concepts evaluated here are representative of the most common characteristics, including physical design, operation, and impacts. The WSP/FXC Team identified a total of four variations on these two alternatives, called design concepts, that aim to double trans-Hudson train capacity and support cross-regional rail service (**Figure E-3**).

Alternative 1
Under Penn Station

This alternative would aim to double trans-Hudson rail capacity at the station by adding a new track and platform level below the existing track level of Penn Station within the existing footprint of Penn Station. This alternative requires two additional lead tunnels from the new Hudson River Tunnel near Twelfth Avenue and does not provide any direct train connectivity from these new tunnels to Penn Station.

Two design concepts are considered:

Design Concept 1:
Underpinning — Single Level

This design concept would add ten single-level station tracks within the existing Penn Station footprint, directly below the existing lower level of the station.

Design Concept 2:
Mined — Single Level

This design concept would add ten single-level station tracks in multiple mined caverns configured side-by-side within the existing Penn Station footprint, directly below the existing lower level of the station.

Alternative 2
Through-Running

In this alternative, Penn Station would be converted to all through-running service within the existing footprint of the station, aiming to obtain the needed doubling of trans-Hudson rail capacity without expanding the station footprint.

Two design concepts are considered:

Design Concept 1:
Full Station Reconstruction with Side-by-Side Operations

This design concept would completely reconstruct the tracks and platforms of existing Penn Station to optimize it for 100% through-running operations. Total reconstruction would maximize throughput capacity but would be extremely costly and disruptive.

Design Concept 2:
Limited Track and Platform Reconfiguration

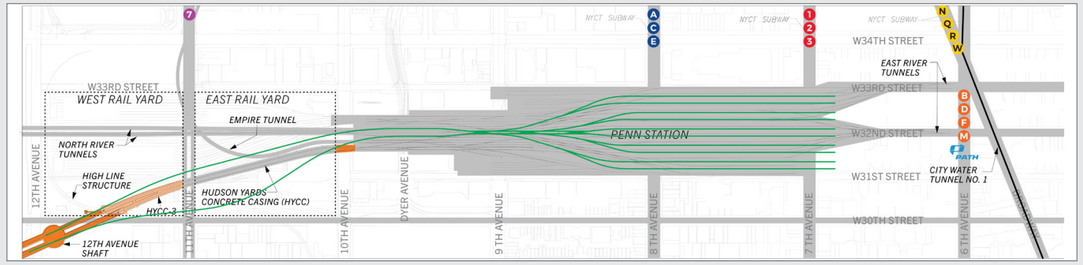
This design concept would deck-over every other track in the existing Penn Station configuration so that the existing platforms could be widened to support simultaneous boarding and alighting, which would shorten dwell times and increase train throughput on the 12 remaining tracks. The objective of this concept is to enable 100% through-running service between points east and west of New York City through Penn Station while minimizing the amount of capital investment required at Penn Station itself. It is based on proposals put forward by ReThinkNYC, an organization advocating for conversion of the existing Penn Station to a fully through-running operation..

Figure E-2

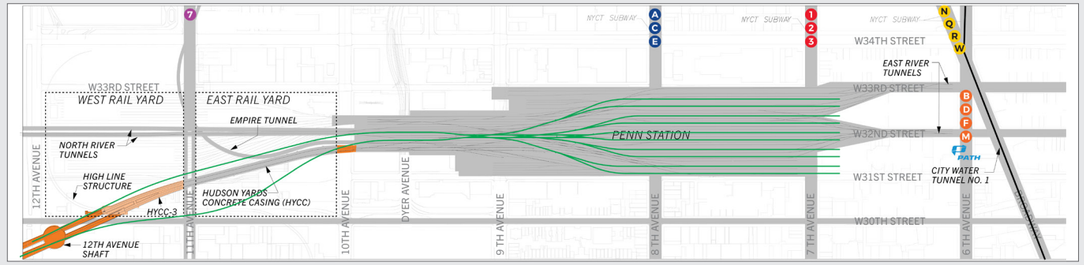
Two alternatives for maximizing rail capacity at Penn Station within the existing station footprint

Figure E-3

Design Concepts Evaluated

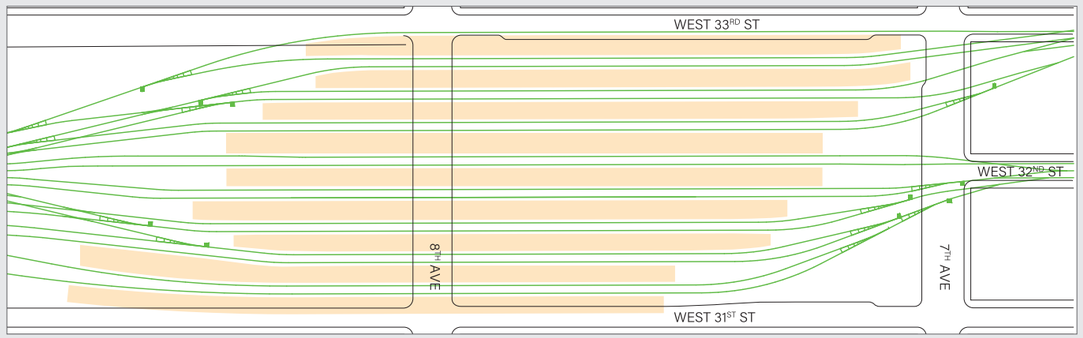


Alternative 1 (Under Penn) Design Concept 1: Underpinning — Single Level

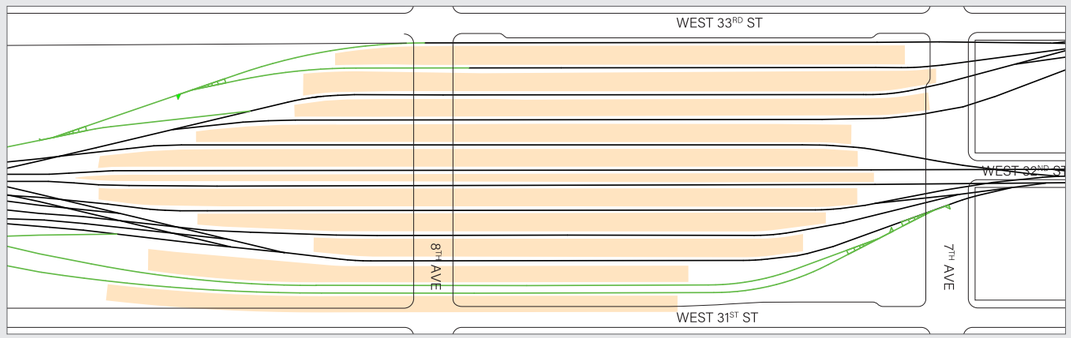


Alternative 1 (Under Penn) Design Concept 2: Mined — Single Level

Legend
- Existing below-grade infrastructure
- Hudson Tunnel Project below-grade infrastructure (30% Design)
- HTP HYCC-3 infrastructure (100% Design)



Alternative 2 (Through-Running) Design Concept 1: Full Reconstruction — Side-by-Side Operations



Alternative 2 (Through-Running) Design Concept 2: Limited Track and Platform Reconfiguration

Legend
- Reconfigured Track Alignment
- Existing Track Alignment
- Reconfigured Station Platforms

Determining Technical Feasibility

The four design concepts were evaluated with respect to their technical feasibility. For the purposes of this report, technical feasibility is a design concept's ability to meet basic engineering requirements, be constructable, and provide the minimum operational performance required for the Gateway Program and consistent with the NEC FUTURE Selected Alternative. Key considerations are:

1. Can the **track geometry** function operationally, and can it provide connections to the existing Penn Station, the existing North River Tunnel, the future Hudson River Tunnel, and the East River Tunnel?

2. Is the concept **reasonable to construct** from a structural and geotechnical perspective, without untenable impacts to existing train service, passenger flows, network operations, structures, utilities, and systems?

3. Can the concept **comply with governing regulations** for emergency egress and ventilation?

4. Can the concept provide total **operational capacity** sufficient to enable peak trans-Hudson rail service to increase to at least 48 tph in the peak direction (doubling the existing trans-Hudson capacity by enabling at least 24 tph in each direction through the new Hudson River Tunnel) while also maintaining existing levels of bi-directional suburban commuter services?

5. Is the concept compatible with the **future cross-regional rail** vision that includes creating a regional metro network, maintaining longer-distance suburban commuter service, and expanding intercity service?

Each alternative was studied for compatibility with the alignment and profile of the new Hudson River Tunnel and the geometry of the western and eastern interlockings (the collection of switches that allow trains arriving from the tunnel tracks to be connected to multiple platform tracks in the station). Conflicts with existing water tunnels, subways, bridges carrying city streets and avenues, and the foundations of existing buildings were considered. Whether ventilation and other fire and life safety needs could be met was considered as well.

The operational capacity of each alternative was estimated to assess if the station could accommodate the full capacity of the two tracks in the new Hudson River Tunnel (at least 24 tph in each direction), while also maintaining existing levels of bi-directional suburban commuter services. If Penn Station is unable to accommodate the 48 tph that the existing and new tunnels can deliver in each direction, then the benefit of that added tunnel capacity cannot be fully realized. Table E-1 presents the incremental trans-Hudson tunnel throughput that can be achieved by each alternative concept and indicates the infrastructure elements that constrain capacity. How well the alternatives would function to support the envisioned future regional rail network also was assessed.

Additionally, the analysis of Alternative 2 considered how trains would operate in the station and interlockings on either side of the station, and how well this alternative would function to support the representative future regional metro network and operating regime assumed for the purposes of analysis. The WSP/FXC Team assessed the necessary modifications to Penn Station tracks and platforms, including Moynihan Train Hall; the Hudson and East River tunnels; the interlockings on both sides of the station; the Harold Interlocking in Queens; the railroad configuration in New Jersey between the portals of the Hudson River tunnels and the Hackensack River; and other associated infrastructure.

The results of this analysis are summarized in **Table E-2**. For a detailed explanation of why alternatives were given the score they were for each criterion, please visit Chapter 5 of this report.

Table E-1

Incremental Trans-Hudson Rail Capacity, compared with Existing North River Tunnel

		Incremental Trans-Hudson Capacity* (tph)	Maintains Existing Level of Bi-Directional Commuter Service?	Capacity-Constraining Elements
Alternative 1: **Under Penn Station**	Design Concept 1: **Underpinning — Single Level**	+14	Yes	Interlocking and vertical circulation to lower platforms
	Design Concept 2: **Mined — Single Level**	+20	Yes	Interlocking
Alternative 2: **Through-Running**	Design Concept 1: **Full Reconstruction**	+24	No	Tunnels and Station
	Design Concept 2: **Limited Track and Platform Reconfiguration**	+16	No	Station

* Compared with capacity of existing North River Tunnel of 24 tph in the peak direction of travel (eastbound in AM peak and westbound in PM peak).

Table E-2

Assessment Summary

		Step 1 (Pass / Fail)					Step 2*	
		Track Geometry	Constructability	Fire-Life Safety	Operational Performance	Future Regional Rail Vision	Construction Cost	Construction Schedule
Alternative 1: **Under Penn Station**	Design Concept 1: **Underpinning — Single Level**	Pass	Fail	Fail	Fail	Pass	-	-
	Design Concept 2: **Mined — Single Level**	Pass	Fail	Fail	Fail	Pass	-	-
Alternative 2: **Through-Running**	Design Concept 1: **Full Reconstruction**	Pass	Fail	Pass	Fail	Fail	-	-
	Design Concept 2: **Limited Track and Platform Reconfiguration**	Pass	Pass	Pass	Fail	Fail	-	-

* None of the design concepts evaluated in this report passed the Step 1 technical feasibility screening.

Technical Feasibility of the Alternatives

Alternative 1: Expand beneath existing Penn Station
Alternative 1 was developed to examine the feasibility of an alternative that confines all underground station infrastructure within the existing footprint of Penn Station. This alternative has ten new station platform tracks on a single horizontal level below the existing track and platform level within the existing footprint of the station. The difference between the two design concepts developed for the alternative (Underpinning — Single Level and Mined — Single Level) is the method of constructing new station expansion infrastructure below the existing station footprint.

The Underpinning — Single Level design concept would require underpinning over 1,000 existing columns between Eighth and Seventh Avenues, which is not technically feasible. The Mined — Single Level design concept avoids this pitfall, but still has a critical remaining fatal flaw. The required operational capacity cannot be achieved due to train movement conflicts at the new single-level interlocking west of the station, which would feed the new lower-level platform tracks.

The Underpinning – Single Level design concept requires the removal of tracks within existing Penn Station to make vertical circulation possible between the station expansion and the main concourse. While a detailed design for the number of tracks that would have to be eliminated is not available at this time, the feasibility analysis showed that at least two, if not more, tracks would have to be removed from existing Penn Station, and therefore the capacity of the existing station would be reduced by three tph per track, or six tph. Therefore, the overall net increase in total station capacity would be substantially lower with this design concept, after taking into account the loss of tracks (and commensurate reduction in trains per hour) from the existing station.

The feasibility of a bi-level mined cavern concept was also investigated to address the capacity limitation of the single-level concept. A bi-level configuration could achieve 24 tph capacity, but the engineering alignment that would achieve reasonable grades would extend the underground station infrastructure eastward beyond Seventh Avenue, well outside the existing station footprint.

Alternative 1 is deemed not technically feasible and is not recommended for further study. Section 5.1 of this report provides a thorough discussion of this alternative and the reasons why it was determined to be not technically feasible.

Alternative 2: Convert the station to all through-running service without expanding its footprint
This alternative remains entirely within the existing footprint of Penn Station. All trains, except those arriving via the Empire Line, would run through the station.[1] Development of this alternative included a review of international practices to determine how to configure the alternative in Penn Station.

Through-running requires platforms 30 feet wide to alight and board passengers quickly and safely. All but one of the 11 existing platforms are between 17 and 23 feet wide. To address this shortcoming, both design concepts propose widening the platforms, at the cost of reducing the number of tracks, currently 21.

In order for through-running to work, both design concepts would require creation of a four-track trunk line with at least three stations — Penn Station in the middle, plus one new station in New Jersey in the vicinity of Secaucus and one new station east of Manhattan in Queens or the East Bronx. New train storage yards and train turnback facilities would need to be constructed at or near the New Jersey and Queens/Bronx trunk line stations. Amtrak NEC trains would run through the trunk line to NEC destinations as they do now. Regional metro trains would run through the trunk line in revenue service on select branch lines on both sides of Penn Station. All other suburban trains would either go into the new storage yards or turn back at the outer trunk line stations.

Design Concept 1, Full Reconstruction, completely reconfigures the track and platform level of the station, providing 17 tracks and nine 30-foot-wide platforms, all in new locations. It divides the station operationally into two side-by-side zones of seven tracks, each operating as its own through-running station, with the two zones separated by three central tracks reserved for Empire Corridor and Hudson Line turnback service and providing additional capacity to accommodate delayed long-distance trains.

This zonal configuration matches the zonal operation of Harold Interlocking in Queens, the busiest and most complex interlocking in the country. It is not feasible to reconfigure Harold to accommodate a “right-hand running” configuration in Penn Station, with the northerly tracks in the station used by westbound through-running trains and the southerly tracks in the station used by east-bound through-running trains. The Side-by-Side Operations design concept avoids this conflict at Harold Interlocking.

Nonetheless, three fatal flaws were identified in the Full Reconstruction with Side-by-Side Operations design concept:

1. It would require the complete reconstruction of the track and platform level at both Penn Station and Moynihan Train Hall and of much of the passenger levels above to accommodate enough tracks and platforms to meet the operational performance requirement. Approximately 1,045 structural columns supporting Penn Station, Madison Square Garden, the PENN 2 office building, Moynihan Train Hall, Farley Post Office Building, Eighth Avenue, and the Eighth Avenue subway lines would have to be relocated or removed and their loads transferred

1 There is only enough capacity on the four East River Tunnel tracks to accommodate through-running of trains from the four tracks in the existing and new Hudson River Tunnels. Accommodating through-running of the trains from the single-track Empire Tunnel would necessitate building an additional tunnel across Manhattan and under the East River. It would not be cost effective to build a tunnel solely for Empire Corridor and Hudson Line service, so those trains are assumed to turn back at the station in Alternative 2. Development of this alternative included a review of international practices to determine how best to configure the rail service and track and platform infrastructure in Penn Station.

to other adjacent columns, with those columns strengthened, their foundations underpinned, and transfer beams and bracing added at the passenger levels. This would be an unprecedented task. The number and extent of required modifications would exceed the practical ability to design a rational structural system.

2. Even if it were technically feasible, the construction staging within Penn Station and Moynihan Train Hall and at the track and platform level would reduce train service at Penn Station by approximately 30% for approximately 12 years, an unacceptable disruption of service in the heart of the NEC that would ripple through the regional economy. The long construction schedule is driven by the complexity of the work required, the need to keep the station operating, and federal regulations governing Railroad Worker Protection (RWP) for construction activity on or adjacent to an active operating railroad.

3. This concept cannot meet the operating requirement to provide an additional 24 tph in revenue service in each direction, or 48 tph total, due to a self-defeating flaw in the trunk line operating logic. Currently, about 12 commuter trains from New Jersey turn back at Penn Station to provide reverse-peak-direction revenue service in the morning peak hour. These turning trains currently use two North River Tunnel slots — one inbound in the peak direction and one outbound in the reverse peak direction. A similar number of Long Island trains enter Penn Station from the east and turn back at the station, using two East River Tunnel slots.

If the New Jersey commuter trains were to turn back at the outer trunk stations instead of at Penn Station, they would need to run through Penn Station twice, now using four tunnel slots in the same peak hour eastbound through the North River and East River tunnels, and then returning westbound through the East River and North River tunnels. The return trip to New Jersey, as it passes through the East River Tunnel back towards Penn Station, would claim a westbound slot in the East River tunnel that otherwise could be used by more heavily patronized trains from Long Island in the peak direction of LIRR travel. Similarly, LIRR morning peak trains turning back at a trunk line station in northern New Jersey would claim an eastbound slot crossing the Hudson River that then would not be available for NJ TRANSIT peak direction trains from the New Jersey suburban branch lines.

Since tunnel slots are the ultimate constraint on the capacity of the Penn Station complex, a 100% through-running service at Penn Station with far-side turnbacks is inherently inefficient and would prevent full utilization of the tunnel tracks by peak-direction trains. All 48 peak-direction tunnel slots on both sides of the station are needed to accommodate the increase in service due to the Gateway Program and Penn Station Access Project, which is extending the Metro-North Railroad (MNR) New Haven Line to reach Penn Station. Each turning train would displace the same number of revenue-service trains. Eliminating reverse-peak-direction service is not a viable option, nor is full integration of the suburban rail networks to enable peak trains from one side of the region to provide suburban reverse-peak service to the outer portions of the network on the other side of the region. Therefore, this flaw makes it impossible to meet the new operating capacity requirement.

Some of these turning trains could eventually be incorporated into the regional metro system, reducing the demand for tunnel slots. But the introduction of new NJ TRANSIT and MNR branches via the Gateway and Penn Station Access programs will require some new suburban trains to turn back to provide reverse-peak-direction service for those new branches. This would counteract the through-running benefits of regional metro service. Further, LIRR trains that run through to storage go into the LIRR West Side Yard in Manhattan without using a tunnel slot in either the existing North River Tunnel or new Hudson River Tunnel. Access to the West Side Yard would be eliminated in a 100% through-running alternative, so those trains would now have to use another Hudson River Tunnel slot to reach a new yard in New Jersey, displacing an Amtrak through-running NEC train or a future regional metro through-running train.

Finally, although running trains through Penn Station reduces the dwell time for each train, the turning suburban trains would now be at a Penn Station platform twice — once inbound and once outbound — canceling out the through-running dwell time benefit for those trains.

There is no interim or final configuration that can deliver the required operating capacity.

Given these fatal flaws, this design concept is not technically feasible and is not recommended for further study.

Design Concept 2, Limited Track and Platform Reconfiguration, helps to address the technical infeasibility of relocating over 1,000 columns. It borrows the physical layout of the station from a plan proposed by ReThinkNYC. The design concept widens seven existing platforms to approximately 30 feet, both extends and widens two existing platforms, and retains two existing platforms in their current configuration.[2] Of the 21 existing station tracks, 12 would be retained in their existing locations. This reduces, but does not totally eliminate, the need for structural modifications and track re-alignment under both Penn Station and Moynihan Train Hall.

Although Design Concept 2 would greatly reduce the number of columns to be removed or reframed, the construction would still entail extensive and complex construction work. It would require a multi-year construction schedule, with substantial impacts to rail traffic and station operations.

In this design concept, the station is divided operationally into two side-by-side stations, each operating as a through-running station, as in Design Concept 1. The north side

2 Existing Platform 10 is already more than 30 feet wide, and the existing Platform 6 in the center of the station would not be widened for geometric reasons.

through-running station zone has four tracks (for regional metro service), and the south side station zone has eight tracks (for all other intercity and suburban rail services).

This design concept has the same fatal flaw in its operating logic as Design Concept 1, with respect to the provision of suburban reverse-peak service. Beyond that flaw, 12 station tracks are not enough to meet the operational performance needs of through-running regional metro service and the remaining suburban services, Amtrak's planned growth in NEC intercity service, and rail service from the Empire Corridor or Metro-North Hudson Line. The throughput capacity of the 12 station tracks is insufficient to handle the three types of train service (intercity, regional metro, and suburban) at 48 tph in the peak direction of flow through the Hudson and East River tunnels, in addition to trains using the Empire Tunnel. It is therefore not technically feasible and is not recommended for further study.

There is no combination of through-running tracks and platforms within the footprint of the existing station that can meet the operational performance needs and still be constructed without massive and unacceptable disruption to service, and there is no lesser modification plan that can be constructed within acceptable limits of disruption of service and still meet the operational performance needs. With fatal flaws in both design concepts, Alternative 2 is deemed not technically feasible and is not recommended for further consideration. Section 5.2 of this report provides a thorough discussion of this alternative and the reasons why it was determined to be not technically feasible.

Conclusion

International best practice for achieving high-density cross-regional rail service includes building purpose-built tunnels and station expansions. Through this study, focused on the specific characteristics of New York Penn Station and its associated infrastructure, it has been found that achieving the needed doubling of trans-Hudson capacity and accommodating regional metro service entirely within the envelope of existing Penn Station is not feasible, so it will be necessary to evaluate the construction of an expansion of Penn Station beyond its existing footprint and provide additional tracks and platforms to meet the operational performance needs.

A separate, future analysis will evaluate alternatives that expand the footprint of Penn Station.