SOUTH STATION
EXPANSION

South Station Expansion Project

Appendix 2 - Track Configuration Alternatives Analysis - Tier 1 Screening Technical Report

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massDOT
Massachusetts Department of Transportation

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1. Introduction

The Massachusetts Department of Transportation (MassDOT), the Massachusetts Bay Transportation Authority (MBTA), and the National Railroad Passenger Corporation (Amtrak) have for decades identified the expansion of rail capacity at Boston South Station as a crucial transportation need, one that has been articulated in multiple local, regional, state, and Northeast Corridor (NEC)-wide planning documents.[1] In cooperation with the Federal Railroad Administration (FRA), Amtrak, and the MBTA, MassDOT is now pursuing the expansion of South Station to support existing NEC and commuter rail services and to provide for future Amtrak and MBTA service expansions. The current track capacity, layout, and operations of South Station limit the ability to accommodate projected future expanded services. In addition to expanding South Station terminal facilities, the South Station Expansion (SSX) project will also identify a solution to address existing and future intercity and commuter rail service layover needs. The SSX project includes planning, environmental reviews, and preliminary engineering for the five primary elements of the project:

1. **Expand the South Station terminal facilities,** including the addition of up to seven tracks and four platforms and construction of a new passenger concourse and other amenities.

2. **Acquire and demolish the U.S. Postal Service (USPS) General Mail Facility** located on Dorchester Avenue adjacent to South Station, which would provide an approximately 14-acre site on which to expand South Station. (Note that the relocation of the USPS facility will be the subject of a separate environmental review process by others.) Dorchester Avenue would be restored for public and station access.

3. **Create an extension of the Harborwalk along reopened Dorchester Avenue**.

4. **Provide for the possibility of future joint public/private development** adjacent to and over an expanded South Station.

5. **Provide adequate rail vehicle layover space** to address existing and future intercity and commuter rail service needs.

This Track Configuration Alternatives Analysis - Tier 1 Screening Technical Report has been prepared in support of the Draft Environmental Impact Report (Draft EIR) and Environmental Assessment (EA) for the SSX project, in accordance with the Certificate of the Secretary of the Office of Energy and Environmental Affairs (EEA) on the Environmental Notification Form (ENF) for the SSX project (April 19, 2013), the Massachusetts Environmental Policy Act (MEPA) regulations, 301 CMR 11.00 (revised, May 10, 2013), and the FRA's Procedures for Considering Environmental Impacts, 64 Federal Register (FR) 101 (26 May 1999), pp. 28545-28556.

2. Summary of Findings

Boston South Station is the northern terminus of the Northeast Corridor, connecting the cities of New Haven, New York, Philadelphia, Baltimore, Washington, D.C. and beyond to local and intercity destinations around New England. It is also one of Greater Boston's most important transportation assets.

[1] Documents citing the need for an expanded South Station include: *Critical Infrastructure Needs on the Northeast Corridor* (2013), *The Northeast Corridor Infrastructure Master Plan* (2010); *The Amtrak Vision for High-Speed Rail in the Northeast Corridor* (2010), *A Vision for the Northeast Corridor* (2012), the Massachusetts Department of Transportation *Rail Plan* (2010), the Massachusetts Department of Transportation *Freight Plan* (2010), and the two most recent long range transportation plans of the Boston Region Metropolitan Planning Organization (2007, 2011).

South Station offers commuters and travelers not only Amtrak intercity and MBTA commuter rail services, but also intercity bus, MBTA rapid transit, and MBTA bus rapid transit services (including a direct bus rapid transit connection to Boston's Logan International Airport).

During the planning stage of project development, MassDOT identified and evaluated a first set of rail infrastructure alternatives for consideration at the SSX project site. These concepts were developed and evaluated as a part of a first level, or Tier 1, analysis. The alternatives remaining from this analysis were identified as those to be advanced into the DEIR. This Technical Report provides a summary of the preliminary rail alternatives that were considered and studied to date, and the results of the evaluation and screening of these alternatives.

Section 3 of this Technical Report gives an overview of the existing conditions with respect to rail systems at the South Station Terminal. Rail systems consist of:

- Railroad tracks.
- Signal system.
- Traction power.
- Overhead contact system (OCS).
- Communication system.
- Civil works as well as appurtenant structures.

Section 4 documents the track configuration alternatives studied as part of this Tier 1 Alternatives Analysis. Two sets of rail alternatives that would satisfy the project purpose were evaluated: Unconstrained and Constrained Alternatives. The Unconstrained Rail Alternatives presented alternatives that were not limited by the boundary of the existing South Station and USPS property and/or contemplated a complete rebuild of the South Station Terminal to capture all potential operational benefits. These alternatives explored opportunities that were outside of the original study area, but could help achieve the project goals. However, the Unconstrained Rail Alternatives were found to have a substantial impact to the existing infrastructure adjacent to and within the terminal. Also, the costs associated with the Unconstrained Rail Alternatives outweighed operational benefits gained by these alternatives, and alternatives within a more defined boundary, the Constrained Rail Alternatives, were then analyzed.

A total of four Constrained Rail Alternatives were analyzed with a more conservative approach in order to minimize impacts to the existing infrastructure, while still improving operations to and from the terminal. Constrained Rail Alternative 1 proposed a total of 19 tracks while Constrained Rail Alternatives 2 through 4 proposed a total of 20 station tracks. MassDOT had previously determined[2] that 20 tracks was the optimal number to achieve the 2030 operating plan. The use of 19 tracks was contemplated, but the study found that while the service plan was possible, delays could result. As such, it would be preferable to have 20 tracks for the expansion program.

Section 5 sets forth the rating criteria utilized and the results of the screening of the Tier 1 alternatives. Rating criteria were established to evaluate the ability of the Constrained Rail Alternatives to meet future rail system requirements as measured by: platform accessibility and length; infrastructure maintenance requirements; constructability; and capital costs. Based on this evaluation, it was determined that Constrained Rail Alternatives 2 and 3 be further studied in the next phase of project development. Constrained Rail Alternatives 2 and 3 are both similar in size, configuration and operations. As such, the

[2] Massachusetts Department of Transportation, *Massachusetts Department of Transportation Boston South Station HSIPR Expansion Project, Technical Memorandum: Network Simulation Analysis of Proposed 2030 MBTA/Amtrak Operations at South Station*. Final Report. August 1, 2010. http://www.massdot.state.ma.us/Portals/25/Docs/FRA_HSIPR/Appendix_A1.pdf.

similar track configuration of these alternatives was evaluated in the DEIR in order to determine the rail impacts of the SSX project.

Section 6 discusses the steps that would be involved in the next phase of the Tier 2 analysis.

Figures are provided at the end of this technical report.

3. Existing Conditions

The South Station project site is shown on Figure 1. The project site includes the station as well as the approach (or setup) interlockings and layover yards. Approach interlockings are further discussed in the following section. The South Station Rail Terminal area consists of 13 tracks, eight platforms and a system of trackwork (also referred to as interlockings) that allow Amtrak and MBTA trains to access the station from the NEC and Framingham/Worcester Line from the west and southwest and the MBTA's Fairmount Line and Old Colony Railroad from the south. As South Station is a terminal facility, every arriving train results in a departing trip, either as a scheduled trip to another outlying terminal or to a layover or service facility. Current weekday operations at South Station include 40 Amtrak and 280 MBTA revenue trips, and 32 Amtrak and 97 MBTA non-revenue trips, for a total of 434 daily train movements at the terminal.[3]

Amtrak and the MBTA currently use four layover yards to support South Station operations: Amtrak's Southampton Street Yard, Amtrak's Front Yard, MBTA's South Side Service and Inspection (S&I), and MBTA's Readville – Yard 2. All of Amtrak's existing layover needs (daytime and overnight) are accommodated at the Southampton Street Yard, which allows the MBTA to utilize a portion of the Amtrak yards during the midday hours. Current MBTA service levels require daytime layover space for 28 trainsets (locomotives and coaches), but space exists only for 22 trains. This shortfall in six layover spaces requires the MBTA to store non-revenue trains at the station platforms while waiting for available slots at the existing south side layover facilities, or to move the trains around the rail system.

Other components of rail systems are signal systems, traction power, OCS, communications system, and civil work, as well as appurtenant structures. Civil work typically includes impervious parallel drainage systems and related drainage structures to properly convey stormwater runoff; any embankments and cuts on which the railway is built; and any retaining walls or other earth supporting structures required to hold railway embankment and cut side slopes in place. Rail systems include elements such as turnouts, switches, and frogs, among others. Standard turnouts and frog angles are utilized to tie into the main line tracks. A turnout is an arrangement of a switch and a frog with closure rails which diverts the train from one track to another. A switch is a pair of movable track rails providing a connection over which to move the train from one track to another. A frog is an assembly that lets the flanged rail wheels cross over the opposite rail. The closure rails are the rails that connect the switch and the frog. Turnout sharpness is designated by the angle of the frog and determines the speed by which a train can go over the frog in a diverging movement, which is a move from one track to another. Figure 2 shows a yard area catch basin, a combined sewer service connection, a dwarf signal, and overhead contact system (Tower 1 Interlocking) in the South Station terminal area. Signal systems, traction power, OCS, communication system, and civil works are not the subject of this report as the same challenges apply for all alternatives. These would be further studied as part of preliminary engineering design once a preferred alternative is chosen.

[3] Current weekday daily train movements are based on Amtrak Timetable effective January 14, 2013; MBTA Schedules effective April 29, 2013; and MBTA South Side Equipment Cycle effective April 29, 2013.

Additionally, though it is not yet under construction, the proposed South Station Air Rights (SSAR)[4] project is considered to be built and in place prior to the expansion of South Station and, as such, all improvements to be made as part of the SSAR project were considered in the rail alternatives development.

3.1 Existing Terminal Interlocking System

Figure 3 presents a diagram of the existing South Station terminal area track, layover, and six interlockings controlling train movements. An interlocking is a segment of railroad infrastructure comprised of track, turnouts, and signals linked (interlocked) in a way that allows for trains to move from one track to another, or across tracks, safely preventing conflicting train movements. The interlockings enable train dispatchers to route incoming trains over a variety of tracks to/from available station tracks. In addition to the primary interlocking close to South Station, called Tower 1 Interlocking, approach interlockings are critical to terminal operations because they maximize incoming and outgoing train movements during peak periods. Additionally, interlockings serve to stage trains during off-peak periods, thereby keeping non-revenue trains off active tracks and minimizing congestion at the station.

There are nine main line approach tracks, which currently converge through Tower 1 Interlocking and then expand into 13 station tracks and eight platforms in the South Station Terminal area. Of these nine main line tracks, five mainline tracks arrive at South Station from the west, consisting of the NEC main line, which operates on Tracks 1, 2, and 3, and the Framingham/Worcester Line, which operates on Tracks 5 and 7. The remaining four main line tracks arrive at South Station from the south, and consist of the Fairmount Line/Dorchester Branch, which operates on Fairmount Line/Dorchester Branch Tracks DB1 and DB2 and the Old Colony Line, which operates on Tracks OC1 and OC2. These four tracks also access the Amtrak and MBTA train maintenance facilities and layover yards.

Amtrak and the MBTA currently utilize one main (Tower 1) interlocking and two approach interlockings for routing trains into and out of South Station. Presented in order from closest to most distant from South Station, the three interlockings are as follows:

3.1.1 Tower 1 Interlocking

Located immediately south of the South Station passenger terminal at the northerly end of all MBTA and Amtrak lines which come into South Station from the south and west. The existing Tower 1 Interlocking consists of nine main line approach tracks converging through Tower 1 Interlocking and expanding into 13 station tracks and eight platforms in the station area. It contains two long ladder tracks that allow a train approaching South Station on any track to reach nearly every platform track.

3.1.2 Cove Interlocking

Located southwest of South Station at the confluence of the Northeast Corridor (NEC) and the Framingham/Worcester Line, the Cove Interlocking consists of eight crossovers and one turnout. This interlocking allows for the movement of trains between the three NEC and two Framingham/Worcester Line tracks and allows trains to access more South Station platform tracks than if they were limited to Tower 1 Interlocking only. This interlocking also allows trains to access the MBTA and Amtrak maintenance facilities via the Wye track.

[4] The South Station Air Rights (SSAR) project was approved by the Secretary of the Executive Office of Energy and Environmental Affairs, April 2006 (EEA No. 3205/9131).

3.1.3 Broad Interlocking

Located just north of the MBTA's South Side S&I Facility, in the vicinity of Broadway Bridge, where the Fairmount Line/Dorchester Branch and Old Colony Railroad Lines merge, Broad Interlocking consists of multiple turnouts and slip switches that allow for the movement of trains to and from South Station, to and from the MBTA's South Side S&I Facility, and to and from Cove Interlocking via the Wye track.

3.2 Current Operating Constraints

Current capacity at South Station constrains existing operations and negatively impacts the ability of the station to service projected intercity and commuter rail service expansions. During the morning and afternoon peak periods, operations are near capacity with a limited ability to expand service on the shoulders of the peak periods. Service reliability at South Station, measured by minutes of delay and on-time performance (OTP), is adversely impacted by chronic terminal congestion. Due to the interconnectedness of service at South Station, where revenue train movements are directly linked to non-revenue train movements, as well as the complexity of crossover moves through the terminal interlocking area, individual train delays not only impact overall station operations, but also produce cascading effects upon service line operations.

3.2.1 Interlocking Infrastructure Constraints

The existing configuration of Tower 1, Cove, and Broad Interlockings limits the capacity of the terminal area. Tower 1 Interlocking allows a train approaching South Station, on any track, to reach nearly every platform track, limiting the number of trains that can simultaneously move through the interlocking. In addition, the shorter, low speed turnouts force diverging moves to be made at reduced speeds (10 miles per hour [mph]) in the Tower 1 Interlocking. Cove and Broad Interlockings have higher speed turnouts but do not have the capacity to handle all the diverging moves needed for efficient operations in and out of the station area. This forces many diverging moves to be made at Tower 1 Interlocking at 10 mph vs. 30 mph at Cove Interlocking, creating more conflicts, and resulting in additional delays.

3.2.2 Location of Layover Facilities

The location of layover facilities is one of the main factors that determines the required diverging moves within Tower 1 and the approach interlockings for both revenue and non-revenue trains moving in and out of South Station. Currently, all layover facilities are located south of South Station. The lack of the layover facilities to the west of the station creates serious capacity constraints within the terminal area. Non-revenue yard movements from the lower numbered tracks at the westerly side of the station must crossover to the Fairmount Line/Dorchester Branch that provides access to Amtrak's Southampton S&I Facility and Readville Yard. While in progress, these crossover moves block access to most of the South Station platforms, obstructing operations on the NEC and Framingham/Worcester Line in or out of the station. As Amtrak and MBTA commuter train volumes increase, these capacity constraints will severely hinder operations within the existing infrastructure. Revenue trains will be competing with each other for limited capacity and terminal track space, as well as with non-revenue trains moving between the station and yards.

In March of 2013, MassDOT initiated an assessment of potential layover sites to address the needs of the SSX project. This report[5] addressed the proposed location and configuration of the layover facility sites for South Station. A key finding of this analysis was that locating layover facilities on both south and

[5] Massachusetts Department of Transportation. *Layover Facility Alternatives Analysis Report*. Version 0. March 2013. www.massdot.state.ma.us/Portals/25/Docs/efs/C-LayoverFacilityAlternativesAnalysisReport.pdf.

west of South Station would be beneficial to operations into South Station by reducing the need for trains to cross over the Tower 1 Interlocking to reach platforms and, as such, impede access into and out of the station.

3.2.3 Inadequate Platform Size

Currently, South Station has 13 platform tracks and eight platforms. Existing platforms are 17 feet-6 inches wide and are of varying lengths. The existing station layout limits the length of several of the platform tracks. Tracks 1, 2, and 12 can hold a maximum of seven-car trainsets each for MBTA trains and Track 13 can only hold a maximum of six-car trainsets. Existing track lengths limit the potential for longer trainsets required to meet future demand. The MBTA anticipates using eight and nine-car trainsets to accommodate projected future growth. Amtrak has stated at stakeholder meetings on the SSX project that while they have not determined the specific size of their trainsets in the future, they are confident that they will be longer than the ones that currently service South Station (current Amtrak train lengths at South Station are 664 feet for Amtrak Acela and 748 feet for Amtrak Regional trainsets).

Additionally, mid-platform boarding with mid-platform access to the headhouse is currently not an option at South Station. Currently, the only access to the headhouse is from the north end of the platforms, which creates crowded conditions for passengers alighting and boarding. Being able to provide mid-platform access would improve passenger flows and would meet modern design standards.

3.2.4 South Station Air Rights Project

Current platform constraints may be further exacerbated by the proposed SSAR project. This project would consist of approximately 1.8 million sf of mixed-use development to be located directly above the railroad tracks at the existing South Station headhouse. The SSAR project will also include expansion of the existing bus terminal towards the existing headhouse. The SSAR project was approved by the Secretary of EEA in 2006; however it has not yet begun construction. Nonetheless, for environmental review of the SSX project, the SSAR project is assumed to be built for the future year analysis, and is part of the SSX project's No Build Alternative. Coordination of the design elements of the SSAR project and the SSX project will be required in the next phase of project development. Consideration of the interrelationship of the two project's design elements, such as platform lengths, column placement and passenger access, will be carefully reviewed to ensure consistency in planning and design. Figure 4 shows the station platform configuration under the SSAR project. Table 1 depicts existing compensated platform lengths and the compensated platform lengths as modified by the SSAR project. The compensated lengths include the distance from the station end of the platform to the face of the bumping post and the 10-foot buffer.

Table 1—Existing Compensated Platform Lengths at South Station

Track	Platform	Existing Length (feet)	SSAR Length (feet)
1	A	706	706
2	B	781	781
3	B	815	795
4	C	956	936
5	C	989	920
6	D	1066	997
7	D	1104	1015
8	E	1183	1094
9	E	1230	1200
10	F	1219	1157
11	F	891	891
12	G	658	658
13	H	538	538

4. Track Configuration Alternatives

In addressing the SSX project goals of eliminating operating capacity constraints, improving (OTP), and facilitating a more efficient and attractive passenger rail network in the NEC, the Tier 1 rail alternative screening evaluated two sets of rail engineering alternatives: "Unconstrained" Rail Alternatives and "Constrained" Rail Alternatives. For both sets of alternatives a list of fixed elements (elements or structures that would remain and could not be modified) and flexible elements (all other elements that could be impacted and/or reconfigured) was developed that determined the limits within the project study area.

The Unconstrained Rail Alternatives presented alternatives that completely rebuild the South Station Terminal and capture all potential operational benefits. In addition to the impact of completely rebuilding the terminal, the Unconstrained Rail Alternatives have substantial impacts to public and private property adjacent to the terminal and along the railroad right-of-way. These alternatives explored opportunities that were outside the limits of the original study area, but were considered for their ability to achieve the project goals. All aspects of a complete rebuild of the station terminal area were explored by studying these "out-of-the-box" alternatives and realizing the opportunities available and quantifying the infrastructure impacts. The costs associated with the Unconstrained Rail Alternatives were determined to outweigh the operational benefits gained therefore, alternatives within a more defined boundary, the Constrained Rail Alternatives, were then analyzed.

The Constrained Rail Alternatives were developed to minimize impacts to the existing infrastructure while still improving operations to and from the terminal. These alternatives were designed to provide the recommended 20 tracks, within the originally determined boundary, and minimize impacts to adjacent infrastructures.

Railroad standards were utilized to modify the existing Tower 1 Interlocking and South Station Terminal area. Future service demands by Amtrak and the MBTA, as reflected in the 2035 operations plan, requires an additional seven station tracks to berth Amtrak and the MBTA trainsets. At Tower 1 Interlocking, restricted Number Eight (No.8) turnouts were utilized to provide connection into the main line track. The rigid special trackwork infrastructure of a Number Eight turnout is approximately a twelve degree (12^{o}) curve and would govern the proposed track alignment off of the existing main line to 10 mph. Specialized trackwork must always maintain the proposed frog angle and degree of curve. This added complexity makes the railroad alignment challenging in the constrained geographic conditions that exist at South Station.

4.1 Unconstrained Rail Alternatives

A set of four unconstrained, conceptual-level alternatives (Unconstrained Rail Alternatives 1, 2, 3A and 3B) were developed for the purpose of expanding rail capacities at South Station. The intent of these alternatives was to approach the design of the rail elements with few limitations and in order to provide idealized design standards. Within the realm of Unconstrained Rail Alternatives, MassDOT determined that certain elements or structures would remain as-is (fixed elements) and all other elements could be impacted and/or reconfigured (flexible elements). Three distinct alternatives were developed within the context of these fixed and flexible elements. Table 2 shows a list of fixed and flexible elements that were determined for the Unconstrained Rail Alternatives.

Table 2—Fixed and Flexible Elements for Unconstrained Rail Alternatives

Project Elements	Fixed	Flexible
South Station headhouse	X	
I-90/Mass Turnpike tunnels and ramps	X	
I-93 and ramps	X	
Fort Point Channel and 100-foot buffer zone	X	
Reopening of Dorchester Avenue for public use	X	
Central Artery/Tunnel (CA/T) vent buildings	X	
MBTA Red Line	X	
Provision not to preclude future subsurface alignment	X	
SSAR Project, Phase 1 (Tower)		✓
245 Summer Street		✓
Acquisition and relocation of the USPS Facility		✓
Existing tracks and platforms		✓
Tower 1 Interlocking		✓
Approach interlockings		✓
South Station Bus Terminal and ramps		✓
Consideration of a grade-separated rail station		✓
Overhead bridges on approaches to South Station		✓
Station tracks being elevated or located below ground surface at Dorchester Avenue		✓
Wye track		✓
MBTA's Red Line train storage facility - Cabot Yard		✓
Addition of overhead contact system (OCS) infrastructure to the Fairmount Line/Dorchester Branch to electrify and facilitate use by Amtrak		✓

X= Fixed Elements; ✓= Flexible Elements

MassDOT determined that all project alternatives would not preclude a future subsurface alignment, as determined by the Secretary of Energy and Environmental Affairs (Certificate on the SSX project Environmental Notification Form, April 19, 2013). Additionally, MassDOT evaluated the Unconstrained Rail Alternatives - as well as Constrained Rail Alternatives – to maintain a 100-foot buffer zone from the Fort Point Channel, as defined by the Massachusetts Wetlands Protection Act.

4.1.1 Unconstrained Rail Alternative 1 – 20 Tracks at Grade

Unconstrained Rail Alternative 1 proposes to demolish all existing tracks and platforms at South Station and construct 20 new tracks and 11 new platforms at South Station, as illustrated in Figure 5. This alternative represents a "best case" scenario from a terminal track design perspective and presents an ideal alignment to serve the existing and future demands of rail operations and passengers at South Station. This alternative proposes to create an entirely new terminal track layout where all of the platforms would

meet the current MBTA standard and at least 10 platforms would be long enough to accommodate Federal Railroad Administration's (FRA's) initial suggestion for 1,312-foot long platforms for future high-speed rail trains. In order to provide those platform lengths, the new station would extend north and require the purchase of the property at 245 Summer Street.

This alternative would acquire and demolish the existing USPS Facility adjacent to Dorchester Avenue, and the new South Station footprint would incorporate both the existing station parcel and the USPS parcel. In the new terminal track layout all tracks would be at the same grade as the existing tracks "at-grade" and would run parallel to Dorchester Avenue, shifting the tangent bearing of the existing tracks to be parallel with the Fort Point Channel. This shift in the terminal track alignment dictates the tracks on the Fort Point Channel bridge to shift easterly requiring a widening of the Fort Point Channel bridge to add two more tracks to the east. All of the platforms would have access to natural daylight and ventilation and a reconfigured Tower 1 would ensure optimal operational capacity.

- **Opportunities – Unconstrained Rail Alternative 1**
  - Adds seven tracks to South Station Terminal increasing the overall terminal capacity by approximately 55%. South Station currently has 13 tracks and the 20 total tracks accommodate the projected future service programs for Amtrak and MBTA.
  - Adds two tracks across Fort Point Channel to reduce complexities associated with the Tower 1 Interlocking and to improve access to and from maintenance facilities. These additional tracks reduce conflicting movements through the Tower 1 Interlocking.
  - Creates potential for 10 or more 1,312-foot long platforms (in accordance with the FRA's preference for high-speed rail station platforms). This platform length is being held as a suggested platform length throughout the NEC and accommodates existing and proposed trainset lengths as well as allows for growth in the future.
  - Creates one fully integrated intermodal station serving intercity passenger rail, commuter rail, transit, and bus service passengers.
  - Provides new 22-foot wide platforms to meet current MBTA and Amtrak standards.
  - The new 22-foot wide platforms could accommodate vertical circulation elements on the platforms. The introduction of vertical circulation elements allow for full mid-platform boarding, improving passenger flow and meeting modern design standards.

- **Impacts/Challenges – Unconstrained Rail Alternative 1**
  - The acquisition of 245 Summer Street requires a significant upfront capital investment for the purchase of the property. The building currently serves as the headquarters for a major financial investment company.
  - The acquisition and demolition of the existing USPS Facility
  - The track configuration would require the removal and reconstruction of the entire South Station Bus Terminal structure. The bus terminal was built over the tracks and southern end of the platforms in 1992 and is fully functional with years of expected life remaining. Demolition and reconstruction of this facility would impact city bus routes that stop in the vicinity of South Station; commuter service between South Station and the greater Boston metropolitan area, and regional service to New England and points beyond provided by eleven private bus companies operating out of the terminal.
  - As part of a previous reconstruction project, foundations for a future bus expansion were set in the existing track layout and columns were constructed in Platform G and Platform H to support expansion of the bus garage north towards the headhouse over the platforms. These foundations and columns would have to be removed.
  - The demolition and reconstruction of all existing tracks and platforms present major impacts to existing operations during construction as all trains entering South Station today would

have to be stopped at nearby Amtrak and/or commuter rail stations for an extended period of time and busing of passengers would be necessary to/from South Station.
- Requires reconfiguration of Tower 1 Interlocking in its entirety. This presents major impacts to existing operations during construction as all trains entering South Station today would have to be terminated at nearby Amtrak and/or commuter rail stations for an extended period of time.
- Requires new two-track bridge across Fort Point Channel. This new bridge would be necessary in addition to the existing bridge to accommodate the new approaches.
- Requires replacement bridges at Broadway and West Fourth Street to accommodate the new approaches.
- Limits the amount of street-front retail along Dorchester Avenue, due to location of platforms at 100-foot setback from Fort Point Channel.

4.1.2 Unconstrained Rail Alternative 2 – Bi-Level South Station

Three different concepts were initially developed to accommodate optimal terminal track infrastructure for existing and future South Station ridership by constructing a bi-level station, but due to considerable impacts and limited benefits only one was fully analyzed in the Tier 1 screening. The three concepts were as follows:

1. The first proposed concept is a new bi-level station on the existing USPS property adjacent to the existing tracks, platforms, and bus terminal. This concept keeps the existing tracks, platforms, and the bus terminal in place. In order to establish a bi-level station in accordance with MBTA and Amtrak standards, a maximum gradient of 1% is required. To meet this criterion, the Old Colony and Fairmount Line/Dorchester Branch tracks would have to be elevated through the Tower 1 Interlocking. The foundations and piers of this aerial structure would create significant complexities and impacts to Tower 1 infrastructure as the Tower 1 Interlocking is already constrained today with existing tracks, special trackwork, signal equipment, OCS poles and foundations. Due to the physical limitations at Tower 1 Interlocking this concept was not progressed further.
2. The second bi-level station concept proposes depressing the lower level of the station below the existing tracks. This concept creates conflicts with the three tunnels (Ramp D, I-90 West Bound, and I-90 East Bound) that are directly beneath the commuter rail tracks leading into the South Station Terminal. These tunnels were constructed as part of the Massachusetts Turnpike Authority's Central Artery/Tunnel (CA/T) project and have shallow soil cover (approximately 18-feet) above the top of the tunnel. Due to conflicts with the CA/T tunnel system this concept was not progressed further.
3. The third concept, Unconstrained Rail Alternative 2, proposes a new bi-level South Station on the site of the existing platforms, tracks, Bus Terminal, and USPS property. This concept was studied further and is explained below.

Unconstrained Rail Alternative 2 proposes a bi-level South Station whereby trains approaching the station from the Framingham/Worcester Line and NEC Main Line would arrive at the first (lower) level; and trains approaching the station from the Fairmount Line/Dorchester Branch and Old Colony Lines would arrive at the second (upper) level, as shown in Figure 6 and Figure 7. In order to establish a bi-level terminal in accordance with MBTA and Amtrak standards, a maximum gradient of 1% is required. Meeting this criterion pushes the modifications for Tower 1 Interlocking to the south substantially, impacting the Fort Point Channel Bridge, West 4th Street and Broadway overhead bridges. In addition to the impact to the bridges, the first and second levels of the bi-level station would completely sever Framingham/Worcester Line and NEC Main Line station tracks and platforms from the Old Colony Line and Fairmount Line/Dorchester Branch station tracks and platforms. This would complicate rail

operations as trains entering the terminal from Framingham/Worcester Line and NEC Main Line would not be able to exit out of the terminal on Fairmount Line/Dorchester Branch and Old Colony Line, essentially creating two separate terminals.

A complete demolition of the existing platforms and tracks allows for all of the proposed platforms to be designed to meet the current MBTA and Amtrak standards as well as the FRA-suggested 1,312-foot long platform length. In order to accommodate those platform lengths, the new station would extend north and require the purchase of the property at 245 Summer Street. The bi-level form of the station creates an enclosed condition for the lower tracks/platforms, but it allows for significantly more terra firma for development opportunities along Dorchester Avenue. Similar to Unconstrained Rail Alternative 1, this alternative would acquire and demolish the existing USPS Facility adjacent to Dorchester Avenue; the new South Station footprint would incorporate both the existing station parcel and the USPS parcel.

- **Opportunities – Unconstrained Rail Alternative 2**
  - Increases the overall terminal capacity by approximately 55%. South Station currently has 13 tracks and the 20 total tracks accommodate the projected future service programs for Amtrak and MBTA.
  - Simplifies Tower 1 special trackwork and reduces congestion by minimizing complex moves and allowing trains to pass through Tower 1 more efficiently.
  - The proposed station consumes less of the USPS property and allows for more terra firma to be available for development along Dorchester Avenue across from the Fort Point Channel. The additional space increases the flexibility of the property for future development and increases the property value to the Commonwealth.
  - Provides new 22-foot wide platforms to meet current MBTA and Amtrak standards.
  - Enables construction of FRA-suggested 1,312-foot long platforms.

- **Impacts/Challenges – Unconstrained Rail Alternative 2**
  - Completely severs Framingham/Worcester Line and NEC Main Line station tracks and platforms from the Old Colony Line and Fairmount Line/Dorchester Branch station tracks and platforms. This, in turn, complicates rail operations not allowing trains entering the terminal from Framingham/Worcester Line and NEC Main Line to exit out of the terminal on Fairmount Line/Dorchester Branch and Old Colony Line; essentially having first and second levels functioning as two separate terminals.
  - NEC Main Line and Amtrak trains on lower level have no access to Southampton Amtrak shop and layover facility. Alternative may be to electrify Fairmount Line/Dorchester Branch and use upper level. Electrification and associated infrastructure modifications have been under discussion for many years in the Northeast and have been determined to be major undertakings.
  - Requires new approach structure and Fort Point Channel bridge replacement. In order for trains to approach the upper level platforms at an acceptable gradient (1% per MBTA and Amtrak standards), the tracks serving these platforms need to start their incline a considerable distance south of the station. The existing rail bridge would need to be replaced with a new bridge at a higher elevation.
  - Requires replacement roadway bridges at Broadway and West Fourth Street. In order for trains to approach the upper level platforms at an acceptable gradient (1% per MBTA and Amtrak standards), the tracks serving these platforms need to start their incline a considerable distance south of the station. These existing roadway bridges over the railroad would need to be replaced with new bridges at a higher elevation. Considering that these bridges are part of the local street network, there would be considerable work necessary to join the new bridges with the existing roadways.

- The acquisition of 245 Summer Street requires a significant upfront capital investment for the purchase of the property. The building currently serves as the headquarters for a major financial investment company.
- The track configuration would require the removal and reconstruction of the entire South Station Bus Terminal structure. The bus terminal was built over the tracks and southern end of the platforms in 1992 and is fully functional with years of expected life remaining. Demolition and reconstruction of this facility would impact city bus routes that stop in the vicinity of South Station; commuter service between South Station and the greater Boston metropolitan area, and regional service to New England and points beyond provided by eleven private bus companies operating out of the terminal.
- As part of a previous reconstruction project, foundations for a future bus expansion were set in the existing track layout and columns were constructed in Platform G and Platform H to support expansion of the bus garage north towards the headhouse over the platforms. These foundations and columns would have to be removed.
- The demolition and reconstruction of all existing tracks and platforms present major impacts to existing operations during construction as all trains entering South Station today would have to be stopped at nearby Amtrak and/or commuter rail stations for an extended period of time and busing of passengers would be necessary to/from South Station.
- Requires reconfiguration of Tower 1 Interlocking in its entirety. This presents major impacts to existing operations during construction as all trains entering South Station today would have to be terminated at nearby Amtrak and/or commuter rail stations for an extended period of time.
- Requires doubled vertical circulation for dedicated access to platforms from third level concourse, resulting in convoluted egress path.
- Creates underground-like user experience for lower platform level passengers.
- Results in limited footprint for new Bus Terminal.

4.1.3 Unconstrained Rail Alternative 3A – Relocate Amtrak to Cabot Yard

Unconstrained Rail Alternative 3A proposes to relocate Amtrak services from South Station to a brand new site that currently houses the Red Line Cabot Yard Facility, as depicted in Figure 8. This facility is located just south of the Fort Point Channel and the existing South Station. This alternative requires the demolition of the existing facility and construction of an entirely new Amtrak station. An Amtrak specific station would reduce track and platform congestion for Amtrak and MBTA and allow for all platforms to be designed using Amtrak guidelines. This alternative proposes that no Amtrak trains would enter Tower 1, easing congestion and simplifying operations. With this alternative both the existing South Station and the USPS Facility would not be modified.

- **Opportunities – Unconstrained Rail Alternative 3A**
  - Amtrak trains would no longer pass through Tower 1 Interlocking simplifying diverging movements, reducing congestion, and improving platform flexibility for MBTA commuter rail trains.
  - The existing South Station site is complex and constrained. By providing separate infrastructure to support the future Amtrak service expansion in a different location, there would be more flexibility to accommodate anticipated MBTA commuter rail service expansion.
  - A separate station would allow Amtrak to tailor the design specific to their unique security, boarding, and passenger amenity needs.
  - Provides new 22-foot wide platforms to meet current MBTA and Amtrak standards.
  - Enables construction of FRA-suggested 1,312-foot long platforms at Cabot Yard.

- **Impacts/Challenges – Unconstrained Rail Alternative 3A**
  - In order to enable Amtrak trains to access new terminal station, the Fairmount Line/Dorchester Branch would need to be electrified and its infrastructure modified. Electrification and the related infrastructure modifications have been under discussion for many years in the Northeast and have been determined to be major undertakings that will not be accommodated in the near future.
  - Requires major work at Wye track, including creating a new interlocking and building a new bridge structure to accommodate multiple tracks. Currently Wye track is a single track and crosses Fort Point Channel on a single track rail bridge.
  - Requires replacement roadway bridges at Broadway and West Fourth Street.
  - Requires major site work at Cabot Yard/ Old Colony connection in order to accommodate the new station entrance/intersection.
  - Creating a separate Amtrak station outside of South Station Terminal eliminates the opportunity for a fully integrated intermodal station. Travelers using South Station have access to the Red Line, Silver Line, MBTA buses, and intercity buses. This new Amtrak station would be too far from those transfer points for passengers to access without introducing another trip. The Broadway Station on the Red Line is in close proximity to this site and could offer an intermodal connection. More analysis would be necessary to determine how the connection could be made.
  - Creates undersized headhouse for Amtrak Station due to the limited size of the Cabot Yard area and proximity to Fort Point Channel.
  - The Cabot Yard Facility provides storage and maintenance services to the Red Line. Replacing this facility with an Amtrak station would require the MBTA to relocate these services to an existing or new facility along the Red Line service area.

4.1.4 Unconstrained Rail Alternative 3B – Relocate Amtrak to Boston Convention Center

Unconstrained Rail Alternative 3B proposes to relocate Amtrak terminal operations to a brand new facility adjacent to the Boston Convention and Exhibition Center (BCEC), as illustrated in Figure 9. This location is approximately ½ mile south of South Station. Similar to Alternative 3A, with this alternative both the existing South Station and the USPS Facility would not be modified. An Amtrak specific station would reduce track and platform congestion and allow for all platforms to be designed using Amtrak guidelines. This alternative proposes that no Amtrak trains would enter Tower 1, reducing congestion and simplifying operations. In order to achieve this alternative, several significant capital investments and operational alterations would be necessary.

- **Opportunities – Unconstrained Rail Alternative 3B**
  - Amtrak trains would no longer pass through Tower 1 Interlocking simplifying diverging movements, reducing congestion, and improving platform flexibility for MBTA commuter rail trains.
  - The existing South Station site is complex and constrained. By providing separate infrastructure to support the future Amtrak service expansion in a different location, there would be more flexibility to accommodate anticipated MBTA commuter rail service expansion.
  - Provides new 22-foot wide platforms to meet current MBTA and Amtrak standards.
  - Enables construction of FRA-suggested 1,312-foot long platforms at the BCEC site.
  - Creates a new transit center in the South Boston Waterfront/Innovation District neighborhood. This is one of the fastest growing neighborhoods in Boston, but it currently lacks transportation alternatives. Providing direct access from Amtrak to the BCEC and the neighborhood greatly improves the long-term viability of the neighborhood.

- Facilitates transit oriented development (TOD) around the new Amtrak station, thereby supporting planned new development in the South Boston Waterfront/Innovation District neighborhood.
- A separate station would allow Amtrak to tailor the design specific to their unique security, boarding, and passenger amenity needs.

- **Impacts/Challenges – Unconstrained Rail Alternative 3B**
  - In order to enable Amtrak trains to access new terminal stations, the Fairmount Line/Dorchester Branch would need to be electrified and its infrastructure be modified. Electrification and the related infrastructure modifications have been under discussion for many years in the Northeast and have been determined to be major undertakings that will not be accommodated in the near future.
  - Requires major work at Wye track, including creating a new interlocking and building a new bridge structure to accommodate multiple tracks. Currently Wye track is a single track and crosses Fort Point Channel on a single track rail bridge.
  - Requires replacement roadway bridges at Broadway and West Fourth Street.
  - Requires new multi-span rail bridge structure from the Fairmount Line/Dorchester Branch across the lead tracks to the Amtrak Maintenance Facility and Southampton Street Yard as well as the Old Colony Main to reach Track 61, the existing track that leads to the Convention Center.
  - Creating a separate Amtrak station outside of South Station Terminal eliminates the opportunity of a fully integrated intermodal station. Travelers using South Station have access to the Red Line, Silver Line, MBTA buses, and intercity buses. This new Amtrak station would be too far from those transfer points for passengers to access without introducing another trip.
  - The location of the new Amtrak station is proposed where the loading docks that currently serve the BCEC are located. This concept would require the BCEC loading area to be rearranged.

4.1.5 Evaluation of Unconstrained Rail Alternatives

Table 3 summarizes the opportunities and impacts/challenges of the four Unconstrained Rail Alternatives. There would be significant challenges associated with each of these alternatives. While these alternatives would be able to accommodate proposed Amtrak and MBTA service expansions, and would provide some opportunities for accommodating both current and future train service, the challenges associated with construction phasing, land acquisition, and separated passenger rail services would outweigh potential benefits. Due to the substantial impacts, these alternatives will not be pursued further.

This analysis has provided a thorough understanding of opportunities and impacts/challenges of a complete rebuild of the South Station Terminal. Due to impacts/challenges illustrated in Table 3, the Unconstrained Rail Alternatives require costly mitigation measures as well as improvements and/or replacement of existing infrastructure. Anticipated benefits are not commensurate with the costs and other impacts associated with them. Thus, none of these alternatives were deemed feasible.

Table 3—Comparison of Unconstrained Rail Alternatives

Potential Impacts	Alternative 1	Alternative 2	Alternative 3A	Alternative 3B
Opportunities				
Reduces existing congestion at South Station	✓	✓	✓	✓
Accommodates MBTA & Amtrak service expansions	✓	✓	✓	✓
Provides longer platforms/allows mid-platform boarding at South Station	✓	✓		
Provides longer platforms at Amtrak Station			✓	✓
Expands passenger concourse/amenities	✓			
Expands retail opportunities along Dorchester Avenue		✓		
Supports TOD in new Boston neighborhood			✓	✓
Supports planned development	✓	✓		✓
Provides single multi-modal South Station	✓	✓		
Impacts/Challenges				
Reconfigures Tower 1 Interlocking	X	X		
Acquires & demolishes 245 Summer Street	X	X		
Demolishes & reconstructs Bus Terminal	X	X		
Demolishes & reconstructs tracks & platforms	X	X		
Requires new 2-track bridge across Fort Point Channel	X	X		
Requires replacement bridges at Broadway & West Fourth Streets	X	X	X	X
Requires extensive, difficult construction staging	X	X		
Limits retail opportunities along Dorchester Avenue	X			
NEC main line and Amtrak trains have no access to Southampton Amtrak shop and layover facility		X		
Provides limited footprint for reconstructed Bus Terminal		X		
Reduces passenger flow/provides complicated egress		X		
Involves infrastructure modification of Fairmount Line/Dorchester Branch			X	X
Requires electrification of Fairmount Line/Dorchester Branch			X	X
Requires site work at Cabot Yard/Old Colony connection			X	
Does not provide for one Boston intermodal station			X	X
Requires land acquisition	X	X	X	X
Requires passenger transfers from Amtrak to South Station			X	X
Provides undersized Amtrak Station headhouse			X	X
Requires bridge from Fairmount Line/Dorchester Branch to Track 61				X
Compromises Convention Center loading dock area				X

✓= Opportunity; X = Impact/Challenge

Following additional discussions with the FRA, MassDOT determined that 1,312-foot long platforms were not feasible for the SSX project due to anticipated impacts upon existing infrastructure. MassDOT determined that the platform/berthing length should be as long as possible and should meet the Amtrak berthing requirement of 1,050 feet and the MBTA berthing requirement of 850 feet. These platform/berthing lengths were used in developing the Constrained Rail Alternatives.

4.2 Constrained Rail Alternatives

After understanding the major impacts to existing infrastructure associated with the Unconstrained Rail Alternatives, a second set of alternatives, Constrained Rail Alternatives were studied. These alternatives were developed in a more conservative approach with respect to impacts to existing infrastructure. MassDOT determined that for the Constrained Rail Alternatives, certain additional elements or structures would remain as-is (fixed elements) and other elements could be impacted and/or reconfigured (flexible elements). Table 4 lists the fixed and flexible elements for this set of alternatives and provides a comparison to Unconstrained Rail Alternatives as discussed in Section 3.1.

Table 4—Fixed and Flexible Elements for Unconstrained and Constrained Rail Alternatives

Fixed and Flexible Elements	Unconstrained Rail Alternatives	Constrained Rail Alternatives
South Station Headhouse	X	X
I-90/Mass Turnpike tunnels and ramps	X	X
I-93 and ramps	X	X
Fort Point Channel and 100-foot buffer zone	X	X
Reopening of Dorchester Avenue for public use	X	X
Central Artery/Tunnel (CA/T) vent buildings	X	X
MBTA Red Line	X	X
Provision not to preclude future subsurface alignment	X	X
SSAR Project, Phase 1 (Tower)	✓	X
245 Summer Street	✓	X
Acquisition and relocation of the USPS facility	✓	X
Existing tracks and platforms	✓	✓
Tower 1 Interlocking	✓	✓
Approach interlockings	✓	✓
South Station Bus Terminal and ramps	✓	✓
Consideration of a grade-separated rail station	✓	X
Overhead bridges on approaches to South Station	✓	X
Station tracks being elevated or located below ground surface at Dorchester Avenue	✓	X
Wye track	✓	X
MBTA's Red line train storage facility – Cabot Yard	✓	X
Addition of OCS infrastructure to the Fairmount Line/Dorchester Branch to electrify and facilitate use by Amtrak	✓	X

X= Fixed Elements; ✓= Flexible Elements

Four distinct alternatives were developed within the context of these fixed and flexible elements. These alternatives are distinct because each Constrained Rail Alternative provides specific benefits in addition to satisfying the project goals. These benefits include streamlining operations, minimizing disruption to existing operations, and maximizing joint/private development potential. The Constrained Rail Alternatives comprise various layouts at the South Station terminal area and Tower 1 Interlocking and are described in Section 3.2.1 through Section 3.2.4 of this Technical Report. Section 3.2.5 describes the reconfiguration of the approach (setup) interlockings, which is proposed for all Constrained Rail Alternatives.

4.2.1 Constrained Rail Alternative 1 – Redesign/Redevelopment

Constrained Rail Alternative 1 is a modified version of Unconstrained Rail Alternative 1 and consists of a total redesign of the existing track and platform alignment to the circa 1899 station approach alignment.

As seen in Figure 10, the original tracks were constructed parallel to Dorchester Avenue, but later reconstruction of the terminal shifted the track alignment to run parallel with Atlantic Avenue. This alternative would hold the tangent bearing from the Fort Point Channel bridge tracks (Old Colony and Fairmount Line/Dorchester Branch Tracks) into Tracks 8 and 9 at the station. By shifting the alignment of the terminal back to its original alignment this alternative reduces the complex movements and eases the approach to the terminal through a redesigned Tower 1, improving operational performance. Whereas Unconstrained Rail Alternative 1 included impacts to the 245 Summer Street property and did not accommodate the SSAR project, Constrained Rail Alternative 1 does not impact either.

As illustrated in Figure 11, the general track layout would resemble the original South Station track headings from 1899. This alternative would require reconfiguration of Tower 1 Interlocking in its entirety, as well as demolition and reconstruction of the existing South Station tracks and platforms. It would accommodate 19 station tracks, with the longest platform length of 1,148 feet and the shortest platform length of 783 feet. Platform tracks would tie into the existing Old Colony, Fairmount Line/Dorchester Branch, NEC and Framingham/Worcester Line tracks within the limits of Tower 1 Interlocking. The NEC and Worcester/Framingham Lines would access station Tracks 1 through 13, the Fairmount Line/Dorchester Branch Tracks 1 through 17 and Old Colony Lines would access station Tracks 1 through 19. This setup provides great operational versatility and also allows for all tracks to have access to the S&I Facility.

This terminal track design allows for full mid-platform boarding at all tracks and with the reconstruction of the bus terminal would be an intermodal station with almost double the capacity for buses and trains as it has today.

Although this alternative achieves the goal of optimizing operational flexibility for both MBTA commuter rail and Amtrak high speed rail trains, this alternative falls short in pursuit of other project goals. In addition to the complete demolition and reconstruction of Tower 1 Interlocking and station tracks and platforms, this alternative also requires the demolition and reconstruction of the existing bus terminal and the foundations and columns for future bus terminal expansion that were installed when the bus terminal was constructed. This proposed work presents major impacts to existing operations during construction as all trains entering South Station today would have to be terminated at nearby Amtrak and/or commuter rail stations for an extended period of time. Another goal of this project is to maximize joint/private development potential. Due to the realignment of the terminal tracks and the width of the proposed platforms, this alternative consumes almost all of the USPS property in addition to the existing South Station terminal area, with very little property remaining for joint/private development opportunities. In particular, there is not sufficient room to allow for street-level retail along Dorchester Avenue that is fundamental to supporting the mixed-use joint/private development element of the project.

- **Opportunities – Constrained Rail Alternative 1**
  - Has the ability to improve railroad operations to meet Amtrak's and MBTA's Future 2035 rail service schedule requirements. (Operations simulation modeling would be conducted to evaluate the ability to meet future South Station operational needs).
  - Adds six tracks to South Station Terminal increasing the overall terminal capacity by approximately 45%. South Station currently has 13 tracks and this alternative proposes a total of 19 station tracks. Nineteen station tracks is the maximum number of tracks that can be accommodated in this alternative.
  - Creates 22-foot wide platforms to meet current MBTA and Amtrak standards.
  - Reduces congestion at terminal by reconfiguring Tower 1 Interlocking and allowing trains to pass through more efficiently.
  - Allows for full mid-platform boarding, improving passenger flow and meeting modern design standards.

- **Impacts/Challenges – Constrained Rail Alternative 1**
  - The track configuration would require the removal of the entire South Station Bus Terminal structure. The bus terminal was built over the tracks and southern end of the platforms in 1992 and is fully functional with years of expected life remaining.
  - As part of a previous reconstruction project, foundations for a future bus expansion were set in the existing track layout and columns were constructed in Platform G and Platform H to support expansion of the bus garage north towards the headhouse over the platforms. These foundations and columns would have to be removed.
  - The demolition and reconstruction of all existing tracks and platforms present major impacts to existing operations during construction as all trains entering South Station today would have to be stopped at nearby Amtrak and/or commuter rail stations for an extended period of time and busing of passengers would be necessary to/from South Station.
  - Requires reconfiguration of Tower 1 Interlocking in its entirety. This presents major impacts to existing operations during construction as all trains entering South Station today would have to be terminated at nearby Amtrak and/or commuter rail stations for an extended period of time.
  - Does not allow for opportunities for street-level retail along Dorchester Avenue due to proposed footprint of tracks.
  - Incurs high capital costs, with a substantial cost differential from Alternatives 2 and 3.

4.2.2 Constrained Rail Alternative 2 – Streamline Operations

After analyzing the significant investment required to demolish and replace the South Station tracks, platforms, and bus terminal in their entirety, alternatives were developed that were less impactful to the existing infrastructure. In particular, two alternatives were developed that maintained all of the existing tracks and platforms and expanded the terminal tracks to the east onto the USPS property. The first of these is Constrained Rail Alternative 2.

Constrained Rail Alternative 2 maintains the existing platform configuration at South Station and expands the terminal track configuration to the east with four new platforms and seven new tracks parallel to the existing tracks. The existing platforms would remain at their current width of 17 feet – 6 inches and the new platforms would meet the current standard of 22 feet in width. In order to accommodate the new configuration of the realigned tracks and to lengthen the platforms as much as possible, all of the existing platforms would require modifications at their ends. In particular, Platform G would require extensive modifications to allow for berthing of Amtrak trains. Once these adjustments are accounted for, this alternative would allow for the longest platform length of 1,177 feet, with the shortest platform length being 824 feet. The conceptual plans show that 15 berthing tracks would accommodate MBTA required length (850 feet) and two berthing tracks would accommodate Amtrak required length (1,050 feet). It is anticipated that all berthing lengths would be lengthened during preliminary engineering through standard upgrades and the adoption of innovative techniques, but more analysis is necessary to determine exact lengths. In addition to the platform modifications, this alternative would result in impacts to the future overbuild columns along the east side of the terminal.

One of the main benefits of Constrained Rail Alternative 2 is that it would streamline operations at South Station due to the redesign of Tower 1 Interlocking and South Station could operate as two separate mini-terminals. The NEC and Worcester/Framingham Lines would access the westerly station tracks and the Fairmount Line/Dorchester Branch and Old Colony Line would access the easterly station tracks. This setup streamlines operations by reducing conflicting movements through the approach interlocking. This alternative would also allow access for 18 of the terminal tracks to the S&I Facility.

In order to achieve this operational optimization, the Tower 1 Interlocking would require extensive reconfiguration. It is possible that this reconfiguration could be staged so that service would not have to

be halted completely during construction, but the impact to service would be substantial in the best case construction staging plan. This alternative layout is illustrated in Figure 12.

In addition to preserving the existing platforms and tracks, this alternative avoids impact to the existing bus terminal and minimizes the impact to the future bus expansion foundations and columns. The bus terminal is close to capacity today and there are plans to expand it in the future. By expanding the rail capacity without impacting the bus service, this alternative increases the opportunities for multi-modality as all existing and new platforms could have direct access to the bus terminal as well as other modes available at South Station. This alternative also allows for the opportunity for joint/private development on the USPS property along Dorchester Avenue as the new proposed terminal tracks do not occupy all of the terra firma adjacent to the street. Early analysis shows that there should be enough land for mixed use development on the ground supporting air rights over the tracks.

- **Opportunities – Constrained Rail Alternative 2**
  - Has the ability to improve railroad operations to meet Amtrak's and MBTA's Future 2035 rail service schedule requirements. (Operations simulation modeling would be conducted to evaluate the ability to meet future South Station operational needs).
  - Adds seven tracks to South Station Terminal increasing the overall terminal capacity by approximately 55%. South Station currently has 13 tracks and this alternative proposes a total of 20 station tracks.
  - Simplifies Tower 1 special trackwork and reduces congestion by minimizing conflicting movements at Tower 1 Interlocking.
  - Allows for expanded opportunities for street-level retail along Dorchester Avenue due to proposed footprint of tracks.
  - Creates new 22-foot wide platforms to meet current standard on newly constructed platforms.

- **Impacts/Challenges – Constrained Rail Alternative 2**
  - As part of a previous reconstruction project, foundations for a future bus expansion were set in the existing track layout and columns were constructed in Platform G and Platform H to support expansion of the bus garage north towards the headhouse over the platforms. The columns along Platform G and Platform H would have to be removed.
  - Substantial reconfiguration of Tower 1 Interlocking is required for all mainline tracks, special trackwork, and station tracks. More analysis would occur during preliminary engineering to determine the level of impact this would have on existing service levels during construction. While it is clear that some level of impact would occur, it is MassDOT's intent to minimize the disruption to passengers and service.
  - In order to accommodate the new configuration of the tracks at Tower 1 Interlocking and to lengthen the platforms, all of the existing platforms would require modifications. These modifications would result in further complexities during construction staging as service would be shut down to these platforms during the reconstruction.

4.2.3 Constrained Rail Alternative 3 – Minimize Disruption to Operations

Constrained Rail Alternative 3 maintains the existing platform configuration at South Station and expands the terminal track configuration to the east with four new platforms and seven new tracks parallel to the existing tracks. The existing platforms would remain at their current width of 17 feet – 6 inches and the new platforms would meet the current standard of 22 feet in width. Similar to Constrained Rail Alternative 2, existing Platform G would require extensive modifications, but the other existing platforms would not require modifications at their ends. Once these adjustments are accounted for, this alternative would allow for the longest platform length of 1,177 feet, with the shortest platform length being 723 feet. The conceptual plans show that eight berthing tracks would accommodate the MBTA required

length (850 feet) and three berthing tracks would accommodate Amtraks' required length (1,050 feet). It is anticipated that several berthing lengths would be lengthened during preliminary engineering through standard upgrades and the adoption of innovative techniques, but more analysis is necessary to determine exact lengths. This alternative layout is illustrated in Figure 13.

One of the main benefits of Constrained Rail Alternative 3 is that there would be minimal impact to the Tower 1 Interlocking track configuration. The additional terminal tracks are accommodated by adding special trackwork to the existing interlocking with minimal impact to existing operations. In addition to minimizing the construction staging impacts, this alternative would provide the maximum platform accessibility. Trains approaching South Station via the Fairmount Line/Dorchester Branch and Old Colony Line would have universal platform accessibility. For the Framingham/Worcester and NEC service lines platform access would vary dependent on if the crossover moves were made at Tower 1 or Cove Interlocking. If crossover moves are made at Cove Interlocking, Framingham/Worcester and NEC service lines would have access to station Tracks 1 through 14. This increased flexibility allows for greater mitigation opportunities for dispatchers in the event of delays. This setup allows for all tracks to have access to the S&I Facility.

In order to achieve this flexibility without requiring significant modifications to Tower 1, the lengths of the proposed platforms will be less than Constrained Rail Alternative 2. In order to accommodate the additional special trackwork appended to Tower 1 and allow for sufficient tangent track at the terminal, the berthing lengths are reduced. As with the other alternatives, it is likely that the berthing lengths can be extended after further engineering and analysis, but those exact lengths are indeterminate during conceptual engineering.

In addition to preserving the existing platforms and tracks, this alternative avoids impacts to the existing bus terminal and minimizes the impact to the future bus expansion foundations and columns. The bus terminal is close to capacity today and there are plans to expand it in the future. By expanding the rail capacity without impacting the bus service, this alternative increases the opportunities for multi-modality as all existing and new platforms could have direct access to the bus terminal as well as other modes available at South Station. This alternative also allows for the opportunity for joint/private development on the USPS property along Dorchester Avenue as the new proposed terminal tracks do not occupy all of the terra firma adjacent to the street. Early analysis shows that there should be enough land for mixed use development on the ground supporting air rights over the tracks.

- **Opportunities – Constrained Rail Alternative 3**
  - Has the ability to improve railroad operations to meet Amtrak's and MBTA's Future 2035 rail service schedule requirements. (Operations simulation modeling would be conducted to evaluate the ability to meet future South Station operational needs).
  - Adds seven tracks to South Station Terminal increasing the overall terminal capacity by approximately 55%. South Station currently has 13 tracks and this alternative proposes a total of 20 station tracks.
  - By avoiding significant modifications to Tower 1 and the existing platforms, it minimizes impacts to rail operations during construction.
  - Allows for expanded opportunities for street-level retail along Dorchester Avenue due to proposed footprint of tracks.
  - Creates new 22-foot wide platforms to meet current standard on newly constructed platforms.
  - Provides operational versatility to station tracks and platforms.

- **Impacts/Challenges – Constrained Rail Alternative 3**
  - As part of a previous reconstruction project, foundations for a future bus expansion were set in the existing track layout and columns were constructed in Platform G and Platform H to support expansion of the bus garage north towards the headhouse over the platforms. The columns along Platform G and Platform H would have to be removed.
  - In order to accommodate the special trackwork added to Tower 1, the platform lengths need to be reduced resulting in shorter berthing lengths.

4.2.4 Constrained Rail Alternative 4 – Maximize Overbuild Potential

Constrained Rail Alternative 4 proposes a total redesign of existing tracks and platforms without impacting existing and future overbuild. This alternative proposes to swap the current positioning of the tracks and platforms so that the proposed track structure would fall within the envelope of the existing platforms and the proposed platforms would fall within the envelope of the existing tracks. Figure 14 illustrates the realignment of the existing track and platforms in plan view and elevation.

This alignment would allow the proposed platforms to be constructed at 22-foot widths. In addition, the existing bus terminal would not be impacted as the support columns that are currently within the track bed would be accommodated in the new platforms.

The remaining tracks and platforms would be constructed parallel to Dorchester Avenue. This alignment provides improved horizontal curve radii for the Old Colony and Fairmount Line/Dorchester Branch tracks approaching the terminal from Tower 1 Interlocking. Where Constrained Rail Alternatives 2 and 3 resulted in an irregular-shaped parcel remaining of the former USPS property, Constrained Rail Alternative 4 creates a uniform-shaped section of terra firma, enhancing the development opportunity along Dorchester Avenue. However, this setup also results in a large wedge-shaped platform between the two differing alignments that is not desirable as it takes up valuable space inside the terminal.

In order to maintain the existing bus terminal and provide enhanced opportunity for future joint/private development and overbuild, the platform lengths in Alternative 4 are significantly shorter. In Constrained Rail Alternative 4, the longest platform length would be 864 feet and the shortest platform length would be 560 feet. Only one berthing length would accommodate MBTA requirements and none would accommodate Amtrak requirements.

Similar to Constrained Rail Alternative 1, Constrained Rail Alternative 4 would require a reconfiguration of Tower 1 Interlocking in its entirety, as well as reconstruction of South Station tracks and platforms. In Constrained Rail Alternative 4, future overbuild columns would be located on the platforms and would no longer exist between tracks. Constrained Rail Alternative 4 is illustrated in Figure 15.

- **Opportunities – Constrained Rail Alternative 4**
  - Has the ability to improve railroad operations to meet Amtrak's and MBTA's Future 2035 rail service schedule requirements. (Operations simulation modeling would be conducted to evaluate the ability to meet future South Station operational needs).
  - Adds seven tracks to South Station Terminal increasing the overall terminal capacity by approximately 55%. South Station currently has 13 tracks and this alternative proposes a total of 20 station tracks.
  - Allows for expanded opportunities for street-level retail along Dorchester Avenue due to proposed footprint of tracks.
  - Creates new 22-foot wide platforms to meet current standard.

- **Impacts/Challenges – Constrained Rail Alternative 4**
  - The demolition and reconstruction of all existing tracks and platforms present major impacts to existing operations during construction as all trains entering South Station today would have to be stopped at nearby Amtrak and/or commuter rail stations for an extended period of time and busing of passengers would be necessary to/from South Station.
  - As part of a previous reconstruction project, foundations for a future bus expansion were set in the existing track layout and columns were constructed in Platform G and Platform H to support expansion of the bus garage north towards the headhouse over the platforms. The columns along Platform G and Platform H would have to be removed.
  - Requires reconfiguration of Tower 1 Interlocking in its entirety. This presents major impacts to existing operations during construction as all trains entering South Station today would have to be terminated at nearby Amtrak and/or commuter rail stations for an extended period of time.
  - Does not provide sufficient platform berthing lengths to accommodate future Amtrak high-speed rail trainsets.
  - Incurs high capital costs, with substantial cost differential from Alternatives 2 and 3.

4.2.5 Approach (Setup) Interlockings

This section presents the proposed configuration of the approach interlockings, which would apply to all of the Constrained Rail Alternatives. The proposed future 20-track South Station layout (19 in Constrained Rail Alternative 1) envisions infrastructure that can support up to seven trains moving simultaneously through the Tower 1 Interlocking area. This proposed layout would be paired with an operating philosophy that reduces the amount of conflicting movements through the terminal area by enabling every train to use the proposed approach interlockings at Cove and Broad, thereby allowing faster and more efficient crossover moves in preparation of berthing at station platforms. The Cove Interlocking on the NEC would allow crossovers to occur at 20-30 mph, versus the speed of 10 mph in the Tower 1 area, making the necessary crossover movements more efficient. The proposed universal interlocking at Broad Interlocking would deploy the same philosophy of pushing the conflicting movements to an area of higher-speed crossovers and away from the Tower 1 Interlocking area. This proposed layout would continue to provide the operational flexibility needed in the event of an equipment failure or emergency.

Operationally, the proposed layout would group the South Station platform tracks into "mini" terminals, allowing for faster movement and reducing conflicting movements in Tower 1. This proposed layout and philosophy would require well-devised operating and maintenance plans that would not require movements across the entire Tower 1 Interlocking. The proposed operating plans would require more segregation between the separate lines and users, as well as require train crews and dispatchers to adhere to planned train placement at platforms and strict schedule.

Cove Interlocking

A new Number 15 crossover from Track WB5 to WB7 at the easterly end of the interlocking would be installed to increase operational flexibility. The remaining existing crossovers would be relocated or replaced to accommodate the new crossover and create operational flexibility for moves to and from all tracks. Realignment of Track WB5 would impact a mid-span support pier at Harrison Avenue.

Broad Interlocking

The most substantial modification at Broad Interlocking would be the introduction of a third running track (labeled OCRR3). This running track would contain an 850-foot minimum sectional release between Cabot and Broad Interlockings, which would allow one commuter rail trainset to occupy this section

(Block) without impacts to Tower 1 Interlocking. This would provide sufficient space to hold one trainset outside of Tower 1 Interlocking, and would help with maintaining speed and maximizing efficient train movements through Tower 1 Interlocking.

Other improvements at Broad Interlocking would include the installation of Number 15 universal crossovers, on the north end of the interlocking, in the vicinity of the existing Wye track, to allow moves between DB2 and OCRR1 and maintain moves to the Wye track and S&I Facility. A new yard lead would be established and the MBTA's S& I Facility yard tracks would be realigned.

5. Alternatives Screening

5.1 Rating Criteria

This section discusses the rating criteria that were used to screen the Constrained Rail Alternatives in the Tier 1 analysis. Each alternative was evaluated for the criterion described in the following sections. A numerical rating of 1 through 4 was established to evaluate the ability of the alternatives to meet future rail system requirements, as measured by platform accessibility and length, infrastructure maintenance requirements, constructability, and capital costs; with 1 being the most favorable alternative to meet system requirements and 4 being the least favorable alternative to meet system requirements. The criterion listed herein is related to operational and physical characteristics of the rail alternatives. Environmental impacts of each of these alternatives were not evaluated at this stage. The preferred rail configuration identified through this screening process was then carried forward into the environmental analysis and is the subject of the DEIR alternatives.

5.1.1 Platform Rating

The platform designs of the Constrained Rail Alternatives were rated for their accessibility by each rail service line and their ability to accommodate future Amtrak and MBTA trainsets. The goals are to:

- Provide maximum platform accessibility. Platform accessibility was evaluated by the ability of each service line to access each platform at South Station. In the case of an emergency or a stopped vehicle, flexibility in platform accessibility is critical. Platform accessibility is measured by the number of platforms that each service line can access whether the crossover move occurs at the approach interlocking or at Tower 1 Interlocking.
- Accommodate Amtrak and MBTA platform length requirements. In order for a trainset to use any platform, adequate berthing length is required. To accommodate future Amtrak trainsets, platform lengths are required to be 1,050 feet. To accommodate future MBTA trainsets, platform lengths are required to be 850 feet. Alternatively, innovations may be incorporated into platform design to "extend" platform capabilities to accommodate berthing of Amtrak and MBTA trainsets. These innovations are depicted in Figure 16.

5.1.2 Infrastructure Maintenance Rating

The Constrained Rail Alternatives were rated by their anticipated maintenance requirements associated with special trackwork. Maintenance needs are directly correlated to the amount of rail infrastructure installed at each interlocking. The Tower 1 Interlocking configuration would vary among the rail engineering alternatives, whereas approach interlocking improvements would be common to all alternatives. The amount of special trackwork required at Tower 1 Interlocking was determined to assess infrastructure maintenance needs associated with each alternative. The goal is to:

- Reduce the complexity of Tower 1 Interlocking infrastructure and accompanying requirements to maintain a state-of-good-repair (SGR). Rail infrastructure includes track, special trackwork, signals, OCS, and communications system.

5.1.3 Constructability Rating

The Constrained Rail Alternatives were evaluated for their constructability, measured by the degree to which they would minimize impacts to existing infrastructure and minimize disruption to passenger service. The goals are to:

- Minimize impacts to existing infrastructure. Existing infrastructure at South Station includes the station tracks and platforms, bus terminal, and foundations for future development (SSAR project).
- Minimize disruption to passenger service. South Station is one of the busiest terminals in the Northeast, thus, keeping the trains running during construction with the least impact to their schedules becomes a challenge. It is critical that construction phasing minimize disruption to operations and maximize safety.

5.1.4 Capital Cost Rating

The Constrained Rail Alternatives were rated according to their anticipated capital costs. The goal is to:

- Minimize capital costs. Order-of-magnitude costs are used to evaluate the constrained alternatives. Capital costs include station area track and platforms, Tower 1 Interlocking, approach interlockings, signal, communication system, and OCS.

5.2 Tier 1 Alternatives Screening

5.2.1 Platform Rating

Platform Accessibility

Table 5 through Table 8 present the proposed platform accessibility at South Station in the various alternatives. The tables compare the station platforms that would be accessible for each rail service line approaching the station in two scenarios: 1) with the crossover move occurring at the approach interlocking; or 2) with the crossover move occurring at Tower 1 Interlocking.

Alternative 3 would provide the maximum platform accessibility regardless of the crossover move scenario. Trains approaching South Station via the Fairmount Line/Dorchester Branch and Old Colony Line would have nearly universal platform accessibility regardless of whether the crossover moves were to occur at the approach interlocking or at Broad Interlocking. For the Framingham/Worcester and NEC service lines, platform accessibility would be identical for crossover moves made at Cove Interlocking, with 14 out of 20 station tracks available for all trains (70% accessibility). While platform accessibility would decrease for the westerly service lines with crossover moves occurring at Tower 1 Interlocking, it would decrease substantially on only one track (Track 7), decreasing to six out of 20 tracks (30% accessibility).

In contrast, Alternative 4 would provide the least amount of platform accessibility by service line. For both Old Colony Lines, platform accessibility would be limited to Tracks 14 through 20 if the crossover move were to occur at the approach interlocking (35% accessibility). Platform accessibility would be further reduced if the crossover moves were to occur at Tower 1 Interlocking (15 to 25% accessibility).

For the westerly service lines, platform accessibility would be identical for crossover moves occurring at Cove Interlocking, with Tracks 1 through 15 accessible (75% accessibility), but would decrease to as low as 20% for the Framingham/Worcester Line (Track 5) for crossover moves occurring at Tower 1 Interlocking.

Table 5—Proposed Platform Accessibility, Constrained Rail Alternative 1

Trains Entering South Station			Accessible Station Tracks																		
Service Line	Track	Crossover move at Proposed Interlocking	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Framingham/ Worcester	7	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						
		Tower 1	✓	✓	✓	✓	✓	✓													
	5	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						
		Tower 1	✓	✓	✓	✓	✓	✓	✓	✓	✓										
Northeast Corridor	3	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						
		Tower 1	✓	✓	✓	✓	✓	✓	✓	✓	✓										
	1	Cove							✓	✓	✓	✓	✓	✓	✓						
		Tower 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						
	2	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						
		Tower 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						
Fairmount/ Dorchester Branch	1	South Bay	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
		Tower 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	2	South Bay	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
		Tower 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Old Colony	19	South Bay	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Tower 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	21	South Bay	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Tower 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

✓ Indicates that the station platform would be accessible if the crossover move were to occur at the approach and/or Tower 1 Interlocking.

Note: Constrained Rail Alternative 1 would add six tracks to the current 13 tracks, for a total of 19 tracks.

Table 6—Proposed Platform Accessibility, Constrained Rail Alternative 2

Trains Entering South Station			Accessible Station Tracks																		
Service Line	Track	Crossover move at Proposed Interlocking	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Framingham/ Worcester	7	Cove	✓	✓	✓	✓	✓	✓	✓	✓												
		Tower 1	✓	✓	✓	✓	✓	✓														
	5	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
		Tower 1			✓	✓	✓	✓														
Northeast Corridor	3	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
		Tower 1			✓	✓	✓	✓	✓	✓	✓											
	1	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
		Tower 1			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓								
	2	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
		Tower 1			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
Fairmount/ Dorchester Branch	1	Broad			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
		Tower 1			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
	2	Broad			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
		Tower 1														✓	✓	✓	✓	✓		
Old Colony	19	Broad														✓	✓	✓	✓	✓	✓	✓
		Tower 1																✓	✓	✓		
	21	Broad														✓	✓	✓	✓	✓	✓	✓
		Tower 1																✓	✓	✓	✓	✓

✓ Indicates that the station platform would be accessible if the crossover move were to occur at the approach and/or Tower 1 Interlocking.

Note: Constrained Rail Alternative 2 would add seven tracks to the current 13 tracks, for a total of 20 tracks.

Table 7—Proposed Platform Accessibility, Constrained Rail Alternative 3

Trains Entering South Station			Accessible Station Tracks																			
Service Line	Track	Crossover move at Proposed Interlocking	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Framingham/ Worcester	7	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						
		Tower 1	✓	✓	✓	✓	✓	✓														
	5	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						
		Tower 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓										
Northeast Corridor	3	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						
		Tower 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓										
	1	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						
		Tower 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						
	2	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						
		Tower 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						
Fairmount/ Dorchester Branch	1	South Bay	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Tower 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	2	South Bay	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Tower 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Old Colony	19	South Bay	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Tower 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	21	South Bay	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Tower 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

✓ Indicates that the station platform would be accessible if the crossover move were to occur at the approach and/or Tower 1 Interlocking.

Note: Constrained Rail Alternative 3 would add seven tracks to the current 13 tracks, for a total of 20 tracks.

Table 8—Proposed Platform Accessibility, Constrained Rail Alternative 4

Trains Entering South Station			Accessible Station Tracks																			
Service Line	Track	Crossover move at Proposed Interlocking	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Framingham/ Worcester	7	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
		Tower 1	✓	✓	✓	✓	✓	✓														
	5	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
		Tower 1			✓	✓	✓	✓														
Northeast Corridor	3	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
		Tower 1			✓	✓	✓	✓	✓	✓	✓											
	1	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
		Tower 1			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓								
	2	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
		Tower 1			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
Fairmount/ Dorchester Branch	1	Broad			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
		Tower 1			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
	2	Broad			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
		Tower 1														✓	✓	✓	✓	✓		
Old Colony	19	Broad														✓	✓	✓	✓	✓	✓	✓
		Tower 1																✓	✓	✓		
	21	Broad														✓	✓	✓	✓	✓	✓	✓
		Tower 1																✓	✓	✓	✓	✓

✓ Indicates that the station platform would be accessible if the crossover move were to occur at the approach and/or Tower 1 Interlocking.

Note: Constrained Rail Alternative 4 would add seven tracks to the current 13 tracks, for a total of 20 tracks.

Berthing Requirements

Table 9 summarizes the ability of the proposed track platforms in Constrained Rail Alternatives 1 through 4 to accommodate Amtrak and MBTA berthing requirements.

Table 9—Proposed Berthing Requirement Accommodations, Constrained Rail Alternatives 1 through 4

Track	Platform	Alternative 1		Alternative 2		Alternative 3		Alternative 4	
		MBTA	Amtrak	MBTA	Amtrak	MBTA	Amtrak	MBTA	Amtrak
1	A	✓		✓					
2	B	✓		✓		✓			
3	B	✓		✓		✓			
4	C	✓		✓		✓	✓		
5	C	✓	✓	✓		✓	✓		
6	D	✓	✓	✓	✓	✓	✓		
7	D	✓	✓	✓		✓	✓		
8	E	✓	✓	✓	✓	✓	✓		
9	E	✓	✓	✓	✓	✓	✓		
10	F	✓	✓	✓	✓	✓	✓		
11	F	✓	✓	✓	✓	✓	✓	✓	
12	G	✓	✓	✓	✓	✓		✓	
13	G	✓		✓		✓		✓	
14	H	✓		✓		✓			
15	H	✓		✓		✓			
16	I	✓		✓		✓		✓	
17	I	✓		✓		✓		✓	
18	J	✓		✓		✓		✓	
19	J	✓		✓		✓		✓	
20	K	N/A	N/A	✓		✓		✓	

✓ indicates that the station platform would be able to accommodate Amtrak and/or MBTA berthing requirements with the locomotive and coach platform length innovation.

Note: All alternatives would provide additional tracks and platforms. Alternative 1 would provide a total of 19 tracks. Alternatives 2 – 4 would provide a total of 20 tracks.

As previously discussed in Section 3.2, South Station terminal area presents many physical constraints. The existing terminal layout limits the length of several of platforms. Mid-platform boarding currently is not an option at South Station. Finally, the SSAR project will further reduce platform lengths at several tracks. Innovations were considered to enhance platform capabilities and accommodate berthing length requirements. These innovations have been implemented successfully in projects with similar constraints. The first innovation would be to locate the locomotive and a portion of the first coach outside the platform, without the ability to board/alight at both ends of the coach. Boarding/ alighting would occur from the first coach using only the station end door, as shown in Figure 16. This innovative approach would effectively reduce platform berthing requirements by 135 feet (65 feet for locomotive and 70 feet for the first coach). As a result, the effective platform length required to accommodate Amtrak trainsets would be 915 feet (as opposed to 1,050 feet), and the effective platform length required to accommodate MBTA trainsets would be 715 feet (as opposed to 850 feet).

All alternatives would include the use of platform boarding and alighting innovations to accommodate Amtrak and MBTA berthing requirements. Figure 16 presents other innovations not included in the platform berthing rating analysis. These include using a fixed type bumping post to replace some of the longer bumping posts currently in use at South Station; and terminating OCS within the station area and using existing station structures (such as canopies, beams, columns, etc.) to support the OCS instead of

using OCS tie-off poles. MassDOT will determine the appropriate innovative mechanisms to extend platform capabilities and will work with project stakeholders, the FRA, Amtrak, and the MBTA, in reviewing these design approaches that are required to maintain acceptable platform/berthing lengths.

As shown in Table 10, both Constrained Rail Alternatives 1 and 3 would meet platform berthing requirements for Amtrak at eight station tracks. Constrained Rail Alternatives 1 and 2 would meet platform berthing requirements for the MBTA at all of its station tracks, 19 and 20 station tracks, respectively. Constrained Rail Alternative 3 would meet platform berthing requirements for the MBTA at 19 out of 20 station tracks. Constrained Rail Alternatives 1 and 3 would receive the highest rating for this criterion, followed by Constrained Rail Alternative 2, which would meet platform berthing requirements for Amtrak at six out of 20 station tracks. Constrained Rail Alternative 4 would not meet platform berthing requirements for Amtrak at any of the station tracks. Constrained Rail Alternative 4 would meet the platform berthing requirements for MBTA at only eight station tracks out of a total of 20 station tracks. Therefore, Constrained Rail Alternative 4 receives the lowest rating for this criterion.

5.2.2 Infrastructure Maintenance Rating

Table 10 summarizes the special trackwork that would be required at Tower 1 Interlocking for the different alternatives. Special trackwork at the approach interlockings would include turnouts, crossovers, slip switches, and diamond crossings. A railway turnout is a device that splits one track into two. A turnout permits trainsets to pass from one track to another. In general, the higher the turnout number, the higher the speed allowed in the turnout (10 mph for Number Eight turnout; 15 mph for Number 10 turnout); however, the higher the turnout number, the longer the required tangent length. Crossovers are defined as two turnouts arranged to form a continuous passage between two nearby and generally parallel tracks. A slip switch is a combination of a crossing and one (or two) turnout(s). A diamond crossing is a structure used to allow one track to cross another at grade.

Table 10—Tower 1 Interlocking Trackwork Requirements, Constrained Rail Alternatives 1 through 4

Special Trackwork Requirements	Alternative 1	Alternative 2	Alternative 3	Alternative 4
No. 8 Turnout	16	12	8	0
No. 8 Crossover	3	2	2	0
No. 8 Slip Switch	13	6	6	0
No. 10 Turnout	0	0	0	13
No. 10 Crossover	0	0	0	1
No. 10 Slip Switch	0	0	1	6
Diamond Crossing	4	0	1	0
Total Trackwork Requirements	36	20	18	20

Constrained Rail Alternative 1 would require the most extensive special trackwork at Tower 1 Interlocking, and is anticipated to also require the highest maintenance requirements. Constrained Rail Alternative 1 would therefore rate the lowest in the infrastructure maintenance criterion. Constrained Rail Alternative 3 would require the least amount of special trackwork at Tower 1 Interlocking, and would be anticipated to require the least amount of maintenance. Constrained Rail Alternative 3 would rate the highest in the infrastructure maintenance criterion.

5.2.3 Constructability Rating

As a complete redesign and full build out of South Station, Constrained Rail Alternative 1 would impact all existing tracks and platforms, the existing Bus Terminal, and foundations for future development. Additionally, it would require a complete reconfiguration of Tower 1 Interlocking. It is anticipated that

construction of Constrained Rail Alternative 1 could shut down operations at South Station for an extended period of time, requiring substitute transportation and busing for up to two to three years. Busing could be required between South Station and the nearest commuter rail stations outside of Tower 1 Interlocking on all lines (Old Colony, Fairmount Line/Dorchester Branch, Framingham/Worcester Line, NEC), as the Tower 1 reconstruction would prohibit access into the terminal. It is envisioned that substitute transportation plans would include the use of the MBTA heavy rail service. As an example, connections between Braintree Station on the Red Line/commuter rail could be used to move passengers into South Station via the Red Line.

Similar to Constrained Rail Alternative 1, Constrained Rail Alternative 4 proposes to demolish existing tracks and platforms, and reconstruct tracks, platforms, and the OCS. Constrained Rail Alternative 4 also would require a complete reconfiguration of Tower 1 Interlocking. Contrary to Alternative 1, however, Constrained Rail Alternative 4 would not impact existing foundations for proposed overbuild development, nor would it impact the existing bus facility. Constrained Rail Alternative 4 also would require a shutdown of operations at South Station for an extended period of time.

Both Constrained Rail Alternative 1 and Constrained Rail Alternative 4 have low ratings in this criterion. Due to the anticipated extensive impact to existing facilities and the extensive service disruption, Constrained Rail Alternative 1 rates the lowest in the constructability criterion. Because it would not impact the existing bus facility or future air rights development, Constrained Rail Alternative 4 rates slightly higher than Constrained Rail Alternative 1 in its constructability rating.

Constrained Rail Alternative 2 would require a redesign of Tower 1 Interlocking, while retaining existing station Track 1 through 13 alignments and platform widths. Several switches and crossovers would be removed from the Tower 1 Interlocking, requiring reconfiguration of the existing track within the interlocking. The complexity of the trackwork would require extensive track outages.

Constrained Rail Alternative 3 would maintain the existing configuration of Tower 1 Interlocking. It would not require the extensive special trackwork and realignment work required in Constrained Rail Alternative 2. The additional track expansion (seven tracks) to the east would tie into Tower 1 at OC2 (the most easterly existing track), substantially limiting the required track outages and impacts to rail service. Because it is anticipated to require the least amount of track outages, Constrained Rail Alternative 3 rates the highest in this criterion.

5.2.4 Capital Cost Rating

Table 11 presents order-of-magnitude costs for constructing the alternatives. Capital costs were calculated for all tracks, signal system, OCS, communication system, and associated civil work within terminal and station areas including work at Tower 1, Cove, Broad, and other minor interlockings. As shown in Table 11, Constrained Rail Alternative 3 rates the highest and Constrained Rail Alternative 1 rates the lowest in this criterion.

Table 11—Capital Costs, Constrained Rail Alternatives 1 through 4

Alternative	Order-of-Magnitude Capital Costs
1	$493 million
2	$202 million
3	$138 million
4	$470 million

5.2.5 Summary of Findings

Table 12 summarizes the findings of the Tier 1 screening of Constrained Rail Alternatives. Due to the major impacts to existing infrastructure and challenges that would be encountered throughout the construction period, Constrained Rail Alternatives 1 and 4 are deemed "not feasible" and will not be further studied in subsequent evaluations. Constrained Rail Alternatives 2 and 3 are recommended as the two alternatives that would advance to a further, more refined evaluation process.

Table 12—Summary Tier 1 Screening, Constrained Rail Alternatives 1 through 4

Constrained Rail Alternative	Platform Rating		Infrastructure Maintenance Rating	Constructability Rating	Capital Cost Rating
	Accessibility	Berthing			
1 – Redesign/Redevelopment	1	1*	4	4	4
2 – Streamline Operations	2*	1*	2*	2	2
3 – Minimize Disruption to Operations	2*	3	1	1	1
4 – Maximize Overbuild Potential	4	4	2*	3	3

Note: A rating of 1 indicates the most favorable alternative in comparison to other alternatives for the specific criterion. A rating of 4 indicates the least favorable alternative in comparison to other alternatives for the specific criterion.
*Indicates that the alternatives have equal ratings in the criterion.

6. Next Steps

Based upon the platform rating, infrastructure maintenance rating, constructability rating, and capital cost rating, Tier 2 analysis is recommended for Constrained Rail Alternatives 2 and 3.

Operations simulation modeling will be conducted for Constrained Rail Alternatives 2 and 3 as part of the Tier 2 evaluation. Constrained Rail Alternatives 2 and 3 will be evaluated by their ability to meet future South Station operational needs, as measured by their ability to accommodate future service plans and to meet on-time performance (OTP) and delay goals, described as follows:

- **Accommodate future service plans**. By the year 2035, Amtrak projects 80 weekday revenue trips and 58 weekday non-revenue trips, representing a 100% revenue service increase above current levels. By 2035, the MBTA projects up to 315 weekday revenue trips and 101 weekday non-revenue trips, representing a 13% revenue service increase above current levels. Projections of train movements in and out of South Station are estimated to be a total of 554 daily trains by the year 2035, representing an overall increase of 23% above current revenue service levels[6].

- **Meet OTP and delay goals.** OTP and delay goals will be established for the Boston South Station complex, which includes the South Station platforms, Tower 1 Interlocking, and the key approach interlockings at Cove on the NEC and Broad in the Southampton Street area. OTP and delay goals for the South Station area will be consistent with the current Amtrak and MBTA service delivery policy goals.

The Tier 2 analysis also will include a reassessment of platform capabilities and berthing accommodations, in accordance with MassDOT's recent determination to evaluate the project alternatives with respect to inclusion/exclusion of the SSAR Tower, Phase 1 of the SSAR project.

[6] 2035 revenue service level weekday train movements are based on Massachusetts Department of Transportation. *Basis of Operations Analysis and Assumptions Verification Report*, Version 3. June 2014.

The next phase of project development will proceed with a Tier 2 analysis that will include further coordination within MassDOT and with other stakeholders regarding rail engineering design criteria, including design innovations. The remaining alternatives selected in the Tier 1 Terminal Track Configuration Alternatives Analysis will be evaluated with respect to other SSX project elements, including station layout and design and layover facility alternatives.

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7. Figures

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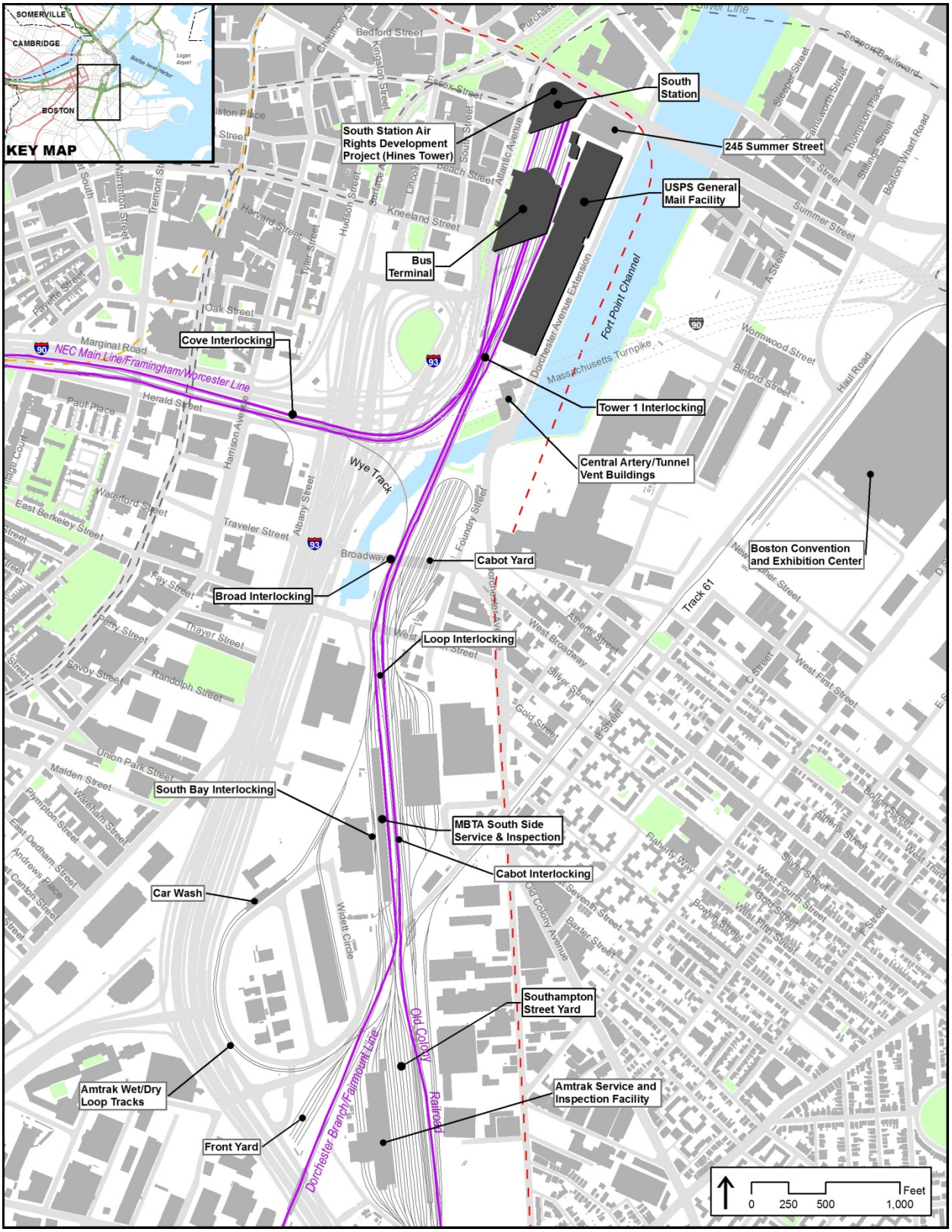


Figure 1—South Station Project Site: Terminal, Approach, and Key Facilities

Yard Area Catch Basin **Combined Sewer Service Connection**

Dwarf Signal at Tower 1 Interlocking **Overhead Contact System at Tower 1 Interlocking**

Figure 2—Existing Rail Infrastructure at South Station Terminal Area

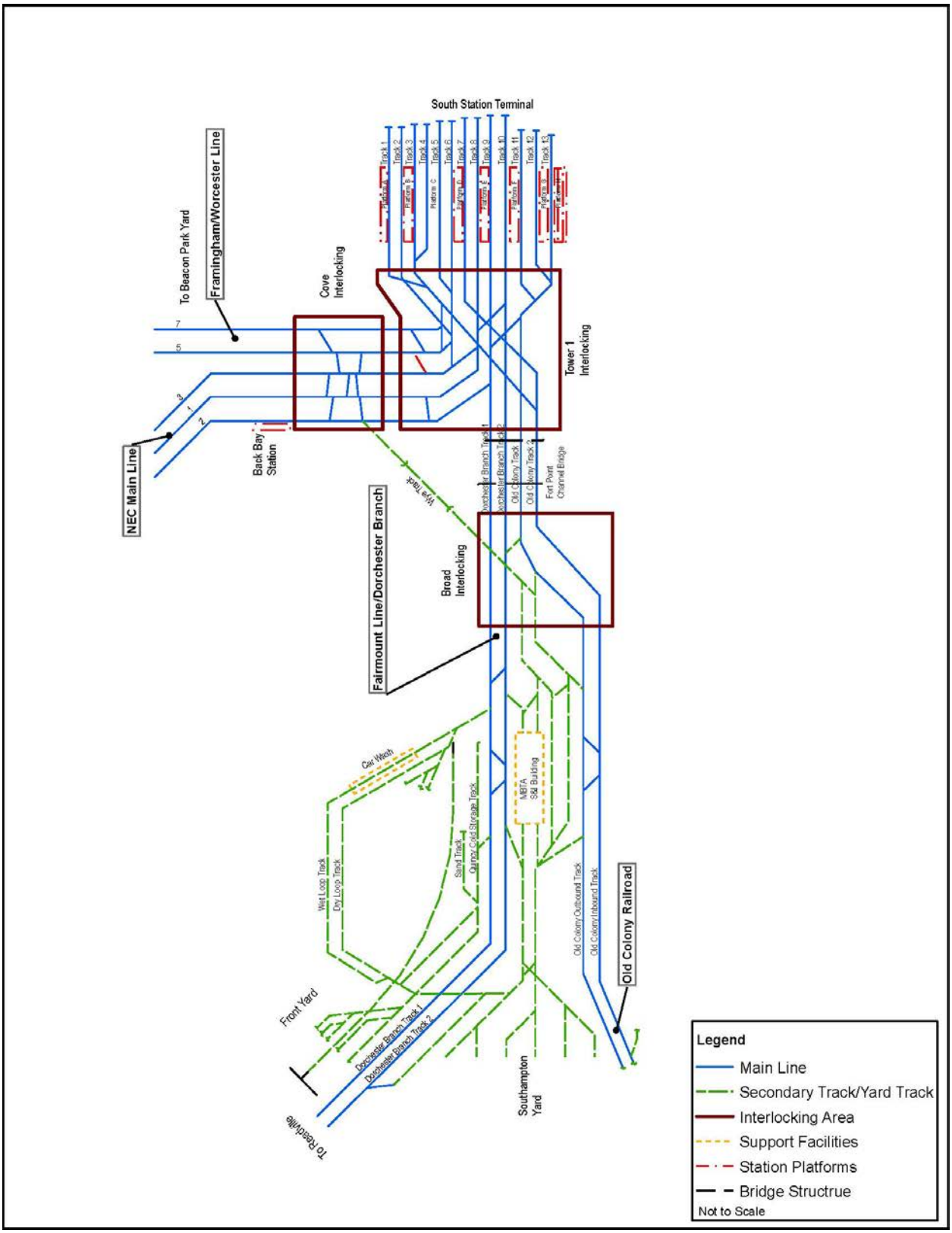


Figure 3—Schematic of South Station Terminal Area Existing Interlocking System

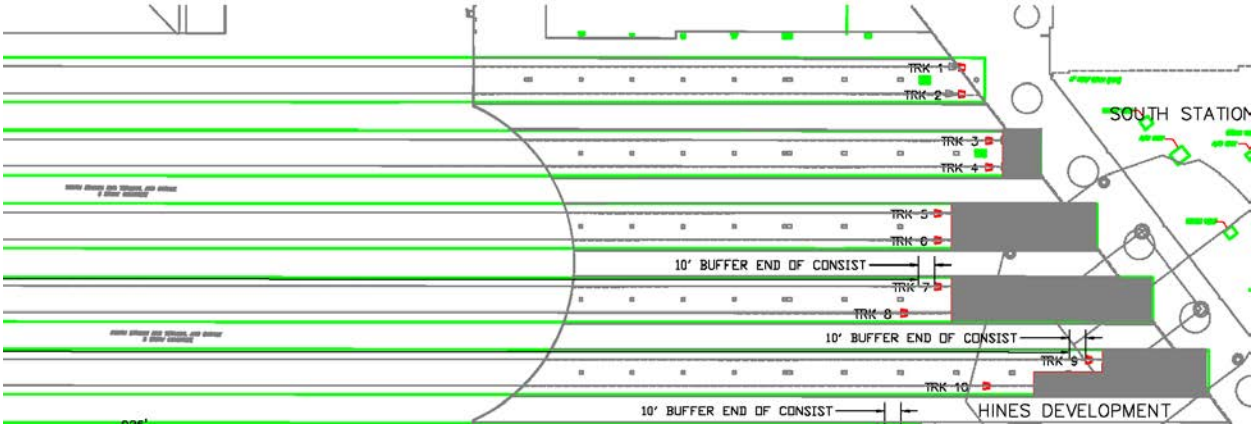


Figure 4—Impact of SSAR Project on Existing Station Platforms

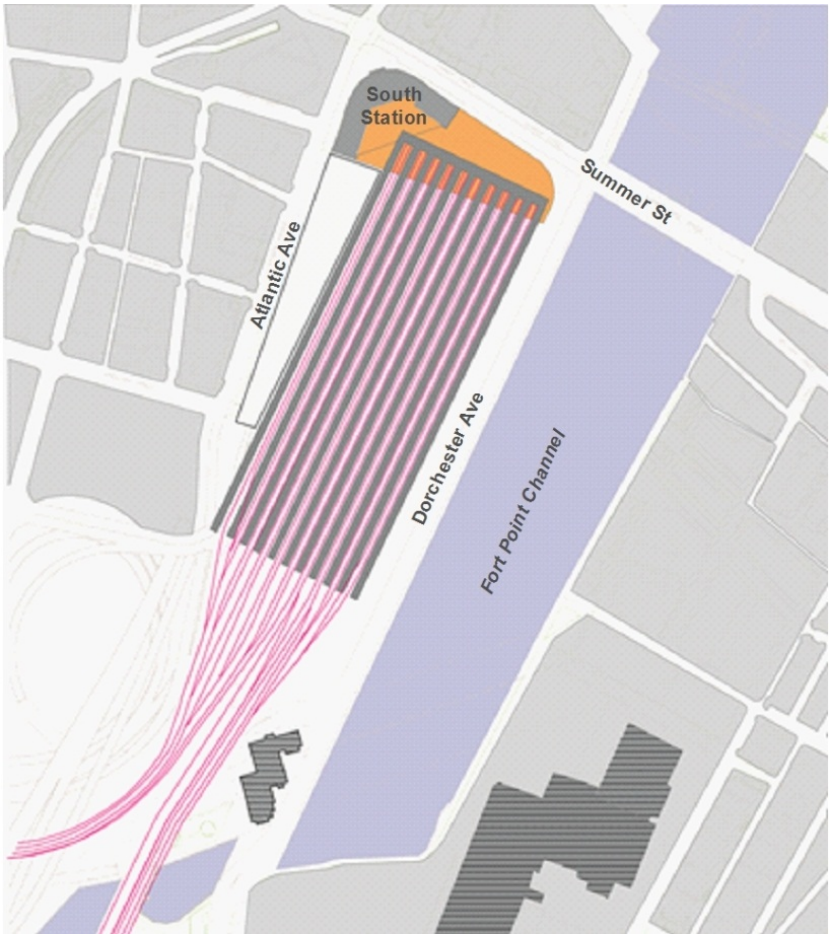


Figure 5—Unconstrained Rail Alternative 1 — 20 Tracks at Grade

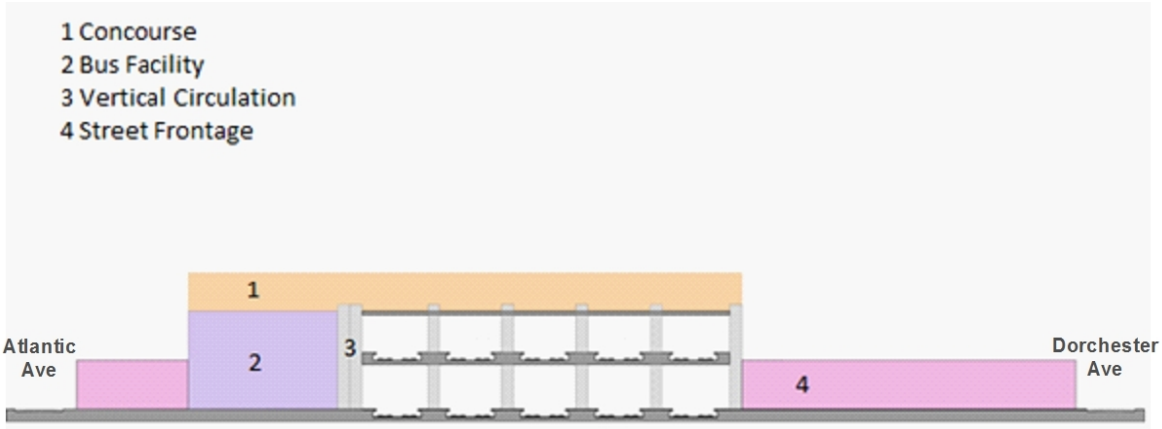
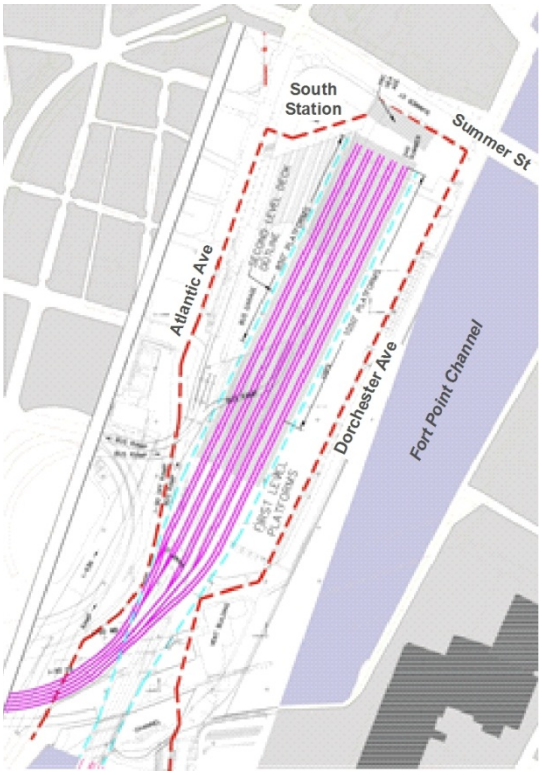


Figure 6—Unconstrained Rail Alternative 2 — Bi-Level South Station, Cross-Section

First Level



Second Level

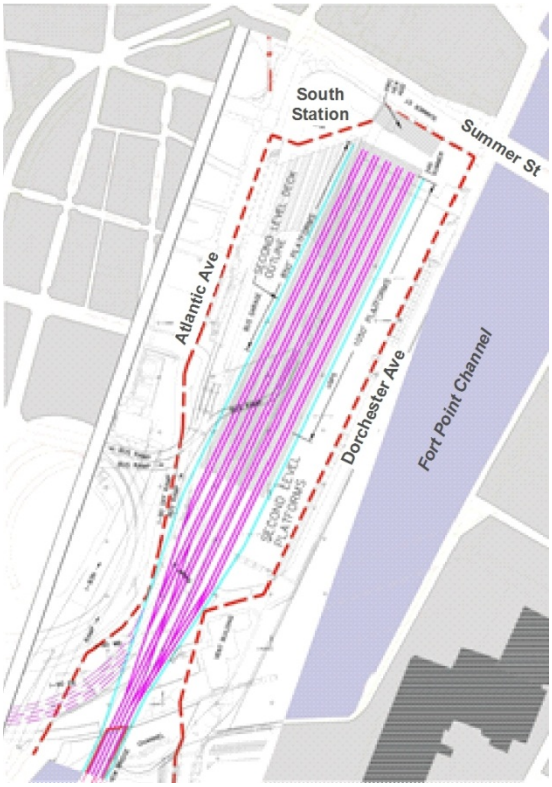


Figure 7—Unconstrained Rail Alternative 2 — Bi-Level South Station, Plan

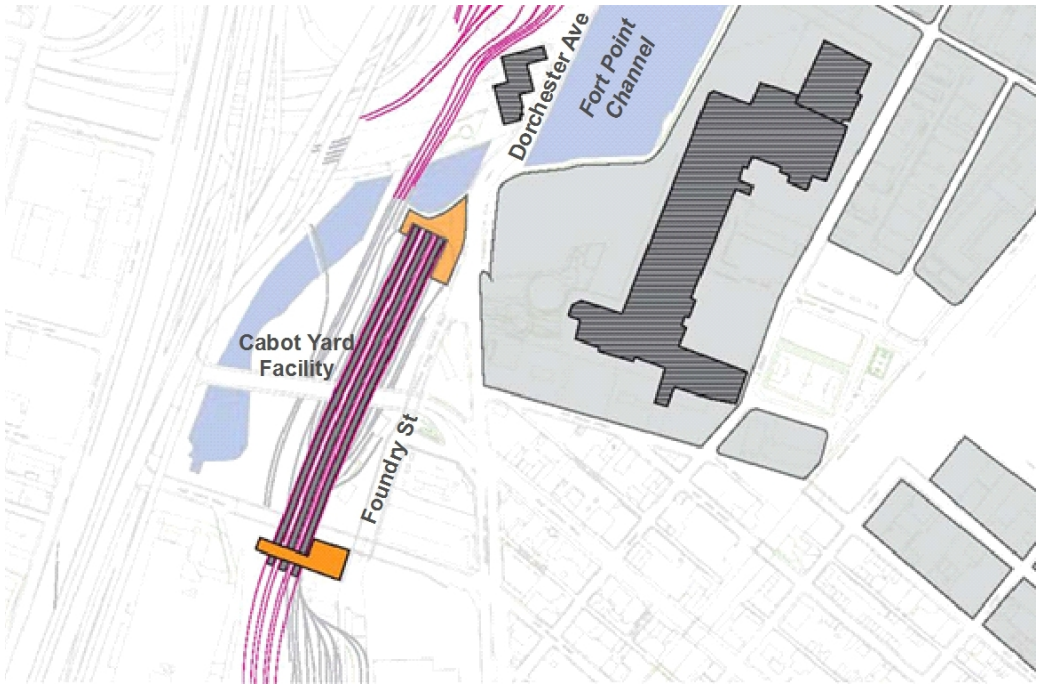


Figure 8—Unconstrained Rail Alternative 3A — Relocate Amtrak to Cabot Yard

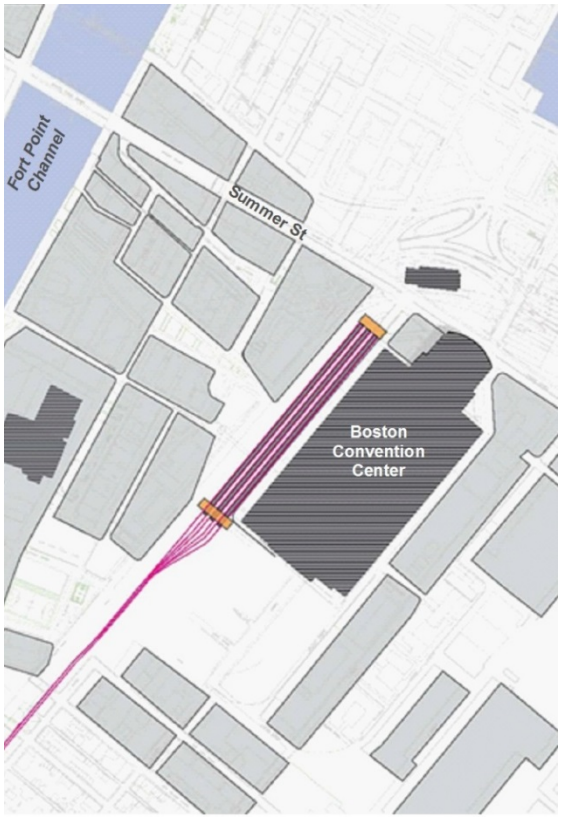


Figure 9—Unconstrained Rail Alternative 3B — Relocate Amtrak to Boston Convention Center

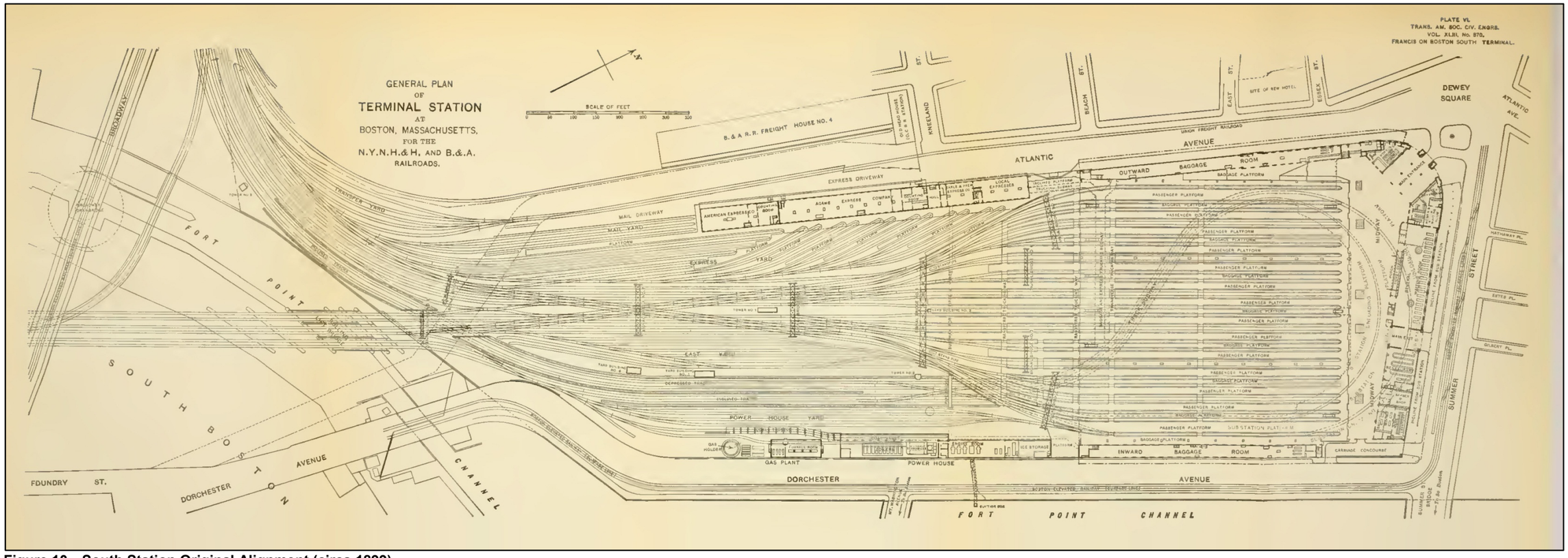


Figure 10—South Station Original Alignment (circa 1899)

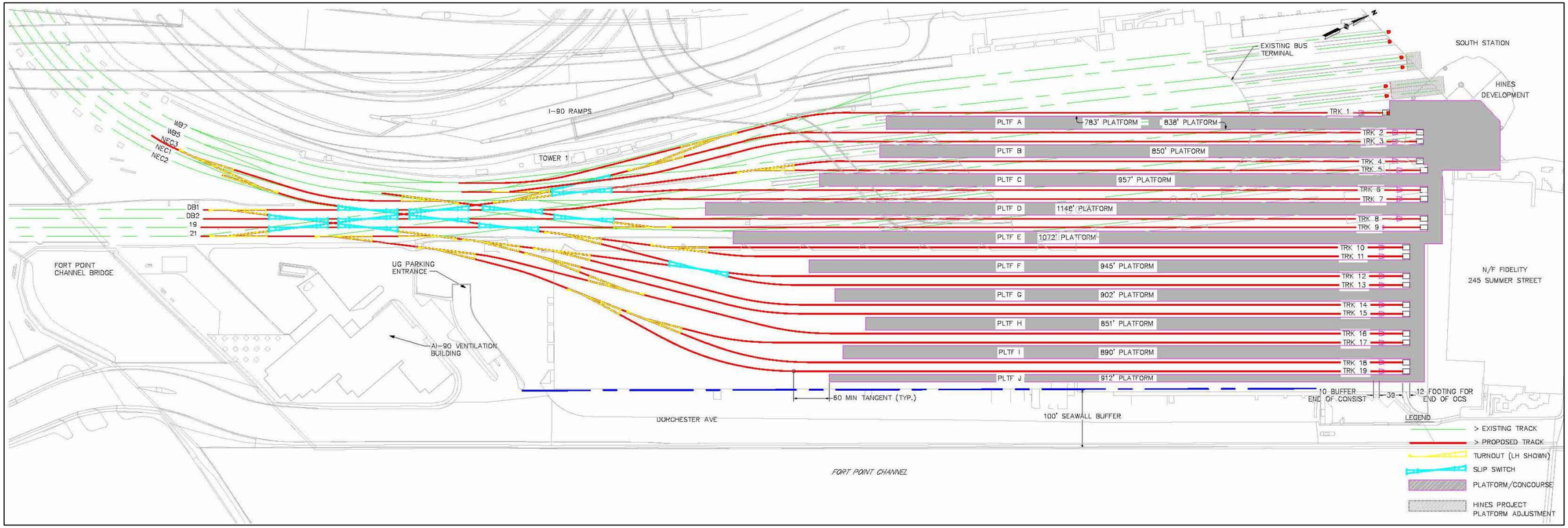


Figure 11—Constrained Rail Alternative 1—Redesign/Redevelopment

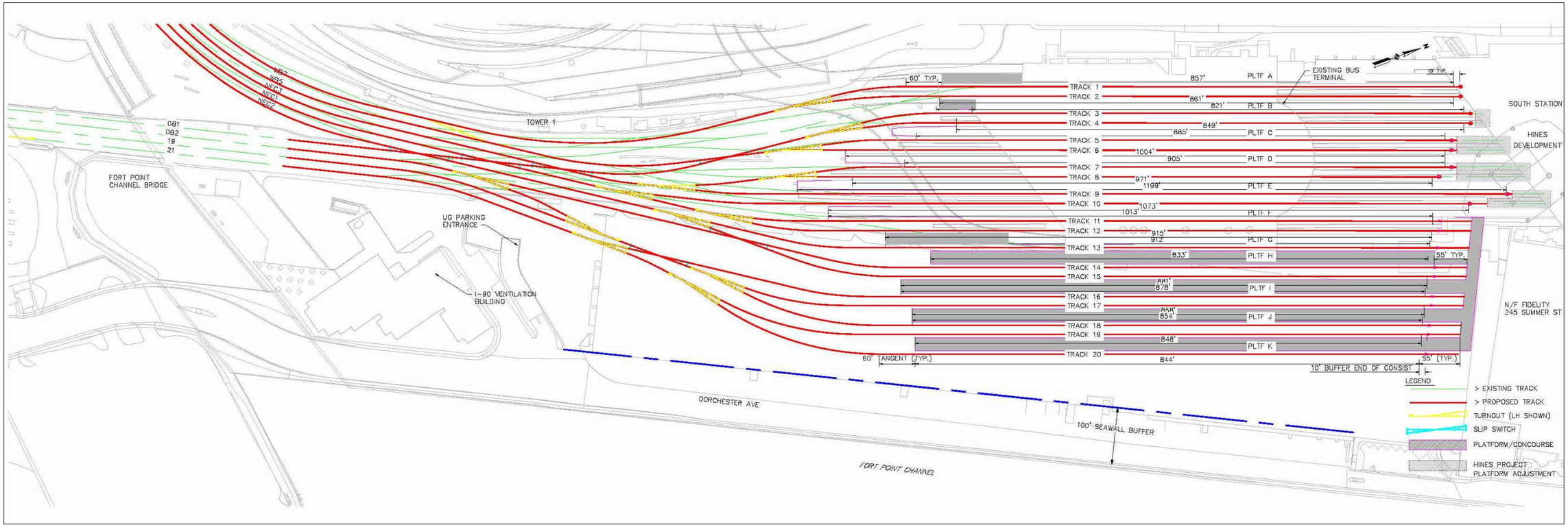


Figure 12—Constrained Rail Alternative 2 — Streamline Operations

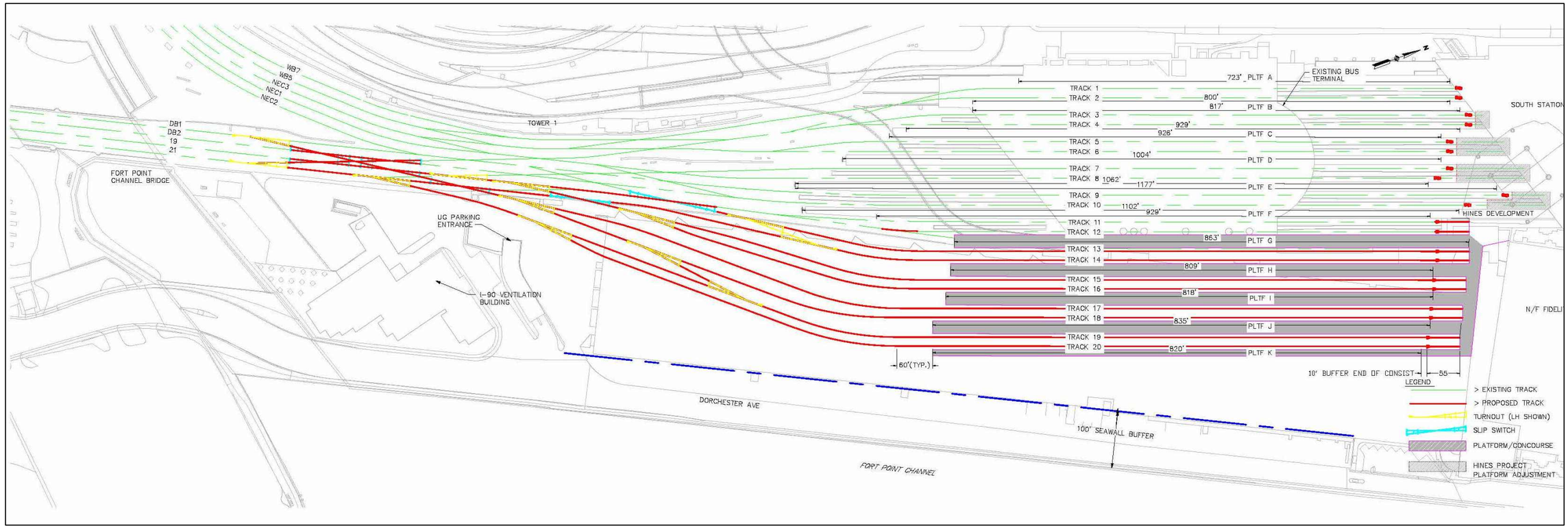


Figure 13—Constrained Rail Alternative 3 — Minimize Disruption to Operations

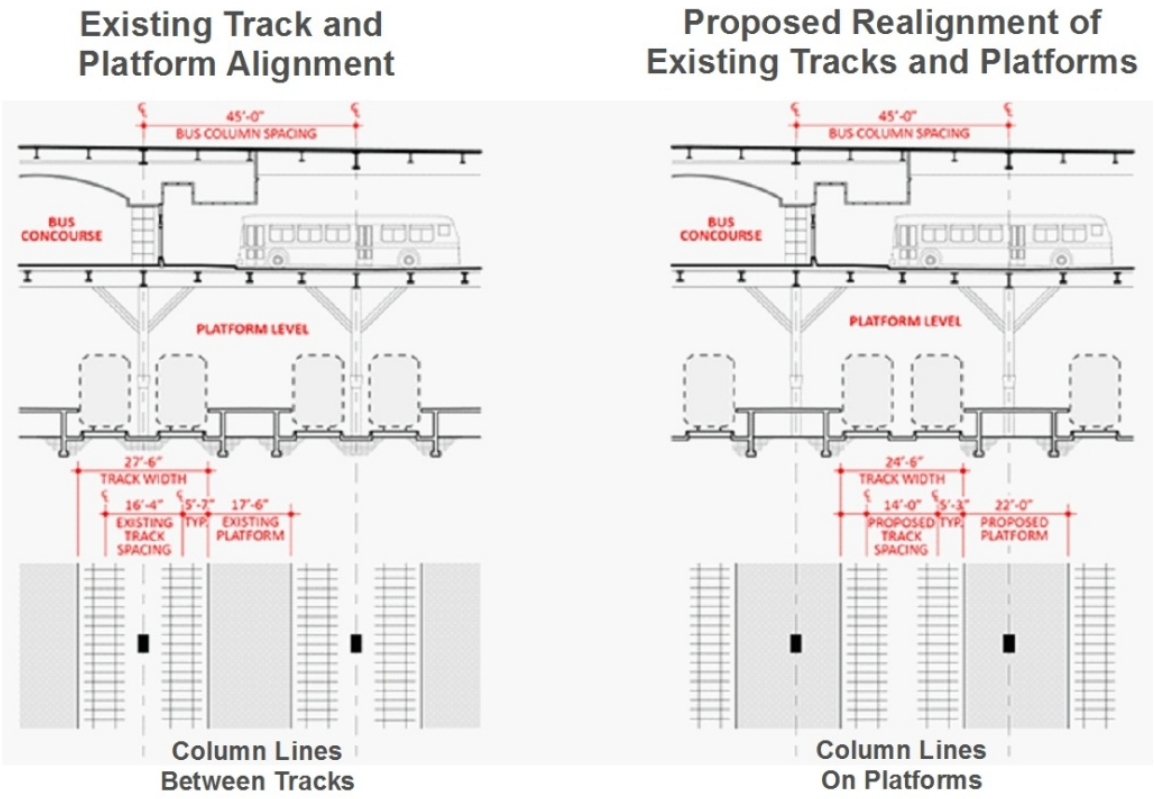


Figure 14—Constrained Rail Alternative 4—Maximize Overbuild Potential, Detail

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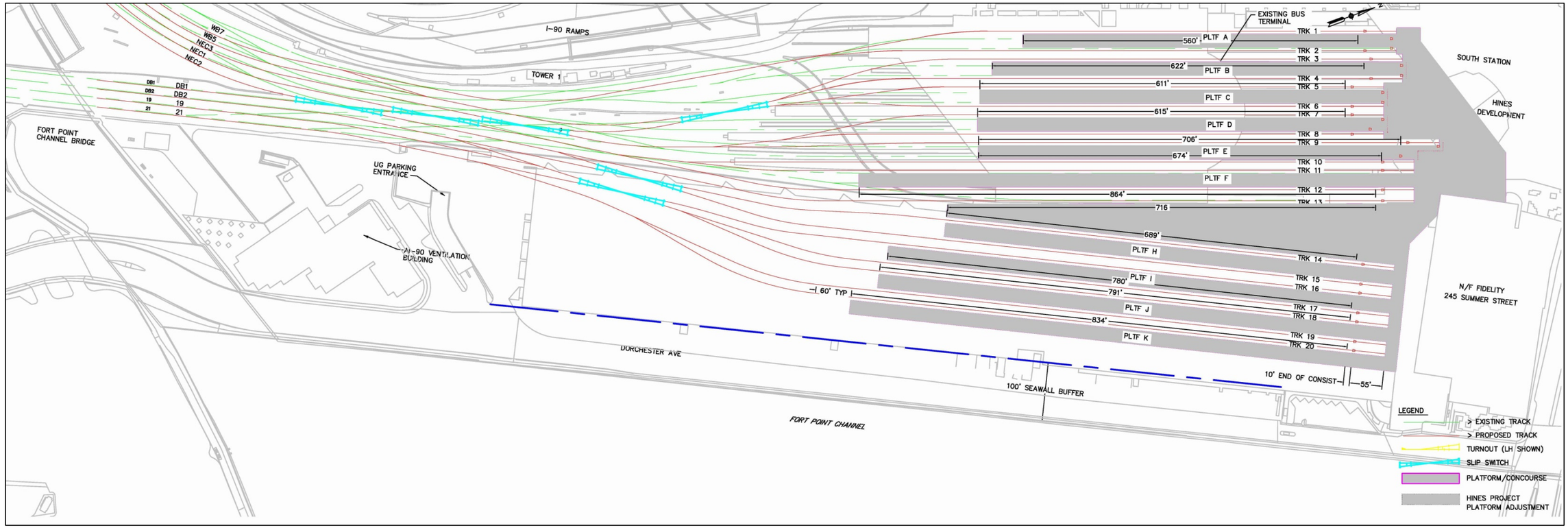

Figure 15—Constrained Rail Alternative 4 — Maximize Overbuild Potential

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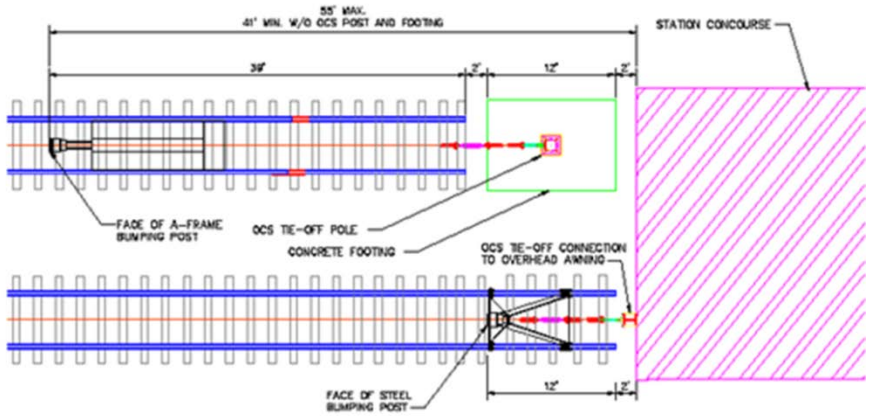
POTENTIAL LOCOMOTIVE AND COACH PLATFORM LENGTH INNOVATIONS



POTENTIAL BUMPING POST AND CATENARY PLATFORM LENGTH INNOVATIONS

Figure 16—Potential Berthing Accommodation Innovations

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