DC TO RICHMOND
SOUTHEAST HIGH SPEED RAIL

OPERATIONS MODELING

D.C. TO RICHMOND SOUTHEAST HIGH SPEED RAIL

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Operations Modeling Technical Report

DRPT
Virginia Department of Rail and Public Transportation

U.S. Department of Transportation
Federal Railroad Administration

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1 INTRODUCTION

This technical appendix describes the operations simulation modeling conducted as part of the alternatives development and screening process for the Washington, D.C. to Richmond Southeast High Speed Rail Tier II Environmental Impact Statement and Service Development Plan (the DC2RVA Project). The operations simulations undertaken and information presented herein was used to support the alternatives analysis and screening for the DC2RVA Draft Environmental Impact Statement and its accompanying Alternatives Technical Report.

1.1 DC2RVA PROJECT

The DC2RVA Project is being undertaken by the Virginia Department of Rail and Public Transportation (DRPT), with funding provided by the Federal Railroad Administration (FRA), DRPT, and CSX Transportation (CSXT). The overall process for the DC2RVA Project includes establishing a range of alternatives for consideration and then systematically evaluating and screening the range down to only the most reasonable for detailed analysis in the Project's Tier II Draft Environmental Impact Statement (EIS).

The DC2RVA Project builds on the decisions made by FRA as part of a Tier I EIS completed in 2002 for the Southeast High Speed Rail (SEHSR) corridor. The SEHSR Tier I EIS addressed the development, implementation, and operation of high speed passenger rail service in the approximately 500-mile travel corridor from Washington, D.C. through Richmond, VA and Raleigh, NC to Charlotte, NC. The 2002 Tier I EIS established the overall purpose for the SEHSR program, which is to provide a competitive transportation choice to travelers within the Washington, D.C. to Richmond, Raleigh, and Charlotte travel corridor. As part of the Tier I EIS process, FRA released a SEHSR Draft Implementation Plan in October 2002 that identified the need for a third main line track to be built in phases between Alexandria and Richmond in order to accommodate the freight and passenger growth needs of all users and to institute the proposed high-speed passenger service.

The current DC2RVA Project carries forward the purpose of the SEHSR Tier I EIS within the Washington, D.C. to Richmond segment of the larger SEHSR corridor. The purpose of the DC2RVA Project is to increase the rail capacity between Washington, D.C. and Richmond to deliver higher speed passenger rail; improve frequency, reliability, and travel times; expand commuter rail; and accommodate growth of freight rail service in an efficient and reliable multimodal rail corridor. The DC2RVA Project will enable passenger rail to be a competitive transportation choice for intercity travelers between Washington, D.C. and Richmond and beyond.

1.2 PURPOSE OF OPERATIONS SIMULATION ANALYSIS

The purpose of railroad operations simulation modeling is to estimate the performance of anticipated or planned trains on a proposed rail network under conditions different than the present day, or, to estimate the infrastructure necessary to deliver anticipated or planned trains to a desired performance level. "Performance" means the travel time and schedule adherence (also called "reliability") of passenger trains, and the travel time (measured as unplanned delay encountered in route) of freight trains. Conditions different than the present day typically include a combination of the following: additional passenger and/or freight trains, a different passenger train schedule and station stop plan, increased maximum speeds for passenger and/or freight trains, different freight train en-route work events, different freight train types (*e.g.*, more intermodal trains as a proportion of all freight trains), longer passenger and/or freight trains, and increased horsepower for passenger and/or freight trains. This combination of changes is determined by the transportation planning of the passenger and freight stakeholders. Typically, increased freight train volume, lengths, or speeds and changes in freight train type are forecast, based on intrinsic economic growth and/or growth of specific industries or freight flows in the region served by the rail network.

Computer-based railroad operations simulation modeling is being conducted by DRPT to assist in the evaluation of alternatives, to provide freight and passenger train operational metrics to enable stakeholders to estimate whether three main tracks between Washington, D.C. and Richmond are sufficient to support the Project's proposed increases in reliability, speed, and service frequency, and to estimate the performance of passenger and freight trains in the Washington, DC to Richmond corridor following the construction of proposed infrastructure.

DRPT has completed a preliminary phase of operations simulation modeling to estimate rail performance in the corridor and inform DRPT's evaluation of alternatives. Operations simulation modeling is an iterative process that is ongoing, and additional operations simulation analyses will be conducted through the Final EIS and Service Development Plan (SDP) phases of the Project. The preliminary phase of operations simulation modeling focused on the development of freight and passenger train operational metrics to enable stakeholders to evaluate whether suggested infrastructure is sufficient to meet the DC2RVA Project's Purpose and Need, and specifically to meet intercity passenger train and freight train service performance goals established by the *Passenger Rail Investment and Improvement Act of 2008* (PRIIA), also known as Public Law 110-432, and published as the *Metrics and Standards for Intercity Passenger Rail Service Under Section 207 of the Passenger Rail Investment and Improvement Act of 2008*, in the Federal Register on May 12, 2010. The preliminary phase of operations modeling assessed, at a high level, the additional infrastructure required to operate the Project's proposed nine additional daily round-trip passenger trains in the DC2RVA corridor at the increased maximum authorized speed (MAS) of 90 mph while maintaining the following:

- An estimated performance of CSXT freight trains similar to that estimated for the No Build Alternative
- An estimated future performance of VRE commuter trains that share a portion of the DC2RVA corridor similar to that estimated for the No Build Alternative
- Meeting or exceeding, on a sustained long-term basis including normal disruptions for weather, rail traffic congestion, and station delays, federally established on-time

performance requirements for intercity Regional, Interstate Corridor, and Long Distance passenger trains that use the DC2RVA corridor

The preliminary estimates were made within the geographic limits of the DC2RVA corridor.

For the operations simulation modeling work performed for the DC2RVA Project, DRPT established a Project implementation year of 2025, in consultation with FRA and other stakeholders, as the Project's implementation year, with a 20-year planning horizon year of 2045. Corridor performance estimates were made for freight and passenger train traffic anticipated to occur in year 2025. Performance estimates in certain modeling cases tested during the preliminary phase were made for year 2045. Each of the different Build Alternatives simulated in 2025 were compared against a 2025 No Build Alternative, while each of the different Build Alternatives simulated in 2045 were compared against a 2045 No Build Alternative. The No Build Alternative parameters were:

- The No Build passenger-train service levels
- Anticipated intrinsic growth of freight train volume that would occur by year 2025 or 2045
- Planned or funded improvements in rail infrastructure identified for the No Build Alternative would be constructed and in service

The Build Alternative parameters were:

- The proposed increase in passenger-train service levels of nine round trips per day between Washington, DC and Richmond
- The same anticipated intrinsic growth of freight train volume that would occur by year 2025 or 2045 as in the respective No Build Case
- The same planned or funded improvements in rail infrastructure identified for the No Build Alternative would be constructed or in service as in the No Build Case
- Different Build Case Alternatives, in order to estimate passenger and freight train performance with all conditions identical to the No Build Case except for the increase in passenger train frequency to nine round trips per day, and the different infrastructure proposed in each Build Alternative

The operations simulation modeling software used in all cases was Rail Traffic Controller©, developed by Berkeley Simulation Software, LLC. Although virtually all of the trains being modeled originate and terminate at locations beyond the DC2RVA Project limits, the operations simulation modeling only measured the impacts on operations within the DC2RVA Project area, based on the infrastructure changes proposed within the DC2RVA Project area.

DRPT performed the operations simulation modeling, and host railroad CSXT reviewed the modeling. The operations simulation modeling work performed was consistent with U.S. rail industry practice for operations simulation modeling of mixed freight, passenger, and commuter corridors, and incorporated experience with FRA, state Rail and Transportation Departments, Amtrak, commuter railroads, and host freight railroad requirements for operations simulation models in other passenger corridors. The work was also informed by FRA's publication *Railroad Corridor Transportation Plans: A Guidance Manual* and the FRA's requirements for operations modeling as described in the July 2010 Notice of Funding Availability for Service Development Programs (Federal Register/Vol. 75, No. 126). The work was consistent with best practices documented in *NCHRP Report 773: Capacity Modeling Guidebook for Shared Use Passenger and Freight Rail Operations* (Transportation Research Board, 2014).

Section 2 of this appendix discusses the parameters and assumptions of the operations simulation model, including geographic limits, implementation and horizon years of the Project, characteristics of passenger, freight, and commuter trains being modeled, proposed service increases resulting from the Project as well as growth projections for freight and commuter traffic that are forecast to occur independent of the Project, operations simulation modeling cases developed for the Project, and operating rules and regulations.

Section 3 summarizes the estimated pure running times for passenger trains in the DC2RVA corridor. These estimates were made using the Train Performance Calculator (TPC) feature of the Rail Traffic Controller (RTC) operations simulation model.

Section 4 presents the results of the preliminary operations simulation modeling and analysis conducted to support the development and screening of alignment alternatives in the Fredericksburg, Ashland, and Richmond areas.

2 PARAMETERS AND ASSUMPTIONS OF THE OPERATIONS SIMULATION MODEL

This section details the parameters and assumptions used in the preliminary operations simulation modeling performed for the Draft EIS. These assumptions and parameters were established by DRPT in cooperation with FRA, CSXT, Amtrak, and VRE prior to commencement of the operations simulation modeling.

2.1 PARAMETERS

2.1.1 Geographic Limits of the Model

The DC2RVA Project limits extend approximately 123 miles from RO, milepost (MP) CFP-110, in Arlington, VA south to the CSXT A-Line/S-Line junction at MP A-11 in Centralia, VA (Chesterfield County). At the northern terminus in Arlington, VA, the Project limits end at the Long Bridge over the Potomac River for infrastructure improvements in Virginia. The southern terminus in Centralia is the midpoint between downtown Richmond and downtown Petersburg. Additional segments of the Project include approximately 8.3 miles of the CSXT Peninsula Subdivision CA-Line from Beulah Road (MP CA-76.1) in Henrico County to AM Junction in the City of Richmond, and the approximately 26-mile Buckingham Branch Railroad (BBRR) from AM Junction to the CSXT RF&P Subdivision crossing (MP CA-111.8) in Doswell, VA.

In order to capture potential effects on capacity and velocity of existing and future freight, passenger, and commuter rail operations, both within and outside of the corridor associated with changes to infrastructure and service, the operations simulation model limits were greater than the DC2RVA Project limits, and included:

- Amtrak Washington Terminal District from the limits of Washington Union Station south to CSXT-owned trackage at CP Virginia in Washington, D.C.
- BBRR Piedmont Subdivision between Doswell and control point Bob near East Gordonsville, VA
- CSXT Philadelphia Subdivision between Philadelphia, PA and Bay View, MD
- CSXT Baltimore Terminal Subdivision between Bay View, MD and St. Denis, MD
- CSXT Capital Subdivision between St. Denis, MD and C Tower in Washington, D.C.
- CSXT Landover Subdivision between Landover, MD and Washington, D.C.
- CSXT Capital Subdivision Alexandria Branch between Riverdale Park, MD (JD Tower) and M Street in Washington, D.C.

- CSXT Metropolitan Subdivision between F Tower in Washington, D.C. and Weverton, MD
- CSXT Cumberland Subdivision between Weverton, MD and the Mexico interlocking in Cumberland, MD
- CSXT Cumberland Terminal Subdivision between the Mexico interlocking and Viaduct Junction in Cumberland, MD
- CSXT Old Main Line Subdivision between St. Denis, MD and Point of Rocks, MD
- CSXT Old Main Line Subdivision Frederick Branch between Frederick Junction, MD and Frederick, MD
- CSXT RF&P Subdivision Dahlgren Branch between Dahlgren Junction, VA and Sealston, VA
- CSXT Peninsula Subdivision between Beulah Road in Henrico County, VA and Newport News, VA
- CSXT Hopewell Subdivision between Bellwood, VA and Hopewell, VA
- CSXT North End Subdivision between Centralia, VA and control point Charlie Baker in Rocky Mount, NC
- CSXT Portsmouth Subdivision between Weldon, NC and Portsmouth, VA
- CSXT Rivanna Subdivision from Rivanna Jct. to Maidens, VA
- NS Washington District between Alexandria, VA and Springfield, VA

The operations simulation model encompassed the following seven railroad operating subdivisions, which are also illustrated in Figure 2.1-1 below:

1. Amtrak Washington Terminal District: Washington Union Station (MP 136.0) to CP Virginia interlocking in Washington, D.C. (MP 137.1) — 1.1 miles
2. CSXT RF&P Subdivision: M Street interlocking in Washington, D.C. (MP CFP 113.8) to Greendale, VA (MP CFP 4.8) — 109.0 miles
3. CSXT Richmond Terminal Subdivision: Greendale, VA (MP CFP 4.8) to Hermitage interlocking in Richmond (MP SRN 3.5) — 4.6 miles
4. CSXT Bellwood Subdivision: Hermitage interlocking in Richmond (MP SRN 3.5) to Centralia (MP S 10.9) — 14.4 miles
5. CSXT North End Subdivision: West Acca Yard (AY) interlocking in Richmond (MP ARN 3.3) to Centralia (MP A 10.7) — 14.0 miles
6. CSXT Peninsula Subdivision: AM Junction in Richmond (MP CA 85.4) to Beulah, VA (MP CA 76.2) — 9.2 miles
7. BBRR Piedmont Subdivision: AM Junction in Richmond (MP 85.5) to Doswell (MP 111.8) — 26.3 miles

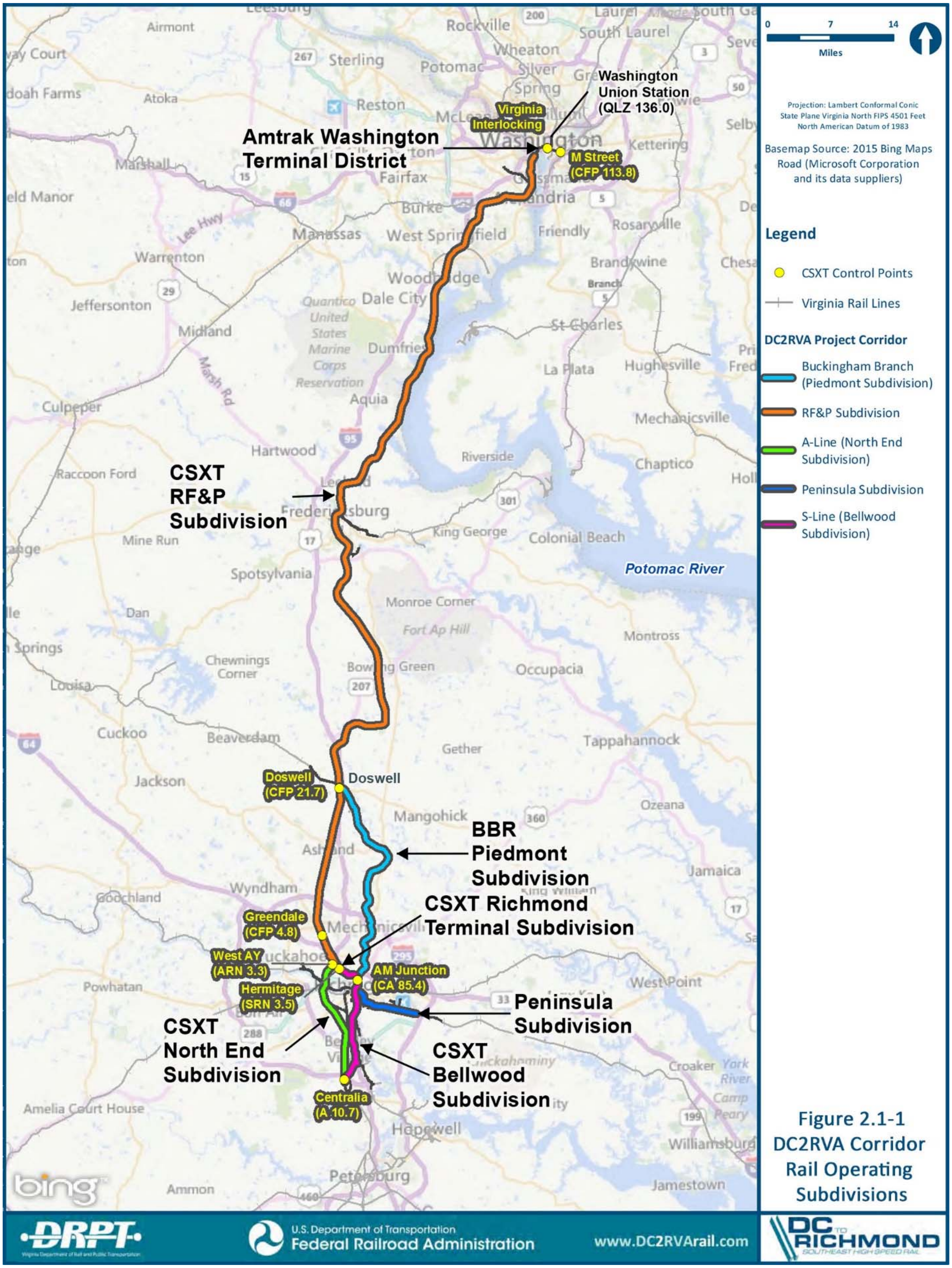

FIGURE 2.1-1: DC2RVA CORRIDOR RAIL OPERATING SUBDIVISIONS

2.1.2 Implementation and Horizon Years for Service

FRA-funded passenger projects generally require that operations analysis (and specifically operations simulation) demonstrate that the proposed Project incorporates sufficient infrastructure capacity to deliver the proposed passenger service for its intended schedule and intended schedule adherence, which may include increased frequency, increased maximum authorized speed, and increased schedule adherence from existing, while reasonably mitigating effects of the proposed passenger service on other passenger rail services and freight services that also use the corridor. The mitigation is typically considered to be effective if the effects of the proposed passenger service on other passenger rail services and freight services are not unreasonable. The measurement of reasonable mitigation is typically made at the 20th year after the implementation of the proposed passenger service. Because the other passenger services and freight services using the corridor are typically not static during this 20-year period, the effects of the proposed passenger service are measured after changes that may occur in other passenger rail services and freight services in the corridor. These changes are inclusive of intrinsic freight traffic growth, and infrastructure projects anticipated to be separately constructed by the other passenger rail services or freight rail services in the corridor.

For the operations simulation modeling work performed for the DC2RVA Project, DRPT established a Project implementation year of 2025, in consultation with FRA and other stakeholders, as the Project's implementation year, with a 20-year planning horizon year of 2045. For the purposes of calibrating the operations simulation model, the year 2015 was selected as data had been compiled for this year.

2.1.3 Time of Year of Model

The trains files used in the base operations simulation modeling case were developed from real-time data provided by CSXT for trains operating in the operations simulation territory limits during a 14-day period between August 27, 2014 and September 9, 2014. Implementation year for passenger service was estimated to be 2025. Future year scenarios were modeled in the years 2025 and 2045, using CSXT-projected freight growth calculations (see Section 2.2.2).

2.1.4 FRA Regulations that Affect Model

The model incorporates current CSXT employee timetables and operating rules, which reflect current FRA regulations on track classification, maximum train speed by track classification, method of operation, etc.

2.1.5 CSXT Rules and Regulations in Effect

Trains in the model adhere to current CSXT operating rules and regulations, signal aspects, and braking curves. Operations and Infrastructure in the model were developed in accordance with the following CSXT documents:

- Baltimore Division Timetable No. 1, effective Wednesday, April 1, 2015
- Florence Division Timetable No. 7.1 effective Tuesday, May 1, 2012 and incorporating Rules Conversion effective January 1, 2014
- Huntington Division East Timetable No. 3.1 effective Sunday, August 5, 2012 and incorporating Rules Conversion effective January 1, 2014

- CSXT Operating Rules, effective January 1, 2014
- CSXT Safe Way rulebook, effective July 1, 2012

2.1.6 Roadway At-Grade Crossing Blockages

Standing trains in the model do not block a public at-grade roadway crossing for more than 10 minutes. Private grade crossings in the model can be blocked for up to 30 minutes by standing trains.

2.1.7 Maximum Authorized Speeds

The maximum authorized passenger rail speed in the Build Cases was 90 miles per hour. The maximum authorized passenger rail speed in the Base and No Build Cases was 70 miles per hour, and the maximum authorized freight train speed in the Base, No Build, and Build Cases was 60 miles per hour for intermodal trains and 55 miles per hour for other freight train types.

Certain sections of the DC2RVA corridor have operating speeds reduced from these maximums owing to track geometry constraints or operating characteristics. For example, the Richmond Terminal area has lower maximum authorized track speeds owing to the constrained geography and complex freight activity, and the main track speed from Washington Union Station to Richmond is limited at certain locations owing to geometric constraints such as curvature. To assist in the screening of alignment alternatives, track speeds were defined using Train Performance Calculations to estimate, for example, the benefit of higher operating speeds, with the results and findings incorporated into this appendix.

On CSXT trackage, train speeds are authorized by:

a) Rules, or
b) Special instructions, or
c) Train documents, or
d) Dispatcher messages, or
e) Form EC-1, or
f) Signal indications.

According to the current CSXT operating rulebook, the following terms apply when used to authorize train speed:

a) Limited Speed: A speed not exceeding 45 mph
b) Medium Speed: A speed not exceeding 30 mph
c) Slow Speed: A speed not exceeding 15 mph
d) Restricted Speed: A speed that permits stopping within one-half the range of vision. It also permits stopping short of a train, a car, on-track equipment, an obstruction, a Stop signal, a derail, or an improperly lined switch. It permits looking out for broken rail. It is not to exceed 15 mph.

Trains using other than main or signaled tracks must move at a speed that permits stopping within one-half the range of vision, short of a train, a car, on-track equipment, an obstruction, a Stop signal, a derail, or an improperly lined switch and must not exceed:

a) 25 mph on non-signaled sidings, or

b) 15 mph when moving to and from the main track, operating through hand-operated switches not equipped with a signal, or
c) 10 mph when not moving to or from the main track, operating through hand-operated switches, or
d) 10 mph on other than main tracks or signaled tracks, or
e) 5 mph within designated locomotive service track or car shop repair track areas.

According to the current CSXT operating rulebook, the following speeds must not be exceeded:

a) 70 mph for passenger trains with multi-level auto-racks or auto frame equipment, or
b) 59 mph for passenger trains operating within the limits of a signal suspension or against the current of traffic, or
c) 49 mph for freight trains operating within the limits of a signal suspension or against the current of traffic, or
d) 10 mph for trains operating on excepted track, or
e) Restricted speed for 15 minutes for trains that encounter an unattended burning fusee near the track, unless the fusee is beyond the first rail of an adjacent track

2.1.8 Curve Superelevation and Unbalance

Superelevation is the height difference in inches between the high (outside) and low (inside) profile rail. Superelevation is used to counteract, or partially counteract the centrifugal force acting radially outward on a train when it is traveling through the curve. A state of equilibrium is reached when the centrifugal force acting on a train is equal to the counteracting force pulling on a train by gravity along the superelevated plane of the track.

On CSXT's Baltimore and Florence divisions, existing curves have a maximum superelevation of 4 inches. Existing maximum curve unbalance for freight trains is 2 inches, and existing maximum curve unbalance for passenger trains is 4 inches.

Where upgrade of track classification and passenger speeds are proposed for the implementation of passenger rail service, main track and controlled siding track and signal standards will allow full interoperability of freight and passenger trains, per the DC2RVA Engineering Basis of Design.

2.2 ASSUMPTIONS

2.2.1 Regulations and Rules Affecting Freight Train Performance

For operations simulation cases modeled in the 2025 Implementation Year and 2045 Horizon Year, trains in the model are assumed to adhere to FRA and CSXT operating regulations and rules in effect in 2015, and that these regulations and rules will not be changed in any substantive way that would reduce maximum operating speeds, acceleration and braking curves, train lengths, train dwells, or other parameters of freight train and passenger train trip time and over-the-road performance. Passenger and freight train performance acceleration, braking, unbalance, and maximum speed limit characteristics in the 2025 and 2045 cases are assumed to be the same as today.

Passenger train on-time performance requirements are assumed to be identical to those in effect today, including the on-time performance metrics developed by FRA and Amtrak in accordance with Section 207 of the Passenger Rail Improvement and Investment Act.

2.2.2 Freight Train Growth Characteristics

To forecast freight growth likely to occur from 2015 to 2025 and ultimately to 2045, the U.S. Department of Transportation (U.S. DOT) Freight Analysis Framework (FAF) data was used. Typically, a selected growth rate is a combination of the general anticipated economic growth of the U.S. (approximately 2 percent Gross Domestic Product [GDP] growth), plus known local expected changes, such as specific industries, customers, or commodities that are exhibiting changes in traffic (*e.g.*, the Port of Virginia) that are substantially less or more than the national GDP growth rate. The host freight railroad may choose to provide data on their own freight growth forecasts, or an annual freight growth rate of 2 percent is used. DRPT, following consultation with CSXT and other stakeholders, applied a freight growth rate of approximately 2.3 percent for CSXT freight traffic. To forecast the growth rate for the DC2RVA corridor, the ton-miles for the states in which CSXT operates was used to forecast growth by train type. Using this approach, CSXT forecast freight volumes on the DC2RVA corridor to increase from an average of 21.6 daily trains in 2015 to an average of 27.8 trains in 2025 and 42.5 trains in 2045. The crucial assumptions in this freight forecast methodology is that freight growth statewide will be uniformly distributed throughout the state, its distribution by mode will be in similar proportion to today, and that shippers will be willing and able to pay similar freight rates in the future adjusted for inflation as they do today. These assumptions are reflected accordingly in the forecasted growth of CSXT freight traffic operating through these states.

2.2.3 Operations Simulation Cases

DRPT has completed a preliminary phase of operations simulation modeling to estimate rail performance in the corridor and inform DRPT's evaluation of alternatives. Operations simulation modeling is an iterative process that is ongoing, and additional operations simulation analyses will be conducted through the Final EIS and SDP phases of the Project. The preliminary phase of operations simulation modeling focused on the development of freight and passenger train operational metrics to enable stakeholders to evaluate whether suggested infrastructure is sufficient to meet the DC2RVA Project's Purpose and Need, and specifically to meet intercity passenger train and freight train service performance goals established by the *Passenger Rail Investment and Improvement Act of 2008* (PRIIA), also known as Public Law 110-432, and published as the *Metrics and Standards for Intercity Passenger Rail Service Under Section 207 of the Passenger Rail Investment and Improvement Act of 2008*, in the Federal Register on May 12, 2010. The preliminary phase of operations modeling assessed, at a high level, the additional infrastructure required to operate the Project's proposed nine additional daily round-trip passenger trains in the DC2RVA corridor at the increased maximum authorized speed (MAS) of 90 mph while maintaining the following:

- An estimated performance of CSXT freight trains similar to that estimated for the No Build Alternative;
- An estimated future performance of VRE commuter trains that share a portion of the DC2RVA corridor similar to that estimated for the No Build Alternative; and

- Meeting or exceeding, on a sustained long-term basis including normal disruptions for weather, rail traffic congestion, and station delays, federally established on-time performance requirements for intercity Regional, Interstate Corridor, and Long Distance passenger trains that use the DC2RVA corridor.

Cases were developed for the years 2015 (Base Case), 2025 (Implementation Year), and 2045 (Horizon Year). In all cases, a ten-day period was modeled, using a two-day warm-up and one-day cool-down period, and output metrics were captured for the middle seven days. The following cases were developed:

- ***2015 Base Case***
  - Infrastructure and service in existence in 2015. This operations simulation case was used to construct and calibrate the operation simulation model's ability to realistically estimate the performance of freight and passenger trains in the corridor.
- ***2025 No Build (Implementation Year) Case with Planned, Programmed and Budgeted Infrastructure Exclusive of the DC2RVA Infrastructure Improvements***
  - This case adds currently planned, programmed, and budgeted infrastructure to the Base Case infrastructure. Forecasted growth in freight traffic and planned commuter growth expected to occur by the year 2025 are also added to the operations simulation model.
- ***2045 No Build (Horizon Year) Case with Planned, Programmed and Budgeted Infrastructure Exclusive of the DC2RVA Infrastructure Improvements***
  - This case adds currently planned, programmed, and budgeted infrastructure to the Base Case infrastructure. Forecasted growth in freight traffic and planned commuter growth expected to occur by the year 2045 are also added to the operations simulation model.
- ***2025 Build (Implementation Year) Case with DC2RVA Infrastructure and Service***
  - This case adds the DC2RVA infrastructure alternatives under evaluation to the 2025 No Build Case and tests and estimates the performance of DC2RVA Project passenger trains described in the proposed DC2RVA service plan, as well as other passenger trains and freight trains, in the corridor, that are expected to operate in the corridor in the year 2025.
- ***2045 Full Build (Horizon Year) Case with DC2RVA Infrastructure and Service***
  - This case adds the DC2RVA infrastructure alternatives under evaluation to the 2045 No Build Case and tests and estimates the performance of DC2RVA Project passenger trains described in the proposed DC2RVA service plan, as well as other passenger trains and freight trains, in the corridor, that are expected to operate in the corridor in the year 2045.

2.2.4 Infrastructure Assumed at Implementation and Horizon Year

Physical improvements to the corridor in the Build Case were identified and developed by DRPT to support the DC2RVA Project's proposed increases in passenger train frequency, reliability, and operating speed. Physical improvements to the corridor in the No Build Case were identified and developed by CSXT to accommodate planned improvements in freight service, by DRPT and CSXT to accommodate planned improvements in regional and intercity passenger service in the corridor, and by DRPT, CSXT, and VRE to accommodate planned improvements in commuter passenger service in the corridor. In the Build Case, the maximum authorized passenger train speed was increased to 90 miles per hour, while the maximum authorized freight train speed remains the same as at present, at 60 miles per hour. The Build Alternatives assume that the corridor between CP Virginia and Centralia will continue to be a shared-use freight, passenger, and commuter corridor with all trains intermingled on main tracks, and a passenger-commuter only segment between CP Virginia and Washington Union Station.

In consultation with stakeholders, DRPT developed conceptual infrastructure parameters for the alternatives. These parameters included maximum authorized speeds on all main tracks and sidings incorporated into the model; the vertical and horizontal alignment of the infrastructure; curve superelevation and spirals; authorized equipment unbalance; track centers; signal spacing and aspects; and whether use of tracks will be restricted by type of train. The operations simulation modeling work described in this appendix was carried out to support the development and screening of rail infrastructure alternatives. DRPT and FRA set 2025 as DC2RVA's year of implementation and 2045 as the long-range planning horizon for purposes of evaluating the proposed infrastructure improvements and service development.

The DC2RVA Project builds on the decisions made by FRA as part of a Tier I EIS completed in 2002 for the Southeast High Speed Rail (SEHSR) corridor. The SEHSR Tier I EIS addressed the development, implementation, and operation of high speed passenger rail service in the approximately 500-mile travel corridor from Washington, D.C. through Richmond, VA and Raleigh, NC to Charlotte, NC. The 2002 Tier I EIS established the overall purpose for the SEHSR program, which is to provide a competitive transportation choice to travelers within the Washington, D.C. to Richmond, Raleigh, and Charlotte travel corridor. The SEHSR Tier I EIS considered and dismissed using locomotives powered by an overhead electrified catenary system in favor of diesel-electric powered equipment; therefore, electrification of the corridor is not evaluated in the DC2RVA Tier II EIS or within the Project's operations simulation modeling. As part of the Tier I EIS process, FRA released a SEHSR Draft Implementation Plan in October 2002 that identified the need for a third main line track to be built in phases between Alexandria and Richmond in order to accommodate the freight and passenger growth needs of all users and to institute the proposed high-speed passenger service.

2.2.5 No Build Infrastructure Alternative Assumptions

The No Build Alternative defines the future (2025) infrastructure and service levels that will result from planned investments in the Washington, D.C. to Richmond rail corridor, independent of the improvements planned by the DC2RVA Project. The No Build Alternative provides a basis for comparing and contrasting the potential impacts of different DC2RVA Build Alternatives.

Information about planned physical improvements and rail service additions in the corridor was gathered from fiscally constrained Metropolitan Planning Organization (MPO) planning documents, Commonwealth multi-year improvement programs, and from transit agency planning documents. If a project was under construction, fully funded, or was the focus of advanced collaborative planning (evidenced by partial funding, board-level commitments, or interagency agreements), it was assumed to be complete by 2025 for the purposes of this evaluation. This includes, for example, projects in the VRE 2040 System Plan, which was adopted by the VRE Operations Board in 2014, and has received support from VDOT and other state agencies.

2.2.5.1 No Build Alternative Infrastructure Improvements

Table 2.2-1 summarizes the infrastructure improvements that are assumed to be in place by 2025 and would remain in place in 2045, and is followed by a detailed description of each infrastructure improvement project included in DC2RVA's No Build Alternative.

TABLE 2.2-1: NO BUILD INFRASTRUCTURE ASSUMPTIONS

Mode	Project	Source for Inclusion
Rail	Washington Union Station Capacity upgrade	Amtrak Washington Union Station Master Plan
	Virginia Avenue Tunnel expansion	CSXT National Gateway Program
	VRE 4th Track: CP Virginia – Long Bridge	VRE 2040 System Plan
	Long Bridge Expansion	FRA/DDOT Pre-NEPA Study
	RF&P Franconia-Featherstone improvements (CSXT "Fast Track agreement")	DRPT FY2016 Six Year Improvement Program
	RF&P Powells Creek – Arkendale improvements	DRPT FY2016 Six Year Improvement Program
	Main Line Relocation Project at Acca Yard and Crossovers South of the James River	DRPT FY2016 Six Year Improvement Program
	Richmond-Petersburg segment improvements for service expansion to Norfolk	DRPT FY2016 Six Year Improvement Program
	Franconia to Occoquan third mainline track improvements	DRPT FASTLANE Grant
	VRE Broad Run/Crossroads Yard expansion	VRE 2040 System Plan
	VRE Gainesville/Haymarket Extension	VRE 2040 System Plan
	VRE Station Platform Expansion Program	VRE 2040 System Plan
	VRE Potomac Shores Station	VRE 2040 System Plan

Washington Union Station Capacity Upgrade—Union Station has two track levels. The upper level consists of mostly high-level platforms serving stub-end tracks and is utilized by MARC and Amtrak trains terminating in Washington, D.C. The lower level consists of four low–level platforms located along eight through-running tracks that lead to the First Street Tunnel, which serves VRE and Amtrak trains that continue south to Virginia. The Union Station Master Plan has identified improvements to the lower track level that will proceed in the first phase of the master plan project. A new low-level side platform will be added on the easternmost track, for a total of five platforms serving eight lower tracks. Two of the existing lower level platforms will be upgraded as high-level platforms to provide level boarding on four tracks for faster boarding and alighting of Amtrak trains. The new side and two other existing platforms will remain low-level providing four tracks to accommodate VRE's rolling stock, which is incompatible with high-level platforms. Construction began January of 2017 with completion in 2021.

Virginia Avenue Tunnel Expansion—CSXT began construction on an expansion of the Virginia Avenue Tunnel in Washington, D.C. in 2015. CSXT uses the current single-track Virginia Avenue Tunnel to bypass Union Station as freight trains travel through Washington, D.C. between Virginia and Maryland. The single-track tunnel is a bottleneck for CSXT, as freight trains must wait for clearance to travel through the tunnel at slow speeds, causing delays for freight movements along the DC2RVA corridor, causing passenger trains to wait behind freight trains, or operate in both directions on the remaining free track. The expansion will add a second track to the tunnel and increase its height to allow for double-stack freight trains to travel through the tunnel.[1] CSXT opened the first of two tracks for double-stack operation in 2016, with completion of both tracks planned for 2017.

VRE 4th Track CP Virginia–CP L'Enfant—VRE has allocated funding under its capital program to construct a 4th mainline track between Control Point (CP) Virginia and CP L'Enfant in Washington, D.C. The track extension, identified in the 2040 System Plan adopted by the VRE Board in 2014, will provide four tracks through the VRE L'Enfant station and generally separate intercity passenger and commuter traffic from CSXT freight traffic in southwest Washington, D.C. The CP Virginia-CP L'Enfant section is outside the limits of the DC2RVA Project, but affects the operation of intercity passenger, commuter and freight operations continuing south to Virginia.

Long Bridge Expansion—DDOT and FRA are preparing a separate EIS for the expansion of rail capacity from CP Virginia in Washington, D.C. across the Potomac River to CP RO in Alexandria, VA through an expansion of the Long Bridge. The existing Long Bridge is a two-track bridge completed in 1903 and owned and operated by CSXT. The Long Bridge is a bottleneck for train traffic capacity between Virginia and Washington, D.C. DDOT is considering alternatives that would add additional capacity to the bridge to accommodate planned growth in intercity passenger, commuter and freight train traffic traveling across the river. As part of the Atlantic Gateway Project, the Commonwealth of Virginia, in cooperation with VRE and the FRA, has begun program development to advance engineering, stakeholder agreements, and outreach in support of the construction of a new bridge. VRE is in the process of identifying money in its capital program to support the Long Bridge Expansion program.

RF&P Subdivision, Franconia-Featherstone Improvements—DRPT is advancing improvements to the DC2RVA corridor in Northern Virginia between Franconia and Featherstone, south of Woodbridge, VA. The improvements are focused around the Auto Train station in Lorton, VA, where the daily Auto Train service originates and runs non-stop to Sanford, FL. The Auto Train station is located on a spur from the DC2RVA corridor. The improvements will provide improved switches to support faster train movements through Lorton. Construction began in the spring of 2016 and is planned for completion in 2020.

Franconia to Occoquan Third Mainline Track Improvements—As part of the Atlantic Gateway Project, DRPT is advancing 8 miles of new third mainline track from the Franconia-Springfield Station south to a location just north of the Occoquan River. The additional third track would connect with the existing third mainline track constructed between Alexandria and

[1] "Double-stack freight trains" are trains in which containers are stacked two high on railroad cars.

Franconia in 2009, to provide approximately 20 miles of continuous three mainline track railroad from Arlington, VA to the Occoquan River. DRPT will prepare a draft Categorical Exclusion (CE) worksheet for FRA review and approval prior to construction of this project. Construction is planned to begin in the spring of 2017 with completion in early 2020.

RF&P Subdivision, Arkendale–Powells Creek Improvements—Construction is underway on approximately 9 miles of third mainline track constructed adjacent to existing tracks in the CSXT right-of-way. Construction encompasses additional track, siding, turnouts, a new platform at Quantico station, and the Bauer Road Bridge near Marine Corps Base Quantico. This capacity project was pursued by DRPT as the first part of the SEHSR corridor to begin construction. Construction began in 2014 and is planned for completion in 2020.

Main Line Relocation Project at Acca Yard—Acca Yard, CSXT's major freight yard in the Richmond area, creates freight-passenger rail conflicts for trains traveling south of Richmond's Staples Mill Road station. The activities in the yard require passenger trains to travel at slow speeds and often require passenger and/or freight trains to wait as freight trains clear the active tracks. Construction is underway on a project that will remove all mainline tracks from inside the yard and relocate them to the western edge of the yard and signal them, enabling through passenger and freight trains to bypass yard operations and move through the terminal area more smoothly and at a higher speed. The project will also add a fourth mainline track between Staples Mill Road station and the north throat of Acca Yard, and rebuild interlockings at the south throat of the yard so through trains can pass by at a higher operating speed. This will reduce passenger train delays and reduce trip time through Acca Yard. In exchange for these improvements, CSXT has provided DRPT with the right to operate an additional round trip of Amtrak's Northeast Regional service between Washington, D.C. and Lynchburg, VA, and extend two Northeast Regional (Virginia) trains currently terminating in Richmond to Norfolk, VA. Construction began in late 2015 and is planned for completion in 2020.

Richmond-Petersburg Segment Improvements for Service Expansion to Norfolk—DRPT restored Amtrak service to Norfolk in 2012 after improvements were made to Norfolk Southern and CSXT track south of Petersburg. Additional improvements are to be constructed between Richmond and Petersburg to support the extension of the two Northeast Regional (Virginia) trains that currently terminate in Richond to Norfolk for a total of three daily Northeast Regional (Virginia) roundtrip trains to Norfolk. Construction began in 2015 and is planned for completion in 2018.

VRE Broad Run/Crossroads Yard Expansion—VRE is expanding two rail yards (the Broad Run Yard serves the Manassas Line, the Crossroads Yard serves the Fredericksburg Line) to store additional train sets needed for VRE's planned future service expansion. Each yard will be able to store eight 8-car train sets overnight. Construction began in 2015 and is planned for completion in 2018.

VRE Gainesville/Haymarket Extension—The VRE 2040 System Plan identified a VRE service expansion to serve population and job centers in Gainesville and Haymarket, Prince William County, VA. The 11-mile extension would include three stops along an existing railroad right-of-way. The service would join the Manassas Line west of Manassas station, and would join the DC2RVA corridor at AF interlocking south of Alexandria Station. VRE has identified funding in its current capital plan to support the planning of service to Gainesville and Haymarket. On March 17, 2017, VRE canceled plans to support the planning of service to Gainesville/Haymarket in favor of expanding and relocating the Broad Run station. The cancellation of this project, however, does not affect the operations simulation modeling that was conducted for the DC2RVA Project as VRE is still increasing the number of trains on thei Manassas Line as anticipated.

VRE Station Platform Expansion Program—Most VRE stations in the DC2RVA corridor consist of a single low-level platform on the east side of the tracks south of Alexandria and on the west side of the tracks between Alexandria and Washington, D.C. At these stations, all VRE trains, regardless of direction, must use the eastern track for boarding and alighting south of Alexandria, then switch to the west side north of Alexandria. This requires all other traffic passing in both directions to utilize the opposite track. Additionally, many VRE stations have platforms that can only accommodate five to six rail cars. As VRE expands to longer train consists (up to ten rail cars), the shorter platforms currently deprive VRE of the ability for simultaneous boarding and alighting passengers of all rail cars, which lengthens station dwell time. In preparation for VRE's planned fleet expansion, and to improve operational flexibility along the DC2RVA corridor, VRE is planning or implementing improvements at the stations listed below. Construction is planned to begin in 2018 with completion by 2021 or earlier.

- VRE L'Enfant Station—VRE will create an island platform serving the two westernmost tracks.
- VRE Crystal City Station—VRE will build a new island platform serving the two westernmost tracks.
- VRE Alexandria Station—VRE will lengthen and widen the existing island platform so that it can also serve Track 1. VRE will also improve the tunnel connecting the island platform to the main station for ADA accessibility.
- VRE Franconia-Springfield Station—VRE will lengthen the existing platforms and widen the east platform.
- VRE Lorton Station—VRE will lengthen the existing eastern platform, and add a side platform on the western side of the right-of-way.
- VRE Woodbridge Station—VRE will lengthen the existing eastern platform.
- VRE Rippon Station—VRE will lengthen the existing eastern platform, and add a side platform on the western side of the right-of-way.
- VRE Quantico Station—VRE is lengthening both existing platforms to accommodate longer trains, and is converting the west side platform into an island platform for operational flexibility.
- VRE Brooke Station—VRE will lengthen the existing eastern platform, and add a side platform on the western side of the right-of-way.
- VRE Leeland Road Station—VRE will lengthen the existing eastern platform, and add a side platform on the western side of the right-of-way.
- VRE Potomac Shores Station—VRE is constructing a new station at Potomac Shores, with two side platforms that accommodate eight car trains.

The track improvements through the VRE stations that are planned as part of the DC2RVA Project will accommodate the additional platforms and modifications outlined in this section.

2.2.5.2 Rail Service Growth in the No Build Alternative

Rail service levels vary along the length of the DC2RVA corridor, and not all passenger service is continuous through the entire DC2RVA corridor. The DC2RVA corridor hosts all VRE commuter rail service and Amtrak passenger rail service to points south of Washington, D.C. between CP Virginia in Washington, D.C. and AF interlocking in Alexandria. At AF Interlocking, VRE and Amtrak trains heading toward Manassas, Charlottesville and Lynchburg leave the DC2RVA corridor (presently two to three daily Amtrak round trips and nine weekday VRE round trips, including one non-revenue VRE round trip). The remaining VRE service (currently, eight weekday round trips) continues on the DC2RVA corridor south of Alexandria to Crossroads Yard south of the VRE Spotsylvania station. Approximately 20 to 30 freight trains operate on the DC2RVA corridor between Washington, D.C. and Richmond, along with five daily round-trip Amtrak Northeast Regional (Virginia) intercity passenger trains and five daily round-trip Amtrak long-distance and interstate corridor (Carolina) passenger trains.

Table 2.2-2 summarizes existing service along the DC2RVA corridor and provides the estimated 2025 and 2045 service assumptions for the No Build condition. The table is a summary of all activity on the corridor, excluding local freight trains and yard assignments. Existing service along the DC2VA corridor is an estimated 79 to 89 daily trains (depending on the volume of freight trains). Planned rail infrastructure improvements described in Section 2.2.5.1 above would support the operation of one additional Amtrak Northeast Regional (Virginia) round-trip passenger train to Lynchburg and two additional VRE commuter train round trips, along with an estimated 2.3 percent annual growth in freight service. Additionally, Amtrak intends to increase the operations of the Cardinal (a long-distance passenger train that operates via Charlottesville and Alexandria) through the corridor from three trips per week to one round trip daily. To forecast freight train growth in the corridor from existing (2015) levels, CSXT provided freight volumes for the future years 2025 and 2045 using the U.S. DOT Freight Analysis Framework projected growth rates for rail. CSXT freight growth is independent of the DC2RVA Project and will occur regardless of whether or not the DC2RVA Project is implemented. CSXT actual freight growth may be greater or less than the projected growth rates based on market demands. DRPT estimates that the total number of trains in the No Build condition in 2025 to be between 91 and 103 daily trains, and in the No Build condition in 2045 to be between 106 and 121 daily trains.

TABLE 2.2-2: EXISTING AND NO BUILD SERVICE ALONG DC2RVA CORRIDOR (DAILY 1-WAY TRIPS)

Service Type	Existing Service	2025 No Build	Proposed Change in Service from Existing	2045 No Build	Proposed Change in Service from Existing
Freight	20-30 trains	25-37 trains (est.)	Increase of 5-7 trains	40-55 trains (est.)	Increase of 20-25 trains
Amtrak Long Distance	11 trains (1 train 3x a week)	12 trains	Increase of 1 train	12 trains	Increase of 1 train
Interstate Corridor (NC)	2 trains	2 trains	No change	2 trains	No change
Northeast Regional (VA)	12 trains	14 trains	Increase of 2 trains	14 trains	Increase of 2 trains

TABLE 2.2-2: EXISTING AND NO BUILD SERVICE ALONG DC2RVA CORRIDOR (DAILY 1-WAY TRIPS)

Service Type	Existing Service	2025 No Build	Proposed Change in Service from Existing	2045 No Build	Proposed Change in Service from Existing
VRE	34 trains (including nonrevenue movements)	38 trains	Increase of 4 trains	38 trains	Increase of 4 trains
Total Daily Trains (est.)	79-89 trains	91-103 trains	Increase of 12-14 trains	106-121 trains	Increase of 27-32 trains

Notes:

- VRE train counts in 2015 include nonrevenue movements. Future train counts assume that nonrevenue movements are converted to revenue movements, based on data provided by VRE
- The 2 additional Northeast Regional (VA) trains in 2025 and 2044 operate between Washington and Lynchburg, and use the DC2RVA corridor only between Washington and Alexandria.
- The 4 additional VRE trains in 2025 and 2045 are comprised of 2 additional Fredericksburg Line trains operating on the DC2RVA corridor between Washington and Spotsylvania, and 2 additional Manassas Line trains that operate on the DC2RVA corridor only between Washington and Alexandria.

Intercity service levels outside the physical boundaries of the DC2RVA corridor are relevant to travel demand estimates within the DC2RVA corridor because mobility improvements that are created by potential transportation improvements would affect total travel both within and outside the DC2RVA corridor. The No Build Alternative includes two additional round-trip intercity passenger trains within North Carolina between Raleigh and Charlotte that will be introduced as a result of the state's Piedmont Improvement Program. The No Build Alternative also incorporates Amtrak's plans for future Northeast Corridor service, including planned changes to Northeast Regional services north of Washington, D.C., as additional NEC infrastructure and additional high-speed-train services are introduced.

2.2.6 Build Alternative Infrastructure Assumptions

For evaluation in the Tier II Draft EIS, DRPT combined and categorized the build alternatives into six areas along the corridor. The build alternatives in each of the six areas are specific to the existing conditions of the area, and will be linked to form a single corridor preferred alternative. The six areas and the segments associated with each are identified in Table 2.2-3. Detailed descriptions of the operations simulation work undertaken to be support the development and screening of these alternatives are provided in subsequent sections of this appendix.

TABLE 2.2-3: SEGMENTS WITHIN SIX BUILD ALTERNATIVE AREAS

Build Alternative Area	Mileposts	Segments	Reason for Grouping
Area 1: Arlington	CFP 110 - CFP 109.3	01: Arlington to Alexandria (ROAF)	Alternative bridge approach alignments developed pending decision on location of Long Bridge capacity expansion

TABLE 2.2-3: SEGMENTS WITHIN SIX BUILD ALTERNATIVE AREAS

Build Alternative Area	Mileposts	Segments	Reason for Grouping
Area 2: Northern Virginia	CFP 109.3 - CFP 62	02: Alexandria to Franconia (AFFR) 03: Franconia to Lorton (FRLO) 04: Lorton to Powells Creek (LOPC) 05: Powells Creek to Arkendale (PCAR) 06: Arkendale to Dahlgren Junction (ARDJ)	Relatively similar alignment throughout this area
Area 3: Fredericksburg	CFP 62 - CFP 48	06: Arkendale to Dahlgren Junction (ARDJ) 07: Dahlgren Junction to Fredericksburg (DJFB) 08: Fredericksburg to Hamilton (FBHA) 09: Hamilton to Crossroads (HAXR) 10: Crossroads to Guinea (XRGU) 21: Fredericksburg Bypass (FBBP)	Consideration of different alignments through or around (bypass option) Fredericksburg
Area 4: Central Virginia	CFP 48 - CFP 19	10: Crossroads to Guinea (XRGU) 11: Guinea to Milford (GUMD) 12: Milford to North Doswell (MDND) 13: North Doswell to Elmont (NDEL)	Relatively similar alignment throughout this area
Area 5: Ashland	CFP 19 - CFP 9	13: North Doswell to Elmont (NDEL) 14: Elmont to Greendale (ELGN) 22: Ashland Bypass (ASBP)	Consideration of multiple alignments through or around (bypass option) Ashland
Area 6: Richmond	CFP 9 - A 011 (Centralia)	14: Elmont to Greendale (ELGN) 15: Greendale to South Acca Yard/west Acca Yard (GNSA) 16: SAY/WAY to AM Junction (Hermitage Lead) (SAAM) 17: AM Junction to Centralia- S-Line (AMCE) 18: West Acca Yard to Centralia–A Line (WACE) 19': AM Junction to Fulton Yard (AMFY) 20'. Buckingham Branch/Hospital Wye (BBHW)	Multiple station options for Richmond on separate alignments

2.2.7 Train Types in the 2015 Base Case

The purpose of the 2015 Base Case is to estimate the initial operating performance based on the existing infrastructure and the operating characteristics of existing services on the corridor prior to implementing the investments that will be defined in the DC2RVA EIS. The 2015 Base Case is used to calibrate the model to enable accurate modeling of future cases.

The 2015 Base Case captures the infrastructure and freight, passenger, and commuter operations of the selected territory as they exist as of August, 2014. This case was run with randomized freight, passenger, and commuter train schedules. The Project limits as identified in

Section 2.1.1 were the geographic limits for the 2015 Base Case. Operators on the corridor include CSXT, Amtrak, VRE, NS, and BBRR. The maximum authorized passenger rail speed is 70 mph, intermodal freight is 60 mph and other freight is 55 mph. Lower speeds are in effect in many sections due to the physical characteristics of the line and speed restrictions through several communities.

2.2.7.1 Passenger Train Types in the 2015 Base Case

The following four types of Amtrak passenger trains currently operate on the DC2RVA corridor and were modeled in the 2015 Base Case.

- ***Northeast Regional (Virginia)***. Northeast Regional (Virginia) trains provide a travel alternative to driving I-95. Northeast Regional (Virginia) trains are southward extensions of Amtrak regional trains operating on the Northeast Corridor between Boston, New York, and Washington to endpoint stations in Virginia. The trains' trips are extended south of Washington, D.C. on four different routes through Virginia that terminate at Norfolk, Newport News, Richmond, and Lynchburg, providing passengers with a one-seat ride to destinations throughout the Northeast. A Northeast Regional (Virginia) train can carry approximately 300 to 600 passengers, depending on the number of cars in the train. Northeast Regional (Virginia) trains are powered by P42 diesel locomotives south of Washington, D.C. (one per trainset) and consist of Amfleet I coaches (four to seven per trainset), an Amfleet Business class car, and an Amfleet all-table cafe (food-service car). One trainset (an overnight train between Boston and Newport News) also operates with a Viewliner II baggage car. As of 2015, Northeast Regional (Virginia) trains provide six daily round trips that used all or part of the DC2RVA corridor. Five of the six Northeast Regional (Virginia) trains operate from Washington, D.C. to Richmond, VA with two terminating in Richmond, two extending to Newport News, VA and one extending to Norfolk, VA. The sixth Northeast Regional (Virginia) train operates from Washington, D.C. to Lynchburg, VA and departs the DC2RVA corridor after serving the Alexandria station. Northeast Regional (Virginia) trains serve all Amtrak passenger rail stations located in the DC2RVA corridor with the exception of the Auto Train terminal at Lorton, VA. The Commonwealth of Virginia funds the operation of Northeast Regional (Virginia) passenger trains as required under Section 209 of the Passenger Rail Investment and Improvement Act of 2008. The *Northeast Regional* frequencies in the DC2RVA corridor consist of:
  - 2 round trips daily between the NEC, Washington, D.C. and Newport News, VA
  - 2 round trips daily between the NEC, Washington, D.C. and Richmond, VA (Staples Mill Road Station)
  - 1 round trip daily between the NEC, Washington, D.C. and Norfolk, VA
  - 1 round trip daily between the NEC, Washington, D.C. and Lynchburg, VA, operating in the DC2RVA corridor between Washington, D.C. and AF interlocking in Alexandria, VA
- ***Interstate Corridor (Carolinian)***. The Carolinian operates one daily round trip between New York, NY and Charlotte, NC. Carolinian Service is similar to Northeast Regional (Virginia) Service, in that it operates as an extension of Northeast Corridor service south of Washington, D.C., but in this case with funding provided solely by the state of North Carolina. The Carolinian is powered by a single P42 diesel locomotive and consists of a

Viewliner II baggage car, four Amfleet I coaches, an Amfleet Business class car, and an Amfleet café car. The Carolinian serves Alexandria, Quantico, Fredericksburg, Richmond Staples Mill Road, and Petersburg stations in Virginia

- ***Long Distance***. Long Distance trains are trains that operate on routes greater than 750 miles. States are not required to provide operating support for Long Distance trains. As of 2015, Amtrak operated five Long Distance roundtrip trains in the DC2RVA corridor: three roundtrip trains use the full length of the DC2RVA corridor continuing through Virginia to Georgia and Florida and two roundtrip trains use the portion of the DC2RVA corridor between Washington and Alexandria. Most Long Distance trains with journeys that require overnight operation are powered by two P42 diesel locomotives. These trains have a Viewliner II baggage car, Viewliner sleeping cars (one to three per trainset), a Heritage dining car, an Amfleet diner-lounge, and three to five Amfleet II leg-rest coaches (with greater seat pitch than the Amfleet I coaches used on Northeast Regional trains). The daytime-only Palmetto operates between New York and Savannah, GA with one P42 locomotive, one baggage car, and six Amfleet cars. Long Distance trains in the DC2RVA corridor serve Washington Union Station, Alexandria, Fredericksburg, Richmond Staples Mill Road, and Petersburg stations in Virginia. All but one of these trains operates nonstop between Alexandria and Richmond. Long-Distance trains on the DC2RVA corridor originate in New York, NY and operate over the NEC through Washington, D.C. and continue into Virginia to points south and west. These trains consist of:
  - *Palmetto:* 1 round trip daily between New York, NY and Savannah, GA
  - *Silver Meteor:* 1 round trip daily between New York, NY and Miami, FL
  - *Silver Star:* 1 round trip daily between New York, NY and Miami, FL
  - *Crescent:* 1 round trip daily between New York, NY and New Orleans, LA, operating in the DC2RVA corridor between Washington, D.C. and AF interlocking in Alexandria, VA
  - *Cardinal:* 1 round trip tri-weekly (Sunday/Wednesday/Friday in each direction) between New York, NY and Chicago, IL, operating in the DC2RVA corridor between Washington, D.C. and AF interlocking in Alexandria, VA
- ***Auto Train***. Amtrak's Auto Train is a separate Long Distance service that is unique both among trains in the DC2RVA corridor and the entire Amtrak system. It exclusively serves passengers with an accompanying motor vehicle and operates as a daily nonstop, overnight train between dedicated station facilities in Lorton, VA and Sanford, FL. The Auto Train operates with bi-level Superliner passenger equipment (coaches, lounges, diners, and sleepers), and specialized multi-level aluminum vehicle carrier cars that transport automobiles. The train is typically powered by two P40 diesel locomotives and has a maximum consist length of 50 cars (17 Superliner cars and 33 vehicle carriers).

Figure 2.2-1 illustrates the type and frequencies of current Amtrak intercity passenger rail services operating in the DC2RVA corridor. Passenger train schedules for all intercity passenger trains operated in the 2015 Base Case can be found in Appendix J describing the travel demand estimating process for the DC2RVA Project.

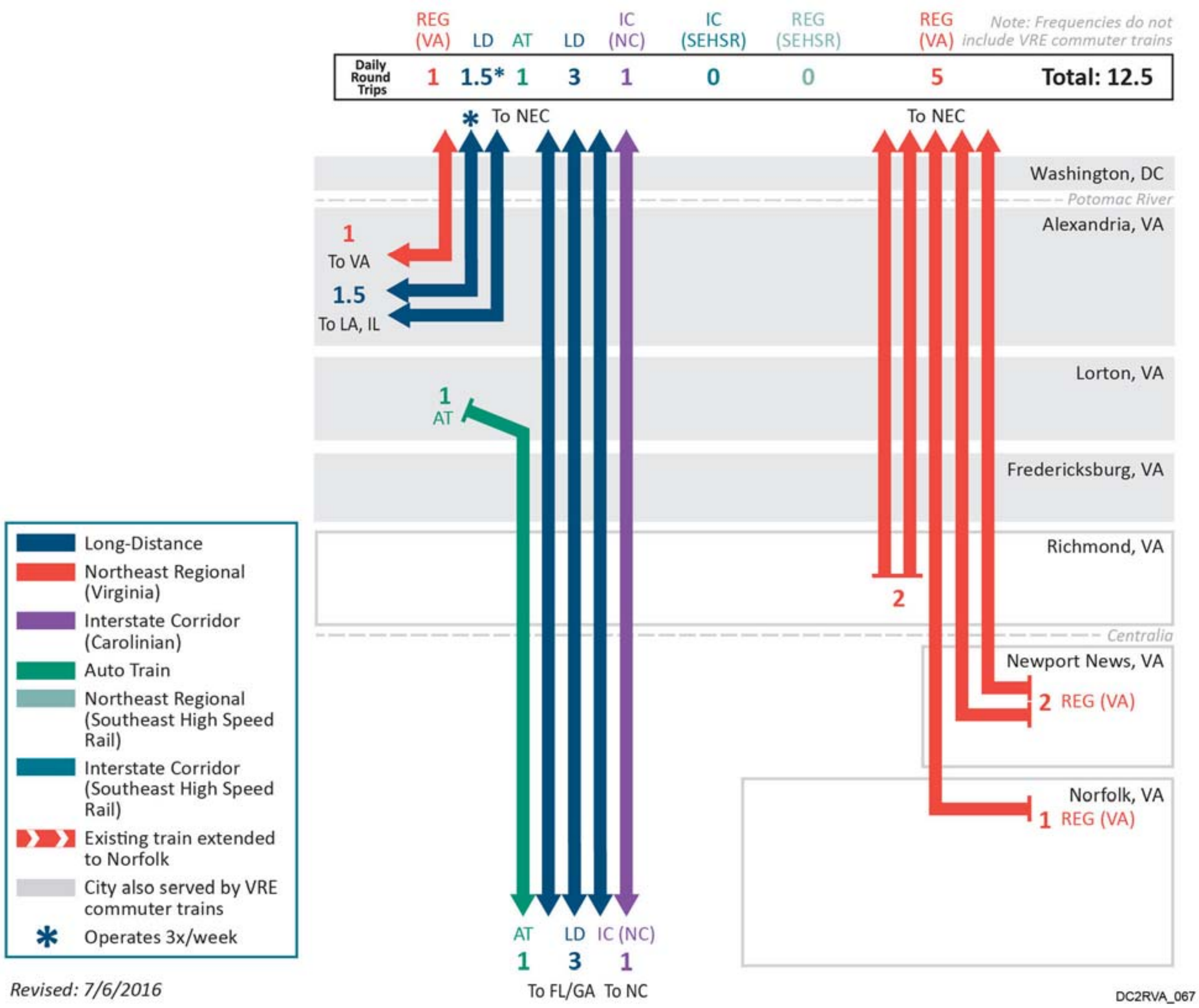

FIGURE 2.2-1: EXISTING (2015) PASSENGER TRAIN FREQUENCIES IN THE DC2RVA CORRIDOR

2.2.7.2 Commuter Train Types in the 2015 Base Case

Commuter services in the DC2RVA corridor are provided by Virginia Railway Express (VRE). VRE commuter trains operate on two routes that serve Union Station in Washington, D.C.:

- **VRE Fredericksburg Line**: 7 weekday-only round trips between Washington, D.C. and Fredericksburg, VA. The model reflects operations on the corridor as of August, 2015, prior to the opening of the VRE Spotsylvania Station and the addition of an 8th round trip.
- **VRE Manassas Line**: 8 weekday-only round trips between Washington, D.C. and Manassas, VA, operating in the DC2RVA corridor between Washington, D.C. and AF interlocking in Alexandria, VA. 1 weekday-only non-revenue round trip between Washington, D.C. and Manassas, VA.

Table 2.2-4 shows the passenger stations in service on the DC2RVA corridor, along with the type of passenger train services currently offered at each station.

TABLE 2.2-4: STATIONS IN THE DC2RVA CORRIDOR (2014 SERVICE SHOWN)

Station	VRE Commuter Service	Amtrak Long Distance Service	Amtrak Northeast Regional (Virginia) Service	Amtrak Auto Train	Amtrak Interstate Corridor (Carolinian) Service
Washington Union Station	✓	✓	✓		✓
L'Enfant, D.C.	✓		✓		
Crystal City, VA	✓				
Alexandria	✓	✓	✓		✓
Franconia/Springfield	✓				
Lorton	✓				
Lorton (Auto Train)				✓	
Woodbridge	✓		✓		
Rippon	✓				
Quantico	✓		✓		✓
Brooke	✓				
Leeland Road	✓				
Fredericksburg	✓		✓		✓
Ashland			✓		
Richmond Staples Mill Road Station		✓	✓		✓
Richmond Main Street Station			✓		

Note: This represents Amtrak service as of August 2014. On August 31, 2015, Amtrak's Silver Meteor, Trains 97 and 98, began serving Fredericksburg.

2.2.7.3 Freight Train Types in the 2015 Base Case

The 2015 Base Case incorporates actual freight operations data, provided by CSXT, from two full weeks of operation in August and September, 2014. The following types of freight trains operate in the DC2RVA Corridor and will be modeled in the 2015 Base Case:

- **Intermodal Trains**: Intermodal trains typically carry time-sensitive cargo, often on expedited schedules to compete with trucks, and as such are often given the highest dispatching priority among freight trains. Intermodal trains on the DC2RVA corridor between Washington and Richmond can operate at a higher maximum speed than other types of freight trains.

- **Manifest Trains**: Manifest trains carry multiple goods and commodities in individual carloads for multiple shippers between multiple origin and destination pairs. Manifest trains carry a variety of commodities, including food products, lumber, metals, chemicals, auto parts, paper products, waste, and scrap using different car types, such as boxcars, gondolas, tank cars, covered hopper cars, and other specialized rail equipment. Most manifest traffic moves door-to-door, although customers without direct rail access or who need less-than-carload quantities use transload facilities, where products can be transferred from railcars to trucks. Manifest trains are usually classified (*i.e.*, sorted) and perform pickups and setouts en route.
- **Bulk Trains**: Bulk trains, often called unit trains, carry one single commodity and generally originate, operate, and terminate as intact trainsets between one shipper and one receiver. Bulk trains do not require intermediate switching en route. Bulk freight trains do not usually operate on set schedules, but rather are dispatched at times where they do not interfere with the operation of intermodal, scheduled manifest freight or passenger and commuter trains, and in a timely manner to meet customer requirements.
- **Local Trains**: Local trains pick up and drop off cars at businesses, industries, bulk transfer facilities, industrial parks, and other locations requiring rail service. Local trains are based out of rail yards, where the cars for local customers are picked up or set out by long-haul manifest freight trains. Local trains usually operate on schedules designed to meet individual customer needs and requirements.

CSXT provided freight train data for current operating levels, based upon actual train dispatch data, which will be incorporated into the modeling process. CSXT provided data for two weeks of freight service operation from August and September, 2014; CSXT data includes, by train:

- Locomotive type and number per train
- Length and tonnage of train
- Classification of train type
  - Intermodal
  - Manifest
  - Bulk
  - Local
- Entry and exit points on model
- Work events and crew change locations and times
- Approximate time of day of train's operation
- Prioritization of freight trains within each type, if any

Table 2.2-5 shows the 2015 Base Case daily service frequencies by train type and corridor section.

TABLE 2.2-5: 2015 BASE CASE DAILY SERVICE FREQUENCY ASSUMPTIONS IN THE DC2RVA CORRIDOR

	Passenger				Commuter	Freight
DC2RVA Corridor Section	Amtrak Northeast Regional (Virginia)	Amtrak Interstate Corridor (Carolinian)	Amtrak Long Distance	Amtrak Auto Train	VRE	CSXT / BBRR
RF&P: RO (CFP 110.1)-AF (CFP 104.3)	12	2	10	0	32	*
RF&P: AF (CFP 104.3)-Lorton (CFP 92.3)	10	2	6	0	14	*
RF&P: Lorton (CFP 92.3)-Crossroads (CFP 53.2)	10	2	6	2	14	*
RF&P: Crossroads (CFP 53.2)-Acca Yard (CFP 1.7)	10	2	6	2	0	*
A-Line: Acca Yard (CFP 1.7)-Centralia (A 10.7)	2	2	6	2	0	*
S-Line: Acca Yard (CFP 1.7)-AM Jct. (SRN 1.0)	4	0	0	0	0	*
S-Line: AM Jct. (SRN 1.0)-Centralia (S 10.9)	0	0	0	0	0	*
Peninsula: AM Jct. (CA 85.4)-Beulah (CA 76.2)	4	0	0	0	0	*
Buckingham Branch: AM Jct. (MP 85.5).-Doswell (MP 111.9)	0	0	0	0	0	*

*Specific freight train volumes by line segment are CSXT confidential and proprietary data.

2.2.8 Train Types in the 2025 and 2045 No Build Cases

The 2025 No Build (Implementation Year) and 2045 No Build (Horizon Year) cases include planned, programmed and budgeted infrastructure exclusive of the DC2RVA improvements, and portray anticipated operations and operating performance on the corridor in 2025 and 2045, assuming there is no DC2RVA Project and service. The case adds planned, programmed and budgeted infrastructure as of 2015, described in Section 2.2.5, to the base infrastructure model. The No Build Cases will include train files for CSXT's forecasted freight growth through 2025 and 2045, VRE service growth through 2045 (1 additional round trip on the Manassas Line and 1 additional round trip on the Fredericksburg Line), and expanded Amtrak-VA Regional service (1 additional round trip from Washington, DC to Lynchburg/Roanoke; 2 additional round trip trains from Richmond to Norfolk).

2.2.8.1 Passenger Train Types in the 2025 and 2045 No Build Cases

The 2025 No Build Case will include the same volume and characteristics of the 2015 Base Case; however, with the addition of two Amtrak Northeast Regional (Virginia) train frequencies from Richmond to Norfolk (south of Richmond); and the addition of one Amtrak Northeast Regional (Virginia) frequency from Washington, D.C. and Lynchburg/Roanoke (north of Alexandria). (This operating plan will introduce one new round trip frequency on the DC2RVA corridor, but only on the section between Washington, D.C. and Alexandria, VA.)

- **Amtrak Northeast Regional (Virginia) Service**:
  - Norfolk Service: 3 round trips daily between Washington, D.C. and the NEC and Norfolk, VA, operating in the DC2RVA corridor between Washington, D.C. and Richmond, VA Staples Mill Station. The operation of 2 additional round trips from Richmond to Norfolk is accomplished by extending 2 existing roundtrip trains that currently terminate in Richmond. (No additional roundtrip frequencies on the DC2RVA corridor between Washington, D.C. and Richmond, VA will be required for this service improvement.)
  - Lynchburg Service: 2 round trips daily between Washington, D.C. and the NEC and Lynchburg, VA, operating in the DC2RVA corridor between Washington, D.C. and AF interlocking in Alexandria, VA. (This will include 1 new round trip frequency between Washington, D.C. and Lynchburg/Roanoke, which will operate over the DC2RVA corridor north of Alexandria, VA).

Figure 2.2-2 illustrates the type and frequencies of Amtrak intercity passenger rail services operating in the DC2RVA corridor in the No Build (2025) Alternative. These frequencies will be identical in the No Build (2045) alternative. Passenger train schedules for all intercity passenger trains operated in the No Build Alternative (scheduled departure times and frequencies were identical for 2025 and 2045) can be found in Appendix J describing the travel demand estimating process for the DC2RVA Project.

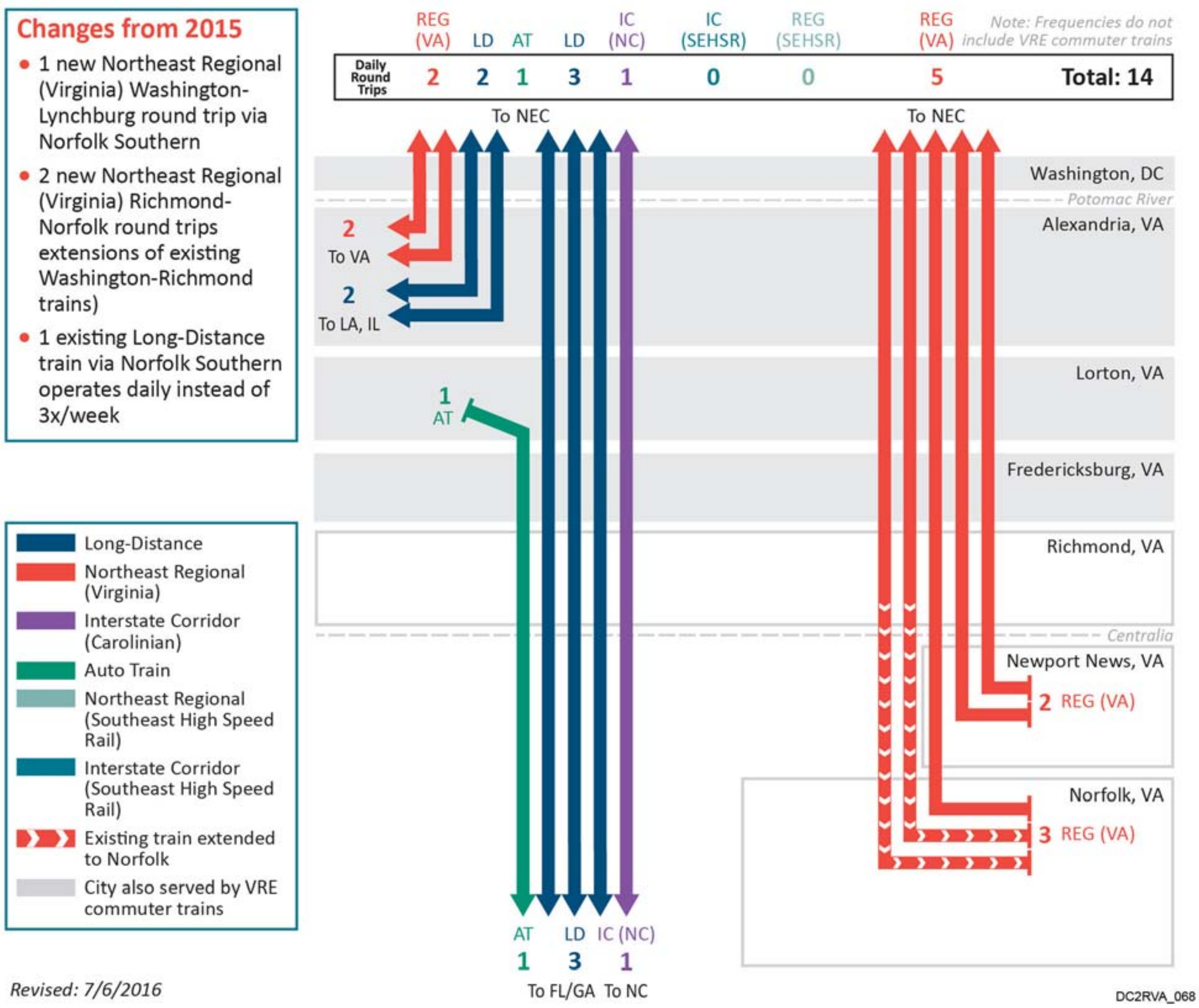

FIGURE 2.2-2: NO BUILD ALTERNATIVE PASSENGER TRAIN FREQUENCIES IN THE DC2RVA CORRIDOR IN 2025 AND 2045

2.2.8.2 Commuter Train Types in the 2025 and 2045 No Build Cases

The 2025 and 2045 No Build Cases will include the same commuter-train volumes and characteristics of the 2015 Base Case, but with the addition of two roundtrip commuter frequencies on the Fredericksburg and Manassas lines.

- **VRE Fredericksburg Line**: 9 weekday-only round trips between Washington, D.C. and Spotsylvania, VA. (This includes one additional round trip frequency.)
- **VRE Manassas Line**: 10 weekday-only round trips between Washington, D.C. and Manassas, VA, operating in the DC2RVA corridor between Washington, D.C. and AF interlocking in Alexandria, VA. (This includes one additional round trip frequency plus the conversion of one existing non-revenue round trip to a revenue round trip on the DC2RVA corridor between Washington, D.C. and Alexandria, VA.)

2.2.8.3 Freight Train Types in the 2025 and 2045 No Build Cases

The primary difference between the 2015 Base Case and 2025 and 2045 No Build Cases will be the forecasted organic growth in freight service by 2025 and 2045, respectively, as provided by CSXT. Table 2.2-6 shows the No Build daily service frequencies by train type and corridor section.

TABLE 2.2-6: NO BUILD CASE DAILY SERVICE FREQUENCY ASSUMPTIONS IN THE DC2RVA CORRIDOR

	Passenger (2025 and 2045)				Commuter (2025 and 2045)	Freight (2025)	Freight (2045)
DC2RVA Corridor Section	Amtrak Northeast Regional (Virginia)	Amtrak Interstate Corridor (Carolinian)	Amtrak Long Distance	Amtrak Auto Train	VRE	CSXT/ BBRR	CSXT/ BBRR
RF&P: RO (CFP 110.1)-AF (CFP 104.3)	14	2	10	0	38	*	*
RF&P: AF (CFP 104.3)-Lorton (CFP 92.3)	10	2	6	0	18	*	*
RF&P: Lorton (CFP 92.3)-Crossroads (CFP 53.2)	10	2	6	2	18	*	*
RF&P: Crossroads (CFP 53.2)-Acca Yard (CFP 1.7)	10	2	6	2	0	*	*
A-Line: Acca Yard (CFP 1.7)-Centralia (A 10.7)	6	2	6	2	0	*	*
S-Line: Acca Yard (CFP 1.7)-AM Jct. (SRN 1.0)	4	0	0	0	0	*	*
S-Line: AM Jct. (SRN 1.0)-Centralia (S 10.9)	0	0	0	0	0	*	*
Peninsula: AM Jct. (CA 85.4)-Beulah (CA 76.2)	4	0	0	0	0	*	*
Buckingham Branch: AM Jct. (MP 85.5).-Doswell (MP 111.9)	0	0	0	0	0	*	*

*Specific freight train volumes by line segment are CSXT confidential and proprietary data.

2.2.9 Train Types in the 2025 and 2045 Build Cases

The purpose of the 2025 Full Build (Implementation Year) Case and 2045 Full Build (Horizon Year) Case is to estimate the future operating performance based on the completion of all infrastructure improvements required for the implementation of 9 new round-trip SEHSR trains as defined in the DC2RVA EIS and improvement to the operating characteristics of all trains on the corridor in 2025 and 2045, respectively, to meet the Purpose and Need of the DC2RVA EIS (increased speed, improved trip time and improved reliability). Each of the 9 new round-trip SEHSR trains to be added in the Build Cases will be one of two train types: Northeast Regional (SEHSR) or Interstate Corridor (SEHSR). Details on the characteristics of each train type appear below in Section 2.2.9.1.

The 2025 Full Build (Implementation Year) Case builds upon all infrastructure from the 2025 No Build Case as well as the 2025 No Build operating plan for freight, passenger and commuter service. This case adds DC2RVA infrastructure improvements to the 2025 No Build Case and tests and estimates the potential infrastructure to efficiently and reliably support the proposed DC2RVA service plan, along with commuter and freight service increases for the model year.

The passenger and commuter service in the 2045 Full Build (Horizon Year) Case remain unchanged and unimpeded from the 2025 Full Build (Implementation Year) Case, however, freight operations were increased to reflect their respective forecasted levels of service through 2045, subject to available capacity.

The 2025 and 2045 Build Cases will estimate the projected performance of both freight, passenger, and commuter traffic on the corridor after planned, programmed, or budgeted improvements are implemented, and will serve as a performance benchmark against which future infrastructure improvement and service increase case will be compared. The infrastructure changes to the Base Case Model are as follows:

- 2025 No Build Infrastructure: Planned, programmed and budgeted (as of 2015) DRPT, Amtrak, CSXT, and VRE infrastructure improvements to be completed in the near term, as determined in consultation with stakeholders.
- 2025 Full Build (Implementation Year) Proposed DC2RVA infrastructure improvements.
  - The maximum authorized passenger train speed will be 90 miles per hour and the maximum authorized freight train speed will be 60 miles per hour.
  - Long Bridge and CSXT improvements to CP Virginia: As in the 2025 No Build Case, it is assumed that 4 tracks will be available north of CP RO in Arlington, VA across the Long Bridge and on CSXT trackage in Washington, D.C. from Long Bridge to CP Virginia.

2.2.9.1 Passenger Train Types in the 2025 and 2045 No Build Cases

The DC2RVA Project proposes to add rail infrastructure to support the following proposed intercity passenger train service frequency increases between Washington, D.C., Richmond, VA and Centralia, VA:

- Four new Interstate Corridor (SEHSR) roundtrip passenger trains operating between New York and Raleigh/Charlotte, NC. These trains will use the DC2RVA corridor between Washington, Richmond, and Centralia, VA. South of Centralia, these trains are assumed to use a restored S-Line right-of-way between Collier, VA (south of Petersburg) and Raleigh, NC, with a maximum speed of 110 mph.

- Five new Northeast Regional (SEHSR) roundtrip passenger trains operating between Boston, New York, or Washington and destinations in Virginia. These trains will use the DC2RVA corridor between Washington, Richmond, and Centralia, VA. Three of the new Northeast Regional (SEHSR) roundtrip passenger trains will operate to Norfolk. One new Northeast Regional (SEHSR) roundtrip passenger train will operate to Newport

News, and one new Northeast Regional (SEHSR) roundtrip passenger train will operate to Richmond.

It is important to note that the implementation of the proposed passenger rail service increases described above are not solely dependent on rail infrastructure improvements made within the DC2RVA corridor, but also depend on improvements made in adjoining rail corridors to accommodate these service increases. Improvements made in adjoining rail corridors are outside the scope of the DC2RVA Project.

The maximum operating speed for all passenger trains on the DC2RVA corridor, with the exception of the Auto Train, will be increased to 90 mph. For planning purposes, a future train consist for all Northeast Regional (Virginia), Northeast Regional (SEHSR), Interstate Corridor (Carolinian), and Interstate Corridor (SEHSR) was developed in consultation with Amtrak consisting of two diesel locomotives and 10 coaches (of which one coach is presumed to be a food service car and one coach is presumed to be a Business class car). Two locomotives were chosen as opposed to the current practice of one locomotive owing to the increased length and weight of the proposed consist and the need for trains to operate at a maximum authorized speed 20 mph higher than the current practice.

Figure 2.2-3 illustrates the type and frequencies of Amtrak intercity passenger rail services operating in the DC2RVA corridor in the 2025 Build (Implementation Year) Alternative. These frequencies will be identical in the 2045 Build (Horizon Year) Alternative. Passenger train schedules for all intercity passenger trains operated in the Build Alternative (scheduled departure times and frequencies were identical for 2025 and 2045) can be found in Appendix J describing the travel demand estimating process for the DC2RVA Project.

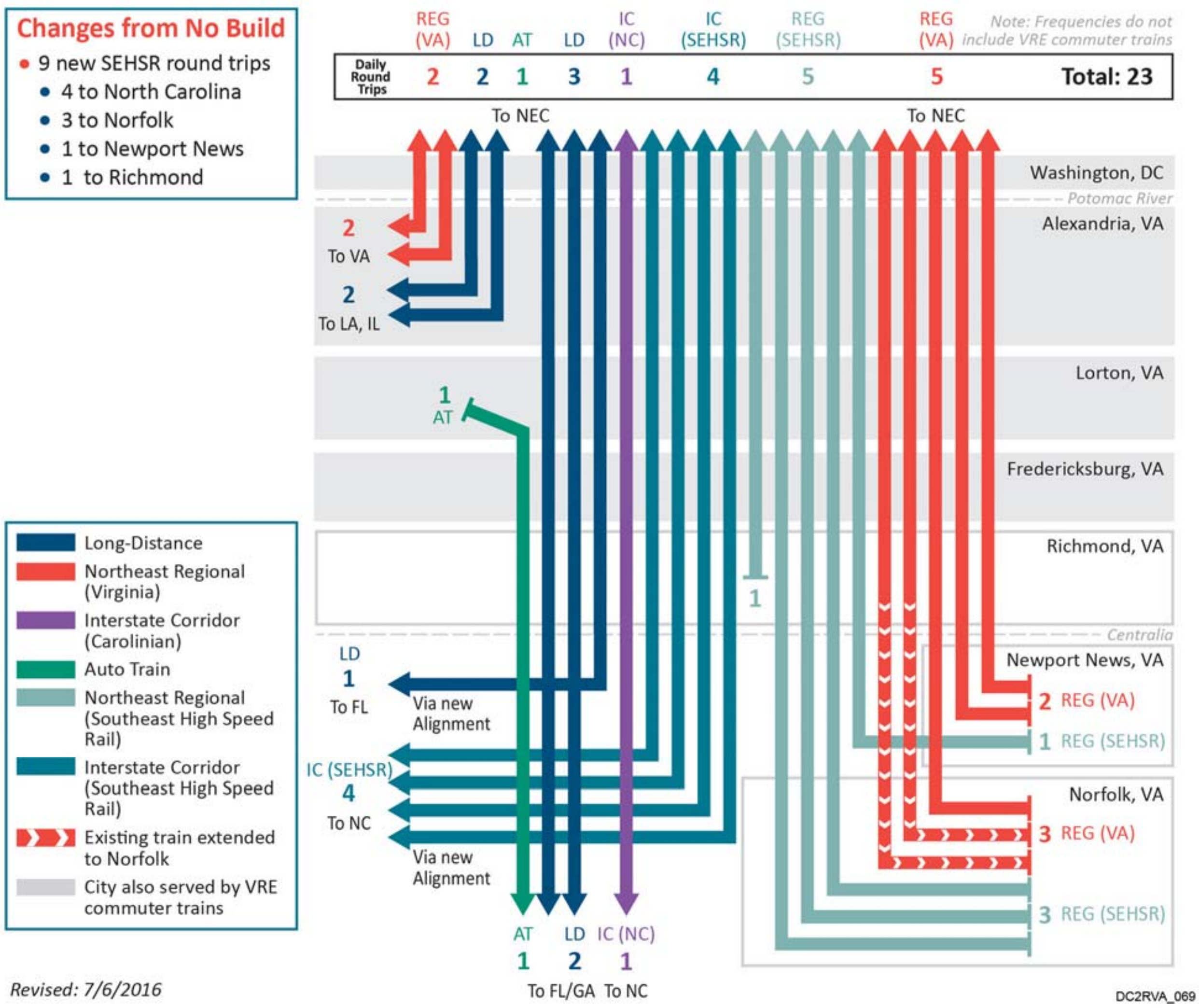

FIGURE 2.2-3: BUILD ALTERNATIVE PASSENGER TRAIN FREQUENCIES IN THE DC2RVA CORRIDOR IN 2025 (IMPLEMENTATION YEAR) AND 2045 (HORIZON YEAR)

Commuter train and freight train frequencies in the 2025 Full Build (Implementation Year) and 2045 Full Build (Horizon Year) Case remain unchanged and unimpeded from frequencies in their respective 2025 No Build (Implementation Year) and 2045 No Build (Horizon Year) cases. As in the No Build cases, freight operations were increased to reflect forecasted levels of service in 2025 and 2045. Table 2.2-7 shows the Build Case daily service frequencies by train type and corridor section.

TABLE 2.2-7: BUILD CASE DAILY SERVICE FREQUENCY ASSUMPTIONS IN THE DC2RVA CORRIDOR

	Passenger (2025 and 2045)				Commuter (2025 and 2045)	Freight (2025)	Freight (2045)
DC2RVA Corridor Section	Amtrak Northeast Regional (Virginia and SEHSR)	Amtrak Interstate Corridor (Carolinian and SEHSR)	Amtrak Long Distance	Amtrak Auto Train	VRE	CSXT/ BBRR	CSXT/ BBRR
RF&P: RO (CFP 110.1)-AF (CFP 104.3)	24	10	10	0	38	*	*
RF&P: AF (CFP 104.3)-Lorton (CFP 92.3)	20	10	6	0	18	*	*
RF&P: Lorton (CFP 92.3)-Crossroads (CFP 53.2)	20	10	6	2	18	*	*
RF&P: Crossroads (CFP 53.2)-Acca Yard (CFP 1.7)	20	10	6	2	0	*	*
A-Line: Acca Yard (CFP 1.7)-Centralia (A 10.7)	*	*	*	2	0	*	*
S-Line: Acca Yard (CFP 1.7)-AM Jct. (SRN 1.0)	*	*	*	0	0	*	*
S-Line: AM Jct. (SRN 1.0)-Centralia (S 10.9)	*	*	*	0	0	*	*
Peninsula: AM Jct. (CA 85.4)-Beulah (CA 76.2)	6	0	0	0	0	*	*
Buckingham Branch: AM Jct. (MP 85.5).-Doswell (MP 111.9)	0	0	0	0	0	*	*

Notes:

a) Passenger counts assume new Interstate Corridor (SEHSR) trains to North Carolina will operate as Amtrak Interstate Corridor (Carolinian) trains, and new Northeast Regional (SEHSR) trains to Virginia will operate as Amtrak Northeast Regional (Virginia) trains.

b) Passenger train service frequencies and routings on specific corridor sections south of Richmond to be determined through the Richmond station alternatives analysis process.

*Specific freight train volumes by line segment are CSXT confidential and proprietary data.

2.2.9.2 Service Plan Development

Sources Used to Determine Future Passenger Train Frequencies. The additional passenger train frequencies proposed in the DC2RVA Project are determined primarily by previously signed federal Records of Decision governing the development of high-speed intercity passenger rail service in the federally designated SEHSR corridor. The proposed DC2RVA

Project service frequency increases would add 9 new round trips (18 passenger trains) to the DC2RVA corridor between Washington, D.C. and Richmond, VA as follows:

- The four proposed Washington-North Carolina Interstate Corridor (SEHSR) round trips are planned to operate between the NEC and Washington, D.C. through the DC2RVA corridor to Raleigh and Charlotte, NC as defined in the Richmond to Raleigh Tier II EIS. The Interstate Corridor (SEHSR) trains do not exist today, and would be new passenger frequencies implemented under the DC2RVA Project. This new Interstate Corridor passenger service would add eight new trains per day under the DC2RVA Project. These new trains would supplement, not replace, the one Interstate Corridor (Carolinian) round trip that currently operates daily between Washington, D.C. and Charlotte, NC.
- One proposed new Northeast Regional (SEHSR) daily round trip (two trains) would be added between Washington, D.C. and Newport News, VA under the DC2RVA Project, supplementing the two daily Northeast Regional (Virginia) round trips (four trains) between Washington, D.C. and Newport News that currently operate. The DC2RVA Project will support the expansion of service between Washington. D.C. and Newport News from two round trips (four trains per day) to three round trips (six trains per day). This additional Northeast Regional (SEHSR) train to Newport News was defined in the Richmond to Hampton Roads Tier I EIS in 2012.
- Three proposed new Northeast Regional (SEHSR) daily round trips (six trains) would be added between Washington, D.C. and Norfolk, VA under the DC2RVA Project. This would supplement the one daily Northeast Regional (Virginia) round trip between Washington and Norfolk that operates today, and the two daily Northeast Regional (Virginia) round trips that currently operate between Washington and Richmond and are planned to be extended to Norfolk with the completion of capacity projects currently underway. The DC2RVA Project will support the expansion of service between Washington and Norfolk from three round trips (six trains) to six round trips (12 trains). The additional Northeast Regional (SEHSR) trains to Norfolk were defined in the Richmond to Hampton Roads Tier I EIS in 2012.

One proposed new Northeast Regional (SEHSR) daily round trip (two trains) would be added between Washington, D.C. and Richmond, VA. This train would provide for a 6 a.m. northbound Richmond origination and a late-evening southbound arrival back in Richmond. This would allow the other trains from Newport News and Norfolk to operate at more traveler-friendly times to improve the attractiveness of the passenger rail service to those cities.

Service Patterns for DC2RVA corridor passenger trains. The following general service patterns were established for the train types proposed to operate in the DC2RVA corridor:

- New Interstate Corridor (SEHSR) trains to/from Charlotte and Raleigh make the following station stops in the DC2RVA corridor: Alexandria, Fredericksburg, and Richmond. These trains operate via the S-Line between Petersburg and Raleigh.
- The daily Interstate Corridor (Carolinian) between New York and Charlotte makes the same stops in the DC2RVA corridor as it does today: Alexandria, Quantico, Fredericksburg, and Richmond. The Carolinian continues to operate via the A-Line between Petersburg and Raleigh.

- New Northeast Regional (SEHSR) trains, as well as existing Northeast Regional (Virginia) trains make the following station stops in the DC2RVA corridor: L'Enfant (limited peak-hour departures), Alexandria, Woodbridge, Quantico, Ashland, and Richmond.
- Long Distance trains and Auto Train frequencies and stopping patterns do not change, except for the following:
  - The Silver Star (trains 91 and 92) is rerouted onto the S-Line between Petersburg and Raleigh.
  - The Cardinal, which uses the DC2RVA corridor between Washington and Alexandra, is projected to operate as a daily train by the proposed DC2RVA 2025 implementation year.
- All trains (including Long Distance trains but not Auto Train) are scheduled to operate at a higher maximum authorized speed between Arlington and Richmond up to 90 mph where authorized.
- All Northeast Regional (Virginia and SEHSR), Interstate Corridor (Carolinian and SEHSR), and Amtrak Long Distance train are planned to operate north of Washington, D.C., with the exception of one roundtrip train, which may terminate in Washington, D.C.

Specific station stop patterns within the DC2RVA corridor, as well as north and south of the corridor are subject to future refinement based on ridership analyses, future operating conditions, and stakeholder and public input.

Figure 2.2-4 illustrates potential service patterns of the proposed intercity passenger rail services operating in the DC2RVA corridor in the Build Alternative by identifying the specific station stop patterns for the different passenger train types. DRPT will finalize service patterns as part of the Service Development Plan.

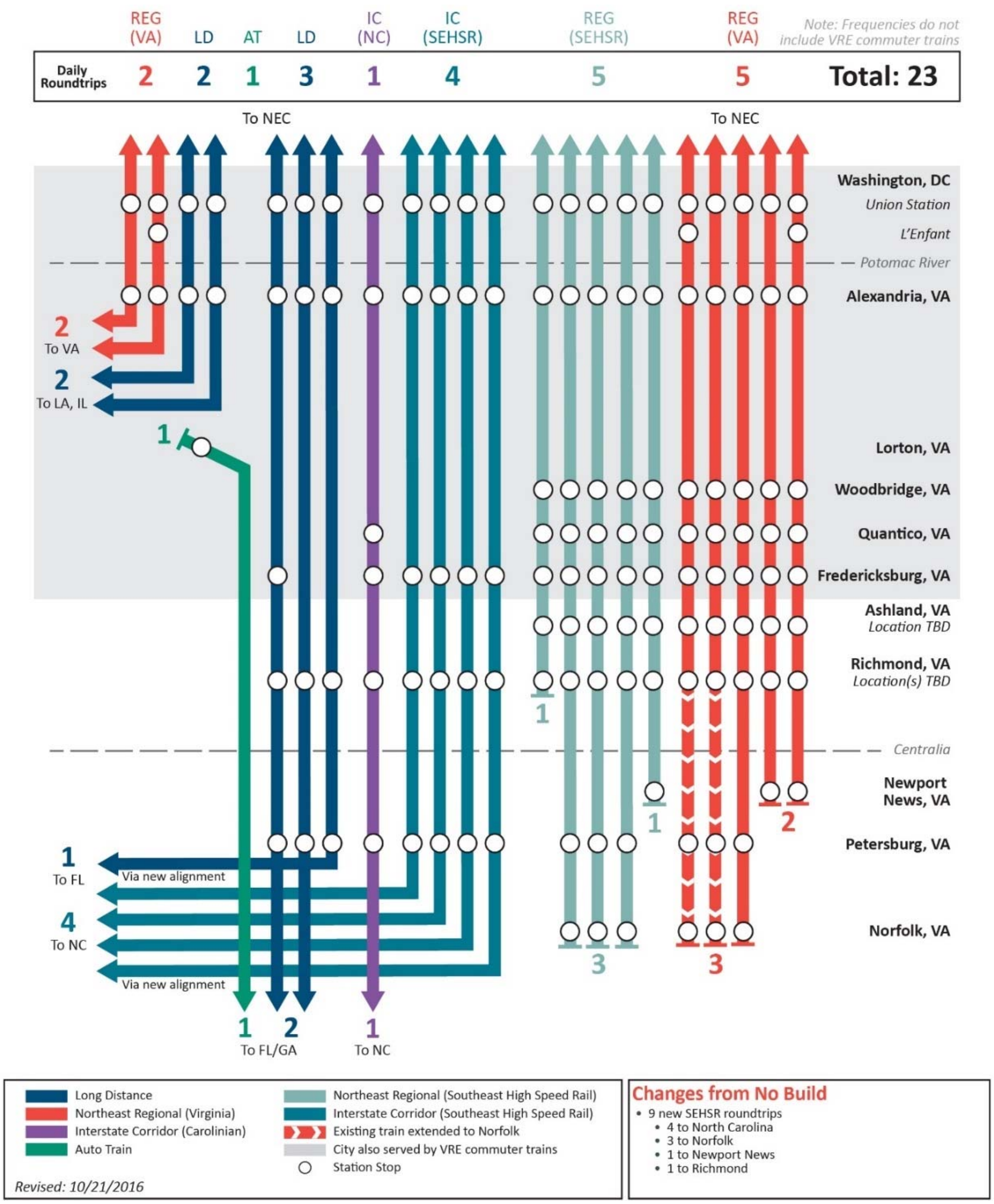

FIGURE 2.2-4: SERVICE PATTERNS OF PROPOSED PASSENGER TRAINS IN THE DC2RVA CORRIDOR

Conceptual timetables incorporating the train frequency, train speed, and consist assumptions described above have been developed, with running time estimates developed using the Train Performance Calculator function of a rail operations simulation software tool developed and marketed under the name Rail Traffic Controller (RTC)© by Berkeley Simulation Software, LLC. To aid in preliminary ridership forecasting, conceptual timetables were developed for each of the Richmond Build Alternatives described in Section 4. These timetables incorporated the estimated RTC running times, intermediate station dwell times of 1 to 4 minutes depending on the station stop, and recovery times (8 percent of the RTC-derived running time for Northeast Regional and Interstate Corridor trains between Washington and Richmond).

2.2.9.3 Travel Time and Reliability

Table 2.2-8 summarizes the estimated travel times, inclusive of station stops, between Washington and Richmond based on the conceptual timetables developed for each Richmond Build Alternative.

TABLE 2.2-8: DC2RVA CORRIDOR TRAVEL TIMES (HOURS:MINUTES) BY RICHMOND STATION OPTION, WASHINGTON UNION STATION TO RICHMOND, VA

Service Type	Interstate Corridor		Northeast Regional		Long Distance	
Direction	**South**	**North**	**South**	**North**	**South**	**North**
No Build (to Staples Mill Road)	2:06	2:16	2:16	2:20	2:02	2:22
No Build (to Main Street Station)	*No Service*	*No Service*	2:40	2:50	*No Service*	*No Service*
6A: Staples Mill Road Station Only	1:50	1:50	1:58	1:57	1:49	2:10
6B–A-Line: Boulevard Station Only, A-Line	1:56	1:58	2:04	2:05	1:55	2:14
6B–S-Line: Boulevard Station Only, S-Line	1:56	1:58	2:04	2:05	1:55	2:14
6C: Broad Station Street Only	2:01	2:02	2:09	2:09	2:00	1:58
6D: Main Street Station Only	2:06	2:06	2:14	2:13	2:05	2:23
6E: Split Service, Staples Mill Road/Main Street Stations (travel time to Staples Mill)	1:50	1:50	1:58	1:57	1:49	2:10
6E: Split Service, Staples Mill Road/Main Street Stations (travel time to Main Street)	2:15	2:13	2:21	2:18	2:20	2:37
6F: Full Service, Staples Mill Road/Main Street Stations (travel time to Staples Mill)	1:50	1:50	1:58	1:57	1:49	2:10
6F: Full Service, Staples Mill Road/Main Street Stations (travel time to Main Street)	*No Service*	*No Service*	2:29	2:25	*No Service*	*No Service*
6G: Shared Service, Staples Mill Road/Main Street Stations (travel time to Staples Mill Road)	1:50	1:50	1:58	1:57	1:49	2:10
6G: Shared Service, Staples Mill Road/Main Street Stations (travel time to Main Street)	2:15	2:13	2:21	2:18	*No Service*	*No Service*

Currently, intercity passenger trains traveling between Washington, D.C. and Richmond reach the end of their trip segment on the DC2RVA corridor on time approximately 66% of the time – meaning that 34% of the trains are late. Given that the definition of "on-time" includes a potential delay interval – *i.e.*, a train may be several minutes past its scheduled arrival into a station and still be classified as "on-time" – this makes it difficult for many train travelers to rely on the train schedules, and forces passengers to allot additional time to their trips to compensate for the potential delays. The DC2RVA Project, by increasing capacity and interoperability of the main tracks, would improve the reliability of intercity passenger trains within the corridor. For example, a recent (June 9, 2017) train trip on Northeast Regional Train #95 from Washington Union Station to Richmond's Staples Mill Road Station, illustrates how the limited track capacity on this busy shared-use corridor can cause delays. Train #95, traveling south from Boston on the Northeast Corridor, arrived in Washington Union Station late. After an engine change, crew change, and passenger loading and unloading, train #95 departed Washington Union Station approximately 20 minutes behind schedule. Because it was late leaving Union Station, and owing to heavy passenger and freight train volume on the corridor south of Washington, D.C., Train #95 was positioned behind a slower freight train. Passenger and freight traffic moving in the opposite direction used the adjacent second main track to pass Train #95, leaving no opportunity for Train #95 to cross to the adjacent track and overtake the slower freight train until well south of Fredericksburg, more than an hour after departing Washington. As a result, Train #95 was 61 minutes late arriving into Staples Mill Road Station – an additional 41 minutes of delay caused by congestion on the corridor.

The DC2RVA Project would not be able to improve the on-time performance of trains arriving into Union Station from the Northeast Corridor – however, the added track capacity and additional crossovers of the DC2RVA Project would provide additional opportunities for higher-speed passenger trains to pass slower-speed freight trains and commuter trains making frequent station stops. The additional infrastructure planned by the DC2RVA Project would allow intercity passenger trains to closely adhere to their scheduled travel time between Washington, D.C. and Richmond without incurring delays in that segment of their total trip. The DC2RVA Project shares PRIIA's performance goals for intercity passenger trains for all passenger trains to be on-time at each station and corridor endpoints at least 90% of the time.

2.2.10 Characteristics of Passenger and Commuter Trains Operated in the Model

2.2.10.1 Existing Passenger and Commuter Trains

Amtrak currently operates General Electric P-40 and P-42AC locomotives on the corridor. One locomotive is assigned to Amtrak Northeast Regional (Virginia) and Amtrak Interstate Corridor (North Carolina) trains, and two locomotives are assigned to Long Distance trains and the Auto Train. VRE currently operates one Motive Power Corporation MP-36 locomotive per trainset. Freight train consists, power, lengths, and tonnage were provided by CSXT as part of their RTC model.

Passenger and commuter train consists, lengths, and tonnages used in the model are summarized in Tables 2.2-8 and 2.2-9. Tonnages in the tables below were derived by determining the empty weight and revenue seating of the equipment consists, then adding weights for passengers and baggage, assuming an average load factor of 85 percent per train and an average weight per passenger with baggage of 200 lbs. per passenger.

TABLE 2.2-8: SEATING CAPACITY OF REVENUE PASSENGER CARS USED ON TRAINS OPERATING IN THE DC2RVA CORRIDOR

Revenue Car Type	Seats	Assigned Service
Amfleet I Capstone coach	72	Amtrak-VA Regional, Amtrak-NC Interstate Corridor

TABLE 2.2-8: SEATING CAPACITY OF REVENUE PASSENGER CARS USED ON TRAINS OPERATING IN THE DC2RVA CORRIDOR

Revenue Car Type	Seats	Assigned Service
Amfleet I Capstone Business Class	62	Amtrak-VA Regional, Amtrak-NC Interstate Corridor, Long Distance
Amfleet II ADA long-distance coach	60	Amtrak Long Distance
Viewliner I sleeping car	30	Amtrak Long Distance
Superliner II coach	74	Amtrak Auto Train
Superliner II sleeping car	42	Amtrak Auto Train
Superliner II deluxe sleeping car	32	Amtrak Auto Train
Gallery cab car	123	VRE commuter
Gallery coach	144	VRE commuter
Gallery coach with toilet	132	VRE commuter

TABLE 2.2-9: EXISTING (2015) PASSENGER AND COMMUTER TRAIN TONS AND LENGTHS OPERATING IN THE DC2RVA CORRIDOR

Train	Cars	Locomotives	Approx. Tons (with passengers)	Approx. Length (without locomotive)	Approx. Length (with locomotive)
Amtrak Northeast Regional (Virginia) trainset	8	1	587	684 feet	753 feet
Amtrak Interstate Corridor (North Carolina) trainset	8	1	587	684 feet	753 feet
Amtrak Long Distance trainset	11	2	1,037	939 feet	1,077 feet
Amtrak Auto Train trainset	50	2	4,405	4,415 feet	4,553 feet
VRE Commuter Train trainset	5	1	453	425 feet	495 feet

Note: Existing VRE train consists vary between 4 and 8 cars. Consists of 7 and 8 cars are employed, along with shorter consists, during peak hour operations.

2.2.10.2 Future Passenger and Commuter Trains

For modeling purposes, no changes were anticipated to passenger train and commuter train consists in the No Build cases.

For modeling purposes, two Motive Power Corporation HSP-46 locomotives were used on all Northeast Regional (Virginia), Northeast Regional (SEHSR), Interstate Corridor (North Carolina) and Interstate Corridor (SEHSR) trains for all Full Build cases. Two locomotives were chosen as opposed to the current practice of one locomotive owing to the increased length and weight of the proposed consist and the need for trains to operate at a maximum authorized speed 20 mph higher than the current practice. This same operating philosophy was used in

Illinois and Michigan, where two locomotives are deployed on consists to allow them to attain 110 mph MAS. The consist length for these trains will be ten cars, after review and consultation with Amtrak. No changes are anticipated to Amtrak passenger train or VRE commuter train consists between the 2025 and 2045 Full Build cases.

Passenger and freight train consists, lengths, and tonnages used in future year modeling cases are summarized in Table 2.2-10.

TABLE 2.2-10: FUTURE (2025 AND 2045) BUILD CASE PASSENGER AND COMMUTER TRAIN TONS AND LENGTHS OPERATING IN THE DC2RVA CORRIDOR

Train	Cars	Locomotives	Approx. Tons (with passengers)	Approx. Length (without locomotive)	Approx. Length (with locomotive)
Amtrak Build Case Northeast Regional (Virginia and SEHSR) trainset (2025 and 2045)	10	2	929	850 feet	992 feet
Amtrak Build Case Interstate Corridor (Carolinian and SEHSR) trainset (2025 and 2045)	10	2	929	850 feet	992 feet
Amtrak Long Distance trainset (2025 and 2045)	11	2	1,037	939 feet	1,077 feet
Amtrak Auto Train trainset (2025 and 2045)	50	2	4,405	4,415 feet	4,553 feet
VRE Commuter Train trainset (2025 and 2045)	5	1	453	425 feet	495 feet

2.2.11 Passenger Train On-Time Metrics and Freight Train Delay Metrics

2.2.11.1 Passenger Train On-Time Performance

On-Time Performance (OTP) of passenger trains in the model is measured using the Metrics and Standards for intercity passenger rail service developed by FRA and Amtrak in accordance with PRIIA, also known as Public Law 110-432, and published as the Metrics and Standards for Intercity Passenger Rail Service Under Section 207 of PRIIA in the Federal Register on May 12, 2010[2]. OTP metrics differ depending on the type of train being operated. OTP requirements for passenger trains operating in the DC2RVA corridor are as follows:

- Northeast Regional (Virginia) and Northeast Regional (SEHSR) trains: OTP of 90%, with “on-time” defined as arriving within 15 minutes of schedule at the endpoint terminal for NEC trains with trips of 251 to 350 miles (*e.g.*, New York-Richmond); within 20 minutes

[2] The U.S. Surface Transportation Board rule July 28, 2016 (STB Docket Number EP-726) requiring OTP to be measured station-by-station, instead of at final terminal only, effective August 26, 2016, is not yet incorporated into the operations simulation methodology or parameters because schedules for existing trains incorporating this rule have not yet been developed or implemented by Amtrak.

of schedule for NEC trains with trips of 351 to 450 miles; within 25 minutes of schedule for NEC trains with trips of 451 to 550 miles; and within 30 minutes of schedule for trips of 551 or more miles (*e.g.*, Boston-Newport News or Boston-Norfolk).

- Interstate Corridor (Carolinian) and Interstate Corridor (SEHSR) trains to Charlotte: OTP of 90%, with "on-time" defined as arriving within 30 minutes of schedule at the endpoint terminal, according to the metrics for a non-NEC corridor train of 551 or more miles.
- Interstate Corridor (SEHSR) trains to Raleigh: OTP of 90%, with "on-time" defined as arriving within 25 minutes of schedule at the endpoint terminal, according to the metrics for a non-NEC corridor train of 451 to 550 miles.
- Long Distance trains and Auto Train: OTP of 85%, with "on-time" defined as arriving within 30 minutes of schedule at the endpoint terminal, according to the metrics for a long-distance train with a route of more than 550 miles.

For the Northeast Regional (Virginia and SEHSR) services above, at intermediate stations, trains are measured as "late" if they depart 15 minutes or more behind schedule.

OTP estimates were calculated for each train incorporating the following late train tolerances:

- For Northeast Regional and Interstate Corridor trains (target OTP = 90%)
  - OTP = 100 x (Actual Running Time in model + 15 minutes / Scheduled Running Time)
- For Long Distance trains and Auto Train (target OTP = 90%)
  - OTP = 100 x (Actual Running Time in model + 15 minutes / Scheduled Running Time)

OTP for intercity passenger trains was measured between the CP Virginia interlocking in Washington, D.C. and the Petersburg, VA passenger rail station for trains destined to and from points south of the DC2RVA corridor, or at Richmond Main Street Station for trains destined to and from Newport News, or at the Alexandria, VA passenger rail station for trains destined to and from Lynchburg and Clifton Forge, VA. OTP for commuter trains was measured between the CP Virginia interlocking in Washington, D.C., and the Alexandria passenger rail station for trains destined to and from Manassas, or at the Crossroads interlocking in Spotsylvania County for trains on the Fredericksburg Line.

2.2.11.2 Freight Train Delay

Changes in freight train delay that occur as a result of the passenger service in the Build Alternative were also measured and compared against freight train delay in the No Build Alternative. Freight train delay is measured as average hours and minutes of delay per train, per 100 elapsed train-miles. This metric compares the actual elapsed time a train takes to cover its route, compared to the elapsed time the train would have taken to cover its route had it encountered no unplanned delays en route. Delays en route include events such as waits for other trains; waits for clear track ahead; waits for signal clearances; and speed reductions caused by taking crossovers or sidings, or clearing in sidings or yard tracks for other trains. Delays en route do not include terminal and yard dwells or work events that are built into each freight train's trip plan. The total estimated delay for all freight trains was calculated as follows:

- Freight Train Delay per 100 train-miles = 100 x (Total Delay of All Trains/Total Train Miles)

Freight train delay was measured between the CP Virginia interlocking in Washington, D.C. and the Petersburg, VA passenger rail station, or at Richmond Main Street Station for trains destined to and from Newport News.

2.2.12 Bypasses

In the alternatives that propose bypasses around Fredericksburg and Ashland, the bypass infrastructure has been designed with two main tracks to enable trains to meet and pass without waits in passing sidings or at either end of the bypass. The use of two-track bypasses enables the bypass infrastructure to deliver the same capacity and flexibility as three main tracks located within the same right-of-way with crossovers between them that enable overtakes and meet/pass events, and to accommodate maintenance-of-way outages on one or more main tracks.

3 ESTIMATED PURE RUNNING TIMES FOR PASSENGER TRAINS IN THE DC2RVA CORRIDOR

3.1 INTRODUCTION

Section 3 summarizes estimated intercity passenger-train pure running times on the DC2RVA Corridor. “Pure” running times (PRTs) are running times that assume no impedance to intercity passenger trains for meet-pass events or conflicts with other trains, and no station or other delay. Recovery time is not included. Station dwell times are one second in duration. Accordingly, actual timetable running times, which include station dwell times sufficient to board and alight passengers and baggage, recovery time, and adjustments for train congestion and seasonal weather affects, are longer.

These estimates were developed in July 2016, using the proposed infrastructure designs and passenger train consists that were current at that time. The endpoints of the running time estimates are Control Point (CP) RO interlocking in Arlington, Virginia, and either 11 miles south of Richmond in Centralia, Virginia, or 9 miles east of Richmond in Beulah, Virginia. Running time estimates were developed for the five types of intercity passenger trains described in Section 3.3 below, proposed to operate or currently operating, on the different main track alignment options described in Section 3.3 below, that were developed as part of Washington, D.C. to Richmond Southeast High Speed Rail Project (the DC2RVA Project).

These running times are based on refinements completed in Spring 2016 to proposed alignments developed by the DC2RVA Project engineering team. Passenger-train running times had also been developed on prior versions of these alignments at previous stages of the Project, as part of the alternatives development and screening process. The refinements developed in Spring 2016 to the rail alignments were generated as mitigation measures or alternative solutions developed in response to initial screening efforts or requests for additional analysis received during public and stakeholder comment periods. The intercity passenger-train pure running times developed on the refined alignments were then used to estimate travel times and develop conceptual train schedules. (Note: Running time estimates were developed for intercity passenger trains only. Travel times for VRE commuter trains were developed by VRE as part of the preparation of commuter train schedules that VRE provided to DRPT to simulate existing and proposed VRE operations in the DC2RVA Project operations simulation modeling work. This approach is consistent with the DC2RVA Project’s operations modeling methodology, and DRPT does not propose making any changes to the VRE schedules used in the DC2RVA modeling effort. DRPT’s modeling approach, consistent with its understanding of the NEPA process, treats the VRE future growth and operations schedule as part of the No Build condition, not a build condition that would be subject to the Project’s alternatives evaluation or screening.)

Developing potential rail alignments was an iterative process. Rail alignment modifications were made to avoid or minimize adverse effects on environmental resources and existing infrastructure, while preserving the ability of that alignment to meet the Project's Purpose and Need. The process focused on each rail alignment's ability to improve passenger service reliability and frequency and reduce trip times based on track design speed and rail operations. The results of prior pure running times estimates calculated between August 2015 and Spring 2016 are also included in this section, where the results led to decisions about proposed train consists and development of potential rail alignments.

The purpose of these pure running time estimates is to assist in the development of alignment alternatives and the analysis and decision-making process for the selection of preferred alignment alternatives between Arlington and Richmond, and between Richmond and Centralia/Beulah among the alternatives carried forward into the DC2RVA Tier II Draft Environmental Impact Statement.

Section 3 is organized as follows:

Section 3.2 (Key Findings) provides a high-level summary of the results of the passenger-train running time estimates calculated for the five proposed alignment alternatives between Arlington and Greendale (the Northern and Central Virginia Areas) with a passenger-train maximum authorized speed of 90 mph, and seven proposed alignment and station alternatives between Greendale and Centralia (the Richmond Area). (An eighth Richmond alternative was not modeled, but is assumed to have similar pure running time characteristics as another alternative modeled.)

Section 3.3 (Tools and Assumptions Used to Develop Running Time Estimates in the Northern and Central Virginia Areas) discusses the passenger-train types and consists, passenger-train stopping patterns, and five different main track alignment alternatives between Arlington and Greendale, including bypasses at Fredericksburg and Ashland, used in the estimates of passenger-train running times.

Section 3.4 (Results of the Northern and Central Virginia Calculations) present the estimated pure running times of different five passenger-train train types between Arlington and Greendale for the five different main track alignment alternatives compared, including bypasses at Fredericksburg and Ashland.

Three sections discuss the intercity passenger-train pure running time estimates for the Richmond Area of the Project between Greendale, Centralia, and Beulah. Section 3.5 (Tools and Assumptions Used to Develop Running Time Estimates in the Richmond Area) discusses the alignment alternatives developed for the seven different Richmond Area station options analyzed, and the intercity passenger-train types and consists used in the estimates of intercity passenger-train running times. Section 3.6 (Results of the Richmond Area Calculations) presents the estimated pure running times of two intercity passenger train types between Greendale, Centralia, and Beulah for the seven different Richmond area track alignments compared. Section 3.7 (Previous Richmond Area Running Time Evaluations) presents the initial draft results of intercity passenger-train running times estimates for prior versions of several Richmond area alignments developed as part of the DC2RVA Project's Richmond-area station location screening process

Section 3.8 (TPC Estimates for Proposed Curve and Infrastructure Improvements Eliminated during Screening) summarizes the results of intercity passenger-train pure running-time estimates between Washington Union Station and the Richmond Staples Mills Road Station to address specific requests from FRA and stakeholders to identify curves that could be reassessed for improved operating performance and to estimate operating results associated with reduced degree of curvature at those locations. This section also describes passenger-train pure running time estimates associated with the construction of a passenger-train flyover to eliminate the at-grade crossing of rail lines at Doswell, Virginia.

Section 3.9 (Train Performance Comparison with One Locomotive or Two Locomotives in SEHSR Consists) compares the results of intercity passenger-train pure running time estimates between Washington Union Station and the Richmond Staples Mills Road Station when either one locomotive or two locomotives are used.

Section 3.10 (Prior Estimates of Passenger-Train Running Time on DC2RVA Main Track Alignment Alternatives) summarizes the results of intercity passenger-train pure running time estimates between Washington Union Station and the Richmond-Staples Mill Road Station under various main track alignment and unbalance alternatives (3 inches, 4 inches, and 5 inches).

It is important to note that Section 3, and Section 4 that follows, summarize only the results of the operations simulation modeling work conducted for the development and screening of alternatives. Many other factors also were incorporated into the process of developing and screening alternatives for the DC2RVA Project. These additional factors are described in detail in the Alternatives Technical Report (Appendix A of the Draft EIS). Likewise, the decisions that determined which alternatives would be carried forward into the Draft EIS are also described in detail in the Alternatives Technical Report. That report should be consulted in order to receive a full understanding of the factors and decisions that determined which alternatives would be carried forward into the Draft EIS.

3.2 KEY FINDINGS

The estimates of passenger-train pure running times indicate the following for the segment of the DC2RVA corridor in the Northern Virginia and Central Virginia Areas between CP RO interlocking in Arlington and the Greendale interlocking in Richmond.

- An Improved Speed rail alignment that enables trains to operate at 90 mph, where possible, permits trains to save approximately 11 minutes of running time compared with the Existing Speed 70-mph alignment between Arlington and Greendale.
- Use of the proposed Ashland bypass route saves 62 seconds to 69 seconds of pure running time compared with the Improved Speed alignment through downtown Ashland.
- Use of the proposed Fredericksburg bypass adds approximately 4 minutes of running time compared with the Improved Speed alignment through downtown Fredericksburg.
- Use of both the Ashland and Fredericksburg bypasses adds approximately 3 minutes of running time compared with the Improved Speed alignment.
- The net effect of the proposed intermediate station stops on pure running time is modest, compared to a pure running time with no intermediate station stops. Each station stop adds approximately 60 seconds of pure running time. (Pure running time

does not include the station dwell time allotted to allow for passengers boarding or other station activities.)

- The addition of a second locomotive on an existing Northeast Regional (Virginia) 8-car consist operating at 90 mph reduced the running time between Arlington and Greendale by approximately 3 minutes.

The estimates of pure passenger-train running times indicate the following for the Richmond Area of the DC2RVA corridor between the Greendale interlocking in Richmond and the southern and eastern limits of the Project in Centralia and Beulah, respectively. (Pure running times are the unimpeded running times between endpoints, and do not include other factors that may affect overall trip time such as operational delays or dwell times at stations.)

- The Staples Mill Road Station Only option using the A-Line offers the fastest pure running time between Centralia and Beulah.
- The Main Street Station Only option using the S-Line offers the second fastest pure running time for Interstate Corridor and Northeast Regional trains, but adds approximately 12 minutes of running time compared to the Staples Mill Road Station only option, owing to the Line's slower proposed track speeds through central Richmond.
- Station options for passenger trains using the A-Line and a loop station track to reach Boulevard Station or Broad Street Station are the slowest pure running time options for Interstate Corridor and Northeast Regional trains, between 12 and 15 minutes slower than operating via the A-Line directly to Staples Mill Road Station only.
- Two-station options that require stops at both Staples Mill and Main Street Station add less than 1 minute of additional running time, owing to the 10-mph track speed in the Main Street Station area. The slow track speed means little additional time is required for braking and acceleration to make a Main Street Station stop.

3.3 TOOLS AND ASSUMPTIONS USED TO DEVELOP RUNNING TIME ESTIMATES IN THE NORTHERN AND CENTRAL VIRGINIA AREAS

Passenger train pure running time estimates were made using the Train Performance Calculator (TPC) feature of the Rail Traffic Controller (RTC) operations simulation model. The TPC analysis was based on rail alignments, curves, distances, and maximum curve speeds provided by the DC2RVA Project engineering team for Project improvements in the Northern Virginia Area and Central Virginia Area between Arlington and Greendale in June 2016. Alignments were developed for five potential main track infrastructure alignment options, and specific rail improvements based on the DC2RVA Engineering Basis of Design were identified for each alignment.

All alignments share a common northern endpoint of the north end of Control Point (CP) RO, located at milepost CFP 110.8 on CSXT's RF&P Subdivision near the south bank of the Potomac River in Arlington, Virginia, and a common southern endpoint of Greendale, Virginia, located at milepost CFP 4.8 on CSXT's RF&P Subdivision just north of the Richmond Staples Mill Road Station, in order to provide a base-line comparison of changes in passenger-train running times on the RF&P Subdivision. Running time estimates were calculated based on track design speed for each alignment.

3.3.1 Alignments and Train Types Developed for Each Alternative

3.3.1.1 General Considerations

Passenger-train pure running time estimates were calculated over five alignment alternatives, which include the existing CSXT main line with a 70-mph passenger train speed, an improved CSXT main line reconfigured for 90-mph passenger train speeds where possible, and two proposed bypass alignments to avoid the existing constrained rail operations within the historic downtowns of Fredericksburg and Ashland, Virginia. Running-time estimates were calculated for five different passenger train types, reflecting proposed operations in the DC2RVA corridor for the year 2025.

3.3.1.2 Descriptions of Alignments

Northern Virginia and Central Virginia Area rail alignment options were identified by DRPT based on their abilities to improve track design speed. The rail alignments these two areas are described below.

(In Richmond, the existing dense urban development, grade changes, and historic rail configuration limit opportunities to improve travel time; additionally, there are multiple rail lines and two CSXT north-south rail lines, the A-Line and S-Line, to consider. Because of these factors, DRPT developed preliminary rail alignments and other improvements for the Richmond area based on the ability to serve potential station locations and passenger train routes. As a result, the potential improvements that were developed stayed largely within the existing right-of-way. Richmond rail alignments and improvements are presented in Sections 3.5 through 3.7.)

Pure running time estimates were calculated for the following rail alignments developed for the Northern Virginia and Central Virginia sections of the DC2RVA corridor.

Existing Speed on Existing Alignment Option. This alignment option uses the existing CSXT RF&P Subdivision between CP RO and Greendale as operated in 2015, with a maximum authorized speed (MAS) for passenger trains of 70 mph. The Existing Speed Option would add one main track, either east or west of the existing tracks, that matches the existing track design speed. Pure running time estimates were calculated for the Existing Speed on Existing Alignment Option, and were also used to provide a baseline of comparison of changes to passenger-train running times with the other proposed alignment options. Total length of the Existing Speed Option alignment between RO and Greendale is approximately 106.0 miles.

Improved Speed Option (Hold Bridges/Tangents). The Improved Speed Alignment was designed to maximize passenger train speed up to 90 mph where possible while keeping all tracks (new and reconfigured) within the limits of the existing right-of-way. A track design to reach 90 mph is not achievable within all sections of existing right-of-way due to existing curves and limited distances of straight (tangent) track between curves. The Improved Speed Alignment includes the following characteristics:

- Addition of a main track within the existing right-of-way that is designed to allow the maximum possible speed up to 90 mph for passenger trains where possible.
- Reconfiguration of existing main line tracks to allow the maximum possible speed up to 90 mph for passenger trains where possible.
- Track alignment for the redesigned tracks is constrained to fit within the existing right-of-way.

A variation on the Improved Speed Alignment was also developed that optimizes use of existing rail infrastructure while also seeking to achieve the maximum possible speed up to 90 mph—the Improved Speed Alignment (Hold Bridges/Tangents). The Improved Speed Alignment (Hold Bridges/Tangents) maintains existing tangent (*e.g.*, straight) tracks and continues to use the existing rail bridges and alignment over roads and waterways. New bridges would be required alongside the existing rail bridges to carry the additional main track, and the existing track would be realigned through some curves to increase track design speed. Where the potential environmental effects of the two improved speed alignments are comparable, the Improved Speed Alignment (Hold Bridges/Tangents) is preferred due to lower infrastructure impacts and anticipated cost savings from continuing use of existing rail bridges and tangent track alignments.

Fredericksburg Bypass. This alignment is identical to the Improved Speed alignment described above, except for the use of a 13.42-mile bypass route that diverges from the existing alignment to the east side of the urban area of Fredericksburg, Virginia. The bypass alignment option tested was Fredericksburg East Bypass 6C. The north end of the bypass diverges from the CSXT main line at milepost CFP 60.83 at Dahlgren Junction, Virginia, and the south end rejoins the CSXT main line at milepost CFP 51.54 near Summit, Virginia. (More information about this bypass alignment option can be found in Chapter 6 of Appendix A, the Alternatives Technical Report.) The bypass is designed with a geometric MAS of 80 mph for passenger trains, although curves on the bypass alignment have lower maximum operating speeds between 35 mph and 70 mph. Trains not required to make a station stop at Fredericksburg, Virginia are presumed to use this bypass. Use of the Fredericksburg Bypass adds approximately 4.13 route-miles to the approximate 106.0 alignment length between RO and Greendale, for a net total of approximately 110.1 miles for trains that use the Fredericksburg Bypass.

Ashland Bypass. This alignment is identical to the Improved Speed alignment described above, except for the use of a 8.32-mile bypass route that diverges from the existing alignment to the west side of the urban area of Ashland, Virginia. The bypass alignment option tested was Ashland West bypass AWB 4. The north end of the bypass diverges from the CSXT main line at milepost CFP 18.52 near Taylorsville, Virginia, and the south end rejoins the CSXT main line at milepost CFP 11.61 just north of the Elmont interlocking. (More information about this bypass alignment option can be found in Chapter 6 of the Alternatives Technical Report.) The bypass is geometrically designed for a MAS of 90 mph for passenger trains. Trains not required to make a station stop at Ashland, Virginia are presumed to use this bypass. Use of the Ashland Bypass adds approximately 1.41 route-miles to the approximate 106.0 alignment length between RO and Greendale, for a net total of approximately 107.4 miles for trains that use the Ashland Bypass.

Fredericksburg and Ashland Bypass. This alignment is identical to the Improved Speed alignment described above, but uses both the 13.42-mile Fredericksburg bypass and 8.32-mile

Ashland bypass in place of the CSXT main line at those locations. Use of both the Fredericksburg and Ashland bypasses adds approximately 5.54 route-miles to the total alignment length between RO and Greendale, for a net total of approximately 111.5 miles for trains that use both the Ashland and Fredericksburg bypasses.

Operating speeds were estimated through an iterative process between the DC2RVA engineering and rail operations teams that maximized the advantages of the Improved Speed Option alignment, without requiring constant or excessively frequent changes in locomotive throttle position in either traction power or dynamic braking modes. From the south end of RO interlocking at milepost CFP 109.75to the north bank of the Occoquan River at milepost CFP 90.15, segment speeds were optimized to achieve a MAS of 80 mph. From the curve north of Brooke station at milepost CFP 68.49 to the Crossroads interlocking at milepost CFP 53.53, segment speeds were optimized to achieve a MAS of 75 mph, owing to the corridor's curvilinear alignment and adjacent urban development in those segments. Total length of the Improved Speed Option alignment between RO and Greendale is also approximately 106.0 miles.

Note that other rail alignments for the Northern Virginia and Central Virginia Areas were also developed and eliminated from screening at stages prior to the beginning of operations simulation modeling work. These additional alignments are described in Chapters 5 and 6 of the Alternatives Technical Report.

3.3.1.3 Train Types and Stopping Patterns

Pure running time estimates were calculated for the following five different types of trains:

1. **Long Distance (LD)**: This train type represents an Amtrak Long Distance train consist of 2 P42 locomotives and 11 cars, forming a total consist length of 1,076 feet and weight including passengers of 993 tons. This train type makes one intermediate stop at Alexandria, Virginia.
2. **Interstate Corridor Nonstop (ICNS)**: This train type represents the proposed Interstate Corridor (SEHSR) train consist of two HSP46 locomotives and 10 Amfleet cars, forming a total consist length of 995 feet and weight including passengers of 875 tons. This train type makes no intermediate stops, and is used in TPC calculations for comparative purposes; it is not representative of a service type being proposed for the DC2RVA Project.
3. **Interstate Corridor Express (ICX)**: This train type represents the proposed Interstate Corridor (SEHSR) train consist of two HSP46 locomotives and 10 Amfleet cars, forming a total consist length of 995 feet and weight including passengers of 875 tons. This train type makes one intermediate stop at Alexandria, Virginia.
4. **Interstate Corridor (IC)**: This train type represents the proposed Interstate Corridor (SEHSR) train consist of 2 HSP46 locomotives and 10 Amfleet cars, forming a total consist length of 995 feet and weight including passengers of 875 tons. This train type makes two intermediate stops at Alexandria and Fredericksburg, Virginia.
5. **Northeast Regional (NER)**: This train type represents the proposed Northeast Regional (SEHSR) train consist of two HSP46 locomotives and 10 Amfleet cars, forming a total consist length of 995 feet and including passengers weight of 875 tons. This train type

makes five intermediate stops at Alexandria, Woodbridge, Quantico, Fredericksburg, and Ashland, Virginia.

One passenger train type that uses the DC2RVA corridor was not included in these estimates: Amtrak's Auto Train. The reason for its omission in the calculations is that the equipment used in the Auto Train consist limits its speed on CSXT to 70 mph, and thus the train would not experience a significant benefit in operating performance on a main line reconfigured for 90-mph passenger train speeds. In addition, the train operates between its endpoint stations of Lorton, Virginia, and Sanford, Florida, without making intermediate passenger stops, eliminating the need to estimate running times between stations within the DC2RVA corridor.

Table 3.3-1 shows the combinations of alignments and train types that were tested.

TABLE 3.3-1: TRAIN CONSISTS AND STOPPING PATTERNS USED IN TPC CALCULATIONS, BY TRAIN TYPE

Train Type	Long Distance (LD)	Interstate Corridor Nonstop (ICNS)	Interstate Corridor Express (ICX)	Interstate Corridor (IC)	Northeast Regional (NER)
Locomotives	2 P42	2 HSP46	2 HSP46	2 HSP46	2 HSP46
Cars	11	10	10	10	10
Station Stops					
Alexandria	x		x	x	x
Woodbridge					x
Quantico					x
Fredericksburg				x	x
Ashland					x
Bypass Used					
Fredericksburg	Y	Y	Y	N	N
Ashland	Y	Y	Y	Y	N
TPCs per direction	5	5	5	3	2

3.3.2 Additional Assumptions

Pure running time estimates comparing the alignment options used the infrastructure alignments, train type, and direction of travel as the independent variables; the pure running time is the sole dependent variable. To control for the effects of the different independent variables, separate estimates were made for each combination of independent variable, as follows:

1. **Infrastructure Alignments**: Alignments used were described in Section 3.1 above.

2. **Curve Unbalance**: Runs were made with passenger trains operating at 4-inch unbalance.
3. **Train Type**: Train types and their station stop patterns were described in Section 3.1 above. Passenger train deceleration into a station and acceleration out of a station were accounted for.

The following assumptions and inputs were used in creating and running the models:

1. Curve speeds and curve locations were provided by the DC2RVA Engineering team.
2. Northbound and southbound runs were recorded.
3. A one-second dwell time was used for modeling all station stops.
4. No recovery time was added to any of the schedules.
5. Existing permanent speed restrictions, *i.e.*, civil speeds not strictly related to curvature (*e.g.*, Ashland, Virginia civil speed restriction) were retained in the cases.

3.4 RESULTS OF THE NORTHERN AND CENTRAL VIRGINIA CALCULATIONS

The following tables present the estimated pure running times of five train types between Arlington and Greendale for the five different main track alignments compared. Estimates were for calculated for all train types operating in both the northbound and southbound direction. Running times are measured in hours and minutes and seconds (hh:mm:ss).

Note that the estimated running times are not ***actual*** travel times that would be contained in a timetable, as they do not include station dwell time, recovery time, and schedule adjustments for train congestion or seasonal weather conditions, nor do they necessarily reflect contractual on-time performance agreements between the operator, owner, and host railroads at present or that might exist in the future.

3.4.1 Running Time Differences by Alignment

Tables 3.4-1 through 3.4-5 show the estimated pure running time between CP RO (Arlington) and Greendale for five different train types over the five alignment options. The tables also show the changes in running time introduced by the Fredericksburg and Ashland bypasses.

The estimates of pure running times presented in Tables 2 through 5 for the different alignment options indicate the following:

- An Improved Speed Option rail alignment that enables trains to operate at 90 mph where possible permits trains to save approximately 11 minutes of running time compared with the Existing Speed Option 70-mph alignment between Arlington and Greendale.
- Use of the proposed Ashland Bypass route saves 62 seconds to 69 seconds of pure running time compared with the Improved Speed alignment through downtown Ashland.
- Use of the proposed Fredericksburg bypass adds approximately 4 minutes of running time compared with the Improved Speed alignment through downtown Fredericksburg.

- Use of both the Ashland and Fredericksburg bypasses adds approximately 3 minutes of running time compared with the Improved Speed alignment.

TABLE 3.4-1: INTERSTATE CORRIDOR NONSTOP TRAIN PURE RUNNING TIMES (HH:MM:SS): CP RO (ARLINGTON)-GREENDALE

Train Type: Interstate Corridor Nonstop						
	Southbound			Northbound		
Alignment Option	Pure Running Time	Change From Base	Change From Main Line Alignment	Pure Running Time	Change From Base	Change From Main Line Alignment
Existing Speed (Base)	01:39:25	00:00	n/a	01:39:12	00:00	n/a
Improved Speed	01:27:50	-00:11:35	00:00	01:27:25	-00:11:47	00:00
Improved Speed with Ashland bypass	01:26:43	-00:12:42	-00:01:07	01:26:16	-00:12:56	-00:01:09
Improved Speed with Fredericksburg bypass	01:31:54	-00:07:31	+00:04:04	01:31:43	-00:07:29	+00:04:18
Improved Speed with Fredericksburg + Ashland bypasses	01:30:47	-00:08:38	+00:02:57	01:30:38	-00:08:34	+00:03:13

TABLE 3.4-2: INTERSTATE CORRIDOR EXPRESS TRAIN PURE RUNNING TIMES (HH:MM:SS): CP RO (ARLINGTON)-GREENDALE

Train Type: Interstate Corridor Express						
	Southbound			Northbound		
Alignment Option	Pure Running Time	Change From Base	Change From Main Line Alignment	Pure Running Time	Change From Base	Change From Main Line Alignment
Existing Speed (Base)	01:40:07	00:00	n/a	01:39:54	00:00	n/a
Improved Speed	01:29:04	-00:11:03	00:00	01:28:44	-00:11:10	00:00
Improved Speed with Ashland bypass	01:27:59	-00:12:08	-00:01:05	01:27:36	-00:12:18	-00:01:08
Improved Speed with Fredericksburg bypass	01:33:05	-00:07:02	+00:04:01	01:33:02	-00:06:52	+00:04:18
Improved Speed with Fredericksburg + Ashland bypasses	01:31:58	-00:08:09	+00:02:54	01:31:58	-00:7:56	+00:03:14

Note: Station dwell times not included in running time calculations. Trains make one intermediate station stop at Alexandria, Virginia.

TABLE 3.4-3: INTERSTATE CORRIDOR TRAIN PURE RUNNING TIMES (HH:MM:SS): CP RO (ARLINGTON)-GREENDALE

Train Type: Interstate Corridor						
	Southbound			Northbound		
Alignment Option	Pure Running Time	Change from Base	Change from Main Line Alignment	Pure Running Time	Change from Base	Change from Main Line Alignment
Existing Speed (Base)	01:40:51	00:00	n/a	01:40:28	00:00	n/a
Improved Speed	01:29:49	-00:11:02	00:00	01:29:22	-00:11:06	00:00
Improved Speed with Ashland bypass	01:28:42	-00:12:09	-00:01:07	01:28:17	-00:12:11	-00:01:05
Improved Speed with Fredericksburg bypass	n/a	n/a	n/a	n/a	n/a	n/a
Improved Speed with Fredericksburg + Ashland bypasses	n/a	n/a	n/a	n/a	n/a	n/a

Note: Station dwell times not included in running time calculations. Trains make intermediate station stops at Alexandria and Fredericksburg, Virginia.

TABLE 3.4-4: NORTHEAST REGIONAL TRAIN PURE RUNNING TIMES (HH:MM:SS): CP RO (ARLINGTON)-GREENDALE

Train Type: Northeast Regional						
	Southbound			Northbound		
Alignment Option	Pure Running Time	Change from Base	Change from Main Line Alignment	Pure Running Time	Change from Base	Change from Main Line Alignment
Existing Speed (Base)	01:43:30	00:00	n/a	01:43:18	00:00	n/a
Improved Speed	01:32:49	-00:10:41	00:00	01:32:33	-00:10:45	00:00
Improved Speed with Ashland bypass	n/a	n/a	n/a	n/a	n/a	n/a
Improved Speed with Fredericksburg bypass	n/a	n/a	n/a	n/a	n/a	n/a
Improved Speed with Fredericksburg + Ashland bypasses	n/a	n/a	n/a	n/a	n/a	n/a

Note: Station dwell times not included in running time calculations. Trains make intermediate station stops at Alexandria, Woodbridge, Quantico, Fredericksburg, and Ashland, Virginia.

TABLE 3.4-5: LONG DISTANCE TRAIN PURE RUNNING TIMES (HH:MM:SS): CP RO (ARLINGTON)-GREENDALE

Train Type: Long Distance						
	Southbound			Northbound		
Alignment Option	Pure Running Time	Change from Base	Change from Main Line Alignment	Pure Running Time	Change from Base	Change from Main Line Alignment
Existing Speed (Base)	01:40:10	00:00	n/a	01:39:50	00:00	n/a
Improved Speed	01:29:10	-00:11:00	00:00	01:28:47	-00:11:03	00:00
Improved Speed with Ashland bypass	01:28:06	-00:12:04	-00:01:04	01:27:45	-00:12:05	-00:01:02
Improved Speed with Fredericksburg bypass	01:33:10	-00:07:00	+00:04:00	01:33:07	-00:06:43	+00:04:20
Improved Speed with Fredericksburg + Ashland bypasses	01:32:04	-00:08:06	+00:02:54	01:32:09	-00:07:41	+00:03:22

Note: Station dwell times not included in running time calculations. Trains make one intermediate station stop at Alexandria, Virginia.

No station stops are planned within the Fredericksburg and Ashland bypass routes. Although the bypasses may serve as an alternate routing for certain trains operating in the DC2RVA corridor, they are not intended to replace the existing CSXT main line through those communities, since passenger and commuter trains would still make use of existing station facilities located on the existing CSXT main line in Fredericksburg and Ashland.

3.4.2 Comparison with Existing Passenger Operations in the DC2RVA Corridor

It is important to note that the estimated approximate 11 minute savings in pure running time with the 90-mph Improved Speed Option rail alignment is measured against projected future consists used uniformly throughout the calculations. These consists are not representative of the intercity and long-distance passenger trains operating in 2015 in the DC2RVA corridor, which have fewer cars and in some cases different motive power. For example, the standard Northeast Regional (Virginia) consist operating in 2015 on the DC2RVA Corridor had one P42 locomotive and 8 cars, compared with the projected future Northeast Regional (SEHSR and Virginia) consist used in the TPC calculations of two HSP46 locomotives and 10 cars.

Amtrak schedules in effect in April 2015 indicate that Northeast Regional (Virginia) trains operating between CP RO and Greendale had a pure running time of approximately 01:45:00 in both directions, using the Existing Speed 70-mph alignment. Long distance trains operating between the same points had a pure running time of approximately 01:43:00. For comparison, the proposed pure running times on the 90-mph Improved Speed Option rail alignment average 01:33:00 for Regional trains and 01:29:00 for Long distance trains.

Thus, the time savings from the Improved Speed Option rail alignment when compared with passenger operations in 2015 is estimated to be approximately 12 minutes to 14 minutes.

3.4.3 Effect of Station Stops on Pure Running Time

Table 3.4-6 examines the effects of station stops on pure running time in the DC2RVA corridor. For this comparison, one train type and one alignment were selected. The train type selected is the proposed Interstate Corridor (SEHSR) trainset consisting of two HSP46 locomotives and 10 coaches, which is the type of trainset proposed for all Interstate Corridor and Northeast Regional services in the DC2RVA corridor. The alignment chosen was the Improved Speed Option, which enables passenger trains to operate at MAS of 90 mph where possible.

The estimated pure running times in Table 3.4-6 indicate that the effect of station stops on running time is modest. Each station stop adds approximately 60 seconds of pure running time to trains using the Optimized alignment. Note that running times do not include station dwell times, which range from 1 minute to 4 minutes, but do factor in train braking and acceleration required for a station stop.

TABLE 3.4-6: EFFECT OF STATION STOPS ON PURE RUNNING TIMES: (HH:MM:SS) CP RO (ARLINGTON)-GREENDALE

Improved Speed (Hold Bridges/Tangents) Alignment (Mas 90 Mph), No Bypasses						
	Southbound			Northbound		
Train Type	Pure Running Time	Change from ICNS Running Time	Station Stops	Pure Running Time	Change from ICNS Running Time	Station Stops
Interstate Corridor Nonstop	01:27:50	00:00	0	01:27:25	00:00	0
Interstate Corridor Express	01:29:04	+00:01:14	1	01:28:44	+00:01:19	1
Interstate Corridor	01:29:49	+00:01:59	2	01:29:22	+00:01:57	2
Northeast Regional	01:32:49	+00:04:59	5	01:32:33	+00:05:08	5

Tables 3.4-7 through 3.4-11 show running times between stations for all train types, and the time savings between each station pair that trains achieve using the Improved Speed alignment when compared to the Existing Speed alignment. Note that running times do not include station dwell times, but do factor in train braking and acceleration.

TABLE 3.4-7: NORTHEAST REGIONAL TRAIN RUNNING TIMES BETWEEN STATIONS (HH:MM:SS): CP RO (ARLINGTON)-GREENDALE

Northeast Regional						
	Southbound			Northbound		
Station Pairs	Existing Speed Alignment	Improved Speed Alignment	Change from Base	Existing Speed Alignment	Improved Speed Alignment	Change from Base
CP RO (Arlington)-Alexandria	00:07:20	00:06:43	-00:00:37	00:07:06	00:06:31	-00:00:35
Alexandria-Woodbridge	00:15:39	00:14:28	-00:01:11	00:15:38	00:14:38	-00:01:00
Woodbridge-Quantico	00:10:08	00:09:12	-00:00:56	00:10:15	00:09:23	-00:00:52
Quantico-Fredericksburg	00:18:27	00:16:44	-00:01:43	00:18:32	00:16:47	-00:01:45
Fredericksburg-Ashland	00:41:10	00:36:10	-00:05:00	00:41:10	00:36:06	-00:05:04
Ashland-Greendale	00:10:46	00:09:32	-00:01:14	00:10:37	00:09:08	-00:01:29

TABLE 3.4-8: INTERSTATE CORRIDOR TRAIN RUNNING TIMES BETWEEN STATIONS (HH:MM:SS): CP RO (ARLINGTON)-GREENDALE

Interstate Corridor						
	Southbound			Northbound		
Station Pairs	Existing Speed Alignment	Improved Speed Alignment	Change from Base	Existing Speed Alignment	Improved Speed Alignment	Change from Base
CP RO (Arlington)-Alexandria	00:07:20	00:06:43	-00:00:37	00:07:06	00:06:31	-00:00:35
Alexandria-Fredericksburg	00:42:06	00:37:54	-00:04:12	00:42:05	00:38:06	-00:03:59
Fredericksburg-Greendale	00:51:25	00:45:12	-00:06:13	00:51:17	00:44:45	-00:06:32
Fredericksburg-Greendale VIA Ashland Bypass	n/a	00:44:05	-00:07:20	n/a	00:43:40	-00:07:37

TABLE 3.4-9: INTERSTATE CORRIDOR EXPRESS TRAIN RUNNING TIMES BETWEEN STATIONS (HH:MM:SS): CP RO (ARLINGTON)-GREENDALE

Interstate Corridor Express						
	Southbound			Northbound		
Station Pairs	Existing Speed Alignment	Improved Speed Alignment	Change From Base	Existing Speed Alignment	Improved Speed Alignment	Change From Base
CP RO (Arlington)-Alexandria	00:07:20	00:06:43	-00:00:37	00:07:06	00:06:31	-00:00:35
Alexandria-Greendale	01:32:47	01:22:21	-00:10:26	01:32:48	01:22:13	-00:10:35
Alexandria-Greendale VIA Ashland Bypass	n/a	01:21:16	-00:11:31	n/a	01:21:05	-00:11:43
Alexandria-Greendale VIA Fredericksburg Bypass	n/a	01:26:22	-00:06:25	n/a	01:26:31	-00:06:17
Alexandria-Greendale VIA Ashland and Fredericksburg Bypass	n/a	01:25:15	-00:07:32	n/a	01:25:57	-00:07:21

TABLE 3.4-10: INTERSTATE CORRIDOR NONSTOP TRAIN RUNNING TIMES BETWEEN STATIONS (HH:MM:SS): CP RO (ARLINGTON)-GREENDALE

Interstate Corridor Nonstop						
	Southbound			Northbound		
Station Pairs	Existing Speed Alignment	Improved Speed Alignment	Change from Base	Existing Speed Alignment	Improved Speed Alignment	Change from Base
CP RO (Arlington)-Greendale	01:39:25	01:27:50	-00:11:35	01:39:12	001:27:25	-00:11:47
CP RO (Arlington)-Greendale VIA Ashland Bypass	n/a	01:26:43	-00:12:42	n/a	01:26:16	-00:12:56
CP RO (Arlington)-Greendale VIA Fredericksburg Bypass	n/a	01:31:54	-00:07:31	n/a	01:31:43	-00:07:29
CP RO (Arlington)-Greendale VIA Ashland and Fredericksburg Bypass	n/a	01:30:47	-00:08:38	n/a	01:30:38	-00:08:34

TABLE 3.4-11: LONG DISTANCE TRAIN RUNNING TIMES BETWEEN STATIONS (HH:MM:SS): CP RO (ARLINGTON)-GREENDALE

Long Distance						
	Southbound			Northbound		
Station Pairs	Existing Speed Alignment	Improved Speed Alignment	Change From Base	Existing Speed Alignment	Improved Speed Alignment	Change From Base
CP RO (Arlington)-Alexandria	00:07:28	00:06:46	-00:00:42	00:07:12	00:06:35	-00:00:37
Alexandria-Greendale	01:32:42	01:22:24	-00:10:18	01:32:38	001:22:12	-00:10:26
Alexandria -Greendale VIA Ashland Bypass	n/a	01:21:20	-00:11:22	n/a	01:21:10	-00:11:28
Alexandria g-Greendale VIA Fredericksburg Bypass	n/a	01:26:24	-00:6:18	n/a	01:26:32	-00:06:06
Alexandria-Greendale VIA Ashland and Fredericksburg Bypass	n/a	01:25:18	-00:07:24	n/a	01:25:34	-00:07:04

3.5 TOOLS AND ASSUMPTIONS USED TO DEVELOP RUNNING TIME ESTIMATES IN THE RICHMOND AREA

Passenger-train pure running times were also calculated for the Richmond area segment of the DC2RVA corridor. This segment of the corridor encompasses two different routes used by passenger trains. One route extends from the Greendale interlocking, just north of Staples Mill Road station in suburban Richmond, Virginia, to the southern end of the DC2RVA corridor in Centralia, Virginia; it is used by passenger trains operating between Washington, D.C. and points south of Richmond such as Norfolk, Charlotte, and Florida. The other route extends from Greendale interlocking through central Richmond to the Beulah interlocking east of Richmond; it is used by passenger trains operating between Washington, D.C. and Newport News, Virginia.

Pure running time estimates for both routes were made using the TPC feature of the RTC operations simulation model. The TPC analysis was based on rail alignments, curves, distances, and maximum curve speeds provided by the DC2RVA Project team for Project improvements between Greendale, Centralia, and Beulah. Alignments were developed for seven of the eight different Richmond Area station location options, and specific rail improvements based on the DC2RVA Engineering Basis of Design were identified for each alignment. The running time estimates presented below are based on refinements made by DC2RVA Project team in Spring 2016 to the seven Richmond-area alignments. Earlier running time estimates had been performed in December 2015 on prior versions of these alignments.

All alignments share a common northern endpoint of Greendale, just north of Staples Mill Road Station, a common southern endpoint of Centralia, 11 miles south of Richmond, and a common eastern endpoint of Beulah, 9 miles east of Richmond, in order to provide a base-line comparison of changes in passenger-train running times through Richmond for each potential station location. Pure running time estimates through Richmond were calculated based on track design speed for each alignment.

3.5.1 Alignments and Train Types Developed for Each Alternative

3.5.1.1 General Considerations and Train Types

Passenger-train pure running time estimates were calculated over seven alignment alternatives, based on the seven Richmond station options described below.

Running-time estimates were calculated for the two different passenger train types that are proposed to operate in the DC2RVA corridor in year 2025. The train types are:

1. **Long Distance (LD)**: This train type represents an Amtrak Long Distance train consist of two P42 locomotives and 11 cars, forming a total consist length of 1,076 feet and weight of 993 tons.
2. **Northeast Regional (NER)/Interstate Corridor (IC)**: This train type represents the proposed future Northeast Regional (Southeast High Speed Rail), Northeast Regional (Virginia), Interstate Corridor (Southeast High Speed Rail) train consists of two HSP46 locomotives and 10 Amfleet cars, forming a total consist length of 995 feet and weight of 875 tons.

3.5.1.2 Descriptions of Richmond Alignments

Eight different rail alignments were developed based on the eight different Richmond area station options carried forward into the Draft EIS. Each alignment makes use of one of the two existing CSXT-owned north-south main lines through the Richmond area. The two CSXT rail lines diverge at the south end of Acca Yard (3 miles south of Greendale), and rejoin at Centralia, operating through the Richmond area as follows:

- **A-Line**: From Acca Yard, this line uses a bypass route that arcs around the west side of Richmond and avoids the city center. The A-Line is CSXT's main north-south freight route through the Richmond area. It is also used by all Amtrak intercity and long-distance passenger trains headed to points south of Richmond.
- **S-Line**: From Acca Yard, this line heads south to serve Richmond's city center and industrial areas south of the James River. The S-Line is the only existing rail line that provides access to Main Street Station in Richmond's city center. The S-Line is used by CSXT local freight trains and by CSXT freight trains and Amtrak intercity passenger trains headed to Newport News.

These eight station options propose the use of one or two stations at four potential Richmond area locations. Figure 3.5-1 below shows the location of the four potential Richmond area station locations, in relation to the CSXT freight lines described above.

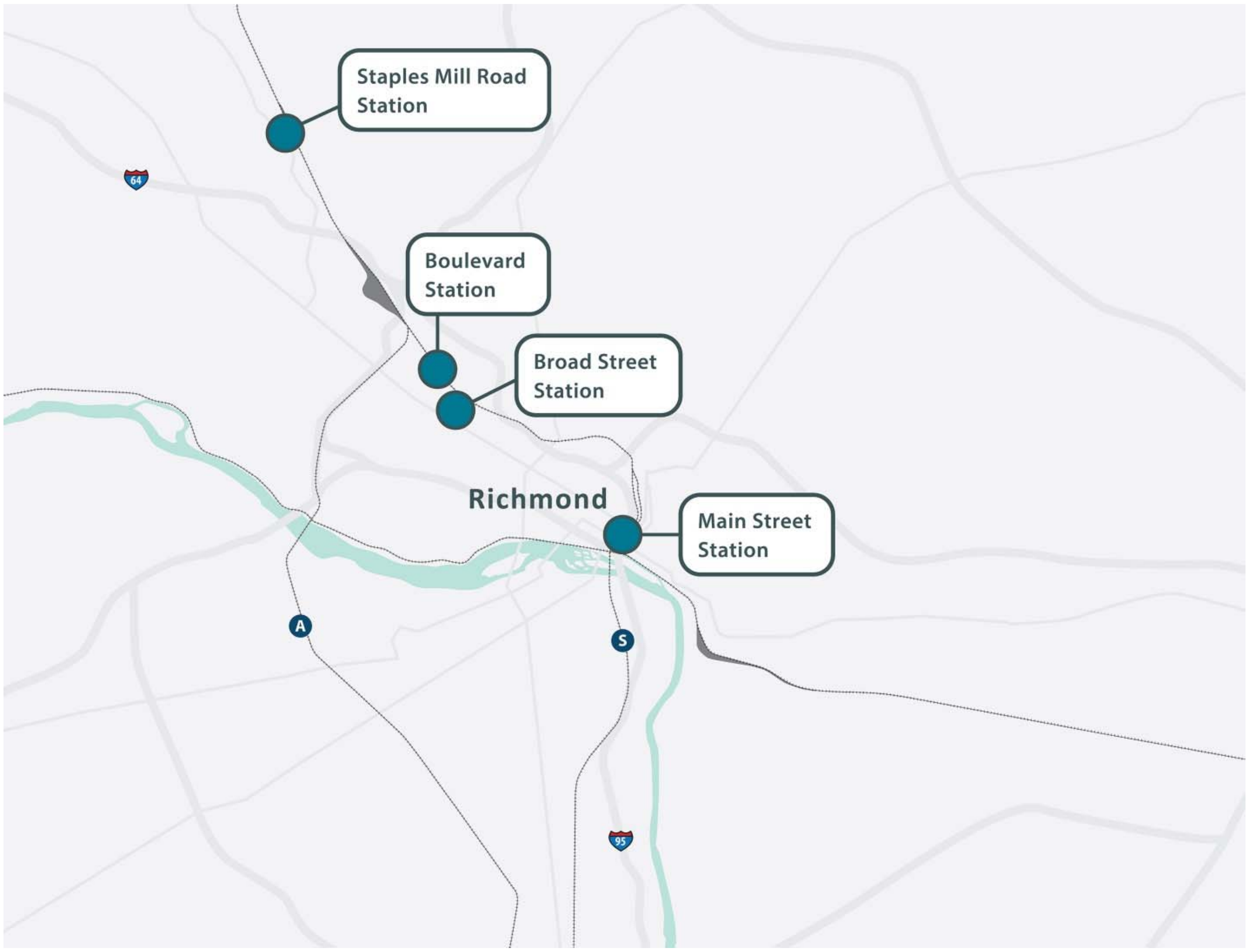

FIGURE 3.5-1: POTENTIAL RICHMOND STATION AREA LOCATIONS

Based on the Stage I, II, and III Screening for the Richmond area, DRPT carried forward the following rail alignment sets (defined by station location options) for further evaluation and screening in the Tier II Draft EIS:

Single Station Options

- Staples Mill Road Station Only (via A-Line).
- Boulevard Station Only, A-Line (via A-Line).
- Boulevard Station Only, S-Line (via S-Line).
- Broad Street Station Only (via A-Line).
- Main Street Station Only (via S-Line).

Two Station Options

- Split Service, Staples Mill Road/Main Street Stations (via S-Line).
- Full Service, Staples Mill Road/Main Street Stations (via A-Line).
- Shared Service, Staples Mill Road/Main Street Stations (via A-Line and S-Line).

The two station options include rail service to both Main Street Station and Staples Mill Road Station in the following service patterns:

- **Full Service (via S-Line)**—All Long Distance, Interstate Corridor, and Northeast Regional passenger trains moving north-south through Richmond route through Staples Mill Road Station and the west side of Main Street Station, and then to Centralia using the S-line; Northeast Regional service to Newport News continues on the east side of Main Street Station, on the Peninsula Subdivision from Beulah.
- **Split Service (via A-Line and S-Line)**—All Long Distance, Interstate Corridor, and Northeast Regional passenger trains moving north-south through Richmond route through Staples Mill Road Station to Centralia using the A-line, bypassing Main Street Station; Northeast Regional service to Newport News continues from the east side of Main Street Station on the S-Line, on the Peninsula Subdivision from Beulah.
- **Shared Service (via A-line and S-Line)**—All Long Distance and Interstate Corridor passenger trains moving north-south through Richmond route through Staples Mill Road Station to Centralia using the A-line; all Interstate Corridor (SEHSR) and Northeast Regional (Virginia and SEHSR) trains moving north-south through Richmond route through Staples Mill Road Station and the west side of Main Street Station and then to Centralia using the S-line; Northeast Regional service to Newport News continues from the east side of Main Street Station on the S-Line, on the Peninsula Subdivision from Beulah.

Alignments for each station location were also developed in consideration of how best to route trains past Acca Yard, CSXT's major freight classification yard serving Richmond. Bypass tracks on either the west side or the east side of Acca Yard were incorporated into the alignments, with the selection of a bypass route based on the particular station location site and routing via the S-Line or A-Line.

3.5.2 Additional Assumptions

Pure running time estimates comparing the alignment options used the infrastructure alignments, train type, and direction of travel as the independent variables; the running time is the sole dependent variable. To control for the effects of the different independent variables, separate estimates were made for each combination of independent variable, as follows:

1. Infrastructure Alignments: Alignments used were described in Section 5.1.2 above.
2. Curve Unbalance: Runs were made with passenger trains operating at 4-inch unbalance.
3. Train Type: Train types and their station stop patterns are described in Section 5.1 above. Passenger train deceleration into a station stop and acceleration out of a station stop were accounted for.

The following assumptions and inputs were used in creating the estimates:

1. Curve speeds and curve locations were provided by the DC2RVA Engineering Team.
2. Northbound and southbound runs were recorded.

3. A one-second dwell time was used for modeling all station stops.
4. No recovery time was added to any of the schedules.
5. Existing permanent speed restrictions, *i.e.* civil speeds, not strictly related to curvature were retained in the cases.

3.6 RESULTS OF THE RICHMOND AREA CALCULATIONS

The following tables present the estimated pure running times of the two train types between Greendale, Centralia, and Beulah for the seven different Richmond area station options compared. (An eighth alternative, Boulevard Station Only, S-Line, was not modeled, but is assumed by DRPT to have similar pure running time characteristics to the Main Street Station Only option.) Estimates were for calculated for all train types operating in both the northbound and southbound direction. Running times are measured in hours, minutes, and seconds (hh:mm:ss).

Note that the estimated running times are not ***actual*** travel times that would be contained in a timetable, as they do not include station dwell time, recovery time, and schedule adjustments for train congestion or seasonal weather conditions, nor do they necessarily reflect contractual on-time performance agreements between the operator, owner, and host railroads at present or that might exist in the future.

The estimates of pure running times presented below in Tables 3.6-1 through 3.6-8 for the different alignment options indicate the following:

- The Staples Mill Road Station Only option using the A-Line offers the fastest pure running time.
- The Main Street Station Only option using the S-Line is second fastest in pure running time for Interstate Corridor and Northeast Regional trains, but adds approximately 12 minutes of pure running time when compared to the Staples Mill Road Station Only option, owing to the route's slower proposed track speeds through central Richmond.
- Station options for passenger trains using the A-Line and a loop station track to reach Boulevard Station or Broad Street Station are the slowest options in pure running time for Interstate Corridor and Northeast Regional trains, between 12 minutes and 15 minutes slower than operating via the A-Line directly to Staples Mill Road Station only. Two-station options that require stops at both Staples Mill and Main Street Station add less than 1 minute of additional running time, owing to the 10-mph track speed in the Main Street Station area. The slow track speed means little additional time is required for braking and acceleration to make a Main Street Station stop.

Table 3.6-1 summarizes the running time estimates among all of the Richmond station options and train types that were calculated.

TABLE 3.6-1: PURE RUNNING TIMES FOR EIGHT RICHMOND STATION OPTIONS (MM:SS) (GREENDALE-CENTRALIA/BEULAH)

Northbound				Southbound			
Station Option	**Northeast Regional: Norfolk/ Int. Corridor**	**Long Distance**	**Northeast Regional: Newport News**	**Station Option**	**Northeast Regional: Norfolk/ Int. Corridor**	**Long Distance**	**Northeast Regional: Newport News**
Staples Mill Road Station Only via A-Line	19:30	19:32	30:57	Staples Mill Road Station Only via A-Line	19:30	19:32	31:19
Boulevard Station Only, A-Line, via A-Line and East Acca bypass	31:32	31:18	30:02	Boulevard Station Only, A-Line, via A-Line and East Acca bypass	34:01	31:18	31:49
Boulevard Station Only, S-Line, via S-Line and East Acca bypass	*	*	*	Boulevard Station Only, S-Line, via S-Line and East Acca bypass	*	*	*
Broad Street Station Only via A-Line and East Acca bypass	32:12	31:38	41:59	Broad Street Station Only via A-Line and East Acca bypass	31:49	31:38	41:50
Main Street Station Only via S-Line	31:18	32:44	29:02	Main Street Station Only via S-Line	31:30	32:44	29:46
Full Service, Staples Mill Road/Main Street stations	31:38	33:04	29:22	Full Service, Staples Mill Road/Main Street stations	31:53	33:04	30:20
Split Service, Staples Mill Road/Main Street stations	19:29	19:32	33:18	Split Service, Staples Mill Road/Main Street stations	19:24	19:32	34:13
Shared Service, Staples Mill Road/Main Street stations	31:51	19:42	29:14	Shared Service, Staples Mill Road/Main Street stations	32:01	19:42	30:35

*Note: The Boulevard Station, S-Line option was not calculated, but is assumed by DRPT to have similar pure running time characteristics to the Main Street Station Only option.

3.6.1 Running Time Differences by Alignment

Specific running time information for each station option is presented in Tables 3.6-2 through 3.6-8. These tables show the estimated pure running time between Greendale and Centralia, and between Greendale and Beulah, for two different train types over the seven alignment options compared. Tables 3.6-2 through 3.6-5 detail the four single-station options.

TABLE 3.6-2: PURE RUNNING TIMES FOR STAPLES MILL ROAD STATION ONLY (HH:MM:SS)

Staples Mill Road Station Only				
	Southbound		Northbound	
Corridor Locations	Northeast Regional / Interstate Corridor	Long Distance	Northeast Regional / Interstate Corridor	Long Distance
Acca Yard Bypass	West	West	West	West
Station Stops	SM	SM	SM	SM
Norfolk/North Carolina/Florida Trains				
Greendale-Centralia (A-Line)	00:19:30	00:19:32	00:19:30	00:19:29
Total Run Time	**00:19:30**	**00:19:32**	**00:19:30**	**00:19:29**
Newport News Trains				
Greendale-Beulah	00:30:57		00:31:19	
Total Run Time	**00:30:57**		**00:31:19**	

TABLE 3.6-3: PURE RUNNING TIMES FOR BOULEVARD STATION, A-LINE (HH:MM:SS)

Boulevard Station, A-Line				
	Southbound		Northbound	
Corridor Locations	Northeast Regional / Interstate Corridor	Long Distance	Northeast Regional / Interstate Corridor	Long Distance
Acca Yard Bypass	East	East	East	East
Station Stops	BV	BV	BV	BV
Norfolk/North Carolina/Florida Trains				
Greendale-Boulevard	00:06:21	00:06:22	00:07:40	00:07:56
Boulevard-Centralia (A-Line)	00:25:11	00:24:56	00:26:21	00:26:03
Total Run Time	**00:31:32**	**00:31:18**	**00:34:01**	**00:33:59**
Newport News Trains				
Greendale-Boulevard	00:06:21		00:05:58	
Boulevard-Beulah	00:23:41		00:25:51	
Total Run Time	**00:30:02**		**00:31:49**	

Note: The Boulevard Station, S-Line option was not calculated, but is assumed by DRPT to have similar pure running time characteristics to the Main Street Station Only option presented in Table 3.6-5.

TABLE 3.6-4: PURE RUNNING TIMES FOR BROAD STREET STATION ONLY (HH:MM:SS)

Broad Street Station Only				
	Southbound		**Northbound**	
Corridor Locations	**Northeast Regional / Interstate Corridor**	**Long Distance**	**Northeast Regional / Interstate Corridor**	**Long Distance**
Acca Yard Bypass	East	East	East	East
Station Stops	BS	BS	BS	BS
Norfolk/North Carolina/Florida Trains				
Greendale-Broad Street	00:11:29	00:11:09	00:11:55	00:11:41
Broad Street-Centralia (A-Line)	00:20:43	00:20:29	00:19:54	00:19:22
Total Run Time	**00:32:12**	**00:31:38**	**00:31:49**	**00:31:03**
Newport News Trains				
Greendale-Broad Street	00:11:29		00:11:49	
Broad Street-Beulah	00:30:30		00:30:01	
Total Run Time	**00:41:59**		**00:41:50**	

TABLE 3.6-5: PURE RUNNING TIMES FOR MAIN STREET STATION ONLY (HH:MM:SS)

Main Street Station Only				
	Southbound		Northbound	
Corridor Locations	Northeast Regional / Interstate Corridor	Northeast Regional / Interstate Corridor	Northeast Regional	Long Distance
Acca Yard Bypass	East	East	East	East
Station Stops	MS	MS	MS	MS
Norfolk/North Carolina/Florida Trains				
Greendale-Main Street (S-Line)	00:15:37	00:15:39	00:15:53	00:16:30
Main Street-Centralia (S-Line)	00:15:41	00:17:05	00:15:37	00:15:36
Total Run Time	**00:31:18**	**00:32:44**	**00:31:30**	**00:32:06**
Newport News Trains				
Greendale-Main Street	00:16:29		00:17:31	
Main Street-Beulah	00:12:33		00:12:15	
Total Run Time	**00:29:02**		**00:29:46**	

Tables 3.6-6 through 3.6-8 present the estimated running times for the three two-station options, which propose varying degrees of service to both Staples Mill Road and Main Street Station.

TABLE 3.6-6: PURE RUNNING TIMES FOR FULL SERVICE, STAPLES MILL ROAD / MAIN STREET STATIONS (HH:MM:SS)

Full Service, Staples Mill Road / Main Street Stations				
	Southbound		Northbound	
Corridor Locations	Northeast Regional / Interstate Corridor	Long Distance	Northeast Regional / Interstate Corridor	Long Distance
Acca Yard Bypass	East	East	East	East
Station Stops	SM + MS	SM + MS	SM + MS	SM + MS
Norfolk/North Carolina/Florida Trains				
Greendale-Main Street (S-Line)	00:15:57	00:16:00	00:16:17	00:16:53
Main Street-Centralia (S-Line)	00:15:41	00:17:04	00:15:36	00:15:35
Total Run Time	**00:31:38**	**00:33:04**	**00:31:53**	**00:32:28**
Newport News Trains				
Greendale-Main Street	00:16:49		00:17:58	
Main Street-Beulah	00:12:33		00:12:22	
Total Run Time	**00:29:22**		**00:30:20**	

TABLE 3.6-7: PURE RUNNING TIMES SPLIT SERVICE, STAPLES MILL ROAD / MAIN STREET STATIONS (HH:MM:SS)

Split Service, Staples Mill Road / Main Street Stations				
	Southbound		Northbound	
Corridor Locations	**Northeast Regional / Interstate Corridor**	**Long Distance**	**Northeast Regional / Interstate Corridor**	**Long Distance**
Acca Yard Bypass	West	West	West	West
Station Stops	SM (all) + MS (Newport News only)	SM	SM (all) + MS (Newport News only	SM
Norfolk/North Carolina/Florida Trains				
Greendale-Centralia (A-Line)	00:19:29	00:19:32	00:19:24	00:19:24
Total Run Time	**00:19:29**	**00:19:32**	**00:19:24**	**00:19:24**
Newport News Trains				
Greendale-Main Street	00:20:52		00:21:51	
Main Street-Beulah	00:12:26		00:12:22	
Total Run Time	**00:33:18**		**00:34:13**	

TABLE 3.6-8: PURE RUNNING TIMES FOR SHARED SERVICE, STAPLES MILL ROAD/MAIN STREET STATIONS (HH:MM:SS)

Shared Service, Staples Mill Road/Main Street Stations				
	Southbound		Northbound	
Corridor Locations	**Northeast Regional/ Interstate Corridor**	**Long Distance**	**Northeast Regional/ Interstate Corridor**	**Long Distance**
Acca Yard Bypass	East	West	East	West
Station Stops	SM + MS	SM	SM + MS	SM
Norfolk/North Carolina/Florida Trains				
Greendale-Centralia (A-Line)		00:19:42		00:19:40
Greendale-Main Street (S-Line)	00:16:10		00:16:25	
Main Street-Centralia (S-Line)	00:15:41		00:15:36	
Total Run Time	**00:31:51**	**00:19:42**	**00:32:01**	**00:19:40**
Newport News Trains				
Greendale-Main Street	00:16:41		00:18:13	
Main Street-Beulah	00:12:33		00:12:22	
Total Run Time	**00:29:14**		**00:30:35**	

3.6.2 Comparisons of Estimated Travel Times through Richmond with Existing Passenger Services

Section 3.6.2 provides some background into the development of proposed passenger-train timetable travel times between the Richmond Staples Mill Road and Main Street stations, based on the TPC running time estimates presented above, and how the proposed travel times compare with today's passenger train operation. This comparative information was requested by FRA during a meeting held on May 25, 2016 with FRA, the DC2RVA Project team, and Amtrak to review the DC2RVA conceptual train schedules.

Comparisons between today's operation between Staples Mill and Main Street and the DC2RVA conceptual timetables can only be made with four of the eight proposed DC2RVA Richmond station options:

1. Main Street Station Only
2. Full Service, Staples Mill Road/Main Street Stations
3. Split Service, Staples Mill Road/Main Street Stations
4. Shared Service, Staples Mill Road/Main Street Stations

The other four Richmond options would not employ the use of Main Street Station; and have other operational characteristics unique to those options, such as loop tracks with the proposed Broad Street and Boulevard station options, do not enable meaningful comparisons with the running time of existing services.

The following general conclusions can be made when comparing current operations to the proposed DC2RVA service:

- When an eastern bypass around Acca Yard is employed, southbound DC2RVA trains experience a total travel time reduction of 7 minutes to 10 minutes and northbound DC2RVA trains experience a travel time reduction of 7 minutes to 15 minutes, when compared with 2015 travel times between Staples Mill Road and Main Street stations.
- In the Split Service, Staples Mill Road/Main Street Stations option, in which an eastern Acca bypass is not used, southbound DC2RVA trains experience a total travel time reduction of 0 minutes to 3 minutes and northbound DC2RVA trains experience travel time changes of 2 additional minutes for one train and a reduction of 4 minutes to 7 minutes for two other trains when compared with 2015 travel times between Staples Mill Road and Main Street stations.

3.6.2.1 Existing Richmond Passenger Train Travel Times

Table 3.6-9 below details the existing passenger rail travel times between the Staples Mill Road and Main Street stations, based on Amtrak schedules, effective April 2015. Travel times are made up of the following components:

- Running time, which is the scheduled operating time between stations.
- Recovery time, which is time added to allow for unanticipated events that may temporarily delay a train.
- Time adjustment, which is time added to allow for anticipated events that will delay a train's journey, usually as a result of infrastructure limitations, such as a scheduled meet at a siding between two trains on a single-track section of railroad.
- Dwell time, which is time allotted for trains to board and disembark passengers at a station.

Table 3.6-9 contains the travel time information for each Amtrak train operating between Staples Mill Road and Main Street Station in April 2015.

TABLE 3.6-9: AMTRAK 2015 TRAVEL TIMES: STAPLES MILL ROAD TO MAIN STREET STATION (MINUTES)

Direction	Southbound				Northbound		
Train Number	**67**	**95**	**99**	**83**	**66**	**94**	**194**
Days of Operation	**Daily**	**M-F**	**Sa-Su**	**Fri**	**Daily**	**M-F**	**Sa-Su**
Dwell time: Staples Mill Road Station (not included in travel time calculation)	5	5	5	5	5	5	5

TABLE 3.6-9: AMTRAK 2015 TRAVEL TIMES: STAPLES MILL ROAD TO MAIN STREET STATION (MINUTES)

Direction	Southbound				Northbound		
Train Number	**67**	**95**	**99**	**83**	**66**	**94**	**194**
Days of Operation	**Daily**	**M-F**	**Sa-Su**	**Fri**	**Daily**	**M-F**	**Sa-Su**
Running time: Staples Mill-Main St.	22	22	22	22	20	20	20
Recovery time: Staples Mill-Main St.	1	2	2	4	0	7	7
Time adjustment: Staples Mill-Main St.	0	0	0	0	5	8	5
Dwell time: Main Street Station (not included in travel time calculation)	3	3	3	2	2	3	3
Total travel time: Staples Mill-Main St.	**23**	**24**	**24**	**26**	**25**	**35**	**32**

Notes for Table 3.6-9: 1) Train 66 schedule is adjusted by 5 minutes for meet with Train 95 on single track.

2) Train 94 schedule is adjusted by 8 minutes for meet with Train 67 on single track. Train 94's recovery time represents recovery time for entire Newport News-Main Street journey, using the industry standard of 8 percent of PRT added.

3) Train 194 schedule is adjusted by 5 minutes for meet with Train 67 on single track. Train 194's recovery time represents recovery time for entire Newport News-Main Street journey, using the industry standard of 8 percent of PRT added.

Staples Mill Road and Main Street Stations are approximately 8 miles apart.

Current average speed between stations is approximately 20 mph for southbound trains, and between 15 mph and 24 mph for northbound trains.

3.6.2.2 Proposed DC2RVA Richmond Passenger Train Travel Times

Table 3.6-10 below details the proposed running times for DC2RVA Southeast High Speed Rail trains between Staples Mill Road and Main Street in three different Richmond station options. Running times for these options were based on TPC calculations performed by the DC2RVA operations modeling team. All three options employ the use of a double-track bypass around the east side of Acca Yard. Operating speeds on the bypass were set at 40 mph for passenger trains, owing to curves around the existing yard, which is the same speed currently in effect for passenger trains on the existing Passenger Main around the west side of Acca Yard. (If discussions between DRPT and CSXT indicated that a passenger train speed increase on the East Acca bypass could potentially be made, travel times might be further reduced.)

Between Acca Yard and Main Street Station, operating speeds were increased slightly, from a passenger MAS of 30 mph to 40 mph. Numerous curves and a northbound grade of 1.2 percent on the S-Line between Acca Yard and Main Street Station precluded a higher increase in operating speeds.

However, the additional track capacity proposed for this area will permit bidirectional passenger operations, which is currently not possible on existing infrastructure, while also adding trackage where freight trains can reverse direction and cut off helper locomotives without delaying passenger operations.

The employment of the bypass tracks, along with the additional track capacity and speed increases on the S-Line proposed between the south end of Acca Yard and Main Street Station, allowed for a reduction in running time and an increase in reliability, reflected in the schedules by the elimination of recovery time between the two stations. (Trains arriving at Richmond from points east and south have recovery time factored into their proposed travel times between Richmond and the station immediately before it, either Petersburg or Williamsburg.)

As a result, southbound DC2RVA trains experience a total travel time reduction of 7 minutes to 10 minutes and northbound DC2RVA trains experience a travel time reduction of 7 minutes to 15 minutes when compared with 2015 travel times between Staples Mill Road and Main Street stations.

TABLE 3.6-10: PROPOSED DC2RVA 2025 TRAVEL TIMES BETWEEN STAPLES MILL ROAD AND MAIN STREET WITH EASTERN BYPASS (MINUTES) (STAPLES MILL + MAIN STREET FULL SERVICE OPTION AND SHARED SERVICE OPTION; MAIN STREET STATION ONLY OPTION)

	Southbound				Northbound			
Train Number	**SEHSR-VA+NC**	**LD**	**REG NPN**	**67 (NPN)**	**SEHSR VA+NC**	**LD**	**REG NPN**	**66 (NPN)**
Dwell time: Staples Mill Road	5 (NFK) 7 (N.C.)	9-12	5	5	5 (NFK) 7 (N.C.)	7-10	5	5
Running time: Staples Mill-Main St.	16	16	17	17	16	17	18	18
Recovery time: Staples Mill-Main St.	0	0	0	0	0	0	0	0
Time adjustment: Staples Mill-Main St.	0	0	0	0	0	0	0	0
Total travel time: Staples Mill-Main St.	**16**	**16**	**17**	**17**	**16**	**17**	**18**	**18**
Dwell time: Main Street Station	2	3	2	2	2	3	2	2

Notes for Table 3.6-10: 1) Running times between Staples Mill Road and Main Street Station are based on TPC calculations prepared by the DC2RVA operations modeling team.

2) Long distance trains and the Carolinian do not serve Main Street Station in Staples Mill+Main Street Shared Service option.

3) Running times and recovery times between Staples Mill and Main Street are identical for Main Street Station Only option as well; however, the Staples Mill Road Station stop would be eliminated and dwell times at Main Street Station would be increased to the dwell times shown at Staples Mill Road.

As a result of the proposed improvements, average speed between stations increases to approximately 28 mph to 30 mph for southbound trains, an improvement of 8 mph to 10 mph, and approximately 27 mph to 30 mph for northbound, an improvement of 3 mph to 15 mph.

Table 3.6-11 below details the proposed travel times for DC2RVA in the Staples Mill Road+Main Street Split Service option. This option differs from other two-station options in that only trains to and from terminating points at Richmond and Newport News would make both Richmond station stops. Other DC2RVA trains would make just one stop at Staples Mill Road and continue around the city of Richmond on the A-Line. The service option closely resembles the current service levels provided by Amtrak passenger trains in Richmond.

As a result of the limited service to Main Street Station, an eastern bypass was not proposed, and trains would be presumed to use the current Passenger Main around the west side of Acca Yard, as they do today, and continue to cross the south throat of the yard at AY interlocking to operate to/from the S-Line and Main Street Station. The limited number of capacity improvements between Staples Mill and Main Street proposed in the Split Service option is reflected in the longer proposed running time between stations, and the continued use of recovery times and adjustment times similar to those found in today's operation.

Table 3.6-11 shows that when an eastern Acca bypass is not used, southbound DC2RVA trains experience a total travel time reduction of 0 minutes to 3 minutes and northbound DC2RVA trains experience travel time changes of 2 additional minutes for one train and a reduction of 4 minutes to 7 minutes for two other trains when compared with 2015 travel times between Staples Mill Road and Main Street stations. The travel time increase experienced by Train 66 is a result of a schedule adjustment to account for a meet with Train 95.

TABLE 3.6-11: PROPOSED DC2RVA 2025 TRAVEL TIMES BETWEEN STAPLES MILL ROAD AND MAIN STREET WITH EASTERN BYPASS (MINUTES) (STAPLES MILL + MAIN STREET SPLIT SERVICE OPTIONS)

	Southbound		Northbound	
Train Number	**REG NPN**	**67 (NPN)**	**REG NPN**	**66 (NPN)**
Dwell time: Staples Mill Road	5	5	5	5
Running time: Staples Mill-Main St.	21	21	22	22
Recovery time: Staples Mill-Main St.	2	2	1	1
Time adjustment: Staples Mill-Main St.	0	0	0	5
Total travel time: Staples Mill-Main St.	**23**	**23**	**24**	**28**
Dwell time: Main Street Station	3	3	3	3

Notes for Table 3.6-11: 1) Long distance trains, the Carolinian, and SEHSR trains to Norfolk and North Carolina do not serve Main Street Station in Staples Mill+Main Street Split Service option.

2) Additional running time and recovery time between Staples Mill and Main Street is incorporated to account for the absence of an eastern Acca bypass and the need for Newport News trains to continue to cross the south throat of Acca Yard at AY interlocking.

In this option, the average speed between stations is approximately 21 mph for southbound trains, slightly better than today's average of 20 mph, and approximately 17 mph to 21 mph for northbound trains, a range that indicates the more consistent and reliable operation of the proposed service when compared with the 15 mph to 24 mph range of today's trains.

3.6.2.3 Travel Times South of Main Street Station on the S-Line

Three of the eight Richmond station options that propose the use of Main Street Station would require trains from points south of Richmond such as Norfolk, North Carolina, and Florida to use the S-Line between Centralia, Virginia and Main Street Station. This portion of the S-Line includes a segment of 10-mph trackage from Main Street Station, where the tracks are on an elevated viaduct, south on a bridge across the James River and across a diamond with a Norfolk Southern Railway (NS) branch line. Normal track speed resumes south of the diamond. (The diamond has recently been replaced; it is now a flange-bearing, one-way low-speed [OWLS] diamond for the crossing route, and normal speed for the main track route.) This segment of 10-mph operation is approximately 0.8 miles in length, and requires approximately 5 minutes for a train to traverse.

As part of the DC2RVA Project, the S-Line south of the James River and the NS diamond would be upgraded to a passenger MAS of 79 mph where curves and grades allow. However, the DC2RVA Project proposes lower operating speeds between Main Street Station and the NS diamond.

A second track will be restored on the historic elevated viaduct between Main Street Station and the James River Bridge, a distance of approximately 0.2 miles; however, the track speed on viaduct is proposed to remain at the existing 10 mph.

The DC2RVA Project proposes to add a second single-track parallel to the existing single-track S-Line bridge. Although the bridge's design and construction may enable a higher operating speed, the proposed scheduling and operation of passenger trains was designed to enable the use of either bridge across the James River and either platform track at Main Street Station. (DRPT and CSXT could coordinate the potential for structural remediation that could increase the operating speed on the bridge above 10 mph.) As a result, TPC runs and train schedules between Main Street Station and Petersburg were derived using the more restrictive existing operating speed of 10 mph between Main Street Station and the NS diamond south of the James River, since some percentage of passenger trains will be presumed to use the existing James River bridge.

3.7 PREVIOUS RICHMOND AREA RUNNING TIME EVALUATIONS

Initial passenger train running times estimates for several Richmond area alignments were developed in December 2015, as part of the DC2RVA Project's Richmond-area station location screening process. Some of the alignments were in earlier stages of preparation at that time, which will account for the differences in running time estimates presented in Section 7 below when compared to the running time estimates calculated in Sections 5 and 6.

As before, estimated passenger-train running times through Richmond were evaluated between the Greendale interlocking, just north of Staples Mill Road station in suburban Richmond, Virginia and the southern end of the corridor in Centralia, Virginia. Running time estimates were developed for six different alignments associated with four potential train station locations within the City of Richmond.

Based on a preliminary screening, the following four potential station locations were identified by DRPT as locations to carry forward for additional analyses. They are:

- Staples Mill Road
- Boulevard
- Broad Street
- Main Street

3.7.1 Key Findings from Previous Richmond-Area Calculations

The estimates of passenger-train running times calculated in December 2015 indicated the following:

- The Staples Mill Road Station only option using the A-Line offers the fastest pure running time.
- Station options for passenger trains using the S-Line, and making one Richmond stop at either Main Street Station or Boulevard Station, are next fastest in pure running time, approximately 2 minutes slower than the Staples Mill Road Only option.
- Station options for passenger trains using the A-Line and a loop station track to reach Boulevard Station or Broad Street Station are the slowest pure running time options, over 3 minutes and 5 minutes slower, respectively, than operating via the A-Line directly to Staples Mill Road Station only.
- Two-station options add approximately 2 minutes to 7 minutes of pure running time between Greendale and Centralia, depending on the alignment and station combination selected.
- The fastest pure running time two-station option is Main Street Station plus Staples Mill Road, which are the two stations that are the farthest distance apart.
- Pure running times are slowest for any two-station option involving Broad Street Station, due to the necessity of a slow-speed loop track required to serve the station facility.

3.7.2 Tools and Assumptions Used to Develop Running Time Estimates

Running time estimates were made using the TPC feature of the RTC operations simulation model. The TPC analysis was based on rail alignments, curves, distances, and maximum curve speeds provided by DC2RVA Project team for Project improvements between Greendale and Centralia. Alignments were developed for each potential Richmond Area station location, and specific rail improvements based on the DC2RVA Engineering Basis of Design were identified for each alignment.

All alignments share a common northern endpoint of Greendale, just north of Staples Mill Road Station, and a common southern endpoint of Centralia, 11 miles south of Richmond, in order to provide a baseline comparison of changes in passenger-train running times through Richmond for each potential station location. Running time estimates through Richmond were calculated based on track design speed for each alignment.

3.7.3 Alignments Developed for Each Station Location

3.7.3.1 General Considerations

Six alignments were developed to serve the four potential Richmond area station locations. All of the alignments made use of existing CSXT-owned rail lines. Because there are two CSXT rail lines through the Richmond area, two different alignments were developed for some station locations, if the site allowed for the use of either CSXT route.

The two CSXT rail lines diverge at the south end of Acca Yard (3 miles south of Greendale), and rejoin at Centralia, operating through the Richmond area as follows:

- **A-Line**: From Acca Yard, this line uses a bypass route that arcs around the west side of Richmond and avoids the city center. The A-Line is CSXT's main north-south freight railroad route through the Richmond area. It is also used by all Amtrak intercity and long-distance passenger trains headed to points south of Richmond.
- **S-Line**: From Acca Yard, this line heads south to serve Richmond's city center and industrial areas south of the James River. The S-Line is the only existing rail line that provides access to Main Street Station in Richmond's city center. The S-Line is used by CSXT local freight trains and by CSXT freight trains and Amtrak intercity passenger trains headed to Newport News.

Alignments for each station location were also developed in consideration of how best to route trains past Acca Yard, CSXT's major freight classification yard serving Richmond. Bypass tracks on the west side and east side of Acca Yard were incorporated into the alignments, with the selection of a bypass route based on the particular station location site and routing via the S-Line or A-Line.

3.7.3.2 Descriptions of Alignments

Running time estimates were calculated for all alignments described below. Note that estimates were prepared only for passenger trains presumed to be operating the entire length of the alignment between Centralia and Greendale. Passenger trains from Newport News, Virginia were not included, because these trains enter Richmond from the east and require only partial use of the alignments.

Staples Mill Road Station Only. This alignment assumes that Staples Mill Road Station is the only Richmond area station. In this alignment, passenger trains from points south of Richmond operate via CSXT's A-Line around the west side of the city. Passenger trains from Newport News operate through the city center via the S-Line, passing Main Street Station without stopping. All passenger trains operate via a West Acca Yard bypass track.

Main Street Station Only. This alignment assumes that Main Street Station is the only Richmond area station. In this alignment, passenger trains (except the Auto Train) from points south of Richmond operate via CSXT's S-Line through Richmond's city center and stop at Main Street Station's west side. Passenger trains from Newport News stop on the east side of Main Street Station as they do today, then continue north on the S-Line. All passenger trains (except the Auto Train) operate via an East Acca bypass. Passenger trains pass Staples Mill Road Station without stopping.

Boulevard Station, S-Line, via S-Line. This alignment assumes the construction of a new station facility at the Boulevard overpass on the CSXT S-Line that would serve as the only Richmond area station. In this alignment, passenger trains (except the Auto Train) from points south of Richmond operate via CSXT's S-Line through Richmond's city center, passing Main Street Station without stopping. Passenger trains from Newport News operate via the S-Line north of Main Street Station to reach the Boulevard Station. All passenger trains (except the Auto Train) operate via an East Acca bypass track.

Boulevard Station, A-Line, via A-Line. This alignment assumes the construction of a new station facility at the Boulevard overpass on the CSXT S-Line that would serve as the only Richmond area station. In this alignment, passenger trains from points south of Richmond operate via the A-Line to Acca Yard, and all (except the Auto Train) then enter an elevated loop track to access the Boulevard station and continue north. Passenger trains from Newport News operate via the S-Line north of Main Street Station to reach the Boulevard Station, without requiring use of the loop track. All passenger trains (except the Auto Train) operate via an East Acca bypass track.

Broad Street Station Only via A-Line and East Bypass. This alignment assumes the construction of a new station facility off the CSXT S-Line right-of-way in the vicinity of the former Broad Street Station (now the Science Museum of Virginia) that would serve as the only Richmond area station. In this alignment, passenger trains from points south of Richmond operate via the A-Line to Acca Yard, and then all (except the Auto Train) enter an at-grade loop track to access Broad Street Station and continue north. Passenger trains from Newport News operate via the S-Line north of Main Street Station and access the same at-grade loop track serving Broad Street Station. All passenger trains (except the Auto Train) operate via an East Acca bypass that requires northbound passenger trains departing Broad Street to cross the CSXT S-Line at grade before accessing passenger bypass tracks around the east side of Acca Yard.

Broad Street Station Only via A-Line and West Bypass. This alignment assumes the construction of a new station facility off the CSXT S-Line right-of-way in the vicinity of the former Broad Street Station (now the Science Museum of Virginia) that would serve as the only Richmond area station. In this alignment, passenger trains from points south of Richmond operate via the A-Line to Acca Yard, and then all (except the Auto Train) enter an at-grade loop track to access Broad Street Station and continue north. Passenger trains from Newport News operate via the S-Line north of Main Street Station and access the same at-grade loop track serving Broad Street Station. All passenger trains operate via a West Acca bypass that enables passenger trains from points south to remain on the west side of the S-Line while serving Broad Street Station and continuing north.

3.7.3.3 Two Station Option Evaluation

In addition to testing pure running times for the single station location options described above, pure running time estimates were also developed for combinations of Richmond stations, to estimate the impact on operations if passenger trains were to stop at more than one Richmond area station. The following station combinations were tested:

- Main Street + Staples Mill Road via S-Line and East Acca bypass
- Main Street + Boulevard via S-Line and East Acca bypass
- Boulevard + Staples Mill Road via S-Line and East Acca bypass
- Boulevard + Staples Mill Road via A-Line and East Acca bypass
- Broad Street + Staples Mill Road via A-Line and West Acca bypass
- Broad Street + Staples Mill Road via A-Line and East Acca bypass
- Main Street + Broad Street via S-Line and East Acca bypass

As detailed in Section 3.7.5 below, six of the seven two station options were dismissed from further review during screening owing to proximity and efficiency of station operations.

3.7.4 Additional Assumptions

Pure running time estimates comparing the potential station location options used the infrastructure alignments, train type, and direction of travel as the independent variables; the running time is the sole dependent variable. To control for the effects of the different independent variables, separate estimates were made for each combination of independent variable, as follows:

1. Infrastructure Alignments Developed for Each Potential Station Location: Alignments used were described in Section 7.3.2 above.
2. Curve Unbalance: Runs were made with passenger trains operating at 4-inch unbalance.
3. Train Type: Runs were made with a proposed Interstate Corridor (SEHSR) train consist of two HSP46 locomotives and 10 Amfleet cars, forming a total consist length of 995 feet and weight of 875 tons. Passenger train de-acceleration into a station and acceleration out of a station were accounted for.

The following assumptions and inputs were used in creating and running the models:

1. Curve speeds and curve locations were provided by the DC2RVA Engineering team.
2. Northbound and southbound runs were recorded.
3. A one-second dwell time was used for modeling all station stops.
4. No recovery time was added to any of the schedules.
5. Existing permanent speed restrictions, *i.e.*, civil speeds, not strictly related to curvature (*e.g.*, James River S-Line bridge) were retained in the cases.

3.7.5 Results of the Calculations

The following tables present the estimated Pure Running Times between Greendale and Centralia for the four different Richmond single station options modeled and the seven two-station options modeled. Estimates were for calculated for a proposed 10-car Interstate Corridor (SEHSR) consist operating in both the northbound and southbound direction. Running times are measured in minutes and seconds (00:00).

Note that the estimated running times are not ***actual*** schedule times that would be contained in a timetable, as they do not include station dwell time, recovery time, and schedule adjustments for train congestion or seasonal weather conditions, nor do they necessarily reflect contractual on-time performance agreements between the operator, owner, and host railroads at present or that might exist in the future.

3.7.5.1 Single Station Options

Table 3.7-1 shows the estimated pure running time between Greendale and Centralia for the four Richmond single station options. Table 3.7-1 also shows the additional time required for passenger trains using a station option other than the Staples Mill Road Station Only option via the A-Line. The Staples Mill Road Only pure running time appears in the table below as 00:00, and is used as a baseline for time comparison with the other options.

The estimates of pure running times for the single station options presented in Table 24 indicate the following:

- The Staples Mill Road Station Only option using the A-Line offers the fastest pure running time.
- Station options for passenger trains using the S-Line, and making one Richmond stop at either Main Street Station or Boulevard Station, are next fastest in pure running time, approximately 2 minutes slower than the Staples Mill Road Only option.
- Station options for passenger trains using the A-Line and a loop station track to reach Boulevard Station or Broad Street Station are the slowest pure running time options, over 3 minutes and 5 minutes slower, respectively, than operating via the A-Line directly to Staples Mill Road Station only.
- Running time estimates for the Broad Street Station option via the West Acca bypass do not take into account potential passenger/freight train conflicts at the AY interlocking.

TABLE 3.7-1: SINGLE STATION OPTION PURE RUNNING TIMES: GREENDALE-CENTRALIA (MM:SS)

Northbound				Southbound			
Station Option	Pure Running Time	Time Differential over Staples Mill Only	Alignment Miles	Station Option	Pure Running Time	Time Differential over Staples Mill Only	Alignment Miles
Staples Mill Road Station Only via A-Line	17:46	00:00	19.08	Staples Mill Road Station Only via A-Line	17:57	00:00	19.32
Main Street Station Only via S-Line	20:05	02:19	20.45	Main Street Station Only via S-Line	19:39	01:42	20.12

TABLE 3.7-1: SINGLE STATION OPTION PURE RUNNING TIMES: GREENDALE-CENTRALIA (MM:SS)

Northbound				Southbound			
Station Option	**Pure Running Time**	**Time Differential over Staples Mill Only**	**Alignment Miles**	**Station Option**	**Pure Running Time**	**Time Differential over Staples Mill Only**	**Alignment Miles**
Boulevard Station, S-Line, via S-Line	20:34	02:48	20.45	Boulevard Station, S-Line, via S-Line	20:14	02:17	20.12
Boulevard Station, A-Line, via A-Line	21:30	03:44	21.59	Boulevard Station, A-Line, via A-Line	21:35	03:38	21.54
Broad Street Station Only via A-Line and East Acca bypass	22:49	05:03	22.11	Broad Street Station Only via A-Line and East Acca bypass	23:13	05:16	22.06
Broad Street Station Only via A-Line and West Acca bypass	23:27	05:41	22.02	Broad Street Station Only via A-Line and West Acca bypass	23:39	05:42	21.97

3.7.5.2 Two-Station Options

Table 3.7-2 summarizes the results of the two-station options. Two-station options add approximately 2 minutes to 7 minutes of pure running time between Greendale and Centralia, depending on the alignment and station combination selected. (Note that any two-station option would also have additional dwell time associated with the second station stop, which would further increase overall travel time through Richmond compared with a single station option.)

Pure running time estimates indicate that the fastest of the two-station options are the stations that are also the farthest distance apart — Main Street plus Staples Mill Road. Running times are slowest for the Broad Street Station options, due to the necessity of a slow-speed loop track required to serve the station facility. Two-station scenarios involving Broad Street add approximately 6 minutes to 7 minutes of pure running time though Richmond, more than any other two-station option.

TABLE 3.7-2: TWO-STATION OPTION PURE RUNNING TIMES: GREENDALE-CENTRALIA (MM:SS)

Northbound					
Station Stops	**Pure Running Time**	**Time Differential**	**Alignment Miles**	**Time Between Stops**	**Miles Between Stops**
Main Street and Staples Mill (via S-Line)	21:42	00:00	20.45	09:36	7.5
Main Street and Boulevard (via S-Line)	21:46	00:04	20.64	06:42	3.9
Boulevard and Staples Mill (via S-Line)	22:11	00:29	20.45	04:54	4.0
Boulevard and Staples Mill (via A-Line)	23:07	01:25	21.59	04:42	3.8
Broad Street and Staples Mill (via A-Line and East Acca bypass)	24:27	02:45	22.11	07:30	4.8
Broad Street and Staples Mill (via A-Line and West Acca bypass)	25:08	03:26	22.06	07:54	4.7
Main Street and Broad Street (via S-Line)	26:15	04:33	21.64	08:00	4.0
Southbound					
Station Stops	**Pure Running Time**	**Time Differential**	**Alignment Miles**	**Time Between Stops**	**Miles Between Stops**
Main Street and Staples Mill (via S-Line)	21:20	00:00	20.17	09:30	7.7
Main Street and Boulevard (via S-Line)	21:32	00:12	20.31	06:42	4.0
Boulevard and Staples Mill (via S-Line)	21:53	00:33	20.12	04:54	4.1
Boulevard and Staples Mill (via A-Line)	23:14	01:54	21.54	04:42	3.8
Broad Street and Staples Mill (via A-Line and East Acca bypass)	24:46	03:26	22.06	07:00	4.9
Broad Street and Staples Mill (via A-Line and West Acca bypass)	25:21	04:01	21.97	07:36	4.9
Main Street and Broad Street (via S-Line)	25:57	04:37	21.35	08:18	4.0

3.7.5.3 Additional Evaluation of Two-Station Options

Table 3.7-3 presents additional evaluation from the DC2RVA Project team of the four potential Richmond-area station locations. It also contains preliminary recommendations by the DC2RVA Project team for whether the Richmond-area station location option should be carried forward or eliminated as part of the screening process. Based on evaluation of the four station locations, and input from the City of Richmond, Henrico County, and others, the DC2RVA Project team recommended that following station locations be carried forward into the Draft EIS for detailed side-by-side evaluation:

- Single Station Options
  - Staples Mill Road Station Only (via A-Line)
  - Boulevard Station, A-Line (via A-Line
  - Boulevard Station, S-Line (via S-Line)
  - Broad Street Station Only (via A-Line)
  - Main Street Station Only (via S-Line)
- Two-Station Options
  - Staples Mill Road/Main Street Stations
    - Full Service (via S-Line)
    - Split Service (via A-Line)
    - Shared Service (via A-Line and S-Line)

TABLE 3.7-3: TWO-STATION OPTION EVALUATION AND PRELIMINARY RECOMMENDATION

Station Option	Pure Running Time (MM:SS)	Time Differential (MM:SS)	Time Between Stops (MM:SS)	Miles Between Stops	Comments	Preliminary Recommendation
Staples Mill Road and Main Street	21:42	00:00	09:36	7.5	Distance between stations ~7.5 miles, similar to distance between Union Station in Washington, D.C. and Alexandria Station, VA	Full Service Option, Long Distance & Norfolk trains use S-Line: Carried forward for detailed analysis
						Split Service Option, Long Distance & Norfolk trains use A-Line: Carried forward for detailed analysis
						Shared Service Option, Long Distance & Norfolk Trains use either S-Line or A-Line: Carried forward for detailed analysis

TABLE 3.7-3: TWO-STATION OPTION EVALUATION AND PRELIMINARY RECOMMENDATION

Station Option	Pure Running Time (MM:SS)	Time Differential (MM:SS)	Time Between Stops (MM:SS)	Miles Between Stops	Comments	Preliminary Recommendation
Boulevard and Main Street (via S-Line)	21:46	00:04	06:42	3.9	Close proximity of stations does not provide adequate choice for regional riders, adversely affects efficiency of train operations, and reduces fuel efficiency	Dismissed
Staples Mill Road and Boulevard (via S-Line)	22:11	00:29	04:54	4.0	Close proximity of stations does not provide adequate choice for regional riders, adversely affects efficiency of train operations, and reduces fuel efficiency	Dismissed
Staples Mill Road and Boulevard (via A-Line)	23:07	01:25	04:42	3.8	Close proximity of stations does not provide adequate choice for regional riders, adversely affects efficiency of train operations, and reduces fuel efficiency	Dismissed
Staples Mill and Broad Street (via A-Line and East Acca bypass)	24:27	02:45	07:30	4.8	Close proximity of stations does not provide adequate choice for regional riders, adversely affects efficiency of train operations, and reduces fuel efficiency	Dismissed
Staples Mill Road and Broad Street (via A-Line and West Acca bypass)	25:08	03:26	07:54	4.7	Close proximity of stations does not provide adequate choice for regional riders, adversely affects efficiency of train operations, and reduces fuel efficiency	Dismissed
Main Street and Broad Street (via S-Line)	26:15	04:33	08:00	4.0	Close proximity of stations does not provide adequate choice for regional riders, adversely affects efficiency of train operations, and reduces fuel efficiency	Dismissed

3.8 TPC ESTIMATES FOR PROPOSED CURVE AND INFRASTRUCTURE IMPROVEMENTS ELIMINATED DURING SCREENING

3.8.1 Running Time Estimates and Curve Analysis Following August 2015 FRA Review

The DC2RVA engineering and operating teams held a Northern Virginia Working Group meeting and Central Virginia Working Group meeting with the Federal Railroad Administration (FRA) on August 13, 2015 to review the proposed DC2RVA Project Improved Speed alignment for the DC2RVA corridor between RO (Arlington), Virginia, and Greendale (Richmond), Virginia.

During the meetings, a request by the FRA was made to review the curves in the Northern Virginia section of the corridor and identify curves as potential candidates for full or partial straightening to improve operating speeds. The DC2RVA operations and engineering teams met on August 24, 2015, and identified nine curves that could be reassessed for improved operating performance and right-of-way impacts associated with improving curves at those locations.

The engineering and operations team examined each of the curves and determined that the potential running time savings from an increased operating speed through the curves would be minimal and not sufficient enough to justify the right-of-way impacts that would occur as a result of the curve realignments at those locations.

Table 3.8-1 details the location of these curves, and a summary of the right-of-way (ROW) impacts and potential time savings for passenger trains.

TABLE 3.8-1: AUGUST 2015 NORTHERN VIRGINIA CURVE RE-ANALYSIS

Location	Curve #	Deg.	Begin MP	End MP	Planned Improved Speed	Potential New Speed	ROW impact	Comments
Four Mile Run	52N	2	107.77	107.40	75	80	Yes	Cannot flatten curve to achieve 80 mph. Flatter curve would require tangent below minimum curves and ROW impacts
Slaters Lane	50N	2	106.90	106.52	75	90	Yes	ROW impacts: buildings, trails, and parallel roadway
Seminary	47N	2	103.22	102.65	75	80	Yes	Cannot flatten curve to achieve 80 mph. Flatter curve would require tangent below minimum curves and ROW impacts
Newington/ Pohick	40N	2	95.30	94.74	75	90	Yes	Significant ROW impact; several businesses and grade crossings

TABLE 3.8-1: AUGUST 2015 NORTHERN VIRGINIA CURVE RE-ANALYSIS								
Location	**Curve #**	**Deg.**	**Begin MP**	**End MP**	**Planned Improved Speed**	**Potential New Speed**	**ROW impact**	**Comments**
Aquia	18N	1	70.59	69.99	80	90	No	Preceding and following track geometry limits MAS to 80 mph
Courthouse Road	17N	1	69.71	69.34	80	90	No	Preceding and following track geometry limits MAS to 80 mph
Mt. Hope Church	15N	2	67.87	67.38	70	80	Yes	ROW impact for roadbed; VRE station platform impact
Ross	14N	2	67.06	66.69	75	90	Yes	Significant ROW impact on private property
Daffan	12N	2	64.98	64.43	75	90	Yes	Significant ROW impact on private property
Note: Curve degree represents the rounded degree of curve for the Planned Improved Speed option								
Southbound Running Time Saving if All 9 Curves are Modified for Potential New Speed								**36 Seconds**
Northbound Running Time Saving if All 9 Curves are Modified for Potential New Speed								**47 Seconds**

A summary of the TPC running time estimates and an assessment of right-of-way impacts appear below.

3.8.1.1 Running Times Estimates for 9 Curves

Pure running time estimates were made using the TPC feature of the RTC operations simulation model. Running times estimated were made for trains operating on the DC2RVA corridor main track between CP Virginia in Washington, D.C. and the Greendale interlocking in Richmond, Virginia. The estimates incorporated the revised curve alignments and potential new speeds at the nine locations listed in Table 3.8-1 above.

Trains were simulated operating over the realigned curve segments as well as the existing alignment to provide a baseline comparison of changes in passenger train running times with the proposed alignment. Note that these running times are not ***actual*** schedule times that would be contained in a timetable, as they do not include station dwell time, recovery time, and schedule adjustments for train congestion or seasonal weather conditions, nor do they necessarily reflect contractual on-time performance agreements between the operator, owner, and host railroads at present or that might exist in the future.

This comparison uses the infrastructure alignments, train type, and direction of travel as the independent variables; the pure running time is the sole dependent variable. To control for the effects of the different independent variables, separate estimates were made for each combination of independent variable, as follows:

1. **Infrastructure Alignments**:
   a) Existing conditions (Base).

   b) Flattened curve alignments outside of the CSXT right of way.

2. **Curve Unbalance:** Runs were made with passenger trains operating at 4-inch unbalance.
3. **Train Type:** Runs were made with the following train types:
   a) Northeast Regional (Virginia) train consist (one P42 locomotive, 8 coaches, 684 feet, 518 tons).

The following assumptions and inputs were used in creating and running the models:

1. Curve speeds and curve locations were provided by the DC2RVA Engineering team.
2. Station stops were made at Alexandria, Woodbridge, Fredericksburg, Ashland, and Staples Mill Road.
3. Northbound and southbound runs were recorded.
4. A one-second dwell time was used for modeling all station stops.
5. No recovery time was added to any of the schedules.
6. Existing permanent speed restrictions, *i.e.*, civil speeds not strictly related to curvature (*e.g.*, Ashland and Doswell were retained in the cases).

Modeling results are detailed in Table 3.8-2.

TABLE 3.8-2: AUGUST 2015 NORTHERN VIRGINIA CURVE REANALYSIS TPC RESULTS (VIRGINIA-GREENDALE)

Alignment	Southbound Running Time	Alignment Notes	Northbound Running Time	Alignment Notes
Improved Speed 90	01:34:34	Improved Speed alignment with 90 mph MAS, 4-inch unbalance only	01:33:35	Improved Speed alignment with 90 mph MAS, 4-inch unbalance only
Improved Speed	01:34:09	Improved Speed alignment with 90 mph MAS, 4-inch unbalance only, and 9 curves set to 80/90 mph, 4-inch unbalance only	01:32:48	Improved Speed alignment with 90 mph MAS, 4-inch unbalance only, and 9 curves set to 80/90 mph, 4-inch unbalance only
Variance (hh:mm:ss)	**- 00:00:36**		**- 00:00:47**	**n/a**

Key finding: A Northeast Regional (Virginia) passenger train operating over the Improved Speed alignment with revised curve alignments at the nine locations identified in Table 3.8-1 experiences a reduction in running time of 36 seconds southbound and 47 seconds northbound compared to the Improved Speed alignment.

3.8.1.2 Right-of-Way Impacts

A description of the right-of-way impacts associated with straightening each of the nine curves appears below.

Curve 52N: At Curve 52N (see Figure 3.8-1), the Improved Speed option track speed for passenger trains is 75 mph. Curve straightening to increase speed above 75 mph would violate the host railroad's minimum tangent length criteria between curves, impact properties adjacent to the right-of-way, and would yield a minimum improvement in trip time. For these reasons, Curve 52N is not feasible to flatten to achieve an 80-mph operating speed.

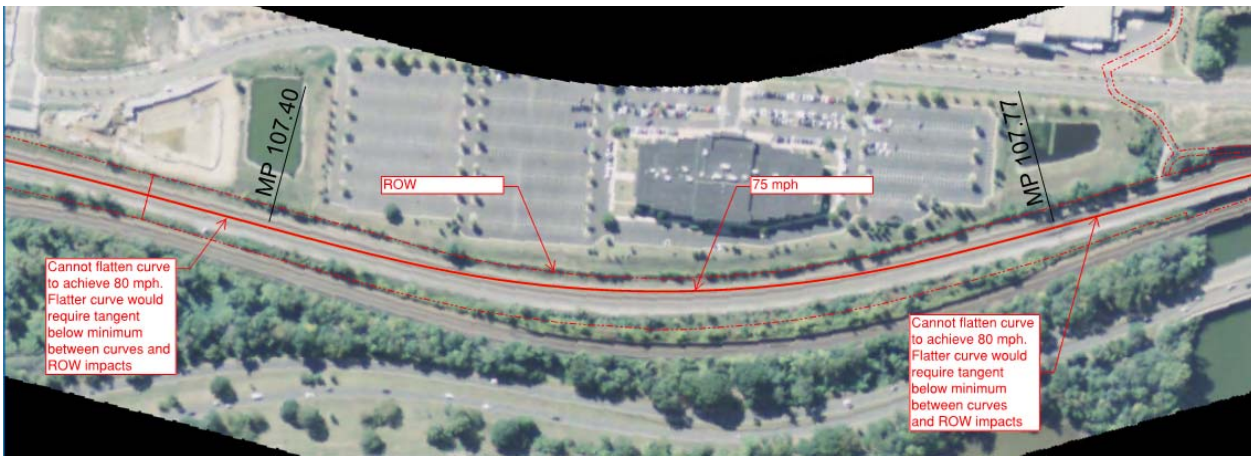

FIGURE 3.8-1: CURVE 52N

Curve 50N: Curve 50N (see Figure 3.8-2) has an Improved Speed option track speed for passenger trains of 75 mph, but was analyzed for a Maximum Speed option track speed of 90 mph. The curve straightening solution to increase speed above 75 mph would result in impacts to parallel roadways, trails, and businesses adjacent to the rail line, and would yield a minimum improvement in trip time. For these reasons, Curve 50N is not feasible to flatten to achieve 80- or 90-mph operating speeds.

FIGURE 3.8-2: CURVE 50N

Curve 47N: Curve 47N (see Figure 3.8-3) has an Improved Speed option track speed for passenger trains of 75 mph. Curve straightening to increase speed above 75 mph would violate the host railroad's minimum tangent length criteria between curves, impact properties adjacent to the right-of-way if property were to be acquired from Cameron Run Regional Park, and would yield a minimum improvement in trip time. For these reasons, Curve 47N is not feasible to flatten to achieve 80- or 90-mph operating speeds.

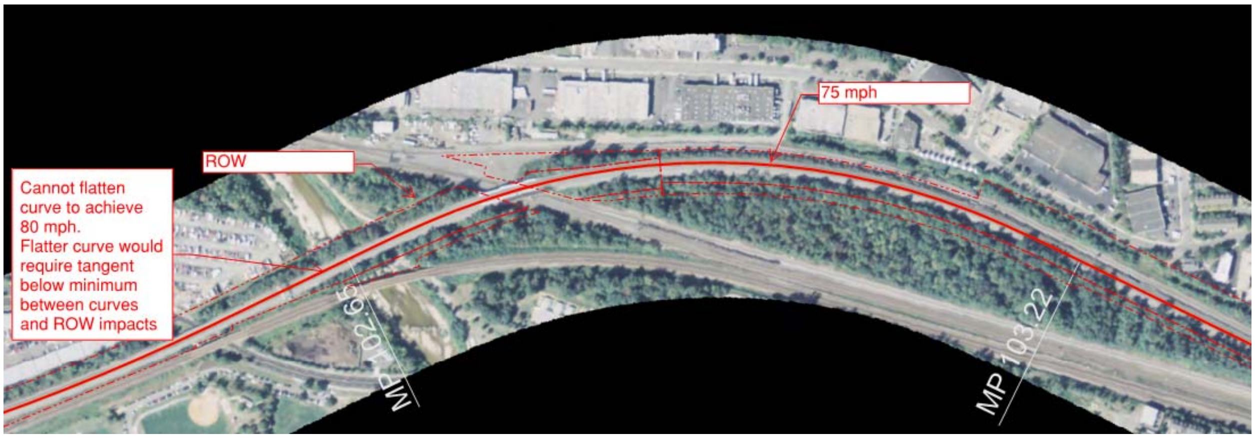

FIGURE 3.8-3: CURVE 47N

Curve 40N: Curve 40N (see Figure 3.8-4) has an Improved Speed option track speed for passenger trains of 75 mph, but was analyzed for a Maximum Speed option of 90 mph. The curve straightening solution to increase speed above 75 mph would result in significant impacts to businesses adjacent to the right-of-way, and would yield a minimum improvement in trip time. Additionally, new grade separations would be required for Backlick Road (a two-lane road) and the Fairfax County Parkway/Route 286 (a four-lane road). For these reasons, Curve 40N is not feasible to flatten to achieve 80- or 90-mph operating speeds.

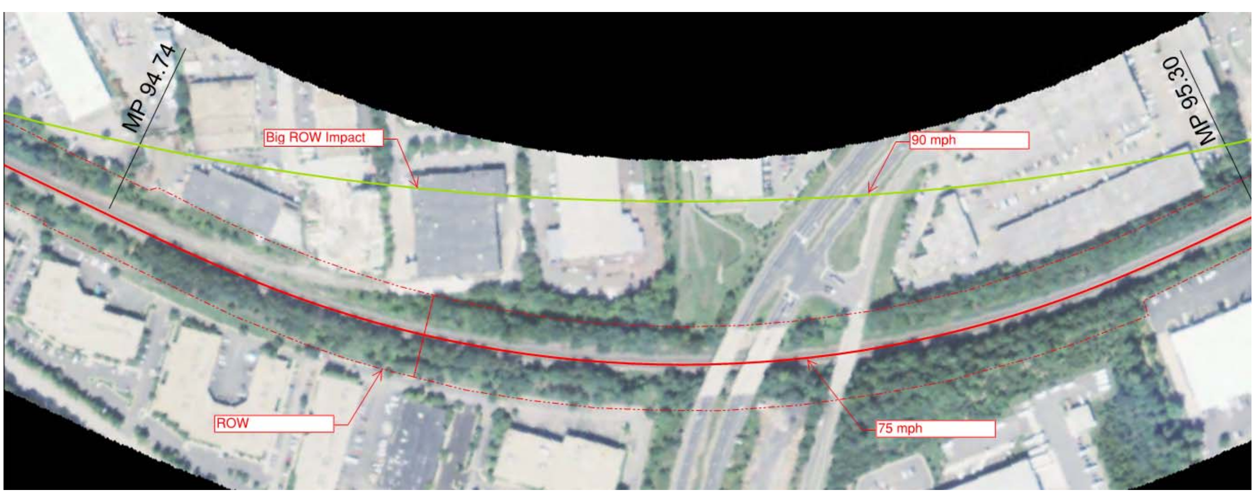

FIGURE 3.8-4: CURVE 40N

Curve 18N: Curve 18N (see Figure 3.8-5) has an Improved Speed option track speed for passenger trains of 80 mph, but was analyzed for a Maximum Speed option of 90 mph. The curve straightening solution to increase speed above 80 mph would result in right-of-way impacts, and would yield a minimum improvement in trip time; however, track speed cannot exceed 80 mph owing to the preceding and following track geometry adjacent to this curve. For these reasons, Curve 18N is not feasible to flatten to achieve a 90-mph operating speed.

Curve 17N: Curve 17N (see Figure 3.8-5) has an Improved Speed option track speed for passenger trains of 80 mph, but was analyzed for a Maximum Speed option speed of 90 mph. Despite no apparent right-of-way impact, track speed cannot exceed 80 mph owing to the preceding and following track geometry adjacent to this curve, and would yield a minimum improvement in trip time. For these reasons, Curve 17N is not feasible to flatten to achieve a 90-mph operating speed.

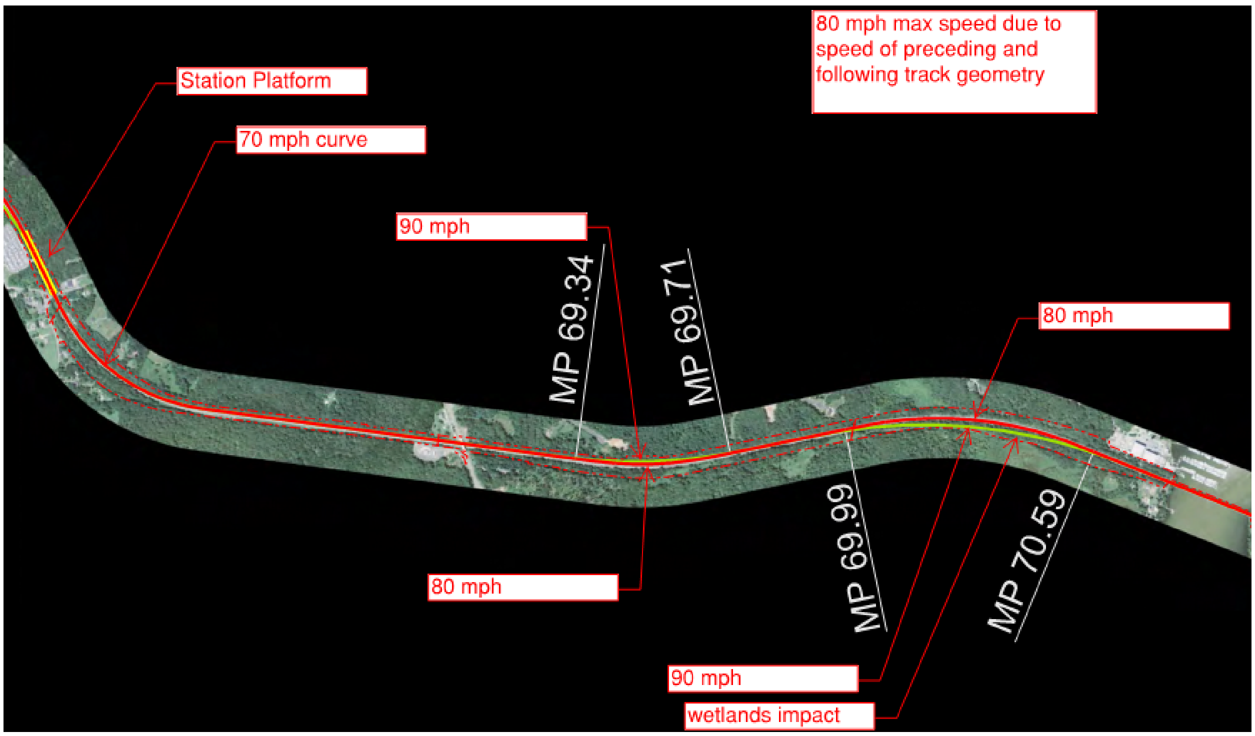

FIGURE 3.8-5: CURVES 18N AND 17N

Curve 15N: Curve 15N (see Figure 3.8-6) has an Improved Speed option track speed for passenger trains of 70 mph, but was analyzed for a higher operating speed of 80 mph. The curve straightening solution to increase speed above 70 mph would result in impacts for roadbed, as well as impacts to the VRE commuter rail station platform at Brooke, and would yield a minimum improvement in trip time. For these reasons, Curve 15N is not feasible to flatten to achieve 80- or 90-mph operating speeds.

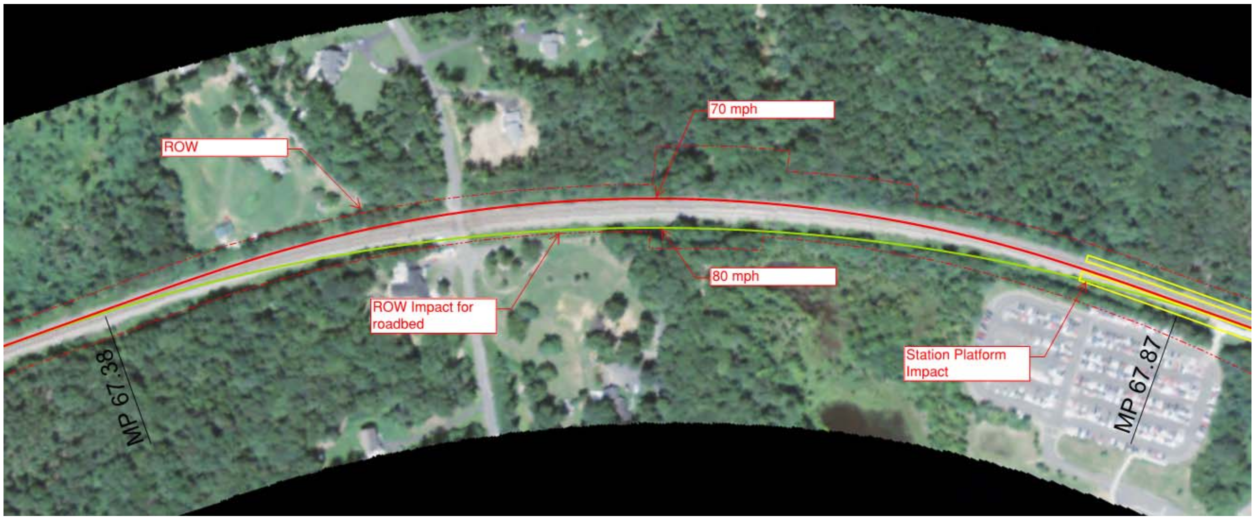

FIGURE 3.8-6: CURVE 15N

Curve 14N: Curve 14N (see Figure 3.8-7) has an Improved Speed option track speed for passenger trains of 75 mph, but was analyzed for a Maximum Speed option track speed of 90 mph. The curve straightening solution to increase speed above 75 mph would result in significant impacts to properties adjacent to the right-of-way, and would yield a minimum improvement in trip time. For these reasons, Curve 14N is not feasible to flatten to achieve a 90-mph operating speed.

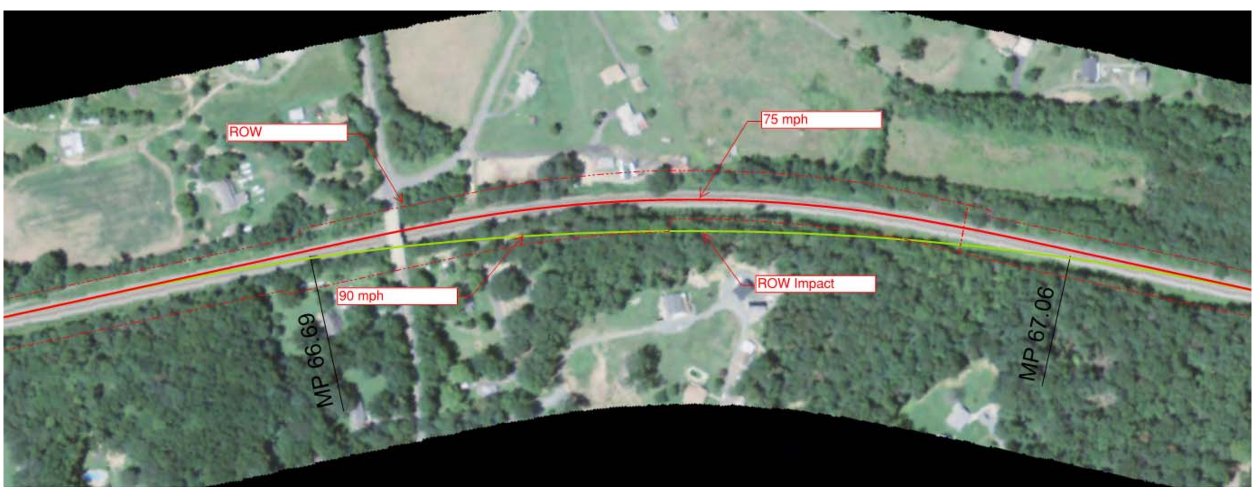

FIGURE 3.8-7: CURVE 14N

Curve 12N: Curve 12N (see Figure 3.8-8) has an Improved Speed option track speed for passenger trains of 75 mph, but was analyzed for a Maximum Speed option speed of 90 mph. The curve straightening solution to increase speed above 75 mph would result in significant impacts to properties adjacent to the right-of-way, and would yield a minimum improvement in trip time. For these reasons, Curve 12N is not feasible to flatten to achieve a 90-mph operating speed.

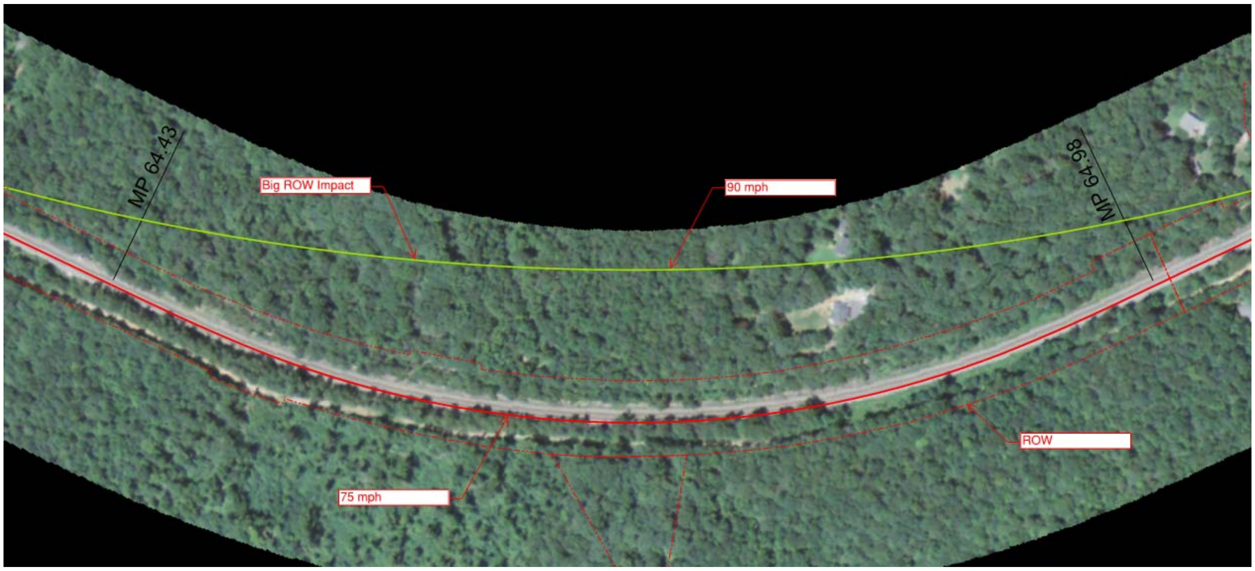

FIGURE 3.8-8: CURVE 12N

3.8.2 Running Time Estimates and Curve Analysis Following April 2016 Engineering/Operations Track Schematic Review

The DC2RVA engineering and operating teams performed a second analysis of potential curves that could be straightened to achieve higher operating speeds as part of a review of DC2RVA corridor track schematics and operating speeds for the Northern and Central Virginia segments of the corridor. This analysis was performed during April 2016. During the review, the teams identified seven curves that could be reassessed for improved operating performance and right-of-way impacts associated with improving curves at those locations.

The engineering and operations team examined each of the curves and determined that the potential running time savings from an increased operating speed through the curves would be minimal and not sufficient enough to justify the right-of-way impacts that would occur as a result of the curve realignments at those locations.

Table 3.8-3 details the location of these curves, and a summary of the right-of-way (ROW) impacts and potential time savings for passenger trains.

TABLE 3.8-3: APRIL 2016 DC2RVA ENGINEERING/OPERATIONS CURVE REANALYSIS

Location	Curve #	Deg.	Begin MP	End MP	Planned Improved Speed	Potential New Speed	ROW Impact	Comments
Widewater/ Arkendale	21N	1	75.87	75.45	85	90	Yes	ROW impact
Widewater/ Arkendale	19N	1	73.32	72.80	80	90	Yes	ROW impact onto parallel road

TABLE 3.8-3: APRIL 2016 DC2RVA ENGINEERING/OPERATIONS CURVE REANALYSIS

Location	Curve #	Deg.	Begin MP	End MP	Planned Improved Speed	Potential New Speed	ROW Impact	Comments
Brooke	16N	2	68.49	67.97	70	75	Yes	Cannot be redesigned for 75 mph; requires too short of a tangent between adjacent curves; will cause ROW impacts and will impact VRE station platform
Mt. Hope Church	15N	2	67.87	67.37	70	75	Yes	Cannot be redesigned for 75 mph; shortens tangent to VRE station; will cause ROW impacts
Hamilton	4N	2	56.78	56.46	70	75	Yes	ROW impact
Hamilton	3N	2	55.59	54.79	70	75	Yes	ROW impact
Penola	15C	1	33.82	32.90	70	75		
Note: Curve degree represents the rounded degree of curve for the Planned Improved Speed option								
Southbound Running Time Saving if All 7 Curves are Modified for Potential New Speed								**23 Seconds**
Northbound Running Time Saving if All 7 Curves are Modified for Potential New Speed								**24 Seconds**

A summary of the TPC running time estimates and an assessment of impacts appear below.

3.8.2.1 Running Times Estimates for Seven Curves

Pure running time estimates were made using the TPC feature of the RTC operations simulation model. Running times estimated were made for trains operating on the DC2RVA corridor main track between CP RO in Arlington, Virginia and the Greendale interlocking in Richmond, Virginia. The estimates incorporated the revised curve alignments and resulting higher operating speeds at the seven locations listed in Table 28 above.

Trains were simulated operating over the realigned curve segments as well as the existing alignment to provide a baseline comparison of changes in passenger train running times with the proposed alignment. Note that these running times are not ***actual*** schedule times that would be contained in a timetable, as they do not include station dwell time, recovery time, and schedule adjustments for train congestion or seasonal weather conditions, nor do they necessarily reflect contractual on-time performance agreements between the operator, owner, and host railroads at present or that might exist in the future.

This comparison uses the infrastructure alignments, train type, and direction of travel as the independent variables; the pure running time is the sole dependent variable. To control for the effects of the different independent variables, separate estimates were made for each combination of independent variable, as follows:

1. **Infrastructure Alignments**:
   a) Existing conditions (Base).
   b) Flattened curve alignments outside of the CSXT right of way.
2. **Curve Unbalance**: Runs were made with passenger trains operating at 4-inch unbalance.
3. **Train Type**: Runs were made with the following train types:
   a) Proposed Interstate Corridor (SEHSR) train consist (2 HSP46 locomotives, 10 coaches).

The following assumptions and inputs were used in creating and running the models:

1. Curve speeds and curve locations were provided by the DC2RVA Engineering team.
2. Existing station stop patterns were used (detail below).
3. Northbound and southbound runs were recorded.
4. A one-second dwell time was used for modeling all station stops.
5. No recovery time was added to any of the schedules.
6. Existing permanent speed restrictions, *i.e.*, civil speeds not strictly related to curvature (*e.g.*, Ashland, Doswell, and Fredericksburg) were retained in the cases.

Modeling results are detailed in Table 3.8-4.

TABLE 3.8-4: APRIL 2016 NORTHERN AND CENTRAL VIRGINIA CURVE REANALYSIS TPC RESULTS (VIRGINIA-GREENDALE)

Curve #	Improved Speed Alignment (mph)	Potential New Speed (mph)	Southbound Running Time Savings (seconds)	Northbound Running Times Savings (seconds)
21N	85	90	1	1
19N	80	90	7	7
16N	70	75	2	3
15N	70	75	2	3
4N	70	75	1	2
3N	70	75	3	3
15C	70	75	7	5
Total Time Savings (seconds)			**23**	**24**

Key finding: An Interstate Corridor (SEHSR) passenger train operating over the revised curve alignment experiences a reduction in running time of 23 seconds southbound and 24 seconds northbound compared to the Improved Speed alignment, but none of the proposed curve realignments were determined to be feasible to flatten to achieve the potential higher operating speed.

3.8.2.2 Right-of-Way Impacts

A description of the right-of-way and environmental impacts associated with straightening each of the seven curves is below.

Curve 21N: Curve 21N (see Figure 3.8-9) has an Improved Speed option track speed for passenger trains of 85 mph, but was analyzed for a Maximum Speed option track speed of 90 mph. The curve straightening solution to increase speed to 90 mph would require land acquisition outside of the right-of-way, resulting in impacts to property adjacent to the right-of-way, and would yield a minimum (1 second) improvement in trip time. For these reasons, Curve 21N is not feasible to flatten to achieve a 90-mph operating speed.

FIGURE 3.8-9: CURVE 21N

Curve 19N: Curve 19N (see Figure 3.8-10) has an Improved Speed option track speed for passenger trains of 80 mph, but was analyzed for a Maximum Speed option track speed of 90 mph. The curve straightening solution to increase speed to 90 mph would result in impacts to parallel roadways, and would yield a minimum (7 seconds) improvement in trip time. For these reasons, Curve 19N is not feasible to flatten to achieve a 90-mph operating speed.

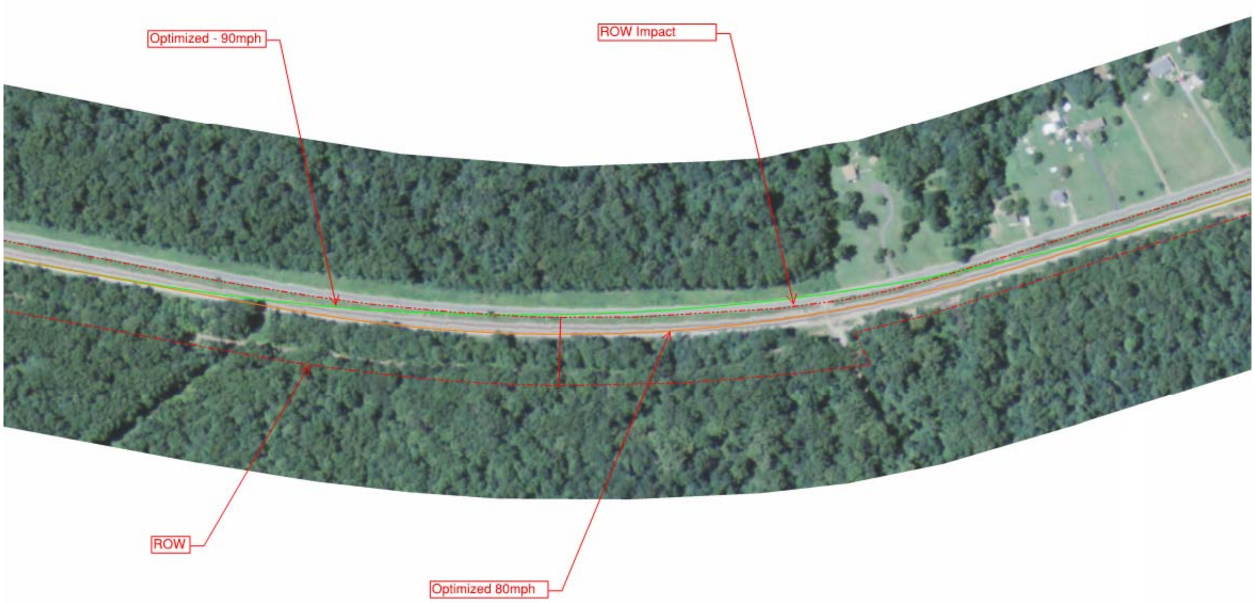

FIGURE 3.8-10: CURVE 19N

Curve 16N: Curve 16N (see Figure 3.8-11) has an Improved Speed option track speed for passenger trains of 70 mph, but was analyzed for a slight realignment at a 70 mph speed, as this curve cannot be designed for 75 mph. This curve straightening solution would create too short of a tangent between the south end of Curve 16N and the north end of Curve 15N, which would violate the host railroad's minimum tangent length criteria between curves, would impact land adjacent to the right-of-way, and would yield a minimum (2 to 3 seconds) improvement in trip time. Additionally, it would also interfere with the VRE commuter rail station platform at Brooke, which is about to be lengthened as part of a VRE platform improvement project. For these reasons, Curve 16N is not feasible to flatten to achieve higher operating speeds.

Curve 15N: Curve 15N (see Figure 3.8-11) has an Improved Speed option track speed for passenger trains of 70 mph, but was analyzed for a higher operating speed of 75 mph. This curve straightening solution to increase speed above 70 mph would create too short of a tangent between the north end of Curve 15N and the south end of Curve 16N, which would violate the CSXT's minimum tangent length criteria between curves, as well as impact adjacent properties, and yield a minimum (2 to 3 seconds) improvement in trip time. Additionally, it would also interfere with the VRE commuter rail station platform at Brooke, which is about to be lengthened as part of a VRE platform improvement project. For these reasons, Curve 15N is not feasible to flatten to achieve a 75-mph operating speed.

FIGURE 3.8-11: CURVES 16N AND 15N

Curve 4N: Curve 4N (see Figure 3.8-12) has an Improved Speed option track speed for passenger trains of 70 mph, but was analyzed for a higher operating speed of 75 mph. There is a potential right-of-way impact associated with this curve straightening solution, and curve straightening to increase speed above 70 mph would yield a minimum (1 to 2 seconds) improvement in trip time. For these reasons, Curve 4N is not feasible to flatten to achieve a 75-mph operating speed.

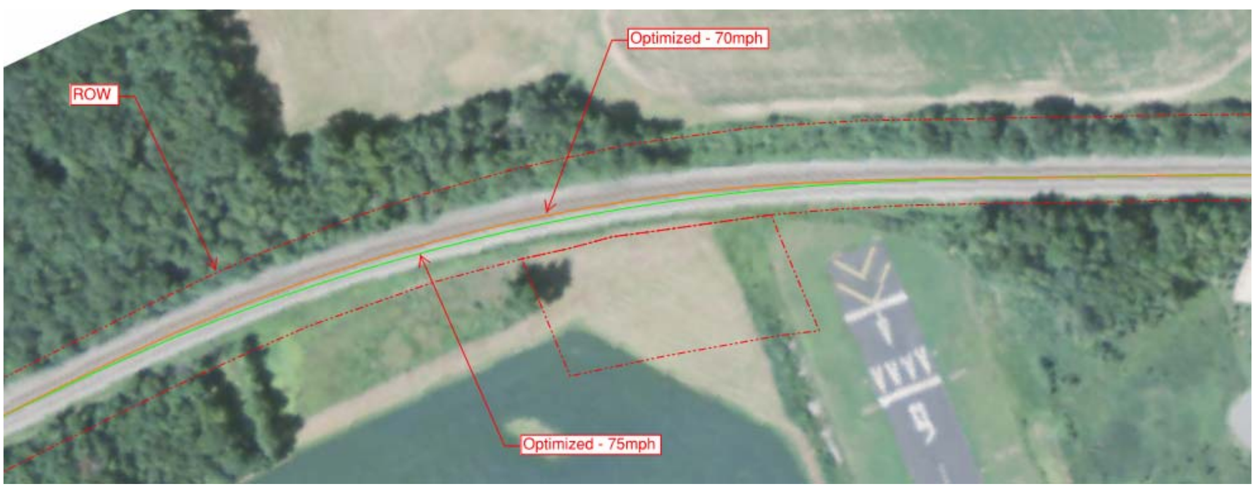

FIGURE 3.8-12: CURVE 4N

Curve 3N: Curve 3N (see Figure 3.8-13) has an Improved Speed option track speed for passenger trains of 70 mph, but was analyzed for a higher operating speed of 75 mph. This curve straightening solution to increase speed above 70 mph would result in right-of-way impacts to adjacent properties located within the Fredericksburg Battlefield of the National Park Service, and would yield a minimum (3 seconds) improvement in trip time. For these reasons, Curve 3N is not feasible to flatten to achieve a 75-mph operating speed.

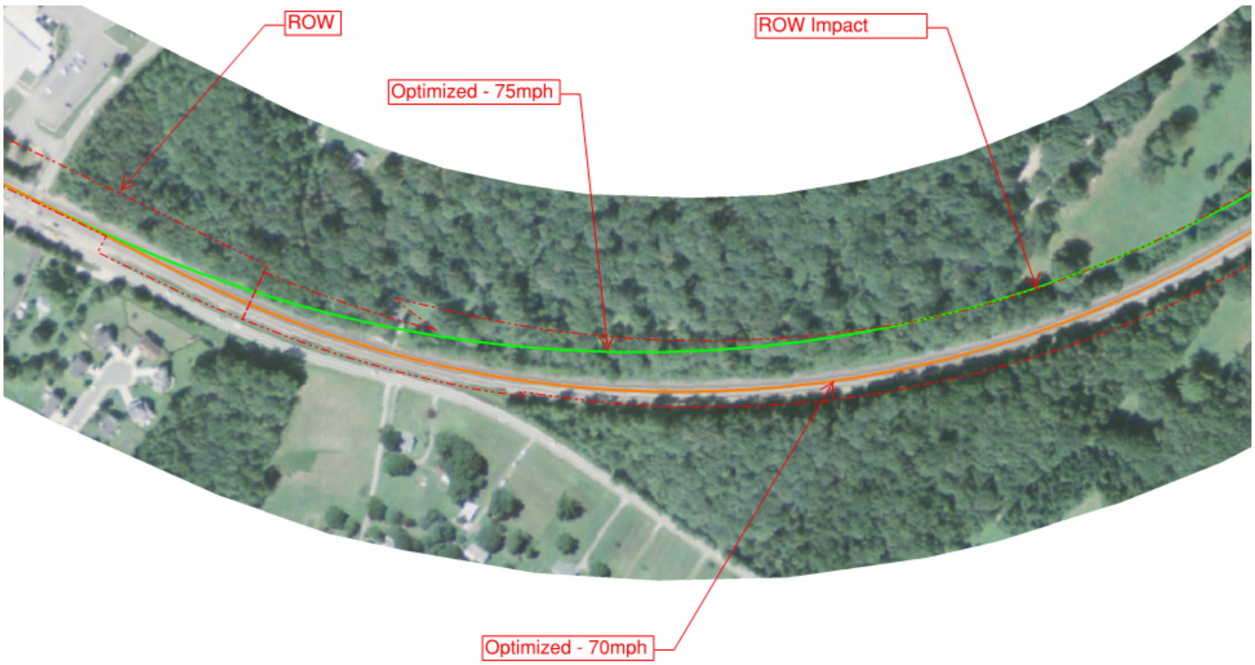

FIGURE 3.8-13: CURVE 3N

3.8.3 Estimated Time Savings from a Flyover at Doswell

At Doswell, the single-track Buckingham Branch Railroad crosses the two track CSXT mainline in an east-west direction at-grade in a double diamond configuration. Passenger trains using the CSXT tracks slow to approximately 60 mph or less to cross through the diamond. The BBRR maintains a rail yard in the northwest quadrant of the rail crossing, with rail served industrial properties north of the rail yard and in the southwest quadrant. The northeast quadrant is occupied by the Doswell Historic District. Immediately to the east of the CSXT mainline is the I-95 interstate corridor. The BBRR passes under I-95. (Additional detail on the CSXT RF&P Subdivision through Doswell and the BBRR is provided in Chapter 3 of Appendix A.) Early in the conceptual design process of the Project, DRPT considered various options to eliminate this at-grade double-track diamond crossing, specifically the potential for grade separating the rail crossing with a flyover. The BBRR is constrained by the I-95 overpass to the east and the need to maintain surface access to their yard and customers on the west of the CSXT mainline, and was therefore dismissed by DRPT from consideration for a flyover.

On July 30, 2015, the DC2RVA operations and engineering teams assessed the potential engineering requirements and operational benefits of replacing the 60-mph at-grade diamond crossing of the CSXT RF&P Subdivision and the Buckingham Branch Railroad (BBRR) with a 90-mph flyover that would carry passenger trains on the RF&P Subdivision over the Buckingham Branch. (See Figure 3.8-14 for the existing track configuration.) Estimates were calculated for existing Northeast Regional trains (one P42 locomotive, 8 coaches) traveling between Arlington and Greendale.

FIGURE 3.8-14: EXISTING CSXT-BBRR AT-GRADE CROSSING AT DOSWELL

The proposed flyover bridge would be able to accommodate 90-mph passenger train speeds, eliminating the need for passenger trains to slow to 60 mph to cross the existing diamond as well as the potential for passenger train delays caused by BBRR trains crossing the diamond. The running time calculations estimated that a passenger train flyover at Doswell would create a potential running time savings of 22 seconds. Figure 3.8-15 shows the track schematic used for this analysis.

Subsequent to the development of these findings, DRPT dismissed the concept of taking the CSXT main line, including a potential third track, up and over the BBRR. A two- or three-track structure carrying passenger and freight trains over the BBRR would necessarily extend for several miles to provide an adequate grade, and would either encroach onto the BBRR rail yard and/or the Doswell Historic District. DRPT also considered the potential for constructing a single-track flyover on the east side of the CSXT mainline to serve as a passenger train only track, allowing intercity passenger trains to pass through the rail crossing without slowing down. However, the time-savings of allowing passenger trains to proceed over the BBRR at 90 mph versus slowing to cross the diamond would be minimal (22 seconds). After considering the minimal reduction in travel time against the potential infrastructure costs and impacts, DRPT determined the concept of grade-separating the CSXT and BBRR rail crossing was not reasonable and would not be evaluated further.

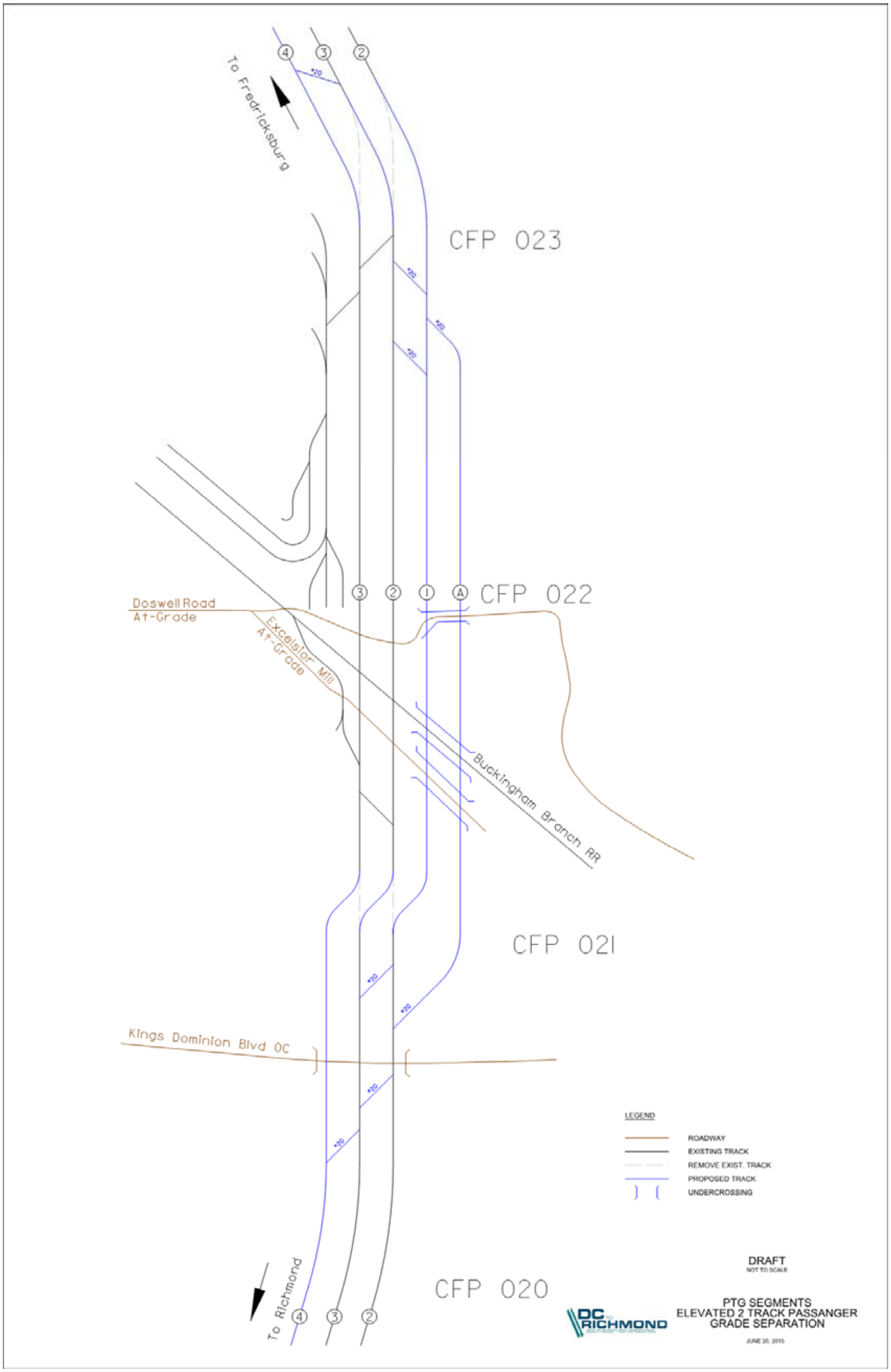

FIGURE 3.8-15: PROPOSED DOSWELL FLYOVER SCHEMATIC

3.9 TRAIN PERFORMANCE COMPARISON WITH ONE LOCOMOTIVE OR TWO LOCOMOTIVES IN SEHSR CONSISTS

On August 26, 2015, the DC2RVA operations modeling team performed pure running times estimates on the DC2RVA main track between CP Virginia in Washington, D.C. and the Amtrak Staples Mills Road station in Richmond, Virginia, incorporating two different consist makeups for Northeast Regional (SEHSR) trains:

1. One P-42 locomotive and eight cars
2. Two P-42 locomotives and eight cars

The purpose of this exercise is to assist in the decision-making process for the selection of a preferred train consist for future Northeast Regional (SEHSR) and Interstate Corridor (SEHSR) trains for the DC2RVA Project.

The estimates were made using the TPC feature of the RTC operations simulation model. Note that these running times are not ***actual*** schedule times that would be contained in a timetable, as they do not include station dwell time, recovery time, and schedule adjustments for train congestion or seasonal weather conditions, nor do they necessarily reflect contractual on-time performance agreements between the operator, owner, and host railroads at present or that might exist in the future.

This comparison used the infrastructure alignments, train type, and direction of travel as the independent variables; the pure running time is the sole dependent variable. To control for the effects of the different independent variables, separate estimates were made for each combination of independent variable, as follows:

1. **Infrastructure Alignment**:
   a) Existing Conditions (Base).
   b) Improved Speed alignment (“Opt”): Operate all segment speeds up to 90 mph to the extent they can be accomplished within the existing right-of-way, with the exception of mileposts 53.53 to 69.38 and 90.16 into Washington Union Station, where segment speeds were designed to achieve 80 mph.
2. **Curve Unbalance**: Runs were made with passenger trains operating at 4-inch unbalance. An accompanying spreadsheet has a tab feature allowing the viewer to review speeds for each run for 3-inch and 5-inch unbalance scenarios as well.
3. **Train Type**: Runs were made with the following train types:
   a) An 8-car train consist with one locomotive
   b) An 8-car train consist with two locomotives

The following assumptions and inputs were used in creating and running the models:

1. Curve speeds and curve locations were provided by the DC2RVA Engineering team.
2. In the constrained alignment scenario, if a train consist could only accelerate on a tangent section to or just above 80 mph, before commencing braking for a subsequent curve or permanent speed restriction, a maximum design speed of 80 mph was designated for that section of tangent track to keep it within the FRA Class 4 standard.

3. Northbound and southbound runs were recorded.
4. Station stop patterns reflect proposed Virginia High Speed services.
5. A one-second dwell time was used for modeling all station stops.
6. No recovery time was added to any of the schedules.
7. Existing permanent speed restrictions, *i.e.*, civil speeds not strictly related to curvature (*e.g.*, Ashland and Doswell) were retained in the cases.

Key findings (4-inch unbalance, optimized track alignment):

The addition of a second locomotive reduced the running time of a Northeast Regional (SEHSR) passenger train operating between CP Virginia and Staples Mill by the following amount:

- Southbound: 3 minutes, 25 seconds
- Northbound: 2 minutes, 58 seconds

3.10 PRIOR ESTIMATES OF PASSENGER-TRAIN RUNNING TIME ON DC2RVA MAIN TRACK ALIGNMENT ALTERNATIVES AND CURVE UNBALANCE

On August 7, 2015, the DC2RVA operations modeling team summarized the results of passenger-train pure running time estimates on the DC2RVA main track between Washington (D.C.) Union Station and the existing station at Staples Mills Road in Richmond, Virginia, under various main track alignment and unbalance alternatives. The results are presented in Table 3.10-1 below.

These estimates were made using the TPC feature of RTC operations simulation model. The purpose of these estimates was to assist in the decision-making process for infrastructure alignment selection. Passenger trains were simulated operating over two proposed alignments as well as the existing alignment to provide a base-line comparison of reductions in passenger-train-running time, if any. Note that these running times are not ***actual*** schedule times that would be contained in a timetable, as they do not include station dwell time, recovery time, and schedule adjustments for train congestion or seasonal weather conditions, nor do they necessarily reflect contractual on-time performance agreements between the operator, owner, and host railroads at present or that might exist in the future.

Estimates were calculated for the three initial alignment options developed to represent the range of potential Additional Alternative alignments along the DC2RVA corridor. (Details about these alignment options can be found in Chapters 5 and 6 of the Alternatives Technical Report.)

This comparison used the infrastructure alignments, train type, and direction of travel as the independent variables; the pure running time is the sole dependent variable. To control for the effects of the different independent variables, separate estimates were made for each combination of independent variable, as follows:

1. **Infrastructure Alignment**:
   a) Existing Speed Alignment: Adds one new track to either side of the existing track while maintaining existing speed.

b) Improved Speed Alignment (Constrained): Maximizes passenger train speed up to 90 mph, while keeping all tracks (new and reconfigured) within the limits of the existing right-of-way.
c) Maximum Speed Alignment: Adds one new track and realigns existing track the maximum allowable speed of 90 mph unconstrained by existing right-of-way.
d) Improved Speed Alignment (Hold Bridges/Tangents): Optimizes use of existing rail infrastructure while also seeking to achieve the maximum possible passenger train speed of 90 mph. This alignment maintains existing tangent (*e.g.*, straight) tracks and continues to use the existing rail bridges and alignments over roads and waterways.

2. **Curve Unbalance**: Runs were made with passenger trains operating at 3-inch, 4-inch, and 5-inch unbalance. Maximum Curve speeds were adjusted for each unbalance.

3. **Train Type**: Runs were made with the following train types:

a) Long Distance. Existing Amtrak Long-Distance train consist of 2 P-42 locomotives and 11 coaches. Station stops were made at Washington Union Station, Alexandria, and Richmond Staples Mill Road Station.
b) Interstate Corridor (SEHSR). Existing Northeast Regional (Virginia) consist and the initial proposed Southeast High Speed Rail train consist of 1 P-42 locomotive and 8 coaches. Station stops were made at Washington Union Station, Alexandria, Fredericksburg, and Richmond Staples Mill Road Station.
c) Northeast Regional (SEHSR). Existing Northeast Regional (Virginia) consist and the initial proposed Southeast High Speed Rail train consist of 1 P-42 locomotive and 8 coaches. Station stops were made at Washington Union Station, Alexandria, Woodbridge, Fredericksburg, Ashland, and Richmond Staples Mill Road Station.
d) Northeast Regional (Virginia). Existing Northeast Regional (Virginia) consist of 1 P-42 locomotive and 8 coaches. Station stops were made at Washington Union Station, Alexandria, Woodbridge, Quantico, Fredericksburg, Ashland, and Richmond Staples Mill Road Station.

The following assumptions and inputs were used in creating and running the models:

1. Curve speeds and curve locations were provided by the DC2RVA Engineering team. (These curves assessed at their original proposed alignment speeds, without considerations for additional flattening as described in Section 3.8.)

2. In the constrained alignment scenario, if a train consist could only accelerate on a tangent section to or just above 80 mph, before commencing braking for a subsequent curve or permanent speed restriction, a maximum design speed of 80 mph was designated for that section of tangent track to keep it within the FRA Class 4 standard.

3. For each type of service, existing station stop patterns were used (detail on the spreadsheet).

4. Northbound and southbound runs were recorded.

5. Station stop patterns reflect existing Long Distance, Interstate Corridor (Carolinian), and Northeast Regional (Virginia) services and proposed Interstate Corridor (SEHSR) and Northeast Regional (SEHSR) services.
6. A one-second dwell time was used for modeling all station stops.
7. No recovery time was added to any of the schedules.
8. Existing permanent speed restrictions not strictly related to curvature (*e.g.,* Ashland, Doswell, and Fredericksburg) were retained in the cases.
9. No proposed bypasses (*e.g.*, Fredericksburg, Doswell, and Ashland) were included in the cases.

TABLE 3.10-1: ESTIMATES OF PASSENGER-TRAIN PURE RUNNING TIME ON DC2RVA MAIN TRACK ALIGNMENT ALTERNATIVES AND CURVE UNBALANCE (HH:MM:SS)

Unbalance	Southbound 3" Unbalance				Northbound 3" Unbalance			
Alignment	Existing Speed	Imp. Speed	Max. Speed	Imp. Speed (Hold B/T)	Existing Speed	Imp. Speed	Max. Speed	Imp. Speed (Hold B/T)
Long Distance	1:51:34	1:33:59	1:27:45	1:34:54	1:52:58	1:35:22	1:28:15	1:35:09
IC (SEHSR)	1:56:39	1:38:42	1:30:26	1:37:08	1:55:20	1:38:01	1:30:52	1:37:30
REG (SEHSR)	1:55:34	1:38:33	1:33:04	1:39:41	1:57:03	1:39:55	1:32:46	1:39:20
REG (VA)	1:56:40	1:39:48	1:34:12	1:40:49	1:57:56	1:41:51	1:34:52	1:41:16
Unbalance	**Southbound 4" Unbalance**				**Northbound 4" Unbalance**			
Alignment	**Existing Speed**	**Imp. Speed**	**Max. Speed**	**Imp. Speed (Hold B/T)**	**Existing Speed**	**Imp. Speed**	**Max. Speed**	**Imp. Speed (Hold B/T)**
Long Distance	1:51:31	1:29:06	1:22:58	1:29:24	1:52:58	1:30:31	1:23:20	1:29:48
IC (SEHSR)	1:56:35	1:33:58	1:26:02	1:31:51	1:55:17	1:33:26	1:26:08	1:32:16
REG (SEHSR)	1:55:29	1:34:03	1:28:58	1:34:39	1:56:59	1:35:20	1:28:04	1:34:07
REG (VA)	1:56:36	1:35:24	1:30:05	1:35:44	1:57:53	1:37:28	1:30:31	1:36:15
Unbalance	**Southbound 5" Unbalance**				**Northbound 5" Unbalance**			
Alignment	**Existing Speed**	**Imp. Speed.**	**Max. Speed**	**Imp. Speed (Hold B/T)**	**Existing Speed**	**Imp. Speed**	**Max. Speed**	**Imp. Speed (Hold B/T)**
Long Distance	1:51:31	1:26:49	1:22:53	1:27:44	1:52:58	1:28:21	1:23:14	1:28:13
IC (SEHSR)	1:56:35	1:31:53	1:25:55	1:30:24	1:55:17	1:31:16	1:26:08	1:30:43
REG (SEHSR)	1:55:29	1:31:59	1:28:51	1:33:11	1:56:59	1:33:10	1:28:04	1:32:29
REG (VA)	1:56:36	1:33:18	1:29:58	1:34:16	1:57:53	1:35:19	1:30:31	1:34:37

As can be seen, pure running time improved from 3-inch to 4-inch unbalance, and further improvements in pure running time were achieved from 4-inch to 5-inch unbalance. For example, on the Improved Speed alignment, the pure running time of Regional (Virginia) trains improved by approximately 5 minutes, 5 seconds when unbalance was increased from 3 inches to 4 inches, and by approximately 1 minute, 28 seconds more when unbalance was increased from 4 inches to 5 inches. Chapter 6 of the Alternatives Technical Report (Appendix A of the Draft EIS) provides detailed descriptions of the screening results for the alignment options tested above, and the selection of alignment options within each segment of the DC2RVA corridor that were carried forward.

4 OPERATIONS ANALYSIS ESTIMATES

4.1 INTRODUCTION AND BACKGROUND

DRPT has conducted preliminary operations simulation modeling to estimate rail performance in the corridor and inform DRPT's evaluation of alternatives. Operations simulation modeling is an iterative process that is ongoing, and additional operations simulation analyses will be conducted through the Final EIS and SDP phases of the Project.

DRPT's preliminary operations simulation modeling focused on the development of freight and passenger train operational metrics to enable stakeholders to evaluate whether suggested infrastructure is sufficient to meet the DC2RVA Project's Purpose and Need, and specifically to meet intercity passenger train and freight train service performance goals established by the *Passenger Rail Investment and Improvement Act of 2008* (PRIIA), also known as Public Law 110-432, and published as the *Metrics and Standards for Intercity Passenger Rail Service Under Section 207 of the Passenger Rail Investment and Improvement Act of 2008*, in the Federal Register on May 12, 2010. PRIIA's performance goals for intercity passenger trains are for all passenger trains to be on-time at each station and at corridor endpoints at least 90% of the time. On-time, as defined by PRIIA, means arriving at a station at the scheduled time or within a set "late tolerance" period following the scheduled time. The length of the late tolerance period varies by the type of intercity passenger service and the total distance between the train's scheduled endpoints. PRIIA's performance goal for freight service is for intercity passenger rail service to not materially delay the movement of freight. The performance of freight trains is compared for different alternatives by estimating future freight train delay and comparing against existing freight train performance. Freight train delay is measured as minutes of delay per train, per 100 train-miles. This metric compares the simulated time a freight train took to cover its route inclusive of interactions with other trains, passenger and freight, compared to the time the freight train would have taken to cover its route had it encountered no delays en route.

The operations simulation analyses evaluate a schedule of planned train movements (encompassing all intercity passenger, commuter, and freight trains moving through the corridor) in combination with a set of existing or proposed infrastructure. The results of the analyses estimate whether the combined schedule of operations and infrastructure performs sufficiently to meet the PRIIA goals. The operations simulation analyses include the proposed intercity passenger trains described in Section 2.2.9.1, as well as CSXT freight trains and VRE commuter trains. DRPT assumed the new DC2RVA service (18 additional intercity passenger trains per day) would be in place in 2025, and that no additional changes in intercity passenger trains would occur between 2025 and the horizon year of 2045. VRE commuter train frequencies were assumed to increase from 34 weekday trains in 2015 to a projected 38 weekday trains for the years 2025 through 2045. To forecast freight train growth from existing (2015) levels, CSXT provided freight volumes for the future years 2025 and 2045 using the U.S. DOT Freight Analysis

Framework projected growth rates for rail. CSXT freight growth is independent of the DC2RVA Project and will occur by itself regardless of whether or not the DC2RVA Project is implemented. CSXT actual freight growth will be driven by market forces and may be greater or less than the projected growth rates.

Intercity passenger train and freight train performance estimates from the different Build Alternatives simulated in 2025 are compared against performance estimates for a 2025 No Build Alternative consisting of the No Build infrastructure and service levels described in Sections 2.2.5.

DRPT has completed three preliminary phases of operations simulation modeling that assess the performance of trains operating in the DC2RVA corridor between Washington, D.C. and Centralia, VA. These three phases have assumed ideal operating conditions: that all tracks are fully operational, with no outages for maintenance, repairs, or other restrictions on operations. These preliminary operations simulations also apply an intercity passenger train schedule developed by DRPT to reduce travel time through the corridor to the maximum extent practical by assuming intercity passenger trains will operate at the maximum practical speed allowed by track design and geometry between station stops. The operations simulations incorporate VRE's operating schedule, and projected movements of CSXT freight trains. The three preliminary phases of operations simulation modeling completed to date are:

1. Preliminary Ashland and Fredericksburg Simulations Modeling - performed to estimate whether two main tracks through Ashland and/or Fredericksburg would be sufficient in the Build Alternative. *See Section 4.2.*
2. Additional Ashland Simulation Modeling - performed to estimate the operational impacts of 11 potential infrastructure and service options in the Ashland/Hanover area that, if proven operationally feasible, would not require the addition of a third main track through the Town of Ashland, VA. *See Section 4.3.*
3. Richmond Area Simulation Modeling - performed to compare passenger train and freight train operating performance among the Richmond-area alternatives carried forward into the Draft EIS. *See Section 4.4.*

4.2 PRELIMINARY ASHLAND AND FREDERICKSBURG SIMULATION MODELING

This first phase of the preliminary operations modeling was performed to estimate whether two main tracks through Ashland and/or Fredericksburg would be sufficient to consider in a Build Alternative. In 2002, the SEHSR Tier I EIS concluded that adding a third track between Alexandria and Richmond was necessary to accommodate the freight and passenger growth needs of all users and institute high speed passenger service.

Based on previous studies, such as the 2002 SEHSR Tier 1 document, DRPT assumed three main tracks in the corridor from Arlington to Richmond, and then evaluated the effects on train performance of having only two main tracks through Fredericksburg and/or Ashland. The operations simulation for year 2025 estimated that having only two main tracks in Fredericksburg and/or Ashland could potentially meet the PRIIA on-time performance goal for the corridor. However, operations simulation for year 2045 estimated that having only two main tracks in Fredericksburg and/or Ashland failed to dispatch (*i.e.*, the operations simulation concluded that the infrastructure had insufficient capacity for the number of trains projected to operate in the corridor in the year 2045). DRPT's preliminary conclusion, based on the schedule, infrastructure, and operating parameters evaluated in this initial phase of operations simulation, was that three main tracks through Fredericksburg, or a two-track bypass around Fredericksburg in lieu of a third main track through the city and town, would be required by year 2045 to accommodate the projected future levels of passenger, freight, and commuter service. DRPT also concluded that additional operations simulation modeling should be undertaken in the Ashland Area to test a broader range of infrastructure and service options that might not require the addition of a third main track through the Town of Ashland.

4.3 ADDITIONAL ASHLAND SIMULATION MODELING

DRPT's second phase of preliminary operations simulation modeling was performed to estimate the operational impacts of additional potential infrastructure and service options in the Ashland/Hanover area that, if proven operationally feasible, would not require the addition of a third main track through the Town of Ashland. DRPT evaluated the effects of a tunnel beneath the Town in lieu of a third track at grade, effects of operating trains at a maximum speed of 70 mph instead of 90 mph, and modifying or eliminating station service, including relocation of the station to south of Ashcake Road. DRPT also evaluated the effects of routing some northbound freight trains onto the Buckingham Branch Railroad between Richmond and Doswell. (Not all northbound freight trains are feasible to be rerouted onto the Buckingham Branch owing to operational requirements and clearance restrictions.) Figure 4.3-1 illustrates how the Buckingham Branch rail line between Richmond and Doswell was used in a directional running operating plan devised for this phase of simulation modeling.

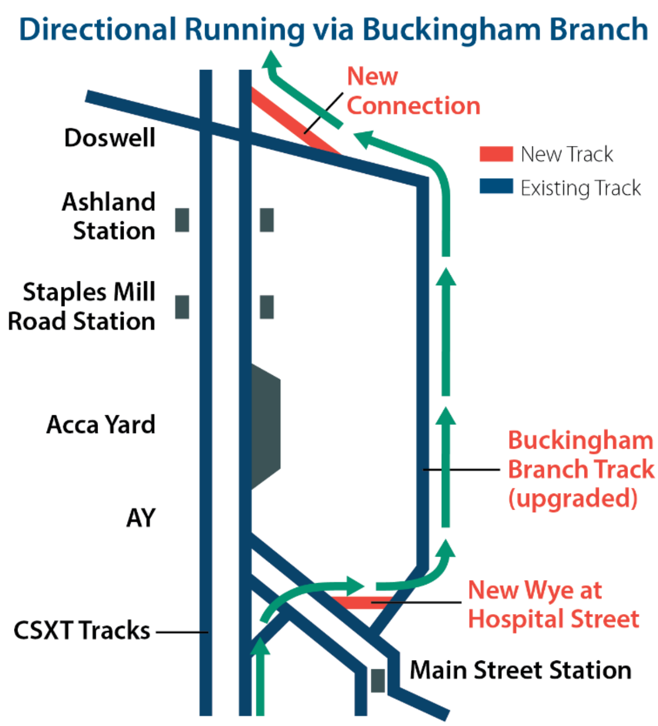

FIGURE 4.3-1: DIRECTIONAL RUNNING OPERATING SCHEME INCORPORATING USE OF THE BUCKINGHAM BRANCH

The train performance estimates derived from this second phase of DRPT's preliminary operations simulation suggested that in order to accommodate the additional 18 intercity passenger trains per day , accommodate CSXT's projected freight growth, and meet PRIIA's passenger and freight train on-time performance goals through 2045, either a third main track through Ashland or a two-track bypass around Ashland would provide the highest likelihood that trains would meet their performance goals under the service level and schedule projected. DRPT's preliminary conclusion, based on the schedule, infrastructure, and operating parameters evaluated in this second phase of operations simulation was that, while a third main track through Ashland or a two-track bypass around Ashland would accommodate the Project's service and performance goals through 2045, other alternatives should be considered, perhaps in concert with service and schedule modifications, that could also achieve the Project's service and performance goals.

4.4 RICHMOND AREA SIMULATION MODELING

Preliminary operations simulation modeling was also performed by DRPT to compare passenger train and freight train operating performance among the Richmond-area alternatives carried forward into the Draft EIS. Like the earlier preliminary operations simulation modeling, DRPT applied a preliminary intercity passenger train schedule based on maximum practical reductions to travel time, assumed an additional 18 intercity passenger trains plus CSXT's projected growth for 2025 and 2045, and assumed ideal operating conditions. The seven Richmond-area Alternatives modeled are listed below:

- 6A. Staples Mill Road Station (all trains via A-Line and West Acca bypass)
- 6B. Broad Street Station (all trains via A-Line and East Acca bypass)
- 6C. Boulevard Station (all trains via A-Line and East Acca bypass). Note: An eighth alternative, Boulevard Station S-Line option (all trains via S-Line and East Acca bypass), was not modeled, but is assumed by DRPT to have similar operating parameters as Alternative 6D Main Street Station.
- 6D. Main Street Station (all trains via S-Line and East Acca bypass)
- 6E. Main Street / Staples Mill – Split Service (only Newport News trains make both stops; all other via trains via A-Line with a Staples Mill only stop; West Acca bypass)
- 6F. Main Street / Staples Mill – Full Service (all trains make both stops, operate via S-Line and East Acca bypass)
- 6G. Main Street / Staples Mill – Shared Service (all Regional and Interstate Corridor trains make both stops, operate via S-Line and East Acca bypass; long distance trains operate via A-Line and stop at Staples Mill Only)

DRPT's third phase of preliminary operations simulation modeling estimated that alternatives relying on the A-Line to carry both passenger and freight trains through 2045 (Alternatives 6A, 6B, 6C, 6E and 6G) failed to meet the PRIIA performance goals. Factors that contributed to the inability of the A-Line options to accommodate the projected passenger and freight train service levels at the performance thresholds required under PRIIA include the lack of a third main track from Acca Yard south within the existing median of I-195 and across the James River and the operating complexities associated with freight trains entering and exiting the Acca Yard terminal area. The third phase also estimated that the two Richmond-area alternatives (6C

Boulevard Station S-Line and 6F Main Street/Staples Mill Road – Full Service) that keep most freight trains and the Amtrak Auto Train on the A-Line while using the S-Line through Richmond for the regular intercity passenger trains could potentially meet the PRIIA performance goals through 2045.