DC TO RICHMOND
SOUTHEAST HIGH SPEED RAIL

P NOISE AND VIBRATION TECHNICAL REPORT

D.C. TO RICHMOND SOUTHEAST HIGH SPEED RAIL

September 2017

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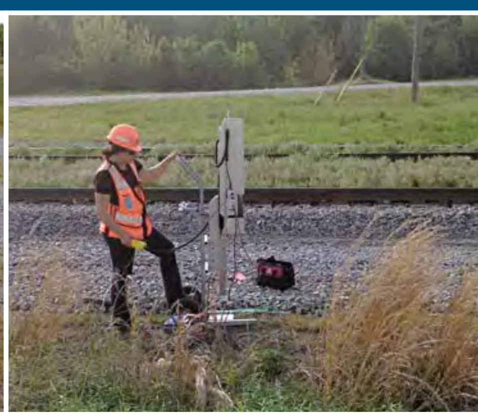
Noise and Vibration Technical Report



DRPT
Virginia Department of Rail and Public Transportation

U.S. Department of Transportation
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1 INTRODUCTION

The Federal Railroad Administration (FRA) and Virginia Department of Rail and Public Transportation (DRPT) propose passenger rail service and rail infrastructure improvements in the north-south travel corridor between Washington, D.C. and Richmond, VA. These passenger rail service and rail infrastructure improvements are collectively known as the Washington, D.C. to Richmond Southeast High Speed Rail (DC2RVA) project. The Project will increase capacity to deliver additional intercity passenger rail, improve conventional speed passenger service, expand commuter rail, and accommodate growth of freight rail service, in an efficient and reliable multimodal rail corridor. The increased capacity will improve passenger rail service frequency, reliability and travel time in a corridor shared by growing volumes of passenger, commuter, and freight rail traffic, thereby providing a door-to-door time-competitive option for travelers between Washington, D.C. and Richmond and those traveling to and from adjacent connecting corridors. The Project is part of the larger Southeast High Speed Rail (SEHSR) corridor, which extends from Washington, D.C. through Richmond, and continues east to Hampton Roads (Norfolk), VA, and south to Raleigh, NC, and Charlotte, NC, and then continues west to Atlanta, GA and south to Florida. The Project connects to the National Railroad Passenger Corporation (Amtrak) Northeast Corridor (NEC) at Union Station in Washington, D.C.

The purpose of the SEHSR program, as stated in the 2002 Tier I Final Environmental Impact Statement (EIS) completed for the full SEHSR corridor, is to provide a competitive transportation choice to travelers within the Washington, D.C. to Charlotte travel corridor. 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 by identifying the infrastructure improvements necessary to provide a competitive transportation choice for current and future conditions. The Purpose of the DC2RVA project is to increase the capacity between Washington, D.C. and Richmond to deliver higher speed passenger rail, improve conventional speed passenger rail, expand commuter rail, and accommodate growth of freight rail service in an efficient and reliable multimodal rail corridor. This Project will enable passenger rail to be a competitive transportation choice for intercity travelers between Washington, D.C. and Richmond and beyond.

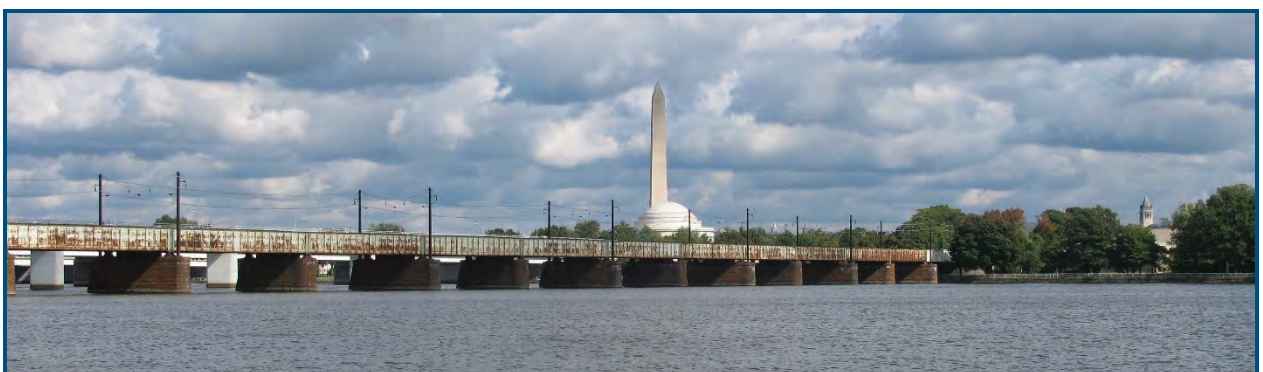
The purpose of this Noise and Vibration Technical Report is to identify the existing noise and vibration environment along the DC2RVA corridor and analyze potential effects that could result from implementation of the build alternatives. Information in this Technical Report supports discussions presented in the Draft EIS.

2 PROJECT OVERVIEW

The Washington, D.C. to Richmond corridor spans 123 miles along an existing rail corridor owned by CSXT between Control Point Rosslyn (RO) at milepost (MP) CFP 110 in Arlington County, VA to the junction of the CSXT North End Subdivision (referred to as the A-Line) between West Acca Yard in Richmond and Centralia, VA, and the CSXT Bellwood Subdivision (referred to as the S-Line) between Control Point Hermitage in Richmond and Centralia, VA (CE) at MP A-11 in Chesterfield County, VA (Figure 2-1). At the northern terminus in Arlington County, the Project limit is marked by the southern approach to Long Bridge, a double-track rail bridge connecting the rail corridor over the Potomac River to Washington, D.C. The Project corridor follows the CSXT Richmond, Fredericksburg & Potomac (RF&P) Subdivision from the Potomac River to Richmond. The southern terminus in Centralia is the junction of two CSXT routes (the A-Line and the S-Line) that begin in Richmond and rejoin approximately 11 miles south of the city.

Additional sections evaluated as part of the Project included approximately 8.3 miles of the CSXT Peninsula Subdivision CA-Line from Beulah Road (MP CA-76.1) in Henrico County, VA east of Richmond to AM Junction in downtown Richmond, and the approximately 26-mile Buckingham Branch Railroad (BBR) from AM Junction to the RF&P Crossing (MP CA-111.8) north of Richmond in Doswell, VA.

In Arlington, the Project connects to existing CSXT track extending across the Potomac River on the Long Bridge into Washington, D.C. and Union Station, the southern terminus of Amtrak's NEC. In downtown Richmond and at Centralia, the Project connects to both the Richmond to Raleigh segment of the SEHSR corridor and the Richmond to Hampton Roads segment of the SEHSR corridor. The Washington, D.C. to Richmond segment is an integral part of the overall Washington, D.C. to Charlotte SEHSR corridor and provides a critical link between high speed passenger service from Boston to Washington, D.C. and the southeastern United States (U.S.).



Long Bridge Over the Potomac River

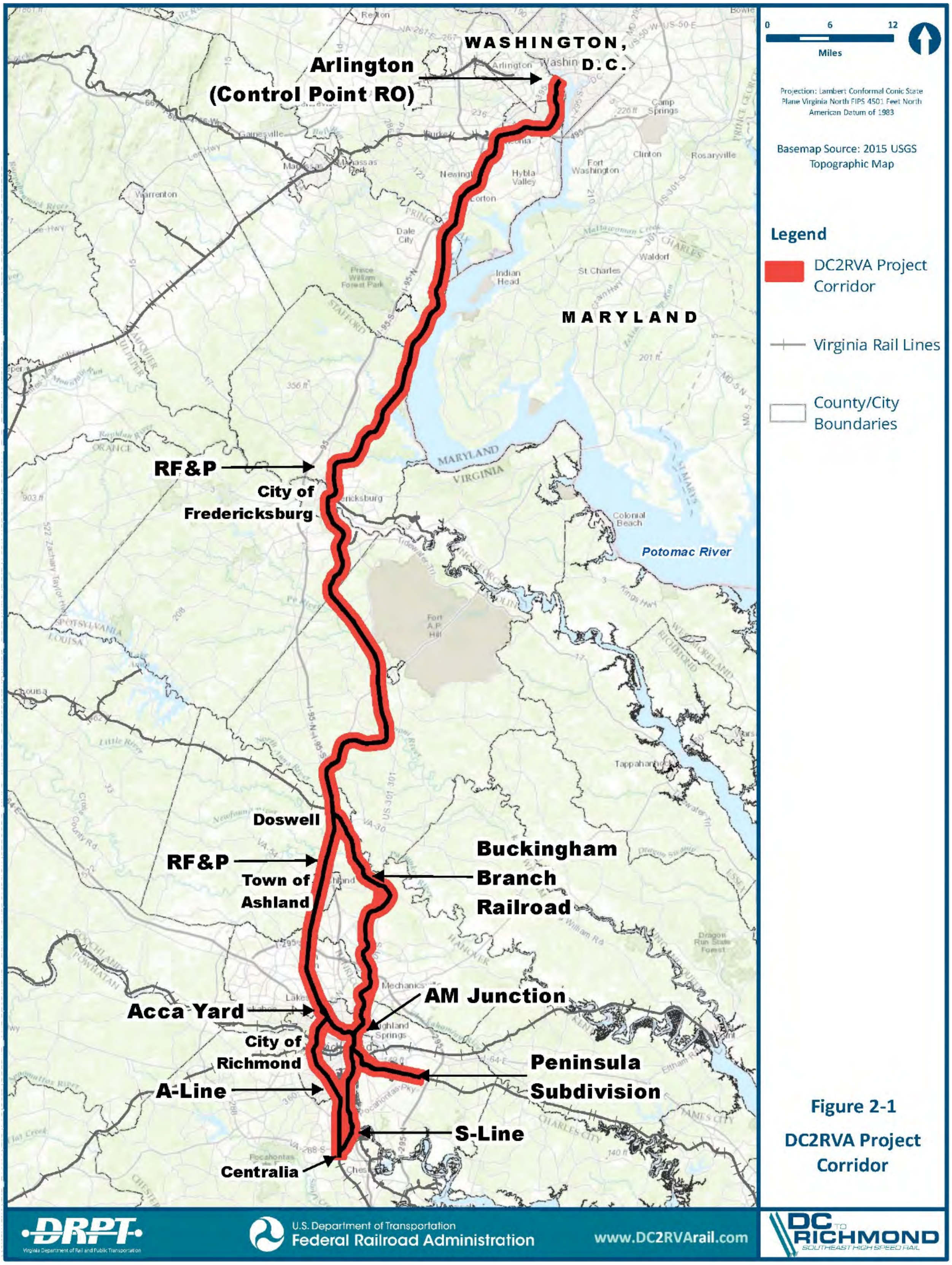


Figure 2-1
DC2RVA Project Corridor

2.1 PROJECT DESCRIPTION

Alternatives developed as part of the DC2RVA Project include two elements: proposed train service that would run throughout the corridor (see Section 2.1.1), and physical improvements along the rail alignment. The Project will include specific rail infrastructure improvements and service upgrades to deliver higher speed passenger rail, expand commuter rail, and accommodate growth of freight rail service in an efficient and reliable multimodal rail corridor. The increased capacity will improve passenger rail service frequency, reliability, and door-to-door competitive travel time in a corridor shared by growing volumes of passenger, commuter, and freight rail traffic. Specific improvements to the existing rail infrastructure between Arlington, VA, and Centralia, VA, include:

- Corridor-wide improvements to train operating capacity to accommodate efficient operation of passenger, commuter, and freight rail service with increased frequency, reliability, and speed, including an additional main track along most of the corridor, additional sidings, crossovers, yard bypasses and leads, and other capacity and reliability improvements at certain locations.
- Corridor-wide upgrades to existing track and signal systems to achieve higher operating speeds, including curve realignments, higher-speed crossovers between tracks, passing sidings, and grade crossing improvements.
- New or replacement station, platform, and parking improvements at intercity passenger stations in the corridor to improve the efficiency of railroad operations, improve quality of service, and accommodate increased ridership.
- Safety improvements to roadway crossing treatments, to include median treatment, grade separations, and/or closure of existing at-grade crossings of the rail corridor.

The environmental impacts of these improvements and measures to avoid, minimize, or otherwise mitigate such impacts are described in the EIS.

Studies in support of the Project addressed passenger and freight rail operations and service between Union Station in Washington, D.C. and Richmond and beyond, but the Project will not include physical improvements to the Long Bridge across the Potomac River or to rail infrastructure within Washington, D.C. Other projects will address these improvements as well as improvements to the rail infrastructure north of Arlington and south of Centralia along the SEHSR corridor.

2.1.1 Passenger Rail Service in Project Corridor

Amtrak operates four types of passenger service in the DC2RVA corridor:

- Northeast Regional (Virginia) Amtrak service provides regional passenger rail service along the length of the Northeast Corridor from Boston and New York and continues south to serve routes in Virginia. Trains make local station stops.
- Interstate Corridor (Carolinian) Amtrak operates between New York and North Carolina (one single daily round trip) through Virginia, making fewer stops in the DC2RVA corridor than the Northeast Regional service.
- Long Distance Amtrak service operates from New York and continues through Washington, D.C. and Virginia to other out-of-state locations. Long distance trains serve the fewest of Amtrak station stops within the DC2RVA corridor.

- Auto Train Amtrak service operates as a daily nonstop, overnight train between dedicated station facilities in Lorton, VA and Florida, and carries passengers and their automobiles.

DRPT is proposing to add nine daily roundtrip SEHSR intercity passenger trains to the corridor:

- Four new roundtrips of Northeast Regional (SEHSR) service, to provide additional frequencies on the same routes of existing Amtrak Northeast Regional (Virginia) services, terminating within Virginia (either Newport News, Norfolk, or Richmond).
- Five new roundtrips of Interstate Corridor (SEHSR) service, to complement Amtrak's current Interstate Corridor (North Carolina) service, by providing additional frequencies to North Carolina. The SEHSR trains have slightly different service patterns in the DC2RVA corridor than the existing Amtrak service, and use different routes south of the DC2RVA corridor, where SEHSR trains are expected to provide a faster and more direct route to Raleigh and Charlotte, NC.

From Washington, D.C., all new SEHSR trains would continue on to Philadelphia, New York, and Boston. The plan is to incorporate this service in to Amtrak's regional and long-distance intercity passenger rail network. Refer to Chapter 2 of the Draft EIS for full summary of proposed service and ridership.

2.1.2 Tier II EIS Planning Dates

For this EIS, FRA and DRPT established two important planning dates. The first planning date is 2025, which is FRA and DRPT's current best estimate of when construction of the DC2RVA infrastructure could be completed and the new DC2RVA service would be placed in operation. FRA and DRPT's estimate of the year 2025 as the "opening day" is dependent on many factors, not the least of which is finalizing the EIS and Record of Decision. The date also assumes that federal funding in addition to other funding sources will be available at the level required to build all of the proposed infrastructure improvements and acquire the necessary equipment and train-sets. DRPT based this date on an aggressive but potentially achievable schedule assumption that all necessary permits, approvals, agreements, and funding could be finalized by 2020, final design would take one year (2021), right-of-way acquisition (if needed) would take one year (2022), and construction would take three years (2023 – 2025). FRA and DRPT also used 2025 as the date when the physical impacts associated with DC2RVA Project construction would take place. Thus, all of the physical impact analyses within this Draft EIS on human and natural resources are estimated for 2025, and compared to the No Build Alternative conditions projected for 2025.

The second key planning date established by FRA and DRPT is the planning horizon date of 2045, 20 years after the projected implementation of the new rail service in 2025. Both the Passenger Rail Investment and Improvement Act (PRIIA) and FRA guidance require that DRPT demonstrate that the proposed project is sufficient to deliver the proposed passenger rail benefits and an efficient and reliable multimodal rail corridor over a 20-year time horizon following the completion of the passenger project. DRPT uses operational simulations analysis, as discussed in Section 2.6.2, to test the proposed alternatives to determine if the rail capacity is adequate for both the opening day (2025) levels of projected freight, commuter and passenger rail traffic and to determine if the infrastructure remains adequate over the 20 year planning horizon or until 2045. DRPT also used the 2045 planning horizon date to estimate some of the longer term effects of the proposed service such as ridership, energy use, and effects on air quality, as well as indirect and cumulative effects.

2.2 PROJECT ALTERNATIVES

Developing potential rail alignments was an iterative process. DRPT relied on previous studies and public scoping comment as the starting point for developing potential rail alignments. Rail alignment modifications were made to avoid or minimize potential adverse effects on environmental resources and existing infrastructure, and to minimize the need for additional new infrastructure, while preserving the ability of that alignment to meet the Project's Purpose and Need. The final screening evaluation—to determine the Build Alternatives to be carried forward for evaluation in the Draft EIS—focused on each rail alignment's ability to reduce trip times based on increased track design speed and to increase the reliability of rail operations based upon added capacity, with the least potential environmental impact and consideration of cost to construct.

As part of the Build Alternatives, DRPT evaluated both existing and potential new passenger rail stations in the DC2RVA corridor. DRPT plans to incorporate the DC2RVA SEHSR passenger train service into Amtrak's regional and long distance intercity passenger rail network; along the DC2RVA corridor, these existing stations include: Alexandria, Woodbridge, Quantico, Fredericksburg, Ashland, and Staples Mill Road and Main Street in Richmond. Additionally, in Richmond, DRPT is considering two proposed new locations under some Build Alternatives: Boulevard Station and Broad Street Station. However, not all proposed trains would necessarily serve all existing or proposed stations.

For evaluation in the Tier II Draft EIS, DRPT combined and categorized Build Alternatives into six alternative areas along the corridor (Figure 2-2):

- Alternative Area 1: Arlington (Long Bridge Approach): 1-mile section that includes approach alignments to the Long Bridge, which crosses the Potomac River between VA and DC.
- Alternative Area 2: Northern Virginia: 47-mile section that includes additional track within existing railroad right-of-way.
- Alternative Area 3: Fredericksburg (Dahlgren Spur to Crossroads): 14-mile section that includes alignments through or around the city.
- Alternative Area 4: Central Virginia (Crossroads to Doswell): 29-mile section that includes additional track primarily within the existing railroad right-of-way.
- Alternative Area 5 Ashland: Ashland (Doswell to I-295): 10-mile section including alignments through or around the town.
- Alternative 6 Richmond (I-295 to Centralia): 23-mile section including different station locations and routing options along the A-Line and/or S-Line.

Project Build Alternatives were developed separately, specific to the existing conditions, constraints, and/or needs of each of the six areas, and will be linked to form a single DRPT Recommended Preferred Alternative for the corridor, to be confirmed in the Final EIS and Record of Decision (ROD).

Refer to Chapter 2 of the Draft EIS for full summary of the alternatives development process and description of Build Alternatives, and Chapter 7 of the Draft EIS for description of the DRPT Recommended Preferred Alternative.

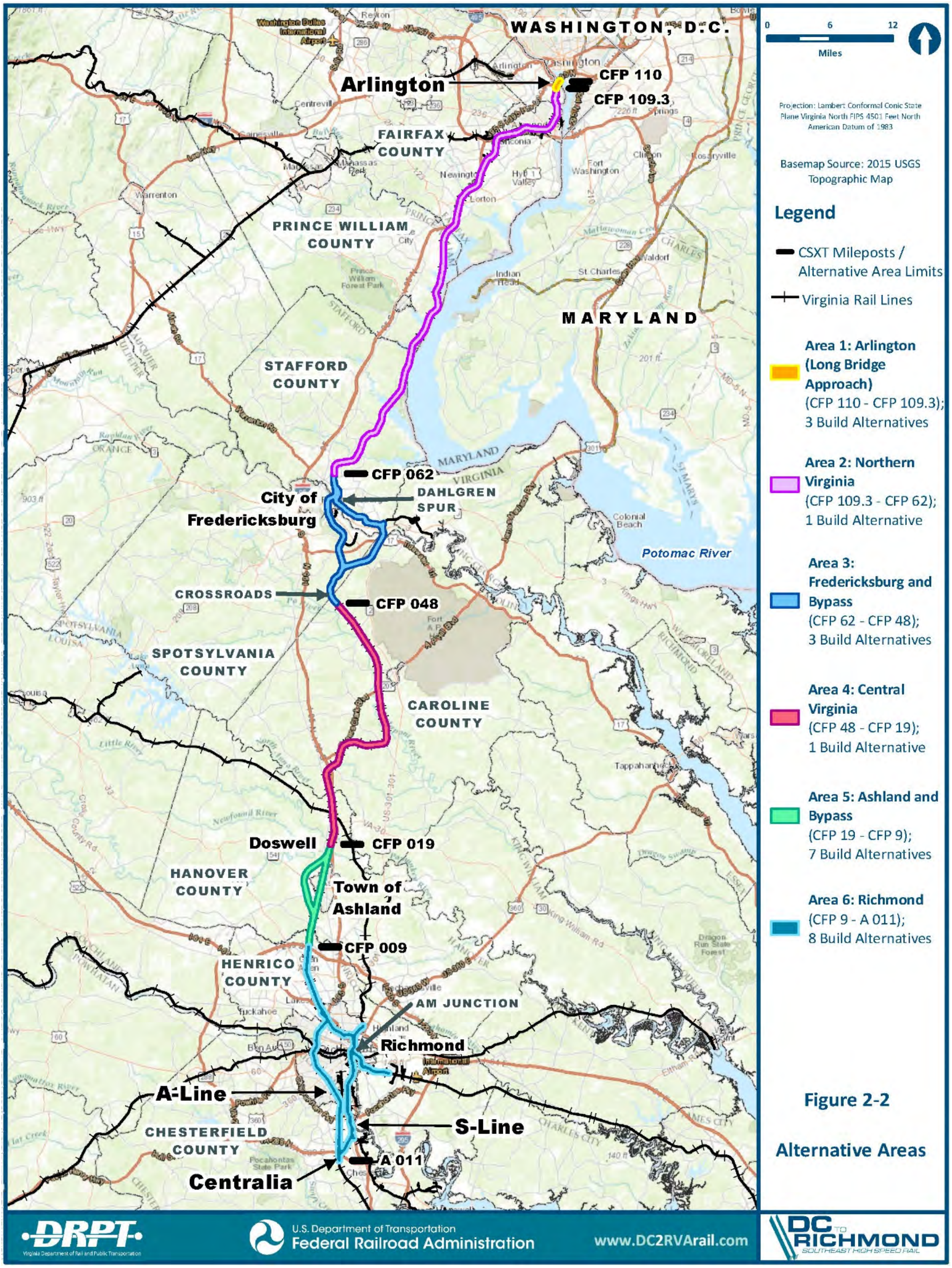


Figure 2-2

Alternative Areas

In general, the DC2RVA Project proposes to increase capacity by adding one additional main track. In most areas, the Project will add a new third track in addition to two existing tracks. The determination of the location of the new track on the east or west of existing trackage varies by location within the corridor based on physical constraints and minimization of impacts. For each alternative, DRPT also evaluated the potential to realign the tracks to improve speeds. The proposed Build Alternatives vary within the City of Fredericksburg and the Town of Ashland, where alignments outside of the existing right-of-way were considered (i.e., bypass alignments around the downtown areas); the typical section of the new bypass alignments consists of two tracks.

From a wide range of options that were considered during the alternatives development process, 23 Build Alternatives, which vary within each alternative area, were included for evaluation in the Draft EIS (Table 2-1).

Table 2-1: Build Alternatives

Alternative Area	Alternative	Description
Area 1: Arlington (Long Bridge Approach)	1A	Add Two Tracks on the East
	1B	Add Two Tracks on the West
	1C	Add One Track East and One Track West
Area 2: Northern Virginia (Long Bridge to Dahlgren Spur)	2A	Add One Track/Improve Existing Track
Area 3: Fredericksburg (Dahlgren Spur to Crossroads)	3A	Maintain Two Tracks Through Town
	3B	Add One Track East of Existing
	3C	Add Two-Track Bypass East
Area 4: Central Virginia (Crossroads to Doswell)	4A	Add One Track/Improve Existing Track
Area 5: Ashland (Doswell to I-295)	5A	Maintain Two Tracks Through Town
	5A–Ashcake	Maintain Two Tracks Through Town (Relocate Station to Ashcake)
	5B	Add One Track East of Existing
	5B–Ashcake	Add One Track East of Existing (Relocate Station to Ashcake)
	5C	Add Two-Track West Bypass
	5C–Ashcake	Add Two-Track West Bypass (Relocate Station to Ashcake)
	5D–Ashcake	Three Tracks Centered Through Town (Add One Track, Relocate Station to Ashcake)
Area 6: Richmond (I-295 to Centralia)	6A	Staples Mill Road Station Only
	6B–A-Line	Boulevard Station Only, A-Line
	6B–S-Line	Boulevard Station Only, S-Line
	6C	Broad Street Station Only
	6D	Main Street Station Only
	6E	Split Service, Staples Mill Road/Main Street Stations
	6F	Full Service, Staples Mill Road/Main Street Stations
	6G	Shared Service, Staples Mill Road/Main Street Stations

As shown in the table, the eight Build Alternatives in Richmond include four single-station options that would consolidate passenger service to one station, and three two-station alternatives that offer combinations of services and rail line routes using Main Street Station and Staples Mill Road Station. These Richmond station options drive the corridor-wide operations of the DC2RVA Project. Ridership, travel time, and on-time performance vary by Build Alternative based on the different Richmond station options. Estimated travel time between Washington, D.C. and Richmond is dependent on the number and location of station stops as well as the track design.

Each Build Alternative includes build-alternative-specific improvements to features such as stations and at-grade roadway crossings, as applicable. The following sections provide details of each of these Build Alternatives, as well as the No Build Alternative.

2.2.1 No Build Alternative

The No Build Alternative defines the future 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.

Information about planned physical improvements and rail service additions in the corridor was gathered from fiscally-constrained Metropolitan Planning Organization (MPO) planning documents, Commonwealth multiyear 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 the Draft EIS evaluation. Chapter 2 of the Draft EIS provides full description of elements included in the No Build Alternative.

The purpose of the No Build Alternative is to serve as a baseline for comparison of potential effects and impacts of the DC2RVA Build Alternatives. The No Build Alternative was fully evaluated and dismissed by the FRA in the 2002 SEHSR Tier I ROD because it does not meet the SEHSR Purpose and Need. Although previously dismissed as not a viable alternative, it is fully considered as part of the Tier II Draft EIS for the DC2RVA Project because the baseline is required by the National Environmental Policy Act (NEPA). However, the FRA guidelines for evaluating noise and vibration do not include evaluation of a No Build Alternative. Therefore, noise and vibration levels associated with the No Build Alternative are not presented in this technical report.

2.2.2 Build Alternatives

The 23 Build Alternatives that are evaluated in the Tier II EIS for the DC2RVA Project are summarized below. Chapter 2 of the Draft EIS provides full information, including lists of specific improvements for track and station improvements, for each Build Alternative.

Figures 2-3 through 2-23 show the proposed rail alignment improvements by alternative. Figures 2-24 through 2-40 show the proposed station improvements. Note that all figures are provided at the end of this section.

2.2.2.1 Build Alternatives in Area 1: Arlington (Long Bridge Approach)

There are three Build Alternatives in Area 1, which are described in Table 2-2. Build Alternative 1A, 1B, and 1C are shown in Figure 2-3. There are no stations within this alternative area.

Table 2-2: Arlington Area Build Alternatives: 1A, 1B, and 1C

TRACK
All three Build Alternatives would: ▪ Equally support expanded intercity passenger service (all types), expanded VRE commuter service, and expanded CSXT freight service ▪ Add two main tracks, with minor shifts to improve speed ▪ Be constructed within existing railroad right-of-way The difference between the alternatives is on which side(s) of the existing track the new track is added (as indicated in Build Alternative names): two tracks on the east (1A); two tracks on the west (1B); one track east and one track west (1C) Final decision deferred to the completion of the Long Bridge Study (separate study by DDOT) Track maximum authorized speed: ≤ 45 mph
STATIONS
No stations within area
CROSSINGS
No changes to existing public roadway crossings

2.2.2.2 Build Alternatives in Area 2: Northern Virginia

There is one Build Alternative in Area 2, which is described in Table 2-3. Build Alternative 2A is shown in Figure 2-4.

Table 2-3: Northern Virginia Build Alternative 2A

TRACK
One main track would be added, with realignment of some curves to improve speed, to create: ▪ Fourth track from Alexandria to Crystal City ▪ Third track from Spotsylvania to Alexandria Improvements are generally within existing right-of-way Track maximum authorized speed: ≤ 79 mph
STATIONS
Station improvements are mainly platform improvements and to be performed by VRE Proposed new DC2RVA service includes: ▪ Alexandria: Northeast Regional (SEHSR) and Interstate Corridor (SEHSR) *(Figure 2-24)* ▪ Woodbridge: Northeast Regional (SEHSR) *(Figure 2-25)* ▪ Quantico: Northeast Regional (SEHSR) *(no figure)* ▪ All other stations: VRE service only *(no figure)* No changes to the locations of Amtrak (Interstate Corridor (Carolinian), Northeast Regional (Virginia), Long Distance, or Auto Train) or VRE commuter stations served
CROSSINGS
Close one existing public roadway crossing (Mount Hope Church Road), with alternate access provided; no grade separations of at-grade crossings All other public roadway crossings would remain at-grade, with safety improvements Major water crossings at Occoquan River, Neabsco Creek, and Aquia Creek

2.2.2.3 Build Alternatives in Area 3: Fredericksburg

There are three Build Alternatives in Area 3, which are described in Table 2-4, Table 2-5, and Table 2-6. Build Alternative 3A, 3B, and 3C are shown in Figure 2-5, Figure 2-6, and Figure 2-7 respectively. All three Build Alternatives would support expanded intercity passenger (all types), VRE commuter, and CSXT freight service, without change to stations served by existing Amtrak Interstate Corridor (Carolinian), Northeast Regional (Virginia), and Long Distance passenger service or VRE commuter service. Due to constraints of the geography through this location, the maximum authorized speed in this section is designed for 79 mph where feasible. Build Alternative 3B is consistent with the City of Fredericksburg Comprehensive Plan (2015).

Table 2-4: Fredericksburg Area Build Alternative 3A

TRACK
No construction of new track / no additional rail capacity within Fredericksburg ▪ Existing two main tracks would be maintained, which are used by freight, passenger, and commuter trains, similar to existing conditions ▪ Tracks would be shifted in some areas to improve speed Construction of one additional track, with some track shifts to improve speed, north and south of the city All improvements are within existing right-of-way Track maximum authorized speed: ≤ 79 mph
STATIONS
Improvements to Fredericksburg Station would include a new station building, side platform improvements, and a new parking structure *(Figure 2-26)* Proposed new DC2RVA service at Fredericksburg Station: Northeast Regional (SEHSR) and Interstate Corridor (SEHSR) The other station in this alternative area is located in Spotsylvania County and provides VRE service only
CROSSINGS
All public roadway crossings would remain at-grade, with safety improvements (no roadway crossing closures or grade separations of public at-grade crossings) Improvements to major rail bridge over the Rappahannock River

Table 2-5: Fredericksburg Area Build Alternative 3B

TRACK
One main track would be added in most areas, with track shifts to improve speed ▪ Within Fredericksburg, the additional track would be added east of the existing two tracks ▪ A third track already exists between Fredericksburg and Spotsylvania stations; therefore, no improvements are required in this section Improvements are generally within existing right-of-way Track maximum authorized speed: ≤ 79 mph
STATIONS
Improvements to Fredericksburg Station would include a new station building, a new elevated railway, side and center platform improvements, and a new parking structure *(Figure 2-27)* Proposed new DC2RVA service at Fredericksburg Station: Northeast Regional (SEHSR) and Interstate Corridor (SEHSR) The other station in this alternative area is located in Spotsylvania County and provides VRE service only
CROSSINGS
Proposed new DC2RVA service at Fredericksburg Station: Northeast Regional (SEHSR) and Interstate Corridor (SEHSR) The other station in this alternative area is located in Spotsylvania County and provides VRE service only Improvements to major rail bridge over the Rappahannock River

Table 2-6: Fredericksburg Area Build Alternative 3C

TRACK
Existing two-track corridor through the city would be maintained, with some track shifts to improve speed New two-track bypass would be constructed east of the city ▪ Would serve all freight rail as well as some or all of Interstate Corridor (SEHSR) and Amtrak Interstate Corridor (Carolinian), Long Distance, and Auto Train passenger trains ▪ Would require new right-of-way Construction of one additional track, with some track shifts to improve speed, north and south of the bypass Track maximum authorized speed: ≤ 79 mph
STATIONS
Improvements to Fredericksburg station would include a new station building, side platform improvements, and a new parking structure *(Figure 2-26)* Proposed new DC2RVA service at Fredericksburg Station: Northeast Regional (SEHSR) and Interstate Corridor (SEHSR) The other station in this alternative area is located in Spotsylvania County and provides VRE service only
CROSSINGS
Public roadway crossings along existing Dahlgren Spur would remain at-grade, with safety improvements All new public roadway crossings on the bypass would be grade-separated All other public roadway crossings would remain at-grade, with safety improvements Improvements to major rail bridge over the Rappahannock River

2.2.2.4 Build Alternatives in Area 4: Central Virginia

There is one Build Alternative in Area 4, which is described in Table 2-7. Build Alternative 4A is shown in Figure 2-8. Based on geography throughout this area, this section is most suitable for higher speed passenger rail service, and therefore provides the greatest contiguous section along the DC2RVA corridor with a maximum authorized speed up to 90 mph. There are no stations within this alternative area.

Table 2-7: Central Virginia area Build Alternative: 4A

TRACK
One main track would be added, with track shifts to improve speed Improvements are generally within existing right-of-way Supports expanded intercity passenger service (all types) and CSXT freight service Track maximum authorized speed: ≤ 90 mph
STATIONS
No stations within the area Would not preclude the development of a proposed future station at Carmel Church (not included as part of this study)
CROSSINGS
Close one existing public roadway crossing (Colemans Mill Road); no grade separations of at-grade crossings All other public roadway crossings would remain at-grade, with safety improvements Multiple crossings of small waterways and wetlands

2.2.2.5 Build Alternatives in Area 5: Ashland

There are seven Build Alternatives in Area 5, which are described in Table 2-8 through Table 2-11 below. Build Alternative 5A, 5A–Ashcake, 5B, 5B–Ashcake, 5C, 5C–Ashcake, and 5D–Ashcake are shown in Figure 2-9, Figure 2-10, Figure 2-11, Figure 2-12, Figure 2-13, Figure 2-14, and Figure 2-15, respectively.

The Ashland Build Alternatives include different station locations: either maintaining the station at the existing downtown station with improvements (Build Alternatives 5A, 5B, and 5C) or relocating the station to south of Ashcake Road (all Build Alternatives with "–Ashcake" in their name). The Build Alternatives with the same letter, with and without the "–Ashcake" designation, are otherwise similar in terms rail alignment through Ashland and identical north and south of Town. For ease of comparison, they are presented together in the tables below.

Due to constraints of the geography through this location, the maximum authorized speed in this section is designed for 79 mph where feasible, with an existing 35 mph municipal slow order through the Town of Ashland.

Table 2-8: Ashland Area Build Alternatives: 5A and 5A–Ashcake

TRACK
Both alternatives would maintain two existing tracks (no construction of new track/no additional rail capacity) within Ashland Both alternatives would construct one additional track, with some track shifts to improve speed, north and south of the town All rail improvements are generally within existing right-of-way
STATIONS
Both alternatives would provide Northeast Regional (SEHSR and Virginia) service at different station locations: ▪ 5A: Would maintain existing station location with improvements, including 850-foot platforms, which would require closure of the existing roadway crossing at College Avenue; use of shorter, 350-foot platforms is an option to minimize impacts *(Figure 2-28 A & B)* ▪ 5A–Ashcake: Would close the existing station location and relocate service to a new the station south of Ashcake Road *(Figure 2-29)*
CROSSINGS
Both alternatives include the grade separation of two existing at-grade roadway crossings in Ashland: West Vaughan Road and Ashcake Road All other existing public roadway crossings would remain at-grade, with safety improvements

Table 2-9: Ashland Area Build Alternatives: 5B and 5B–Ashcake

TRACK
Both alternatives would maintain two existing tracks and construct one additional track east of the existing tracks within Ashland ▪ The addition of a third track through town would require closure of a short portion of Railroad Avenue/Center Street ▪ New right-of-way would be required for rail improvements within the town Both alternatives would construct one additional track, with some track shifts to improve speed, north and south of the town ▪ Rail improvements north and south of the town are generally within existing right-of-way
STATIONS
Both alternatives would provide Northeast Regional (SEHSR and Virginia), with different station locations:

Table 2-9: Ashland Area Build Alternatives: 5B and 5B–Ashcake

▪ 5B: Would maintain existing station location with improvements, including 850-foot platforms, which requires closure of the existing roadway crossing at College Avenue; use of shorter, 350-foot platforms is an option to minimize impacts *(Figure 2-30 A & B)* ▪ 5B–Ashcake: Would close the existing station location and relocate service to a new the station south of Ashcake Road *(Figure 2-29)*
CROSSINGS
Both alternatives include the grade separation of two existing at-grade roadway crossings in Ashland: West Vaughan Road and Ashcake Road All other existing public roadway crossings would remain at-grade, with safety improvements

Table 2-10: Ashland Area Build Alternatives: 5C and 5C–Ashcake

TRACK
Both alternatives would construct a two-track bypass, west of Ashland, to serve all freight rail as well as all Interstate Corridor (SEHSR) and Amtrak Interstate Corridor (Carolinian), Long Distance, and Auto Train passenger trains ▪ New right-of-way would be required on bypass alignment Both alternatives would maintain the existing two-track corridor through town ▪ No additional right-of-way needed in town Both alternatives would construct one additional track, with some track shifts to improve speed, north and south of the bypass ▪ Rail improvements north and south of the town are generally within existing right-of-way
STATIONS
Both alternatives would provide Northeast Regional (SEHSR and Virginia) service at different station locations: ▪ 5C: Would maintain existing station location with improvements, including 850-foot platforms, which requires closure of the existing roadway crossing at College Avenue; use of shorter, 350-foot platforms is an option to minimize impacts *(Figure 2-28 A & B)* ▪ 5C–Ashcake: Would close the existing station location and relocate service to a new the station south of Ashcake Road *(Figure 2-29)*
CROSSINGS
All new roadway crossings on the bypass would be grade-separated All existing public roadway crossings within town would remain at-grade, with safety improvements

Table 2-11: Ashland Area Build Alternatives: 5D–Ashcake

TRACK
One additional main line track, with centering of all main line tracks on the existing alignment, would be constructed through the entire area, which generally requires additional railroad right-of-way, especially within the town of Ashland ▪ The addition of a third track through town would require closure of a short portion of Railroad Avenue/Center Street
STATIONS
This rail alignment would require removal of the existing station building and platforms, resulting in the relocation of service to a new station south of Ashcake Road, to provide Northeast Regional (SEHSR and Virginia) service *(Figure 2-29)*
CROSSINGS
Includes the grade separation of two existing at-grade roadway crossings in Ashland: West Vaughan Road and Ashcake Road All other existing public roadway crossings within town would remain at-grade, with safety improvements

2.2.2.6 Build Alternatives in Area 6: Richmond

There are eight Build Alternatives in Area 6. All Build Alternatives generally add one main track (though they vary whether they use the A-Line or S-Line through the city), and they vary in whether they consolidate passenger train service to a single station (including two potential new stations at Boulevard Station or Broad Street Station) or provide combinations of service at two stations. There are no changes to CSXT freight service routes due to proposed changes to passenger train routes as part of the DC2RVA Project. The Amtrak Auto Train does not stop in Richmond.

Five of the Richmond area Build Alternatives are single-station alternatives, which are presented in Table 2-12 through Table 2-16. The single station alternatives are Build Alternative 6A, 6B–A-Line, 6B–S-Line, 6C, and 6D, which are shown in Figure 2-16, Figure 2-17, Figure 2-18, Figure 2-19, and Figure 2-20, respectively. All single-station alternatives consolidate Northeast Regional (SEHSR) and Interstate Corridor (SEHSR) service, as well as all Amtrak Long Distance, Interstate Corridor (Carolinian), and Northeast Regional (Virginia) service, to one station.

Three of the Richmond area Build Alternatives are two-station alternatives, which are presented in Table 2-17 through Table 2-19. All two station alternatives use the existing Staples Mill Road and Main Street Stations. The two station Build Alternatives are Build Alternatives 6E, 6F, and 6G, which are shown in Figure 2-21, Figure 2-22, and Figure 2-23, respectively. All two-station alternatives provide Northeast Regional (SEHSR) and Interstate Corridor (SEHSR) service to at least one station, and serves Amtrak Long Distance, Interstate Corridor (Carolinian), and Northeast Regional (Virginia) to one or both stations.

Table 2-12: Richmond Single Station Build Alternative: 6A (Staples Mill Road Station Only)

TRACK
One main track would be added along portions of RF&P (north of Richmond) and A-Line (through Richmond), with track shifts to improve speed
STATIONS
Existing Main Street Station would be closed to passenger rail service, and all service consolidated at Staples Mill Road Station Staples Mill Road Station would be improved and becomes the one passenger rail station to serve Richmond *(Figure 2-31)* ▪ Does not meet FRA requirement for CBD location ▪ Would be served by all passenger trains, including new proposed Interstate Corridor (SEHSR) and Northeast Regional (SEHSR) service Freight and passenger rail service operating together on the A-Line, CSXT's principal freight corridor, would increase rail congestion/delay
CROSSINGS
Close four existing public roadway crossings; grade separate three at-grade roadway crossings All other public roadway crossings would remain at-grade, with safety improvements Major waterway crossing of James River

Table 2-13: Richmond Single Station Build Alternative: 6B–A-Line (Boulevard Station Only)

TRACK
One of two Boulevard Station-Only alternatives in Area 6 One main track would be added along portions of existing RF&P (north of Richmond) and A-Line (through Richmond), with track shifts to improve speed Elevated loop track at new station
STATIONS
Main Street and Staples Mill Road stations would be closed to passenger rail service and all service relocated and consolidated to a new station at Boulevard Road New Boulevard Road Station would be the one passenger rail station to serve Richmond *(Figure 2-32)* ▪ May not meet FRA requirement for CBD location ▪ Would be served by all passenger trains, including new proposed Interstate Corridor (SEHSR) and Northeast Regional (SEHSR) service Freight and passenger rail service operating together on the A-Line, CSXT's principal freight corridor, would increase rail congestion/delay
CROSSINGS
Close four existing public roadway crossings; grade separate three at-grade roadway crossings All other public roadway crossings would remain at-grade, with safety improvements Major waterway crossing of James River

Table 2-14: Richmond Single Station Build Alternative: 6B–S-Line (Boulevard Station Only)

TRACK
Second of two Boulevard Station-Only alternatives in Area 6 One main track would be added along portions of existing RF&P (north of Richmond) and S-Line (through Richmond), with track shifts to improve speed
STATIONS
Existing Main Street and Staples Mill Road stations would be closed to passenger rail service and all service relocated and consolidated to a new station at Boulevard Road New Boulevard Road Station would be the one passenger rail station to serve Richmond *(Figure 2-32)* ▪ May not meet FRA requirement for CBD location ▪ Would be served by all passenger trains, including new proposed Interstate Corridor (SEHSR) and Northeast Regional (SEHSR) service Locating all passenger train service (except Auto Train, which does not stop in Richmond) to S-Line, separate from CSXT's principal freight corridor through Richmond (the A-Line), would reduce rail congestion/delay
CROSSINGS
Close five existing public roadway crossings; grade separate four at-grade roadway crossings All other public roadway crossings would remain at-grade, with safety improvements Major waterway crossing of James River

Table 2-15: Richmond Single Station Build Alternative: 6C (Broad Street Station Only)

TRACK
One main track would be added along portions of existing RF&P (north Richmond) and A-Line (through Richmond), with track shifts to improve speed At-grade loop track at new station
STATIONS
Existing Main Street and Staples Mill Road stations would be closed to passenger rail service

Table 2-15: Richmond Single Station Build Alternative: 6C (Broad Street Station Only)

New Broad Street Station would be the one passenger rail station to serve Richmond *(Figure 2-33)* ▪ May not meet FRA requirement for CBD location ▪ Would be served by all passenger trains, including new proposed Interstate Corridor (SEHSR) and Northeast Regional (SEHSR) service Freight and passenger rail service operating together on the A-Line, CSXT's principal freight corridor, would increase rail congestion/delay
CROSSINGS
Station location would require two new at-grade crossings on West Leigh Street adjacent to proposed station, which would require a variance from state code and/or coordination with VDOT Close four existing public roadway crossings; grade separate three at-grade roadway crossings All other public roadway crossings would remain at-grade, with safety improvements Major waterway crossing of James River

Table 2-16: Richmond Single Station Build Alternative: 6D (Broad Street Station Only)

TRACK
One main track would be added along portions of existing RF&P (north of Richmond) and S-Line (through Richmond), with track shifts to improve speed
STATIONS
Existing Staples Mill Road Station would be closed to passenger rail service and all service consolidated at Main Street Station Main Street Station would be improved and be the one passenger rail station to serve Richmond *(Figure 2-34)* ▪ Meets FRA requirement for CBD location ▪ Would be served by all passenger trains, including new proposed Interstate Corridor (SEHSR) and Northeast Regional (SEHSR) service ▪ Potential increases in passenger and freight delay may occur as proximity to I-95 prevents adding sufficient station platforms / track on the west side of the station Locating all passenger train service (except Auto Train, which does not stop in Richmond) to S-Line, separate from CSXT's principal freight corridor through Richmond (the A-Line), would reduce rail congestion/delay
CROSSINGS
Close five existing public roadway crossings; grade separate three at-grade crossings All other public roadway crossings would remain at-grade, with safety improvements Major waterway crossing of James River

Table 2-17: Richmond Two Station Build Alternative: 6E (Split Service)

TRACK
One main track would be added along portions of existing RF&P (north of Richmond) and A-Line (through Richmond), with track shifts to improve speed
STATIONS
Both existing stations would remain operational. All passenger trains would serve Staples Mill Road Station; trains to and from Newport News would additionally serve Main Street Station. ▪ Staples Mill Road Station would be expanded and would be served by all passenger trains that stop in Richmond, including new proposed Northeast Regional (SEHSR) to Norfolk and Interstate Corridor (SEHSR) trains *(Figure 2-35)* ▪ Main Street Station would have platform and parking improvements and would be served by all Northeast Regional (SEHSR and Virginia) passenger trains to Newport News *(Figure 2-36)* Freight and passenger rail service operating together on the A-Line, CSXT's principal freight corridor, would increase rail congestion/delay
CROSSINGS
Close four existing public roadway crossings; grade separate three at-grade roadway crossings

Table 2-17: Richmond Two Station Build Alternative: 6E (Split Service)

All other public roadway crossings would remain at-grade, with safety improvements Major waterway crossing of James River

Table 2-18: Richmond Two Station Build Alternative: 6F (Full Service)

TRACK
One main track would be added along portions of existing RF&P (north of Richmond) and S-Line (through Richmond), with track shifts to improve speed
STATIONS
Both existing stations would remain operational, with all passenger trains serving both stations. ▪ Both stations would be improved, including new/modified station buildings, platforms, and parking *(Figure 2-37 and Figure 2-38)* ▪ Both stations would be served by all passenger trains that stop in Richmond, including new proposed Northeast Regional (SEHSR) and Interstate Corridor (SEHSR) service Locating all passenger train service (except Auto Train, which does not stop in Richmond) to S-Line, separate from CSXT's principal freight corridor through Richmond (the A-Line), would reduce rail congestion/delay
CROSSINGS
Close five existing public roadway crossings; grade separate three at-grade roadway crossings All other public roadway crossings would remain at-grade, with safety improvements Major waterway crossing of James River

Table 2-19: Richmond Two Station Build Alternative: 6G (Shared Service)

TRACK
One main track would be added along portions of existing RF&P (north of Richmond) and the S-Line (through Richmond), with track shifts to improve speed ▪ The A-Line is used for service but does not require proposed track
STATIONS
Both existing stations would remain operational, with both stations being served by all new proposed SEHSR service and other Amtrak passenger train services to either one or both stations. ▪ Both stations would be improved, including new/modified station buildings, platforms, and parking *(Figure 2-39 and Figure 2-40)* ▪ Both stations would be served by all Interstate Corridor (SEHSR) and Northeast Regional (SEHSR and Virginia) trains ▪ Long Distance (Amtrak) and Interstate Corridor (Carolinian) would serve Staples Mill Station only Freight and passenger rail service operating together on the A-Line, CSXT's principal freight corridor, would increase rail congestion/delay
CROSSINGS
Close five existing public roadway crossings; grade separate three at-grade roadway crossings All other public roadway crossings would remain at-grade, with safety improvements Major waterway crossing of James River

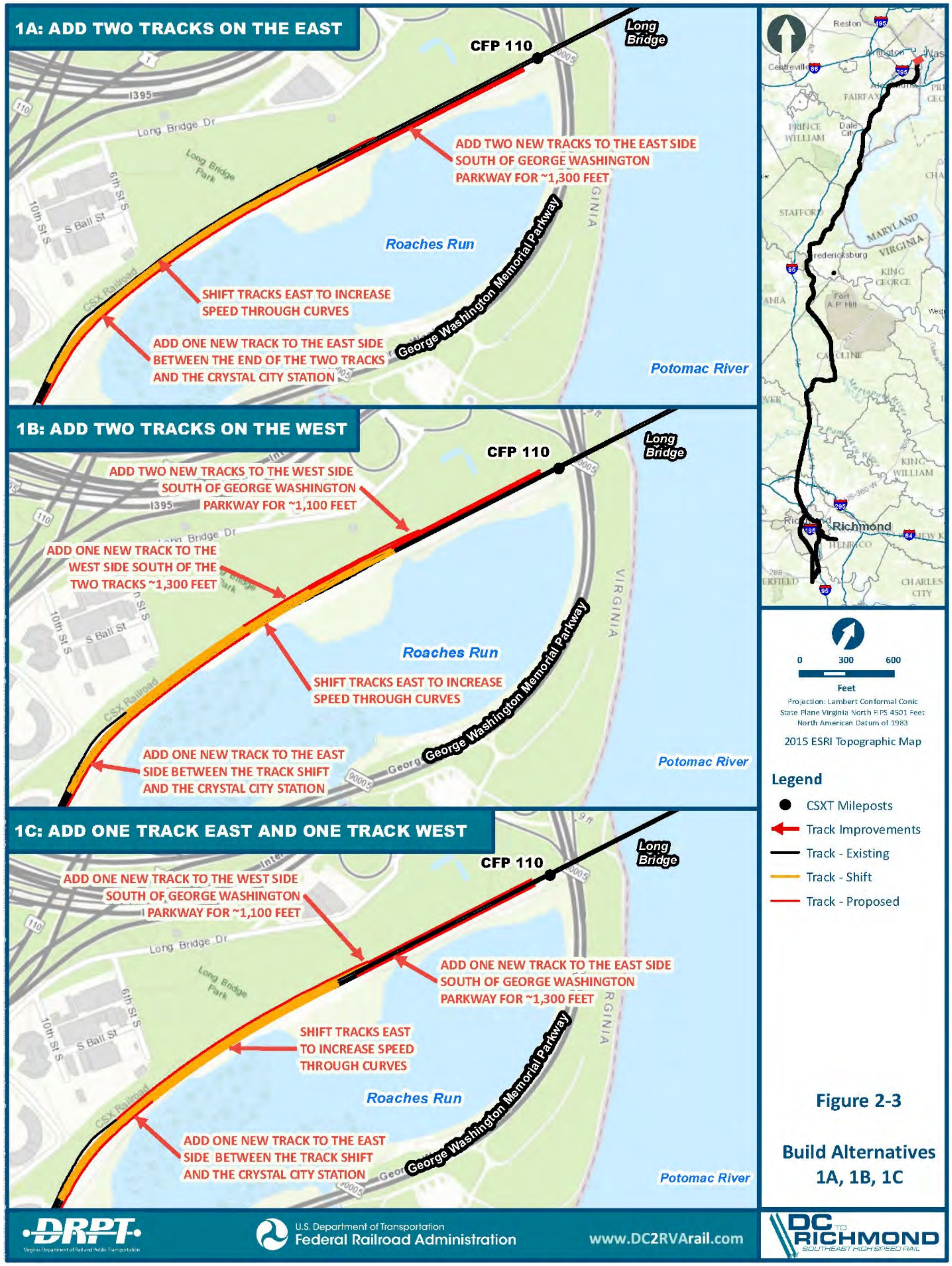


Figure 2-3

Build Alternatives 1A, 1B, 1C

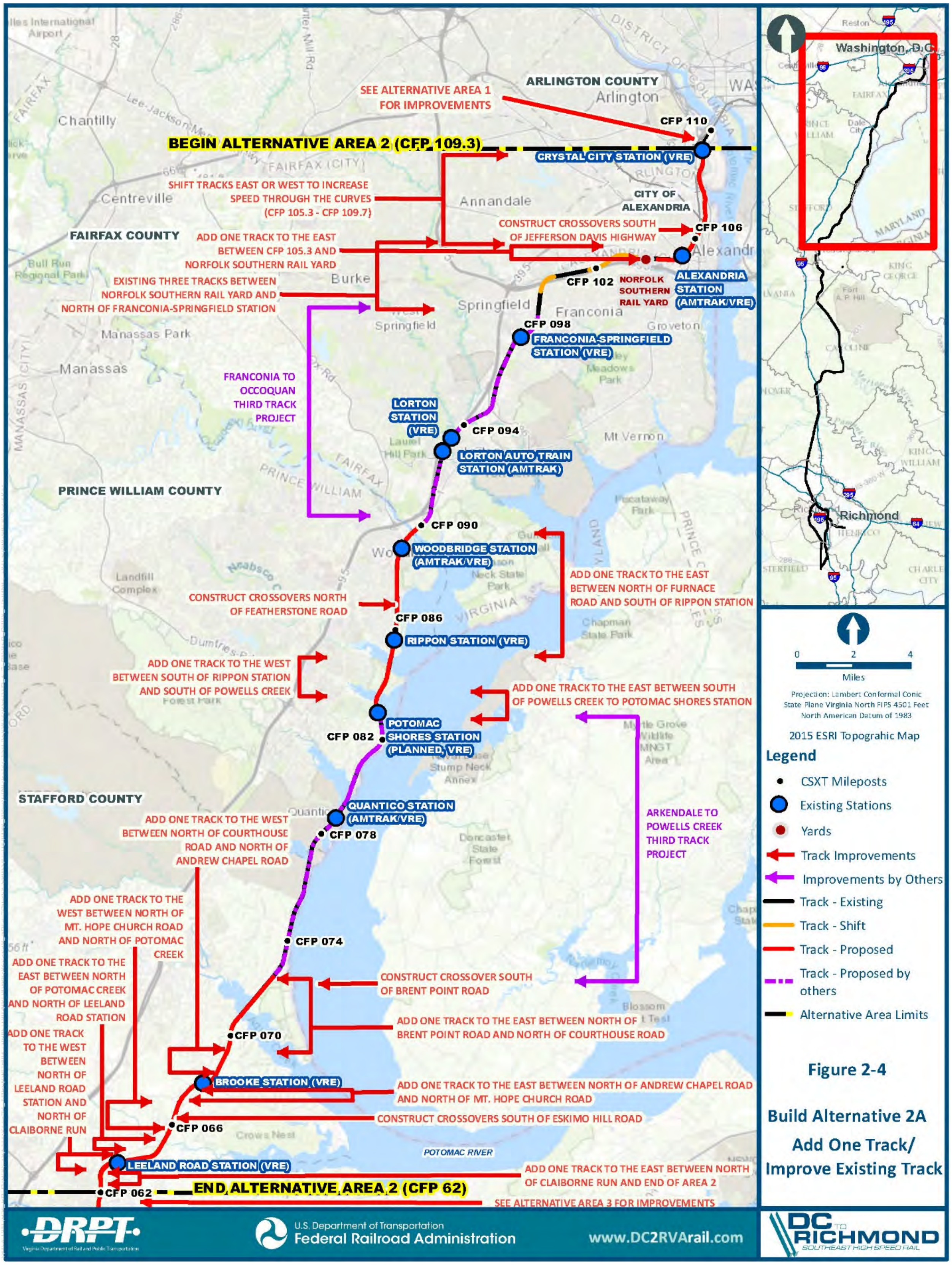
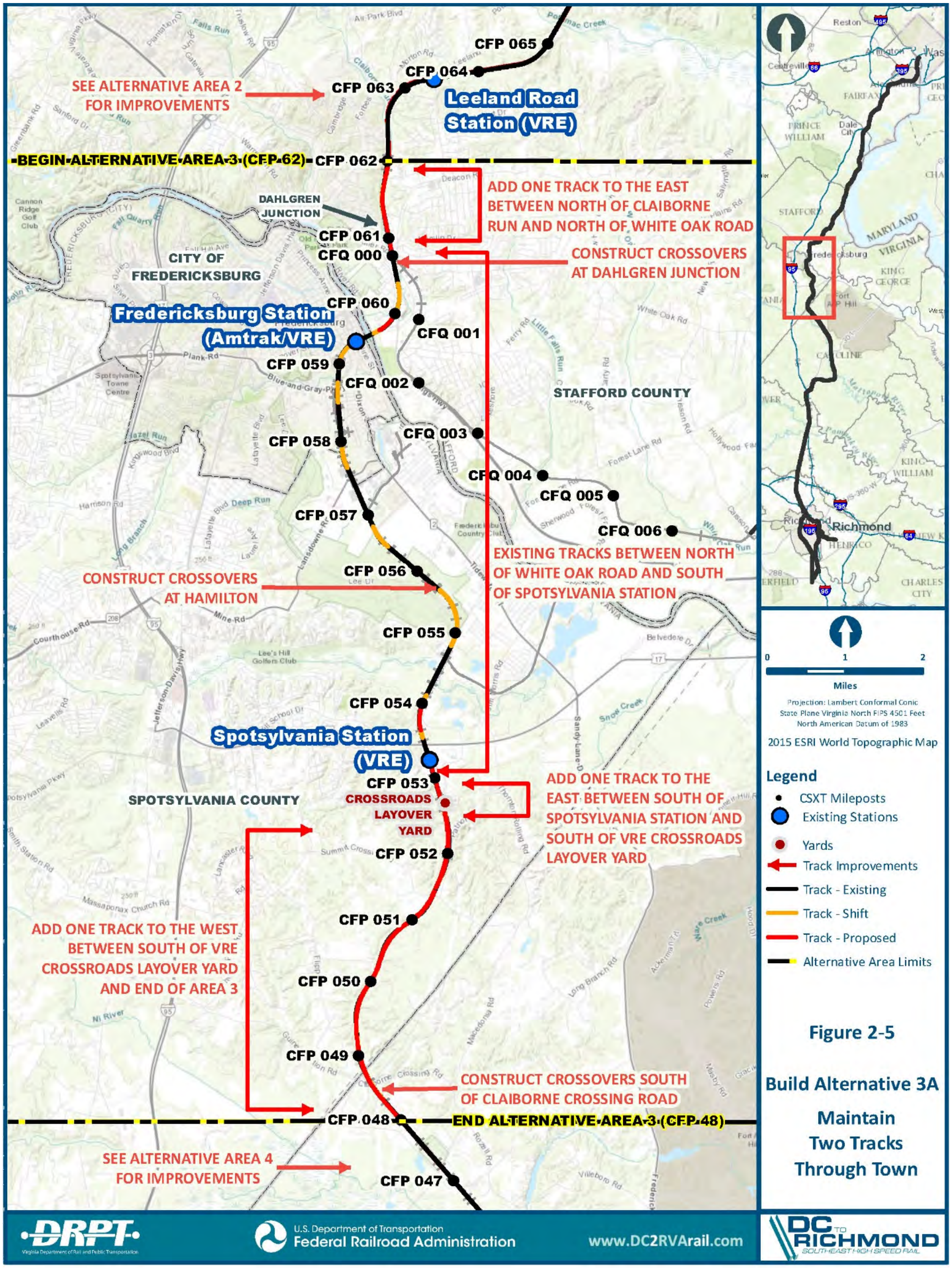


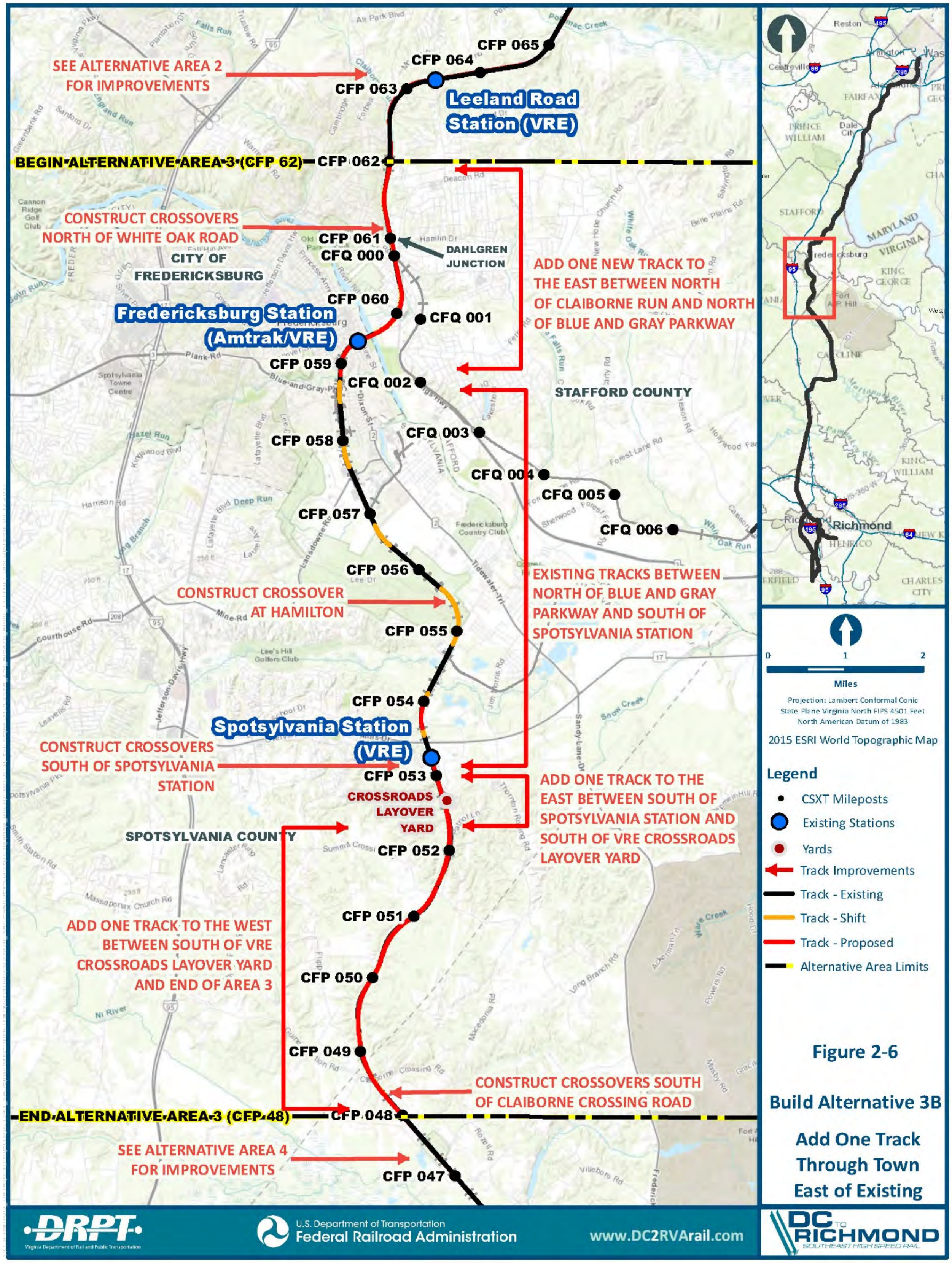
Figure 2-4

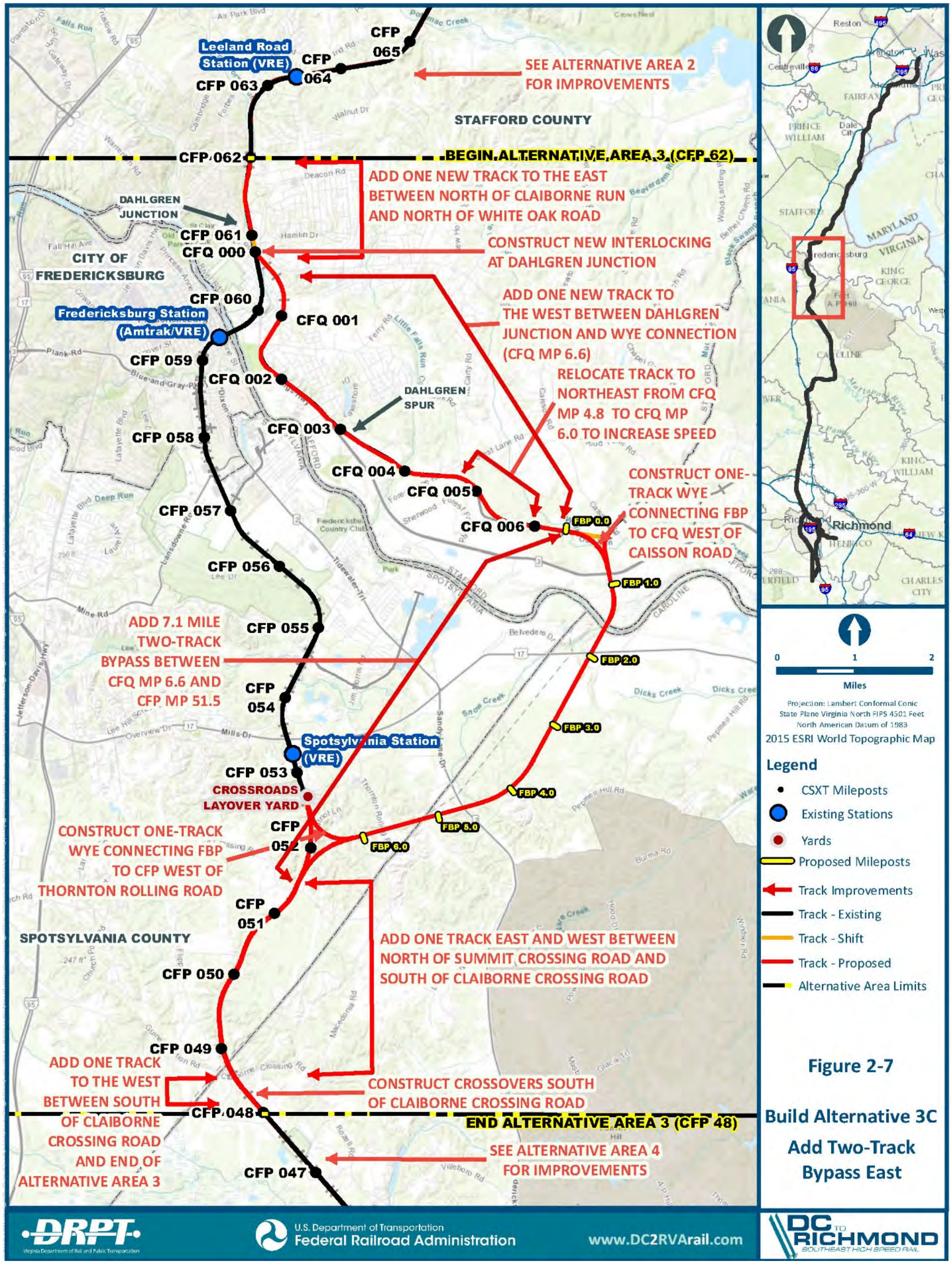
Build Alternative 2A

Add One Track/ Improve Existing Track



CFP 065
CFP 064
CFP 063
SEE ALTERNATIVE AREA 2 FOR IMPROVEMENTS
Leeland Road Station (VRE)
BEGIN ALTERNATIVE AREA 3 (CFP 62)
CFP 062
ADD ONE TRACK TO THE EAST BETWEEN NORTH OF CLAIBORNE RUN AND NORTH OF WHITE OAK ROAD
DAHLGREN JUNCTION
CFP 061
CFQ 000
CONSTRUCT CROSSOVERS AT DAHLGREN JUNCTION
CITY OF FREDERICKSBURG
CFP 060
Fredericksburg Station (Amtrak/VRE)
CFQ 001
CFP 059
CFQ 002
STAFFORD COUNTY
CFP 058
CFQ 003
CFQ 004
CFQ 005
CFP 057
CFQ 006
EXISTING TRACKS BETWEEN NORTH OF WHITE OAK ROAD AND SOUTH OF SPOTSYLVANIA STATION
CFP 056
CONSTRUCT CROSSOVERS AT HAMILTON
CFP 055
CFP 054
Spotsylvania Station (VRE)
CFP 053
CROSSROADS LAYOVER YARD
SPOTSYLVANIA COUNTY
ADD ONE TRACK TO THE EAST BETWEEN SOUTH OF SPOTSYLVANIA STATION AND SOUTH OF VRE CROSSROADS LAYOVER YARD
CFP 052
CFP 051
ADD ONE TRACK TO THE WEST BETWEEN SOUTH OF VRE CROSSROADS LAYOVER YARD AND END OF AREA 3
CFP 050
CFP 049
CONSTRUCT CROSSOVERS SOUTH OF CLAIBORNE CROSSING ROAD
CFP 048
END ALTERNATIVE AREA 3 (CFP 48)
SEE ALTERNATIVE AREA 4 FOR IMPROVEMENTS
CFP 047
Richmond
Miles
0 1 2
Projection: Lambert Conformal Conic
State Plane Virginia North FIPS 4501 Feet
North American Datum of 1983
2015 ESRI World Topographic Map
Legend
CSXT Mileposts
Existing Stations
Yards
Track Improvements
Track - Existing
Track - Shift
Track - Proposed
Alternative Area Limits
Figure 2-5
Build Alternative 3A
Maintain Two Tracks Through Town
U.S. Department of Transportation Federal Railroad Administration
www.DC2RVArail.com
DC TO RICHMOND SOUTHEAST HIGH SPEED RAIL


SEE ALTERNATIVE AREA 2 FOR IMPROVEMENTS
CFP 065
CFP 064
CFP 063
Leeland Road Station (VRE)
BEGIN ALTERNATIVE AREA 3 (CFP 62)
CFP 062
CONSTRUCT CROSSOVERS NORTH OF WHITE OAK ROAD
CFP 061
CFQ 000
DAHLGREN JUNCTION
CITY OF FREDERICKSBURG
ADD ONE NEW TRACK TO THE EAST BETWEEN NORTH OF CLAIBORNE RUN AND NORTH OF BLUE AND GRAY PARKWAY
CFP 060
CFQ 001
Fredericksburg Station (Amtrak/VRE)
CFP 059
CFQ 002
STAFFORD COUNTY
CFP 058
CFQ 003
CFQ 004
CFQ 005
CFP 057
CFQ 006
CFP 056
EXISTING TRACKS BETWEEN NORTH OF BLUE AND GRAY PARKWAY AND SOUTH OF SPOTSYLVANIA STATION
CONSTRUCT CROSSOVER AT HAMILTON
CFP 055
CFP 054
Spotsylvania Station (VRE)
CONSTRUCT CROSSOVERS SOUTH OF SPOTSYLVANIA STATION
CFP 053
ADD ONE TRACK TO THE EAST BETWEEN SOUTH OF SPOTSYLVANIA STATION AND SOUTH OF VRE CROSSROADS LAYOVER YARD
CROSSROADS LAYOVER YARD
SPOTSYLVANIA COUNTY
CFP 052
CFP 051
ADD ONE TRACK TO THE WEST BETWEEN SOUTH OF VRE CROSSROADS LAYOVER YARD AND END OF AREA 3
CFP 050
CFP 049
CONSTRUCT CROSSOVERS SOUTH OF CLAIBORNE CROSSING ROAD
END ALTERNATIVE AREA 3 (CFP 48)
CFP 048
SEE ALTERNATIVE AREA 4 FOR IMPROVEMENTS
CFP 047
Richmond
0 1 2
Miles
Projection: Lambert Conformal Conic
State Plane Virginia North FIPS 4501 Feet
North American Datum of 1983
2015 ESRI World Topographic Map
Legend
CSXT Mileposts
Existing Stations
Yards
Track Improvements
Track - Existing
Track - Shift
Track - Proposed
Alternative Area Limits
Figure 2-6
Build Alternative 3B
Add One Track Through Town East of Existing
DRPT
U.S. Department of Transportation Federal Railroad Administration
www.DC2RVArail.com
DC TO RICHMOND SOUTHEAST HIGH SPEED RAIL


Leeland Road Station (VRE)
CFP 065
CFP 064
CFP 063
SEE ALTERNATIVE AREA 2 FOR IMPROVEMENTS
STAFFORD COUNTY
CFP 062
BEGIN ALTERNATIVE AREA 3 (CFP 62)
ADD ONE NEW TRACK TO THE EAST BETWEEN NORTH OF CLAIBORNE RUN AND NORTH OF WHITE OAK ROAD
DAHLGREN JUNCTION
CFP 061
CFQ 000
CONSTRUCT NEW INTERLOCKING AT DAHLGREN JUNCTION
CITY OF FREDERICKSBURG
CFP 060
Fredericksburg Station (Amtrak/VRE)
CFQ 001
ADD ONE NEW TRACK TO THE WEST BETWEEN DAHLGREN JUNCTION AND WYE CONNECTION (CFQ MP 6.6)
CFP 059
CFQ 002
DAHLGREN SPUR
RELOCATE TRACK TO NORTHEAST FROM CFQ MP 4.8 TO CFQ MP 6.0 TO INCREASE SPEED
CFP 058
CFQ 003
CFQ 004
CFQ 005
CONSTRUCT ONE-TRACK WYE CONNECTING FBP TO CFQ WEST OF CAISSON ROAD
CFP 057
CFQ 006
FBP 0.0
CFP 056
FBP 1.0
ADD 7.1 MILE TWO-TRACK BYPASS BETWEEN CFQ MP 6.6 AND CFP MP 51.5
CFP 055
FBP 2.0
CFP 054
FBP 3.0
Spotsylvania Station (VRE)
CFP 053
CROSSROADS LAYOVER YARD
FBP 4.0
FBP 5.0
CONSTRUCT ONE-TRACK WYE CONNECTING FBP TO CFP WEST OF THORNTON ROLLING ROAD
CFP 052
FBP 6.0
CFP 051
SPOTSYLVANIA COUNTY
ADD ONE TRACK EAST AND WEST BETWEEN NORTH OF SUMMIT CROSSING ROAD AND SOUTH OF CLAIBORNE CROSSING ROAD
CFP 050
CFP 049
ADD ONE TRACK TO THE WEST BETWEEN SOUTH OF CLAIBORNE CROSSING ROAD AND END OF ALTERNATIVE AREA 3
CONSTRUCT CROSSOVERS SOUTH OF CLAIBORNE CROSSING ROAD
CFP 048
END ALTERNATIVE AREA 3 (CFP 48)
SEE ALTERNATIVE AREA 4 FOR IMPROVEMENTS
CFP 047
Miles
0 1 2
Projection: Lambert Conformal Conic
State Plane Virginia North FIPS 4501 Feet
North American Datum of 1983
2015 ESRI World Topographic Map
Legend
CSXT Mileposts
Existing Stations
Yards
Proposed Mileposts
Track Improvements
Track - Existing
Track - Shift
Track - Proposed
Alternative Area Limits
Figure 2-7
Build Alternative 3C
Add Two-Track Bypass East
DRPT
U.S. Department of Transportation Federal Railroad Administration
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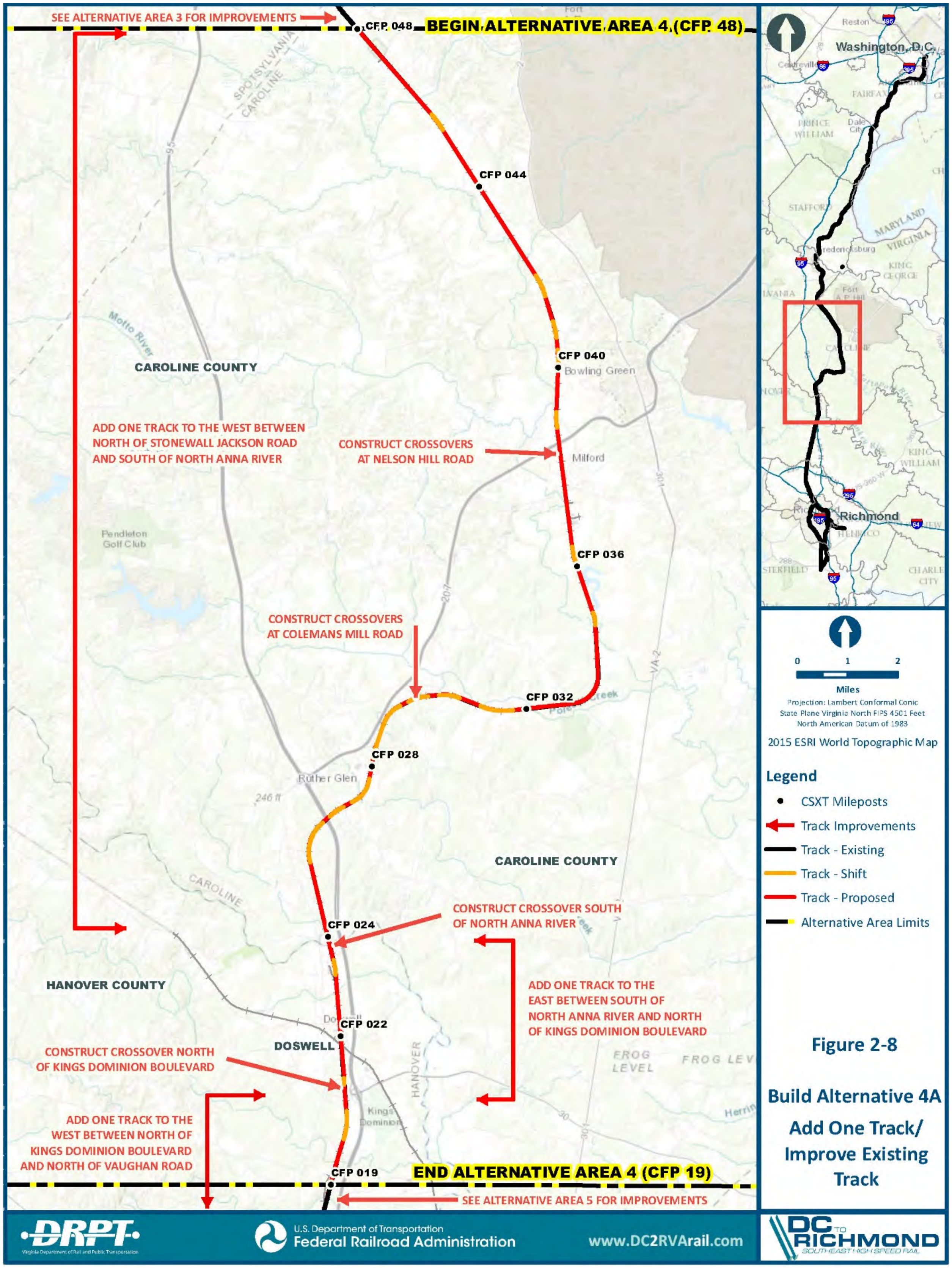
DC TO RICHMOND SOUTHEAST HIGH SPEED RAIL


SEE ALTERNATIVE AREA 3 FOR IMPROVEMENTS
CFP 048
BEGIN ALTERNATIVE AREA 4 (CFP 48)
CFP 044
CFP 040
Bowling Green
CAROLINE COUNTY
ADD ONE TRACK TO THE WEST BETWEEN NORTH OF STONEWALL JACKSON ROAD AND SOUTH OF NORTH ANNA RIVER
CONSTRUCT CROSSOVERS AT NELSON HILL ROAD
Milford
Pendleton Golf Club
CFP 036
CONSTRUCT CROSSOVERS AT COLEMANS MILL ROAD
CFP 032
CFP 028
Ruther Glen
CAROLINE COUNTY
CFP 024
CONSTRUCT CROSSOVER SOUTH OF NORTH ANNA RIVER
HANOVER COUNTY
ADD ONE TRACK TO THE EAST BETWEEN SOUTH OF NORTH ANNA RIVER AND NORTH OF KINGS DOMINION BOULEVARD
CFP 022
DOSWELL
CONSTRUCT CROSSOVER NORTH OF KINGS DOMINION BOULEVARD
FROG LEVEL
ADD ONE TRACK TO THE WEST BETWEEN NORTH OF KINGS DOMINION BOULEVARD AND NORTH OF VAUGHAN ROAD
CFP 019
END ALTERNATIVE AREA 4 (CFP 19)
SEE ALTERNATIVE AREA 5 FOR IMPROVEMENTS
Washington, D.C.
Richmond
0 1 2
Miles
Projection: Lambert Conformal Conic
State Plane Virginia North FIPS 4501 Feet
North American Datum of 1983
2015 ESRI World Topographic Map
Legend
CSXT Mileposts
Track Improvements
Track - Existing
Track - Shift
Track - Proposed
Alternative Area Limits
Figure 2-8
Build Alternative 4A
Add One Track/ Improve Existing Track
DRPT
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Federal Railroad Administration
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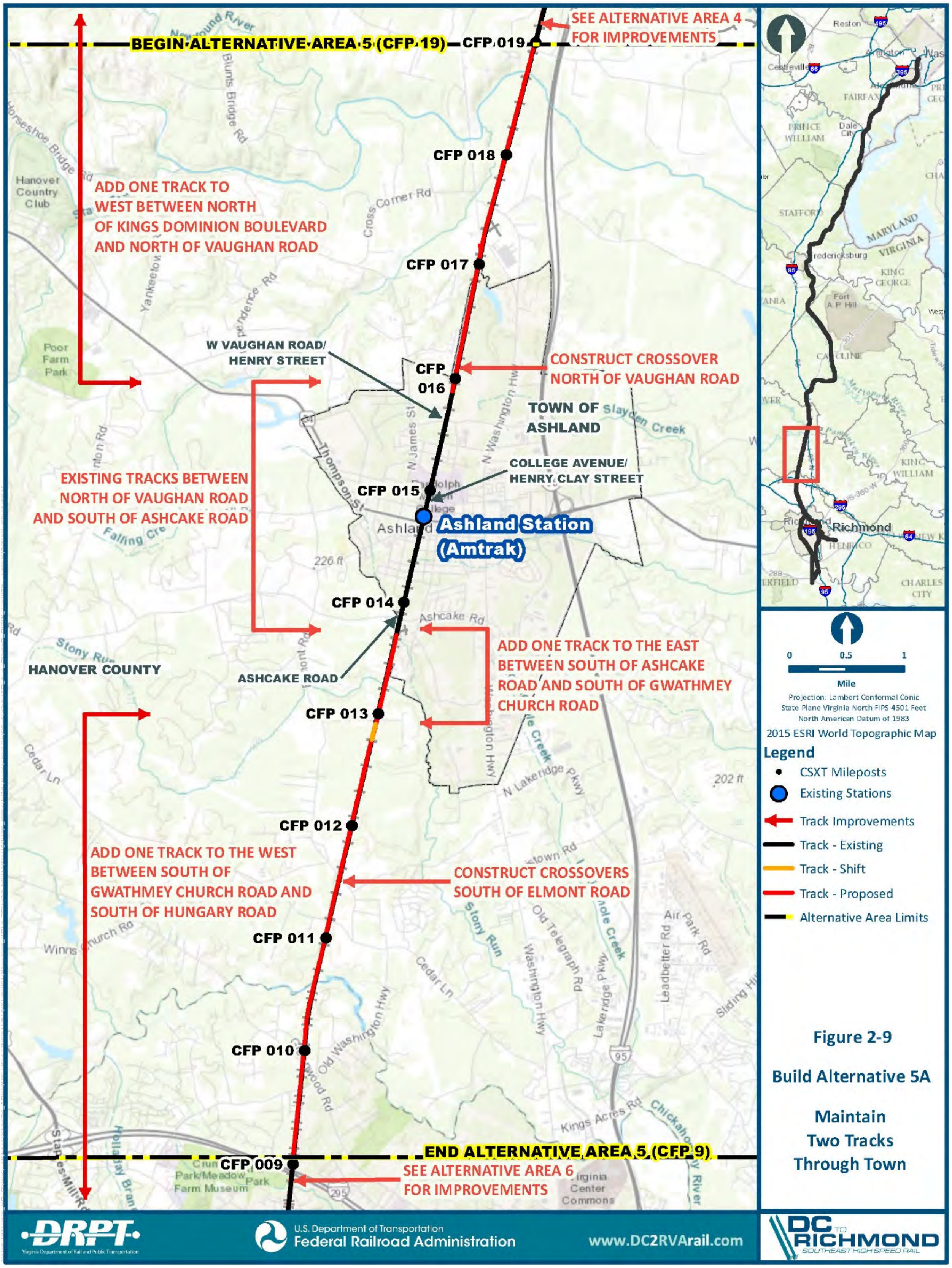
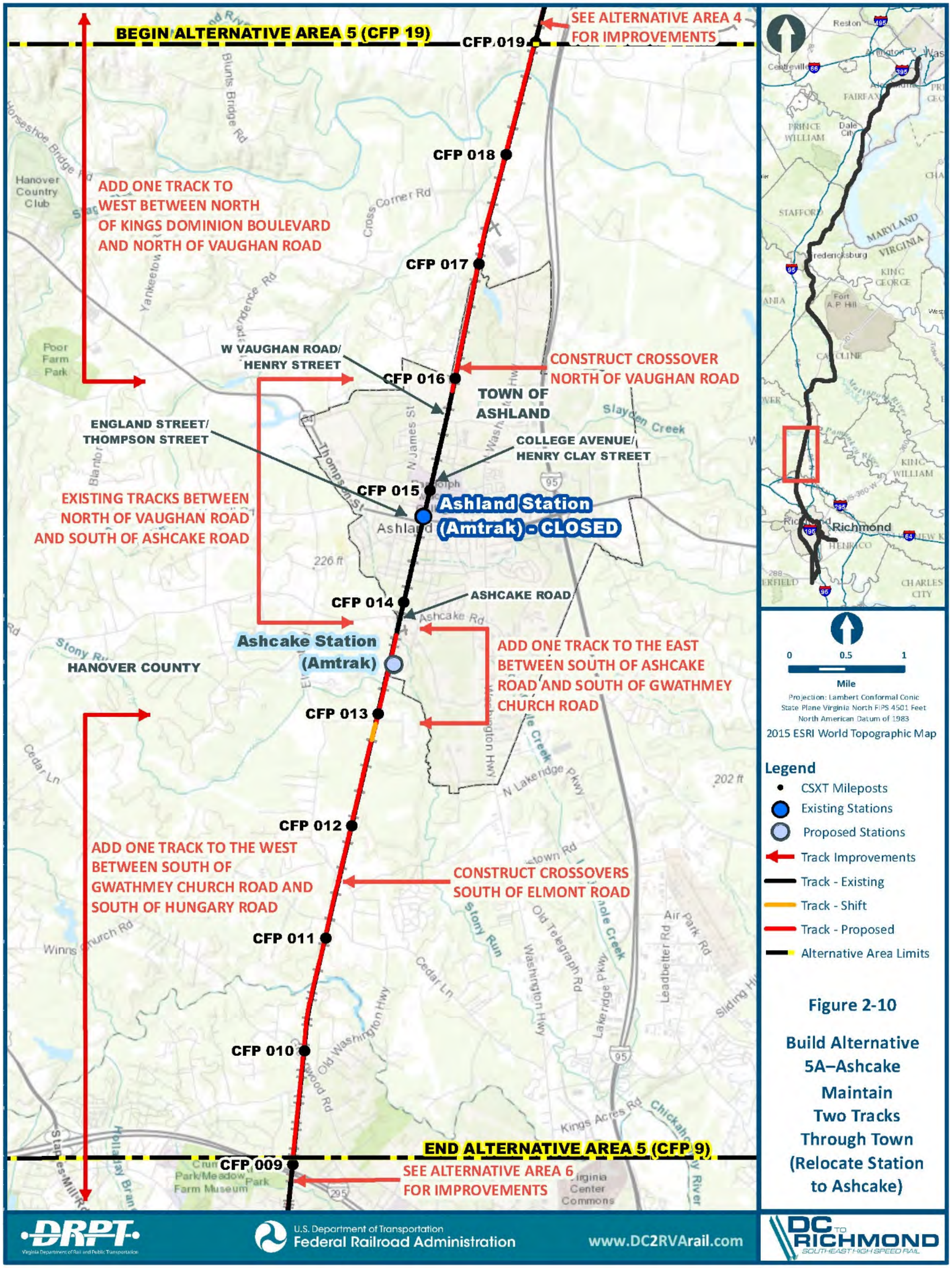
DC TO RICHMOND
SOUTHEAST HIGH SPEED RAIL


SEE ALTERNATIVE AREA 4 FOR IMPROVEMENTS
BEGIN ALTERNATIVE AREA 5 (CFP 19)
CFP 019
CFP 018
CFP 017
CFP 016
CFP 015
CFP 014
CFP 013
CFP 012
CFP 011
CFP 010
CFP 009
ADD ONE TRACK TO WEST BETWEEN NORTH OF KINGS DOMINION BOULEVARD AND NORTH OF VAUGHAN ROAD
W VAUGHAN ROAD/ HENRY STREET
CONSTRUCT CROSSOVER NORTH OF VAUGHAN ROAD
TOWN OF ASHLAND
COLLEGE AVENUE/ HENRY CLAY STREET
EXISTING TRACKS BETWEEN NORTH OF VAUGHAN ROAD AND SOUTH OF ASHCAKE ROAD
Ashland Station (Amtrak)
ADD ONE TRACK TO THE EAST BETWEEN SOUTH OF ASHCAKE ROAD AND SOUTH OF GWATHMEY CHURCH ROAD
HANOVER COUNTY
ASHCAKE ROAD
ADD ONE TRACK TO THE WEST BETWEEN SOUTH OF GWATHMEY CHURCH ROAD AND SOUTH OF HUNGARY ROAD
CONSTRUCT CROSSOVERS SOUTH OF ELMONT ROAD
END ALTERNATIVE AREA 5 (CFP 9)
SEE ALTERNATIVE AREA 6 FOR IMPROVEMENTS
0 0.5 1
Mile
Projection: Lambert Conformal Conic
State Plane Virginia North FIPS 4501 Feet
North American Datum of 1983
2015 ESRI World Topographic Map
Legend
CSXT Mileposts
Existing Stations
Track Improvements
Track - Existing
Track - Shift
Track - Proposed
Alternative Area Limits
Figure 2-9
Build Alternative 5A
Maintain Two Tracks Through Town
DRPT
U.S. Department of Transportation Federal Railroad Administration
www.DC2RVArail.com
DC TO RICHMOND SOUTHEAST HIGH SPEED RAIL


BEGIN ALTERNATIVE AREA 5 (CFP 19)
SEE ALTERNATIVE AREA 4 FOR IMPROVEMENTS
CFP 019
CFP 018
ADD ONE TRACK TO WEST BETWEEN NORTH OF KINGS DOMINION BOULEVARD AND NORTH OF VAUGHAN ROAD
CFP 017
W VAUGHAN ROAD/ HENRY STREET
CONSTRUCT CROSSOVER NORTH OF VAUGHAN ROAD
CFP 016
TOWN OF ASHLAND
ENGLAND STREET/ THOMPSON STREET
COLLEGE AVENUE/ HENRY CLAY STREET
CFP 015
Ashland Station (Amtrak) - CLOSED
EXISTING TRACKS BETWEEN NORTH OF VAUGHAN ROAD AND SOUTH OF ASHCAKE ROAD
CFP 014
ASHCAKE ROAD
Ashcake Station (Amtrak)
HANOVER COUNTY
ADD ONE TRACK TO THE EAST BETWEEN SOUTH OF ASHCAKE ROAD AND SOUTH OF GWATHMEY CHURCH ROAD
CFP 013
CFP 012
ADD ONE TRACK TO THE WEST BETWEEN SOUTH OF GWATHMEY CHURCH ROAD AND SOUTH OF HUNGARY ROAD
CONSTRUCT CROSSOVERS SOUTH OF ELMONT ROAD
CFP 011
CFP 010
END ALTERNATIVE AREA 5 (CFP 9)
CFP 009
SEE ALTERNATIVE AREA 6 FOR IMPROVEMENTS
0 0.5 1
Mile
Projection: Lambert Conformal Conic
State Plane Virginia North FIPS 4501 Feet
North American Datum of 1983
2015 ESRI World Topographic Map
Legend
CSXT Mileposts
Existing Stations
Proposed Stations
Track Improvements
Track - Existing
Track - Shift
Track - Proposed
Alternative Area Limits
Figure 2-10
Build Alternative 5A–Ashcake
Maintain Two Tracks Through Town (Relocate Station to Ashcake)
DRPT
U.S. Department of Transportation Federal Railroad Administration
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DC TO RICHMOND SOUTHEAST HIGH SPEED RAIL

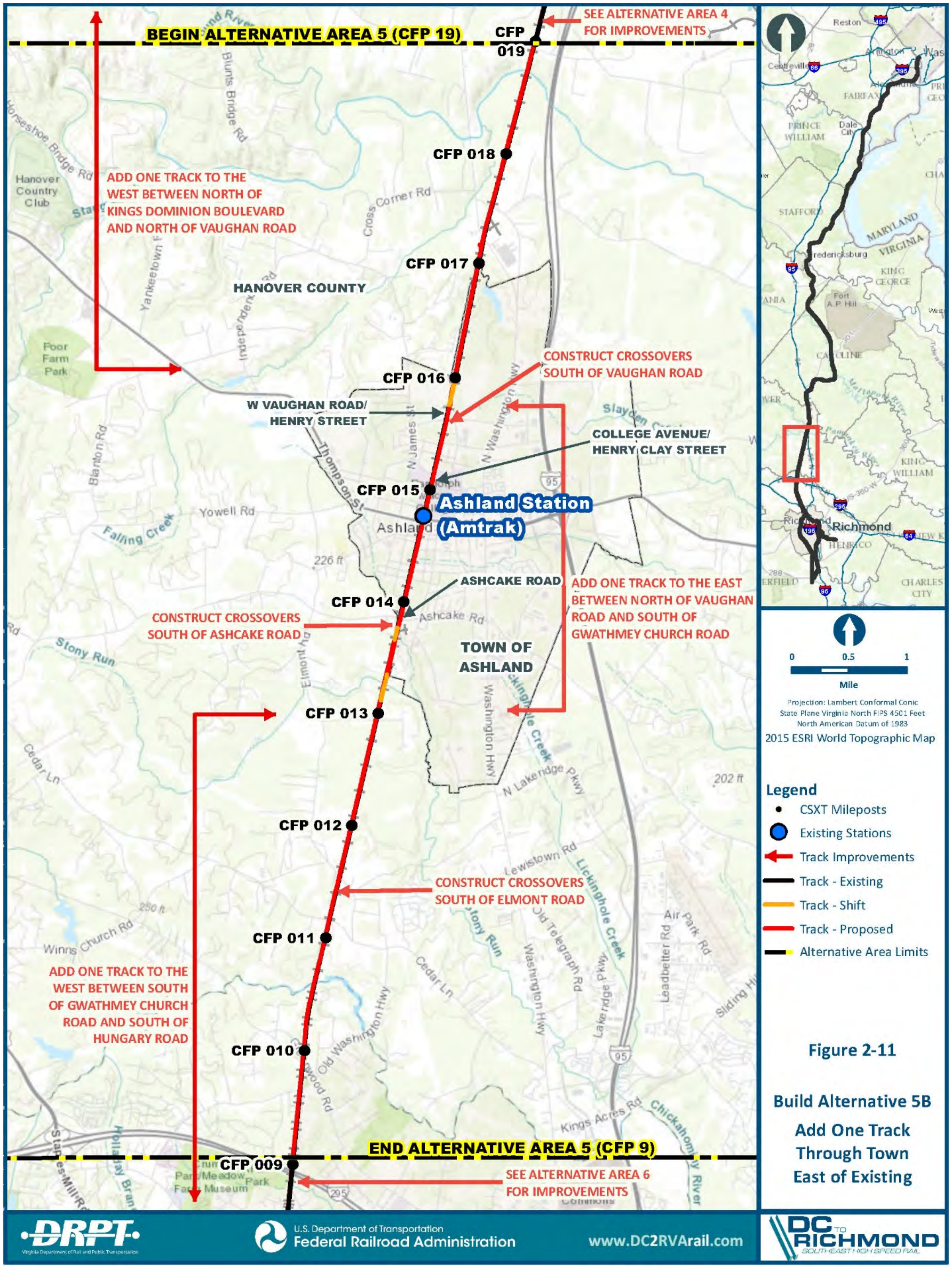


Figure 2-11

Build Alternative 5B
Add One Track Through Town East of Existing

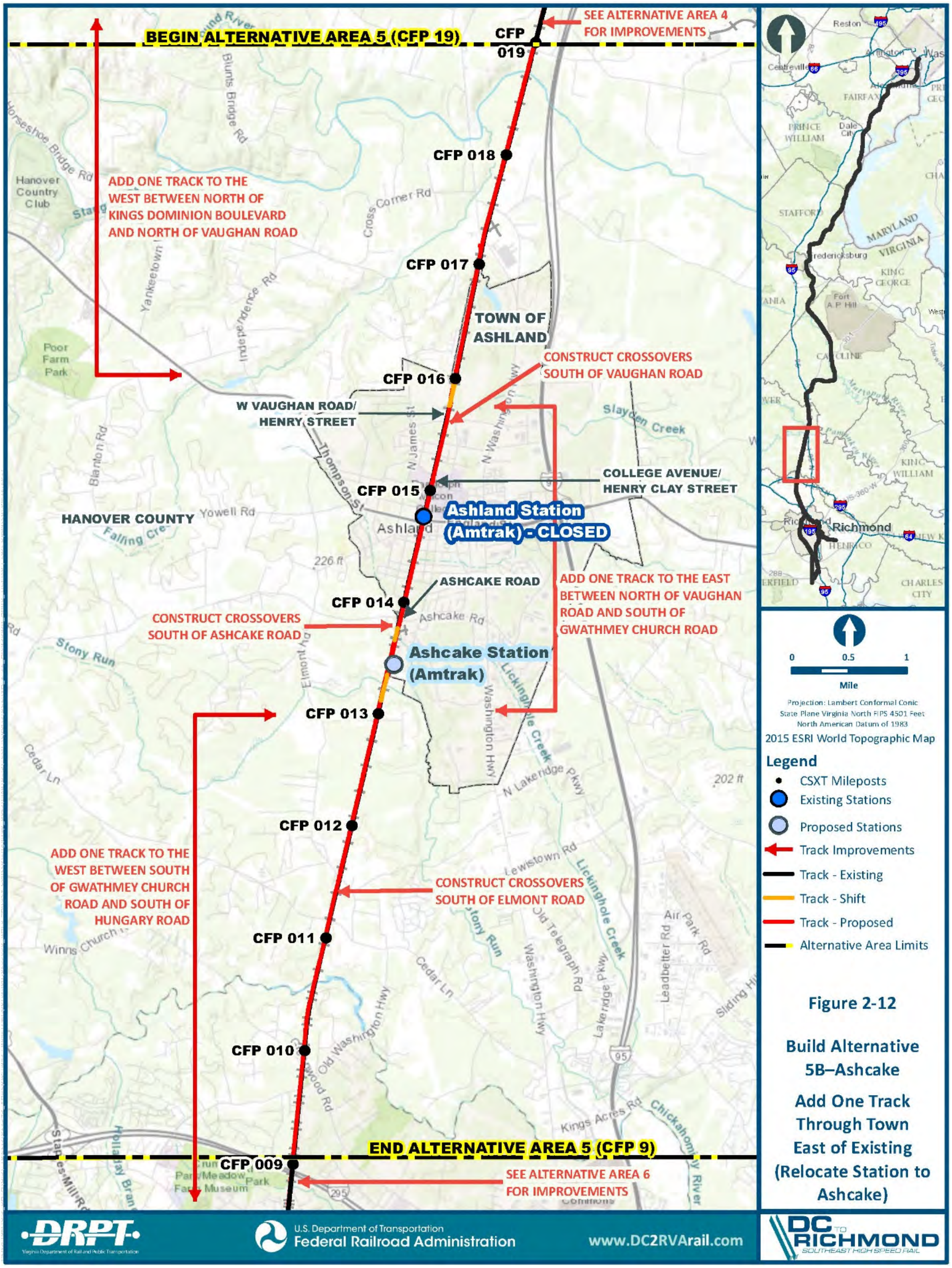
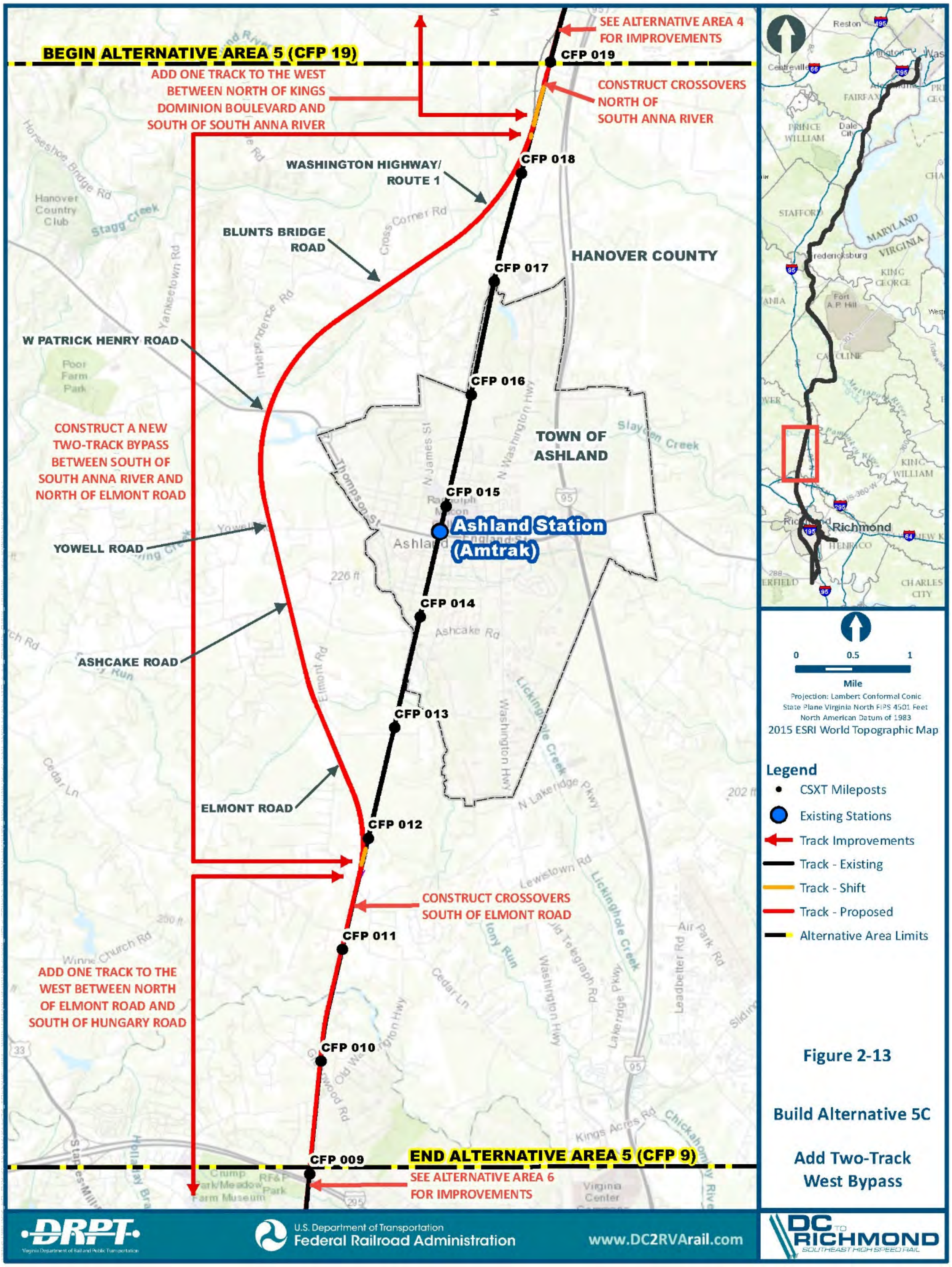


Figure 2-12

Build Alternative 5B–Ashcake

Add One Track Through Town East of Existing (Relocate Station to Ashcake)


BEGIN ALTERNATIVE AREA 5 (CFP 19)
SEE ALTERNATIVE AREA 4 FOR IMPROVEMENTS
CFP 019
ADD ONE TRACK TO THE WEST BETWEEN NORTH OF KINGS DOMINION BOULEVARD AND SOUTH OF SOUTH ANNA RIVER
CONSTRUCT CROSSOVERS NORTH OF SOUTH ANNA RIVER
CFP 018
WASHINGTON HIGHWAY/ ROUTE 1
BLUNTS BRIDGE ROAD
CFP 017
HANOVER COUNTY
W PATRICK HENRY ROAD
CFP 016
TOWN OF ASHLAND
CONSTRUCT A NEW TWO-TRACK BYPASS BETWEEN SOUTH OF SOUTH ANNA RIVER AND NORTH OF ELMONT ROAD
CFP 015
Ashland Station (Amtrak)
YOWELL ROAD
CFP 014
ASHCAKE ROAD
CFP 013
ELMONT ROAD
CFP 012
CONSTRUCT CROSSOVERS SOUTH OF ELMONT ROAD
CFP 011
ADD ONE TRACK TO THE WEST BETWEEN NORTH OF ELMONT ROAD AND SOUTH OF HUNGARY ROAD
CFP 010
CFP 009
END ALTERNATIVE AREA 5 (CFP 9)
SEE ALTERNATIVE AREA 6 FOR IMPROVEMENTS
Richmond
0 0.5 1
Mile
Projection: Lambert Conformal Conic
State Plane Virginia North FIPS 4501 Feet
North American Datum of 1983
2015 ESRI World Topographic Map
Legend
CSXT Mileposts
Existing Stations
Track Improvements
Track - Existing
Track - Shift
Track - Proposed
Alternative Area Limits
Figure 2-13
Build Alternative 5C
Add Two-Track West Bypass
DRPT
U.S. Department of Transportation Federal Railroad Administration
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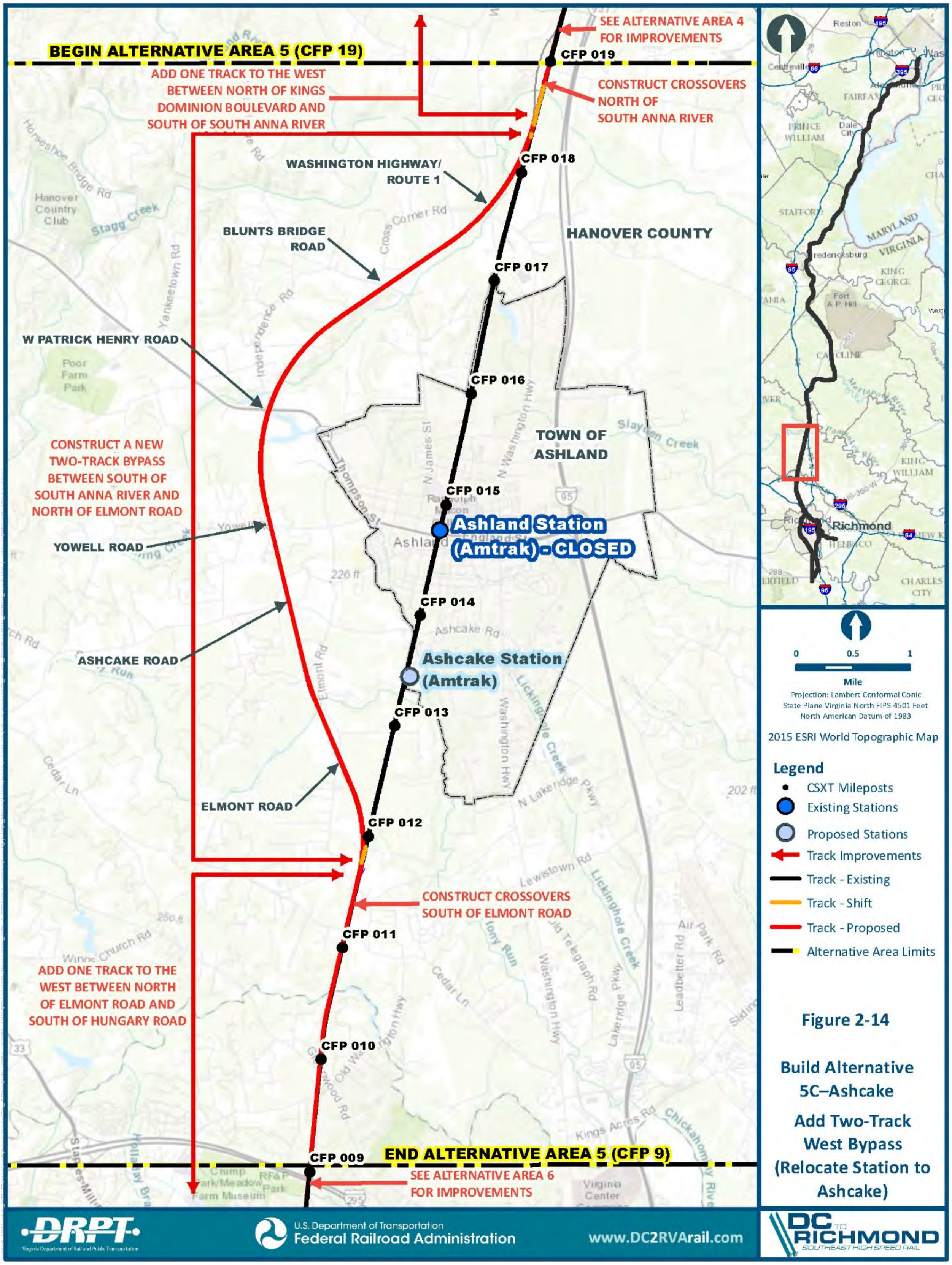
DC TO RICHMOND SOUTHEAST HIGH SPEED RAIL


BEGIN ALTERNATIVE AREA 5 (CFP 19)
SEE ALTERNATIVE AREA 4 FOR IMPROVEMENTS
CFP 019
ADD ONE TRACK TO THE WEST BETWEEN NORTH OF KINGS DOMINION BOULEVARD AND SOUTH OF SOUTH ANNA RIVER
CONSTRUCT CROSSOVERS NORTH OF SOUTH ANNA RIVER
CFP 018
WASHINGTON HIGHWAY/ ROUTE 1
HANOVER COUNTY
BLUNTS BRIDGE ROAD
CFP 017
W PATRICK HENRY ROAD
CFP 016
TOWN OF ASHLAND
CONSTRUCT A NEW TWO-TRACK BYPASS BETWEEN SOUTH OF SOUTH ANNA RIVER AND NORTH OF ELMONT ROAD
CFP 015
Ashland Station (Amtrak) - CLOSED
YOWELL ROAD
CFP 014
ASHCAKE ROAD
Ashcake Station (Amtrak)
CFP 013
ELMONT ROAD
CFP 012
CONSTRUCT CROSSOVERS SOUTH OF ELMONT ROAD
CFP 011
ADD ONE TRACK TO THE WEST BETWEEN NORTH OF ELMONT ROAD AND SOUTH OF HUNGARY ROAD
CFP 010
CFP 009
END ALTERNATIVE AREA 5 (CFP 9)
SEE ALTERNATIVE AREA 6 FOR IMPROVEMENTS
0 0.5 1
Mile
Projection: Lambert Conformal Conic
State Plane Virginia North FIPS 4501 Feet
North American Datum of 1983
2015 ESRI World Topographic Map
Legend
CSXT Mileposts
Existing Stations
Proposed Stations
Track Improvements
Track - Existing
Track - Shift
Track - Proposed
Alternative Area Limits
Figure 2-14
Build Alternative 5C–Ashcake
Add Two-Track West Bypass (Relocate Station to Ashcake)
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U.S. Department of Transportation Federal Railroad Administration
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DC TO RICHMOND SOUTHEAST HIGH SPEED RAIL

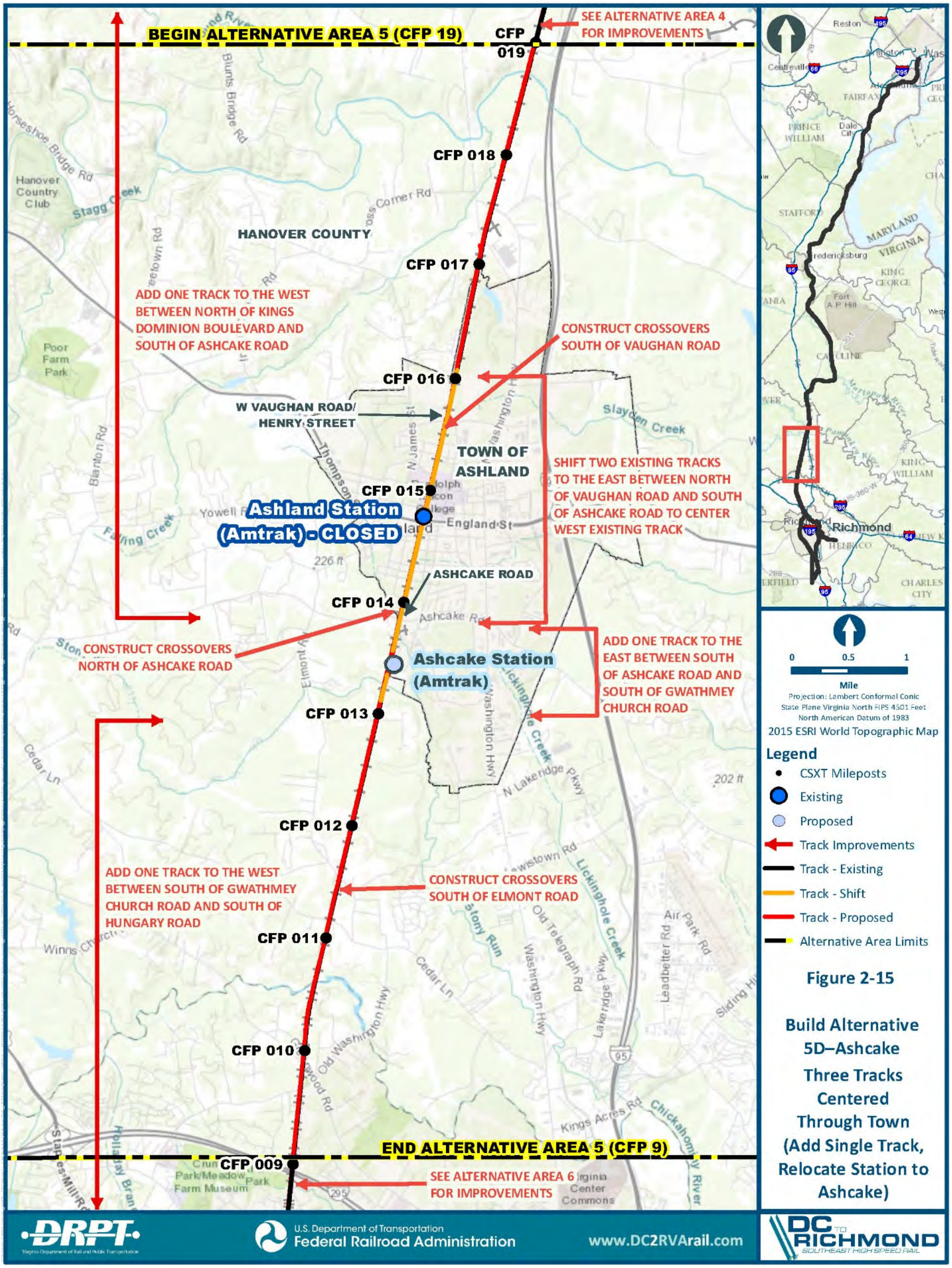


Figure 2-15

Build Alternative 5D–Ashcake Three Tracks Centered Through Town (Add Single Track, Relocate Station to Ashcake)

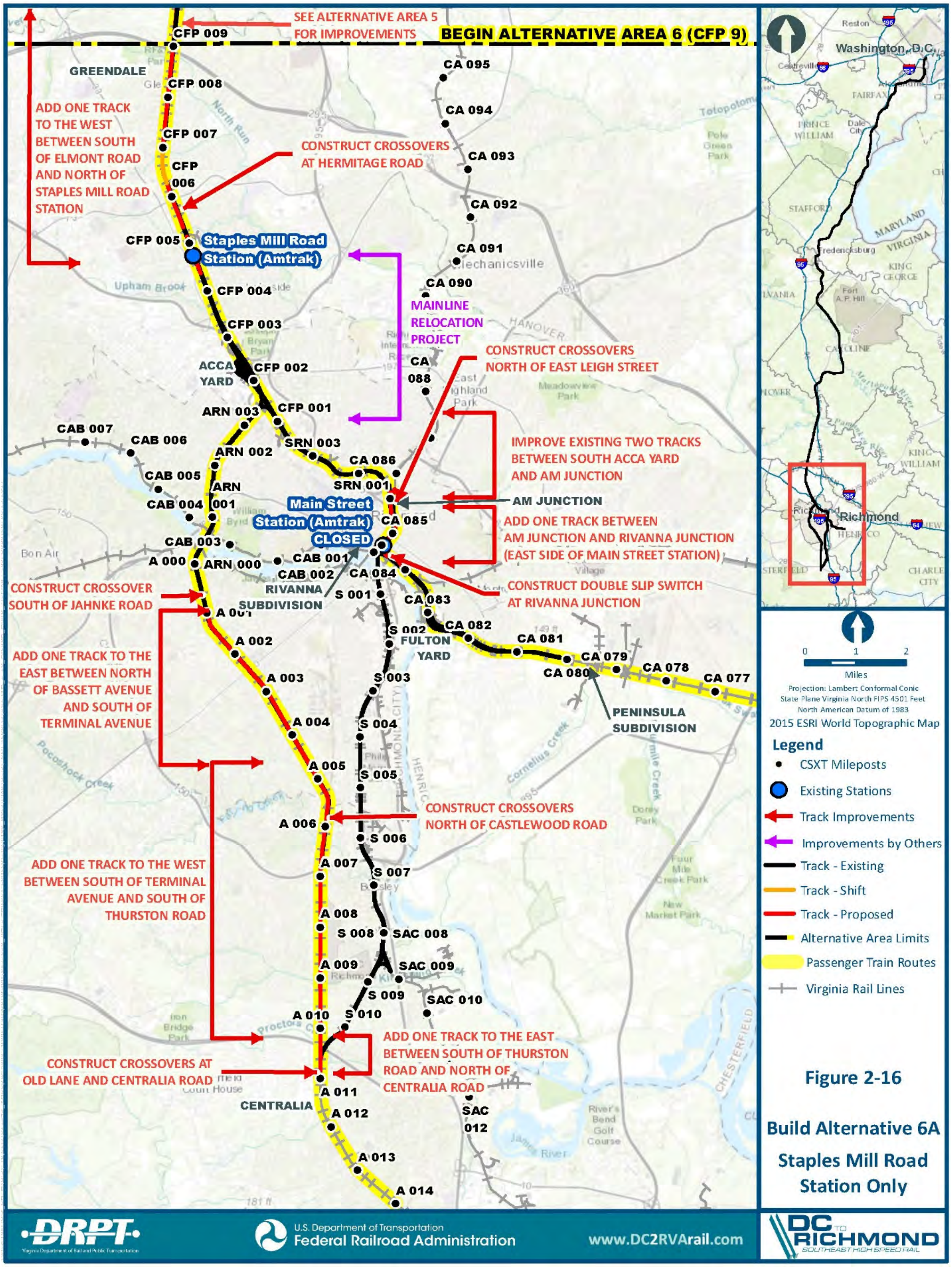


Figure 2-16

Build Alternative 6A

Staples Mill Road Station Only

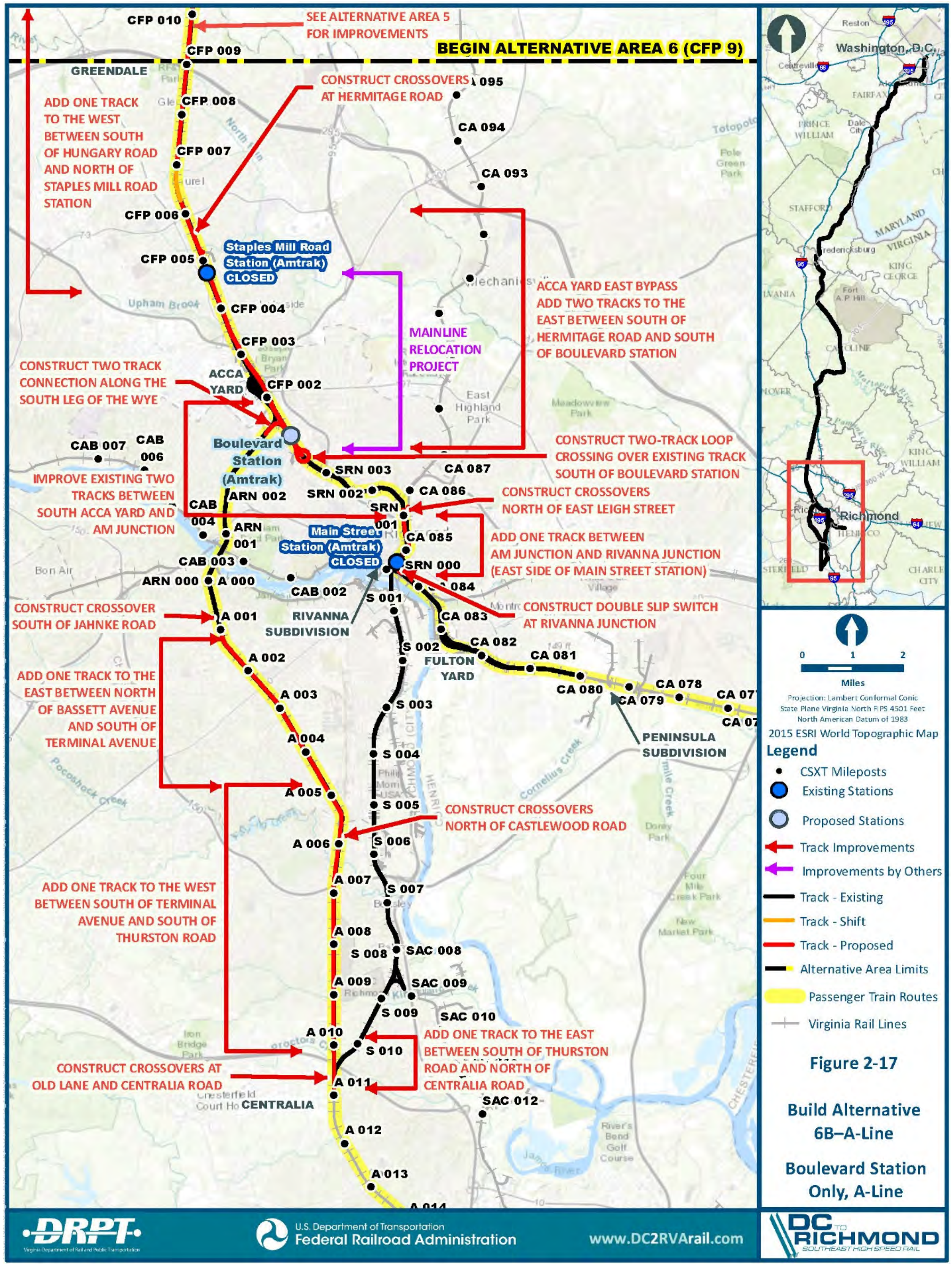
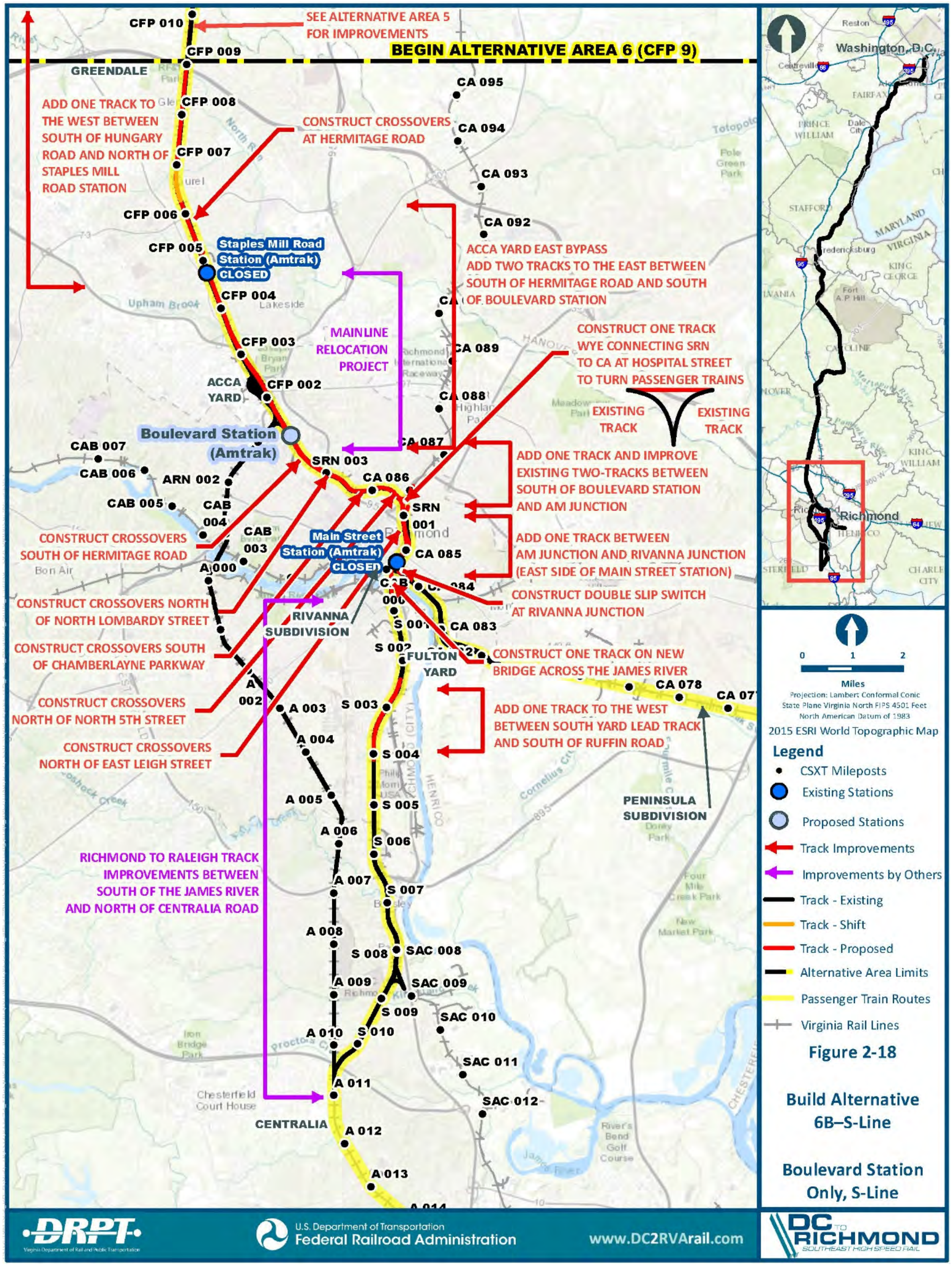


Figure 2-17

Build Alternative 6B–A-Line

Boulevard Station Only, A-Line



SEE ALTERNATIVE AREA 5 FOR IMPROVEMENTS
BEGIN ALTERNATIVE AREA 6 (CFP 9)
GREENDALE
ADD ONE TRACK TO THE WEST BETWEEN SOUTH OF HUNGARY ROAD AND NORTH OF STAPLES MILL ROAD STATION
CONSTRUCT CROSSOVERS AT HERMITAGE ROAD
Staples Mill Road Station (Amtrak) CLOSED
MAINLINE RELOCATION PROJECT
ACCA YARD EAST BYPASS ADD TWO TRACKS TO THE EAST BETWEEN SOUTH OF HERMITAGE ROAD AND SOUTH OF BOULEVARD STATION
CONSTRUCT ONE TRACK WYE CONNECTING SRN TO CA AT HOSPITAL STREET TO TURN PASSENGER TRAINS
EXISTING TRACK
EXISTING TRACK
ACCA YARD
Boulevard Station (Amtrak)
ADD ONE TRACK AND IMPROVE EXISTING TWO-TRACKS BETWEEN SOUTH OF BOULEVARD STATION AND AM JUNCTION
ADD ONE TRACK BETWEEN AM JUNCTION AND RIVANNA JUNCTION (EAST SIDE OF MAIN STREET STATION)
Main Street Station (Amtrak) CLOSED
CONSTRUCT CROSSOVERS SOUTH OF HERMITAGE ROAD
CONSTRUCT CROSSOVERS NORTH OF NORTH LOMBARDY STREET
CONSTRUCT CROSSOVERS SOUTH OF CHAMBERLAYNE PARKWAY
CONSTRUCT CROSSOVERS NORTH OF NORTH 5TH STREET
CONSTRUCT CROSSOVERS NORTH OF EAST LEIGH STREET
CONSTRUCT DOUBLE SLIP SWITCH AT RIVANNA JUNCTION
RIVANNA SUBDIVISION
FULTON YARD
CONSTRUCT ONE TRACK ON NEW BRIDGE ACROSS THE JAMES RIVER
ADD ONE TRACK TO THE WEST BETWEEN SOUTH YARD LEAD TRACK AND SOUTH OF RUFFIN ROAD
PENINSULA SUBDIVISION
RICHMOND TO RALEIGH TRACK IMPROVEMENTS BETWEEN SOUTH OF THE JAMES RIVER AND NORTH OF CENTRALIA ROAD
CENTRALIA
CFP 010
CFP 009
CFP 008
CFP 007
CFP 006
CFP 005
CFP 004
CFP 003
CFP 002
CA 095
CA 094
CA 093
CA 092
CA 089
CA 088
CA 087
CA 086
CA 085
CA 083
CA 078
CAB 007
CAB 006
CAB 005
CAB 004
CAB 003
ARN 002
SRN 003
SRN
A 000
A 002
A 003
A 004
A 005
A 006
A 007
A 008
A 009
A 010
A 011
A 012
A 013
S 002
S 003
S 004
S 005
S 006
S 007
S 008
S 009
S 010
SAC 008
SAC 009
SAC 010
SAC 011
SAC 012
Washington, D.C.
Richmond
MARYLAND
VIRGINIA
0 1 2
Miles
Projection: Lambert Conformal Conic
State Plane Virginia North FIPS 4501 Feet
North American Datum of 1983
2015 ESRI World Topographic Map
Legend
CSXT Mileposts
Existing Stations
Proposed Stations
Track Improvements
Improvements by Others
Track - Existing
Track - Shift
Track - Proposed
Alternative Area Limits
Passenger Train Routes
Virginia Rail Lines
Figure 2-18
Build Alternative 6B–S-Line
Boulevard Station Only, S-Line
DRPT
U.S. Department of Transportation
Federal Railroad Administration
www.DC2RVArail.com
DC TO RICHMOND SOUTHEAST HIGH SPEED RAIL

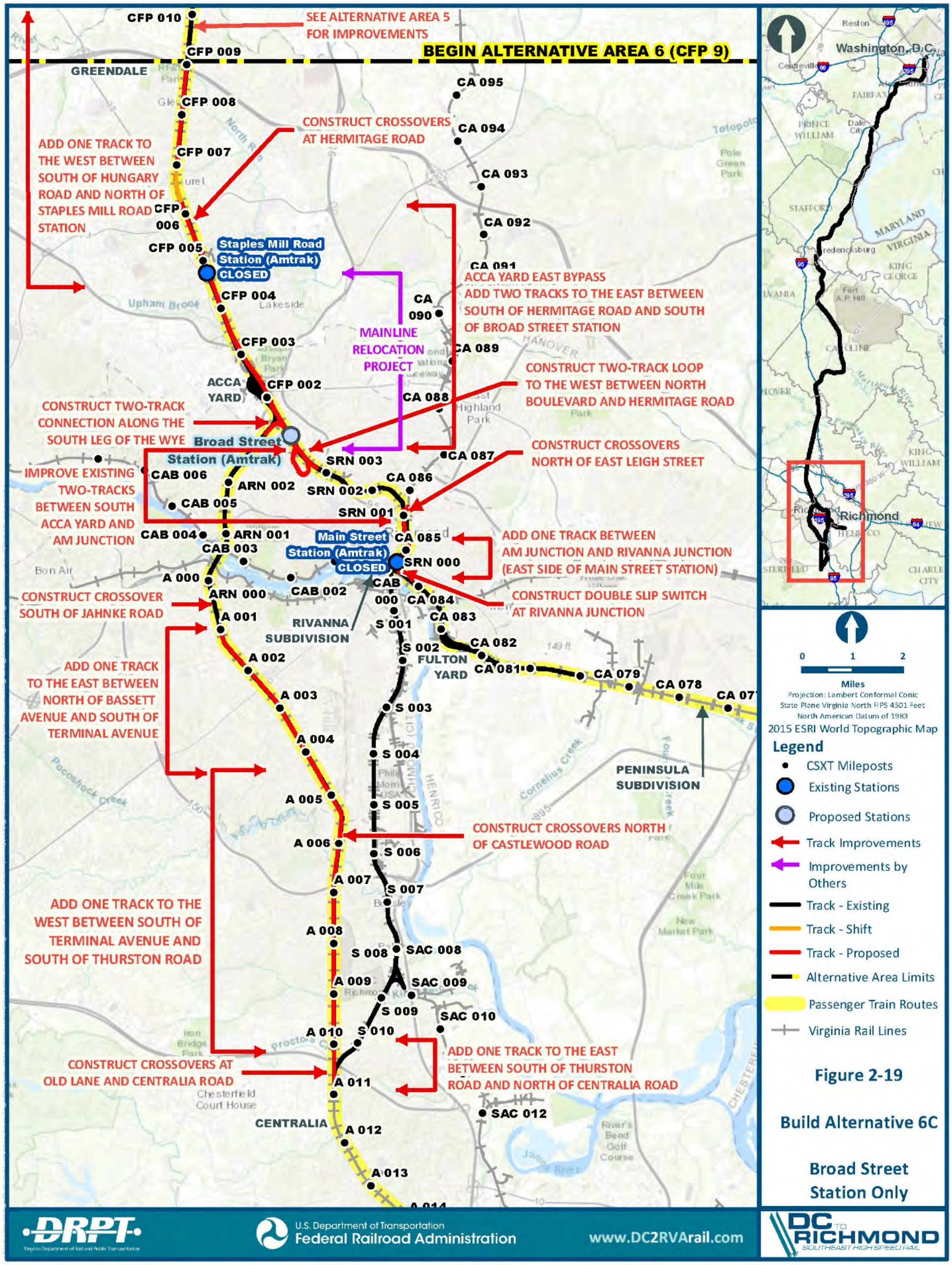


Figure 2-19

Build Alternative 6C

Broad Street Station Only

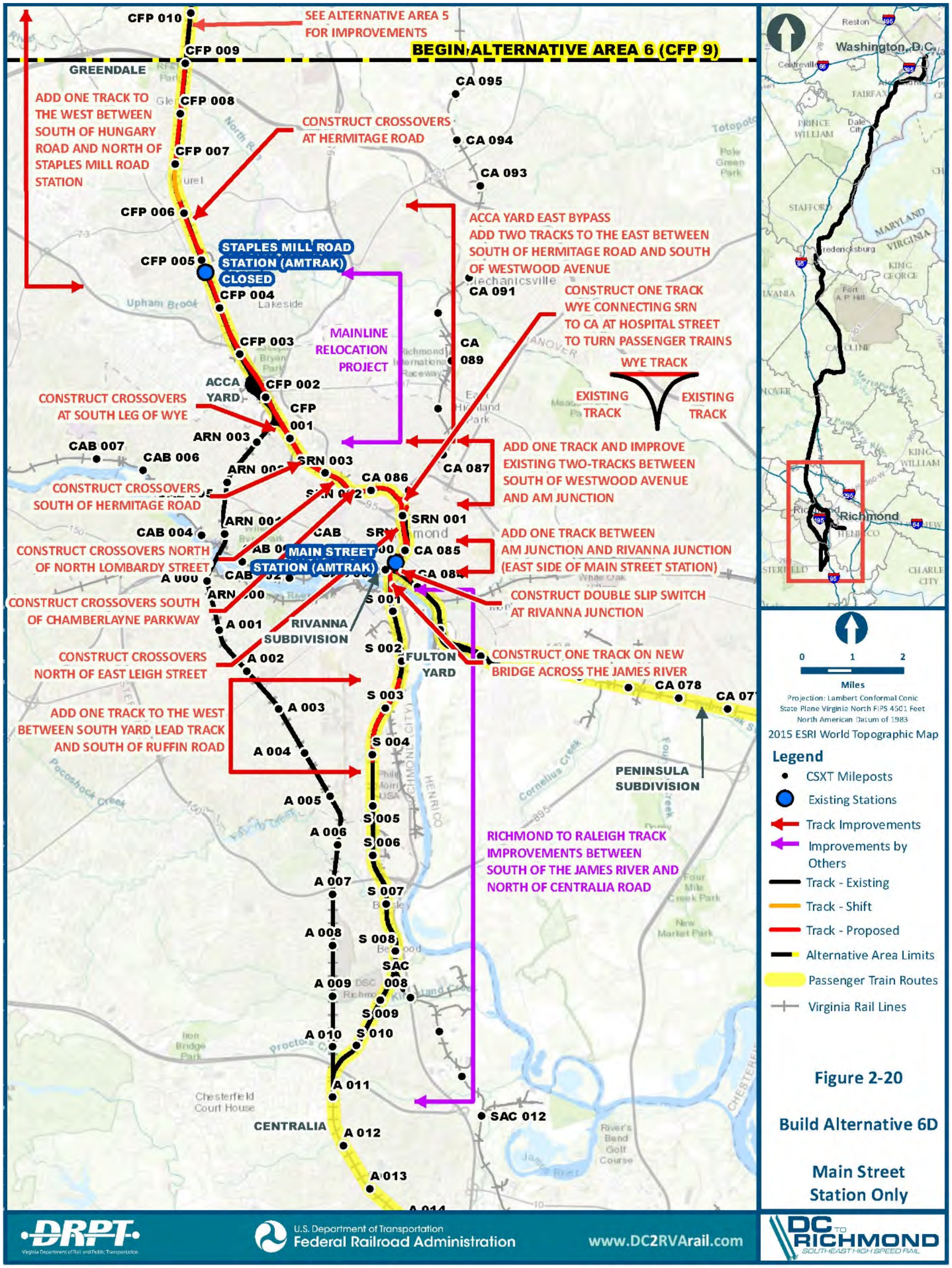


Figure 2-20

Build Alternative 6D

Main Street Station Only

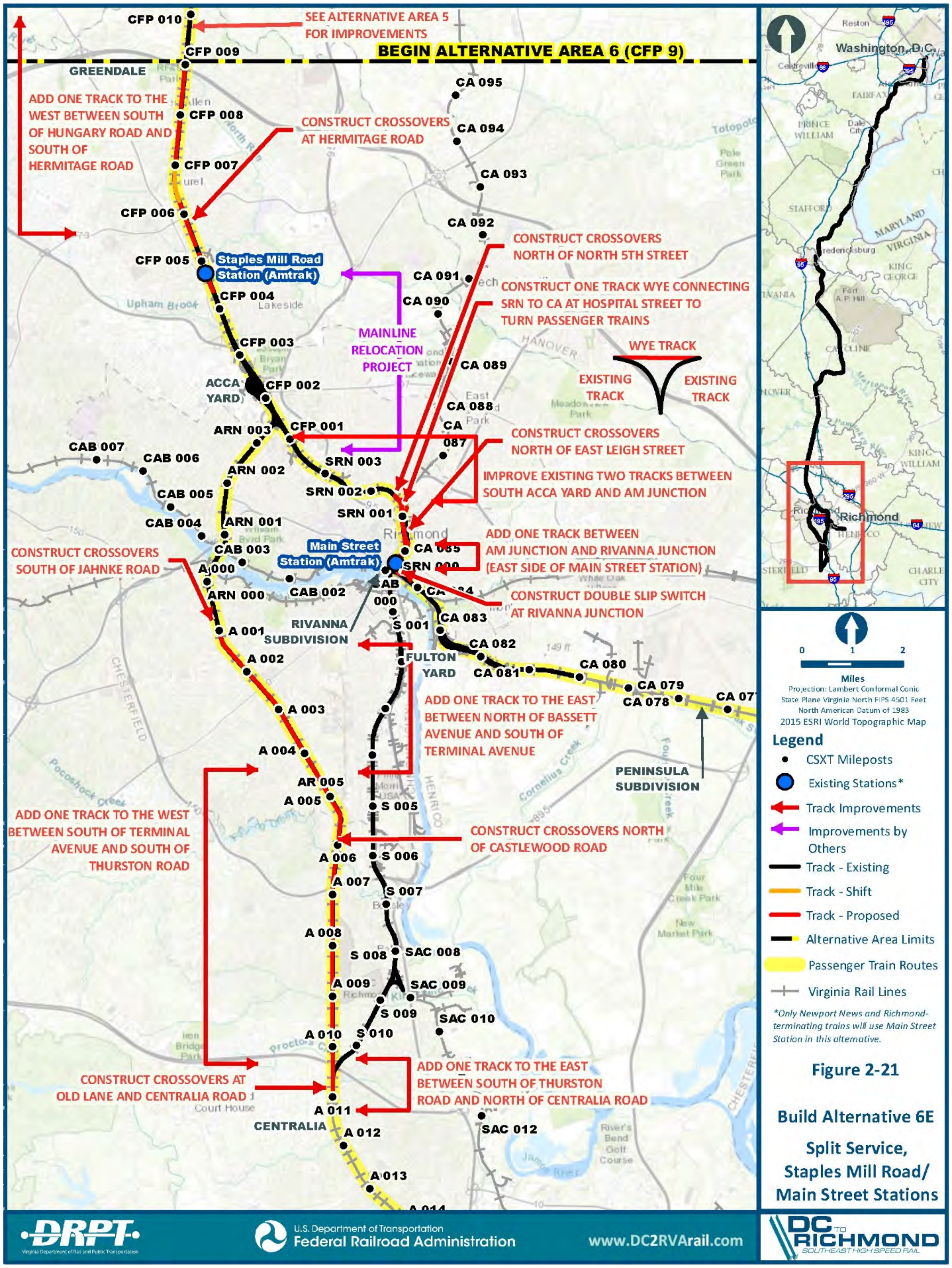
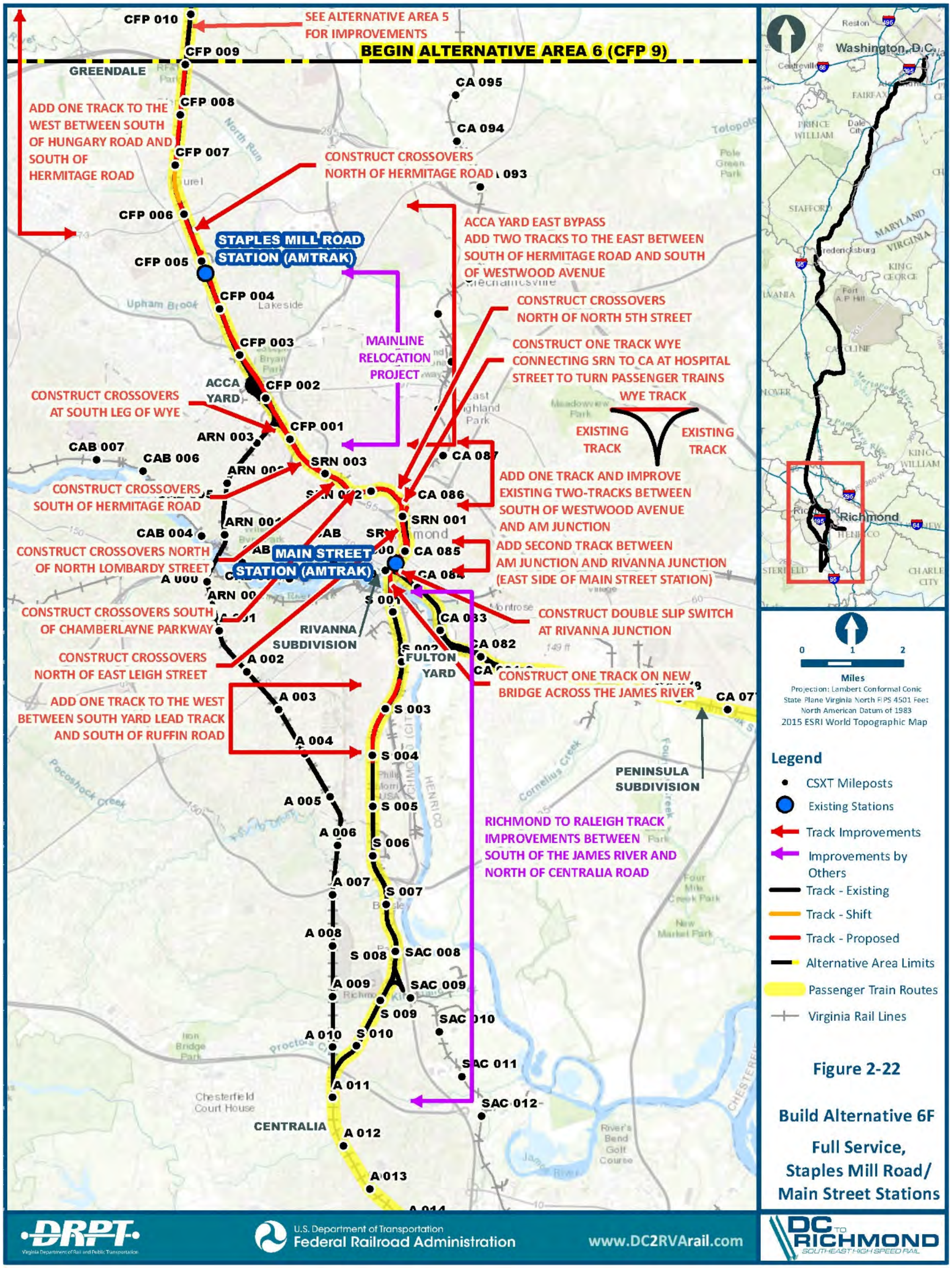


Figure 2-21

Build Alternative 6E

Split Service, Staples Mill Road/ Main Street Stations


BEGIN ALTERNATIVE AREA 6 (CFP 9)
SEE ALTERNATIVE AREA 5 FOR IMPROVEMENTS
ADD ONE TRACK TO THE WEST BETWEEN SOUTH OF HUNGARY ROAD AND SOUTH OF HERMITAGE ROAD
CONSTRUCT CROSSOVERS NORTH OF HERMITAGE ROAD
ACCA YARD EAST BYPASS ADD TWO TRACKS TO THE EAST BETWEEN SOUTH OF HERMITAGE ROAD AND SOUTH OF WESTWOOD AVENUE
STAPLES MILL ROAD STATION (AMTRAK)
CONSTRUCT CROSSOVERS NORTH OF NORTH 5TH STREET
MAINLINE RELOCATION PROJECT
CONSTRUCT ONE TRACK WYE CONNECTING SRN TO CA AT HOSPITAL STREET TO TURN PASSENGER TRAINS
WYE TRACK
EXISTING TRACK
EXISTING TRACK
CONSTRUCT CROSSOVERS AT SOUTH LEG OF WYE
ADD ONE TRACK AND IMPROVE EXISTING TWO-TRACKS BETWEEN SOUTH OF WESTWOOD AVENUE AND AM JUNCTION
CONSTRUCT CROSSOVERS SOUTH OF HERMITAGE ROAD
ADD SECOND TRACK BETWEEN AM JUNCTION AND RIVANNA JUNCTION (EAST SIDE OF MAIN STREET STATION)
CONSTRUCT CROSSOVERS NORTH OF NORTH LOMBARDY STREET
MAIN STREET STATION (AMTRAK)
CONSTRUCT CROSSOVERS SOUTH OF CHAMBERLAYNE PARKWAY
CONSTRUCT DOUBLE SLIP SWITCH AT RIVANNA JUNCTION
RIVANNA SUBDIVISION
CONSTRUCT CROSSOVERS NORTH OF EAST LEIGH STREET
FULTON YARD
CONSTRUCT ONE TRACK ON NEW BRIDGE ACROSS THE JAMES RIVER
ADD ONE TRACK TO THE WEST BETWEEN SOUTH YARD LEAD TRACK AND SOUTH OF RUFFIN ROAD
PENINSULA SUBDIVISION
RICHMOND TO RALEIGH TRACK IMPROVEMENTS BETWEEN SOUTH OF THE JAMES RIVER AND NORTH OF CENTRALIA ROAD
GREENDALE
ACCA YARD
CENTRALIA
CFP 010
CFP 009
CFP 008
CFP 007
CFP 006
CFP 005
CFP 004
CFP 003
CFP 002
CFP 001
CA 095
CA 094
CA 086
CA 085
CA 082
SRN 003
SRN 001
ARN 003
CAB 007
CAB 006
CAB 004
A 002
A 003
A 004
A 005
A 006
A 007
A 008
A 009
A 010
A 011
A 012
A 013
S 003
S 004
S 005
S 006
S 007
S 008
S 009
S 010
SAC 008
SAC 009
SAC 011
SAC 012
Washington, D.C.
Richmond
Miles
Projection: Lambert Conformal Conic
State Plane Virginia North FIPS 4501 Feet
North American Datum of 1983
2015 ESRI World Topographic Map
Legend
CSXT Mileposts
Existing Stations
Track Improvements
Improvements by Others
Track - Existing
Track - Shift
Track - Proposed
Alternative Area Limits
Passenger Train Routes
Virginia Rail Lines
Figure 2-22
Build Alternative 6F
Full Service, Staples Mill Road/ Main Street Stations
U.S. Department of Transportation
Federal Railroad Administration
www.DC2RVArail.com
DC TO RICHMOND SOUTHEAST HIGH SPEED RAIL

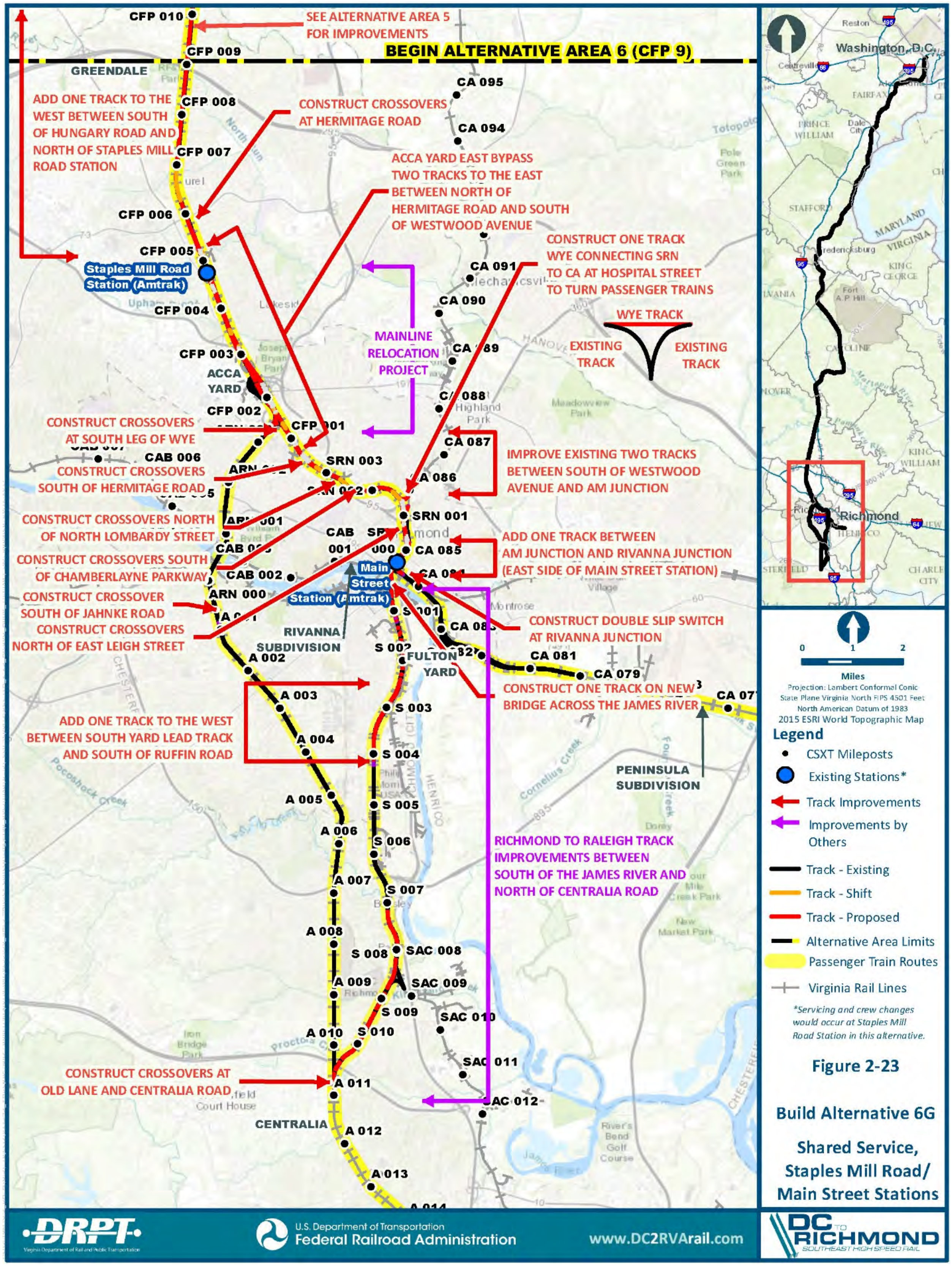


Figure 2-23
Build Alternative 6G
Shared Service, Staples Mill Road/ Main Street Stations

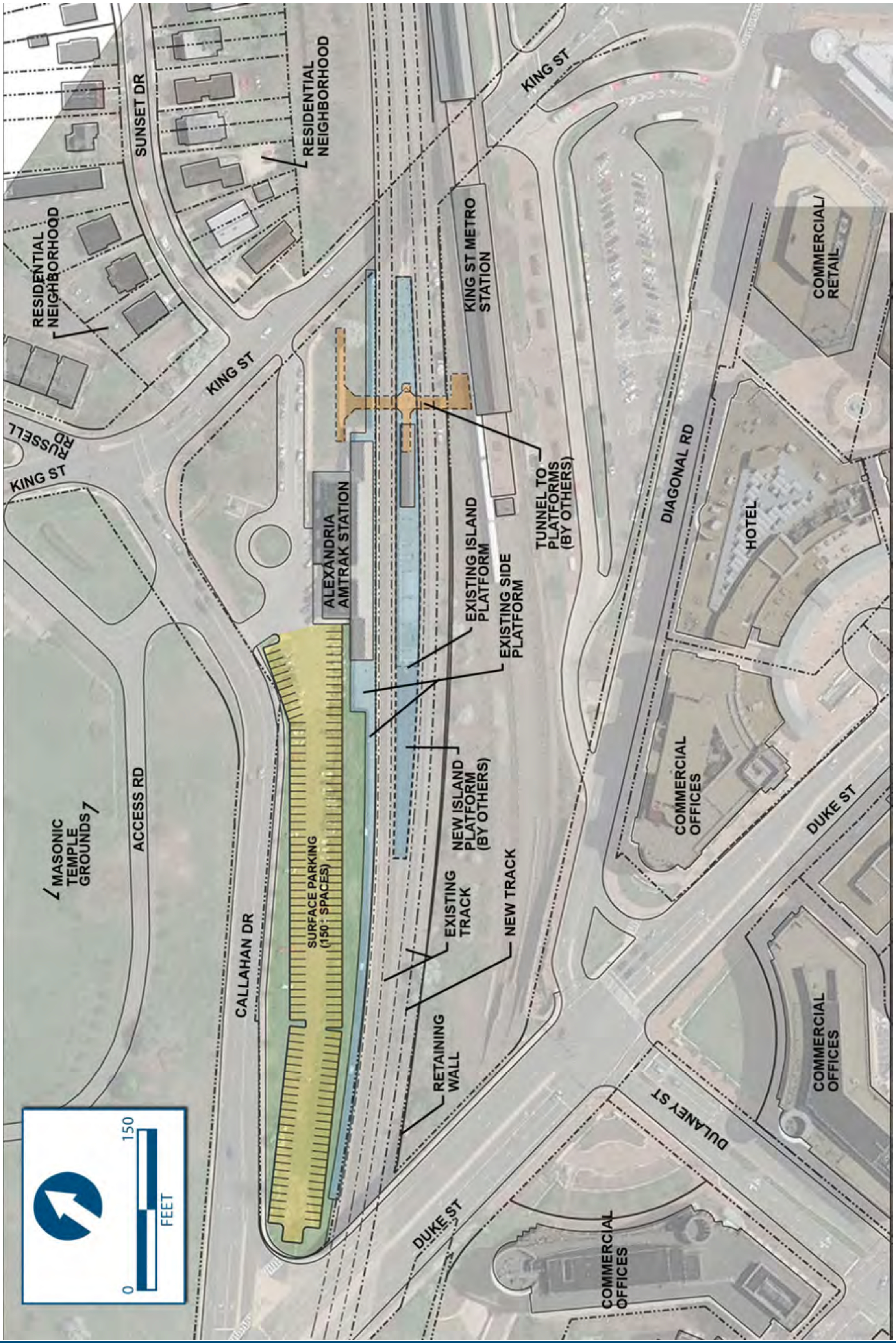


Figure 2-24: Alexandria Station Improvements for Build Alternative 2A

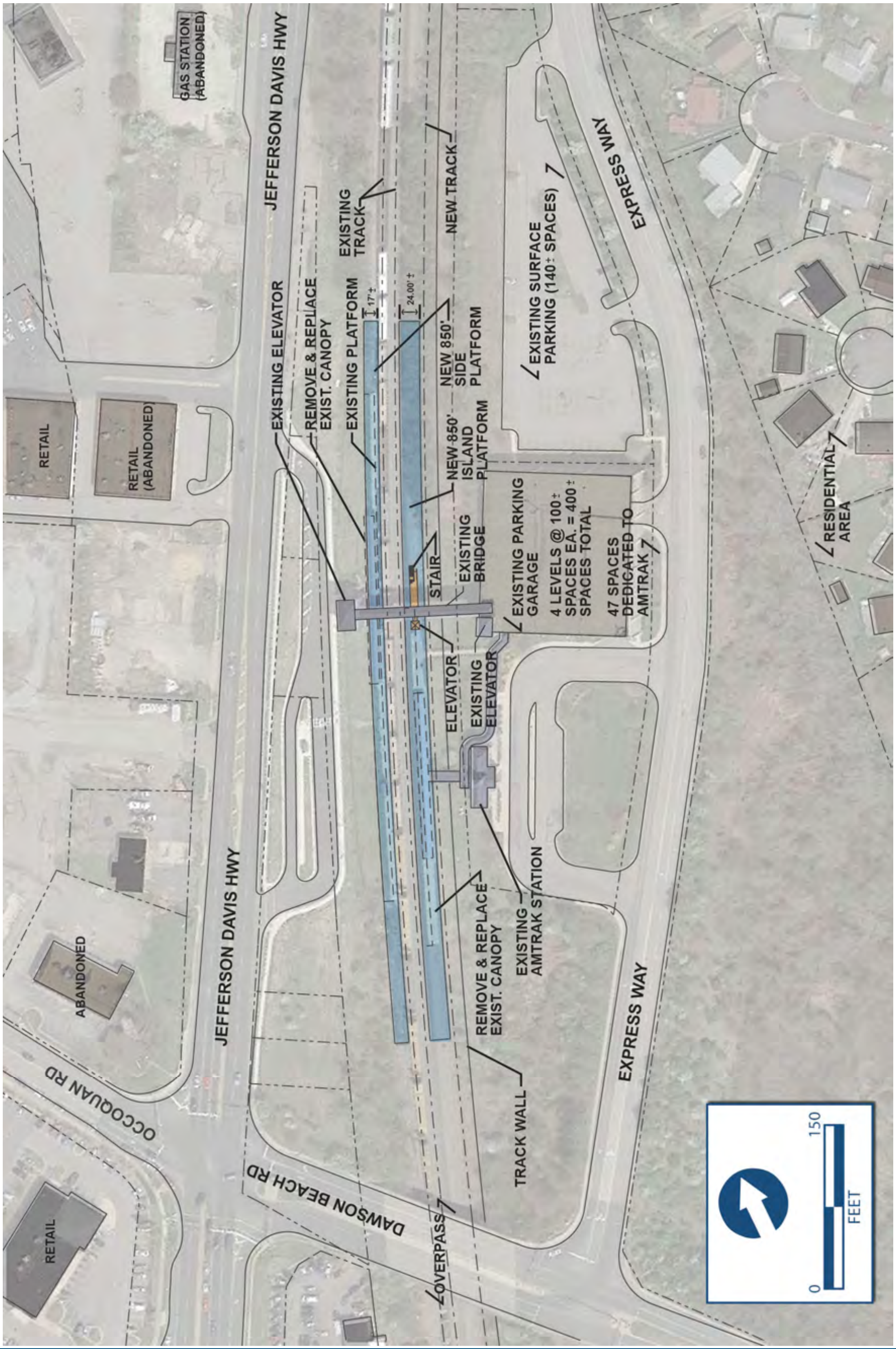


Figure 2-25: Woodbridge Station Improvements for Build Alternative 2A

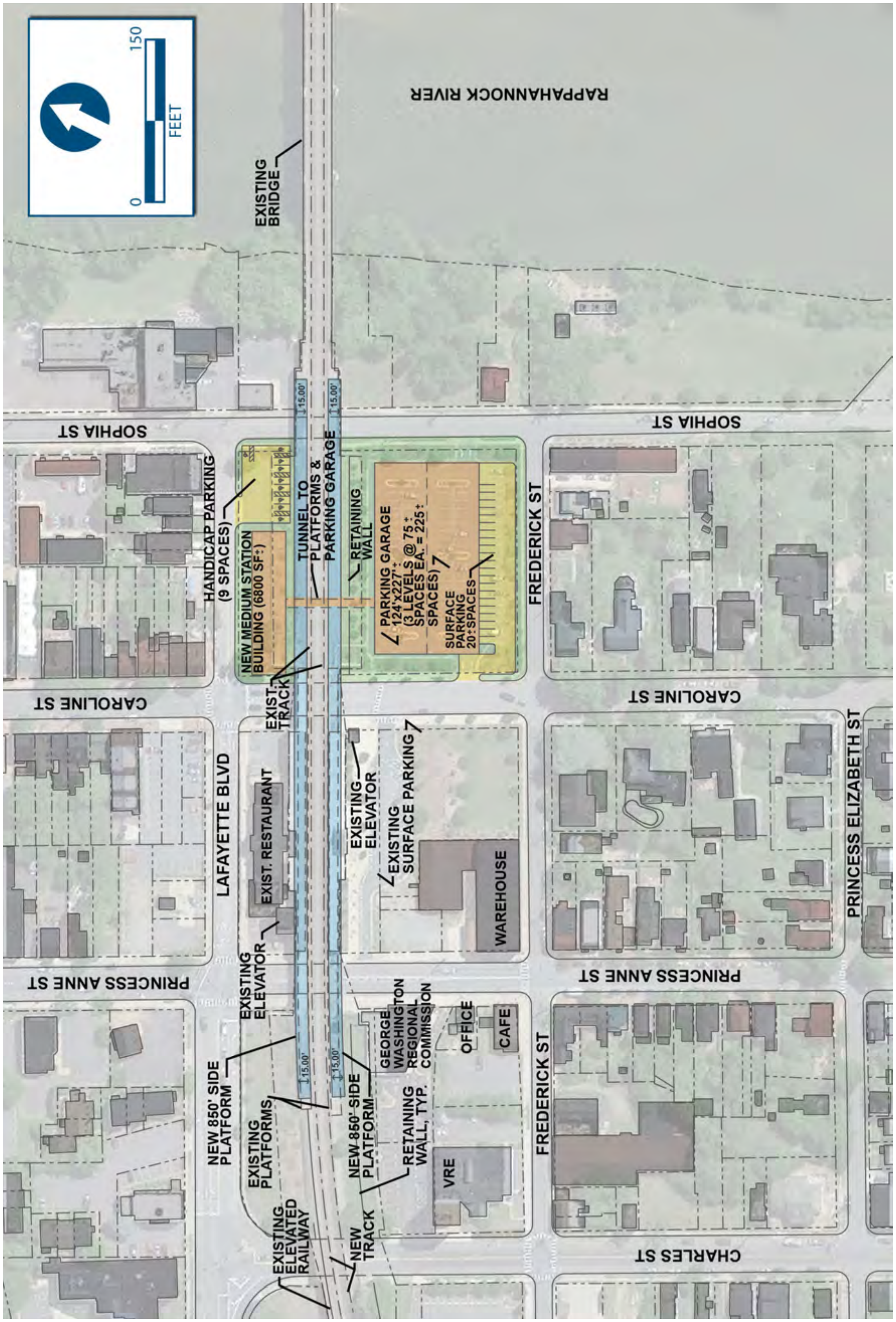


Figure 2-26: Fredericksburg Station Improvements for Build Alternatives 3A and 3C

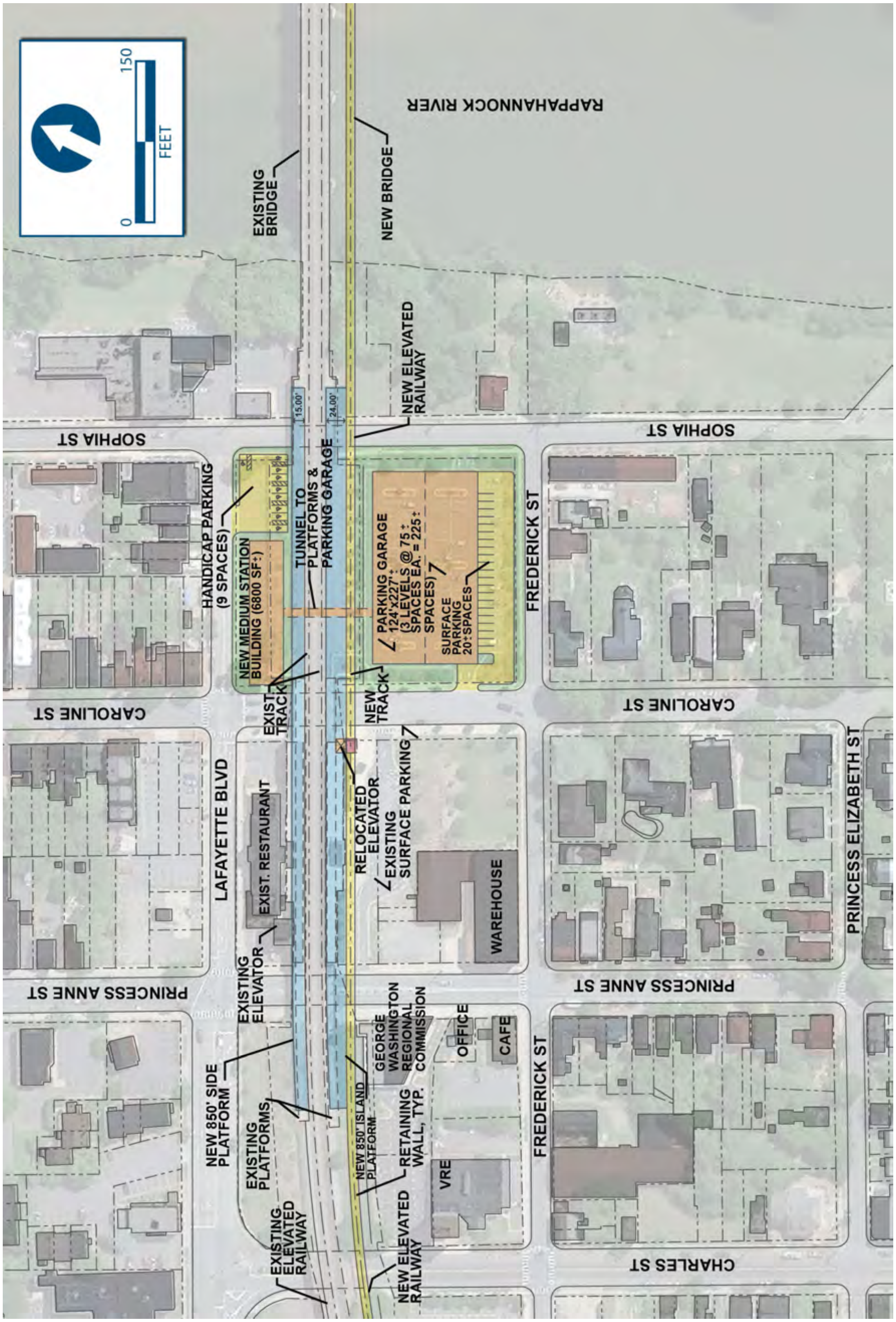


Figure 2-27 Fredericksburg Station Improvements for Build Alternative 3B

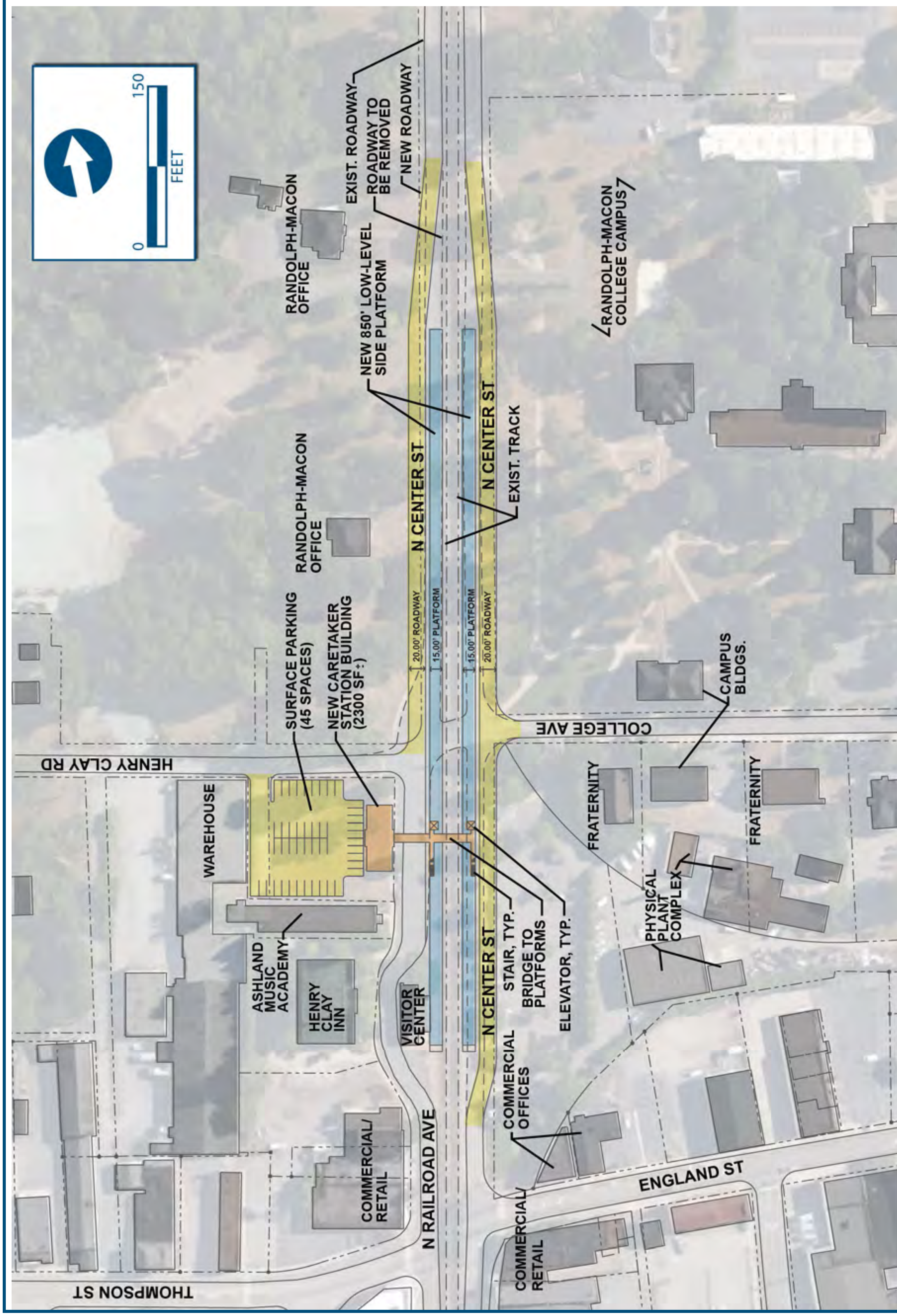


Figure 2-28A: Ashland Station Improvements for Build Alternatives 5A and 5C (Two-Track/850-Foot Platforms)

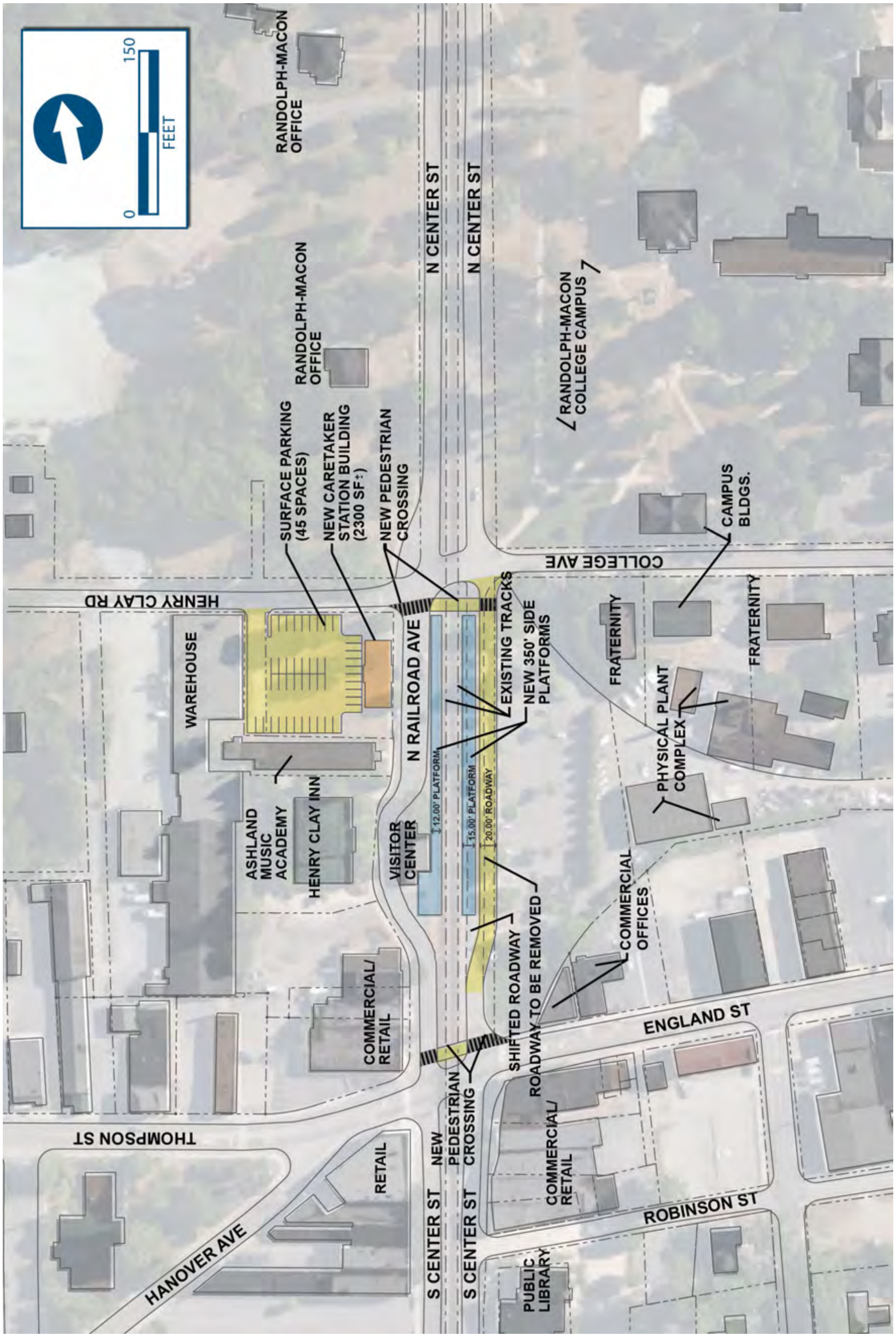


Figure 2-28B: Ashland Station Improvements for Build Alternatives 5A and 5C (Two-Track/350-Foot Platforms)

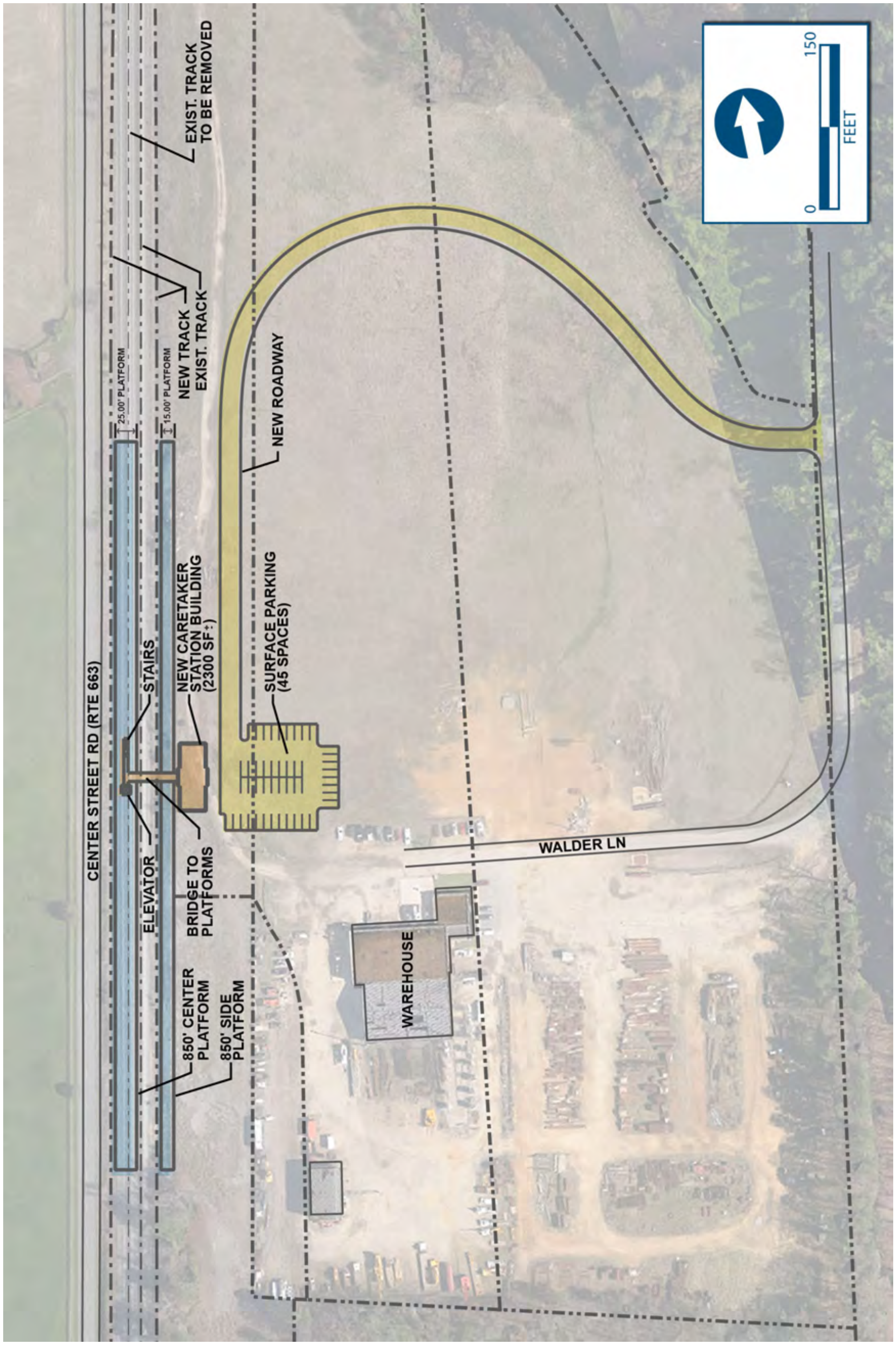


Figure 2-29: Ashcake Station Improvements for Build Alternatives 5A–Ashcake, 5B–Ashcake, 5C–Ashcake, and 5D–Ashcake

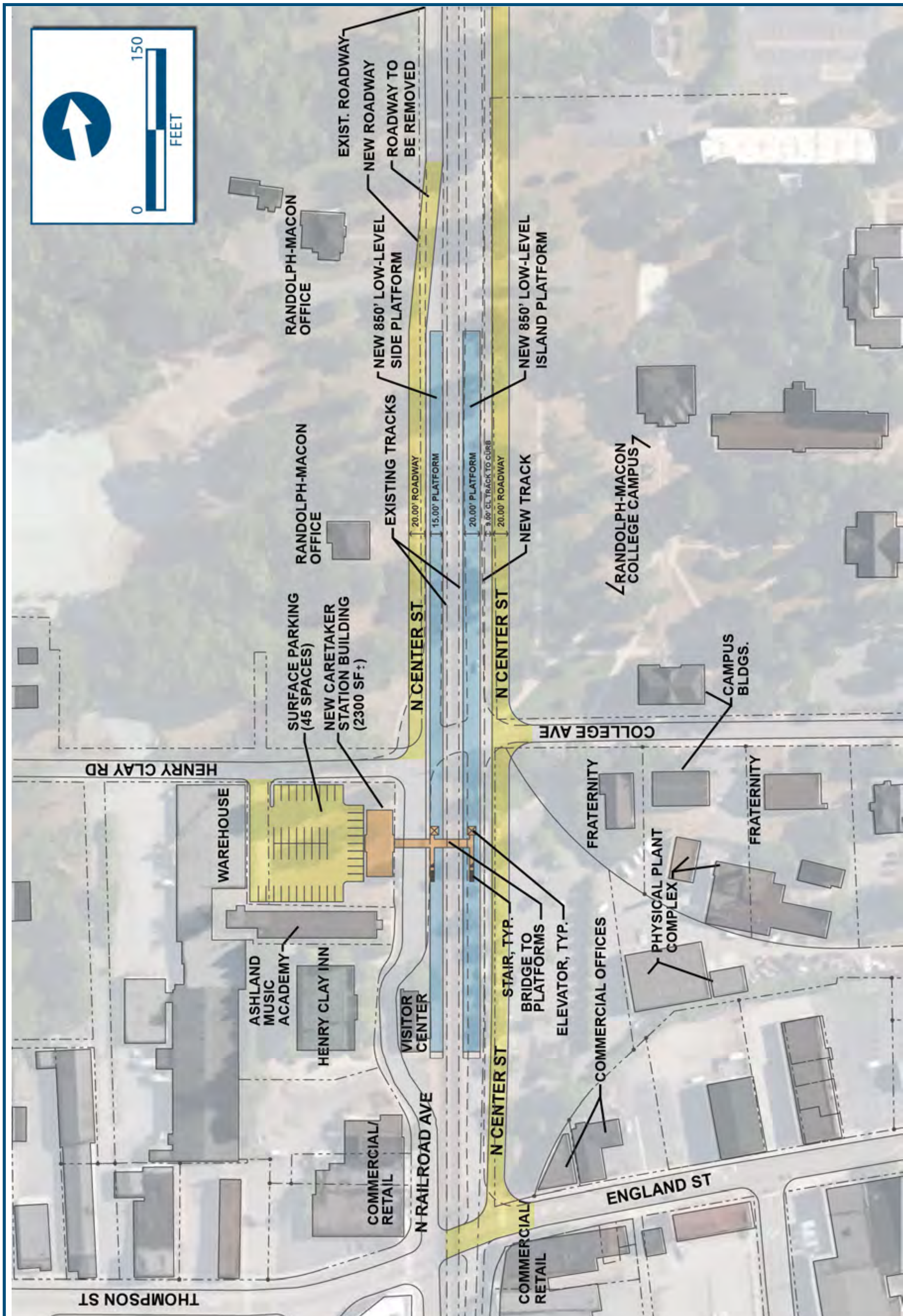


Figure 2-30A: Ashland Station Improvements for Build Alternative 5B (Three-Track/850-Foot Platforms)

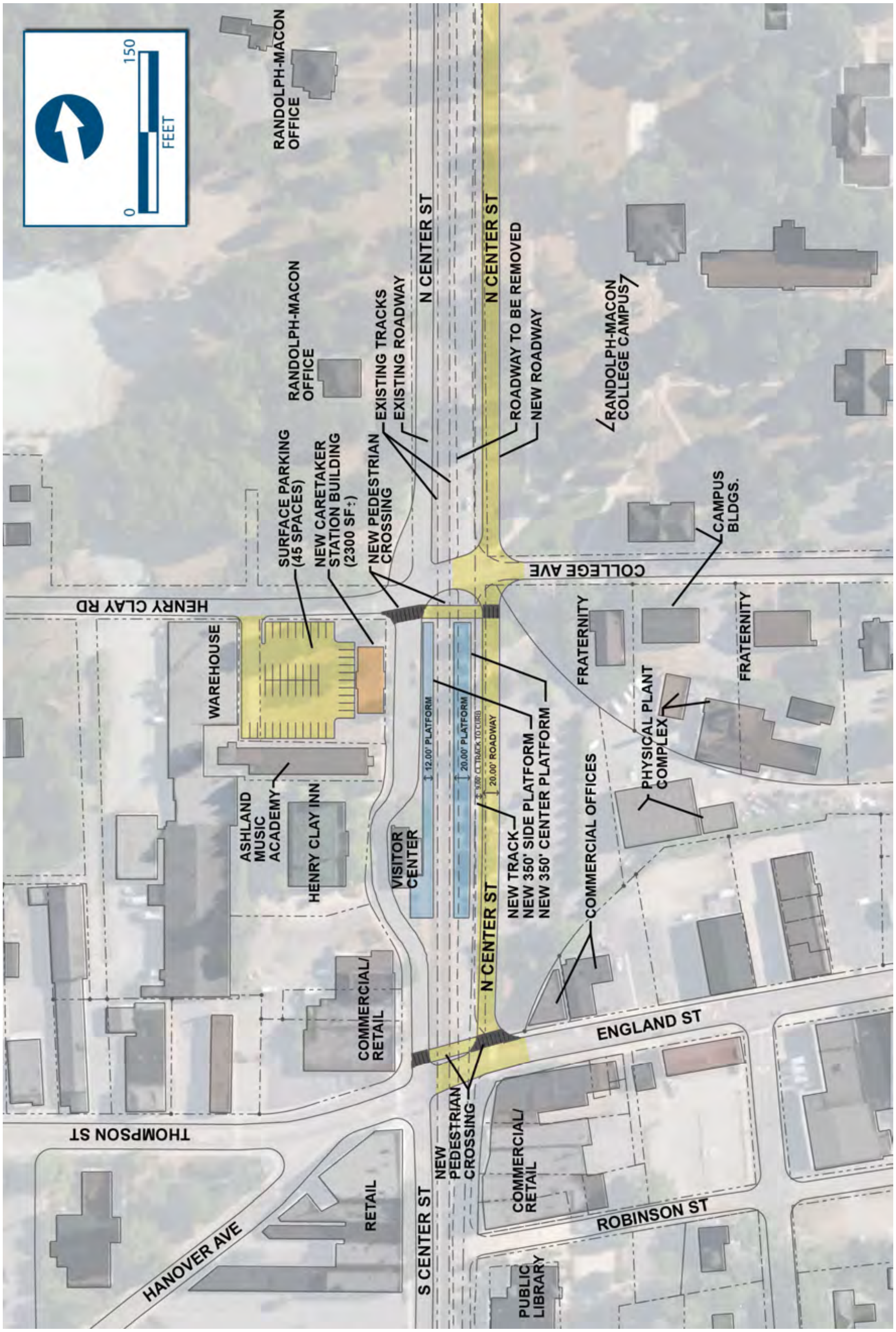


Figure 2-30B: Ashland Station Improvements for Build Alternative 5B (Three-Track/350-Foot Platforms)

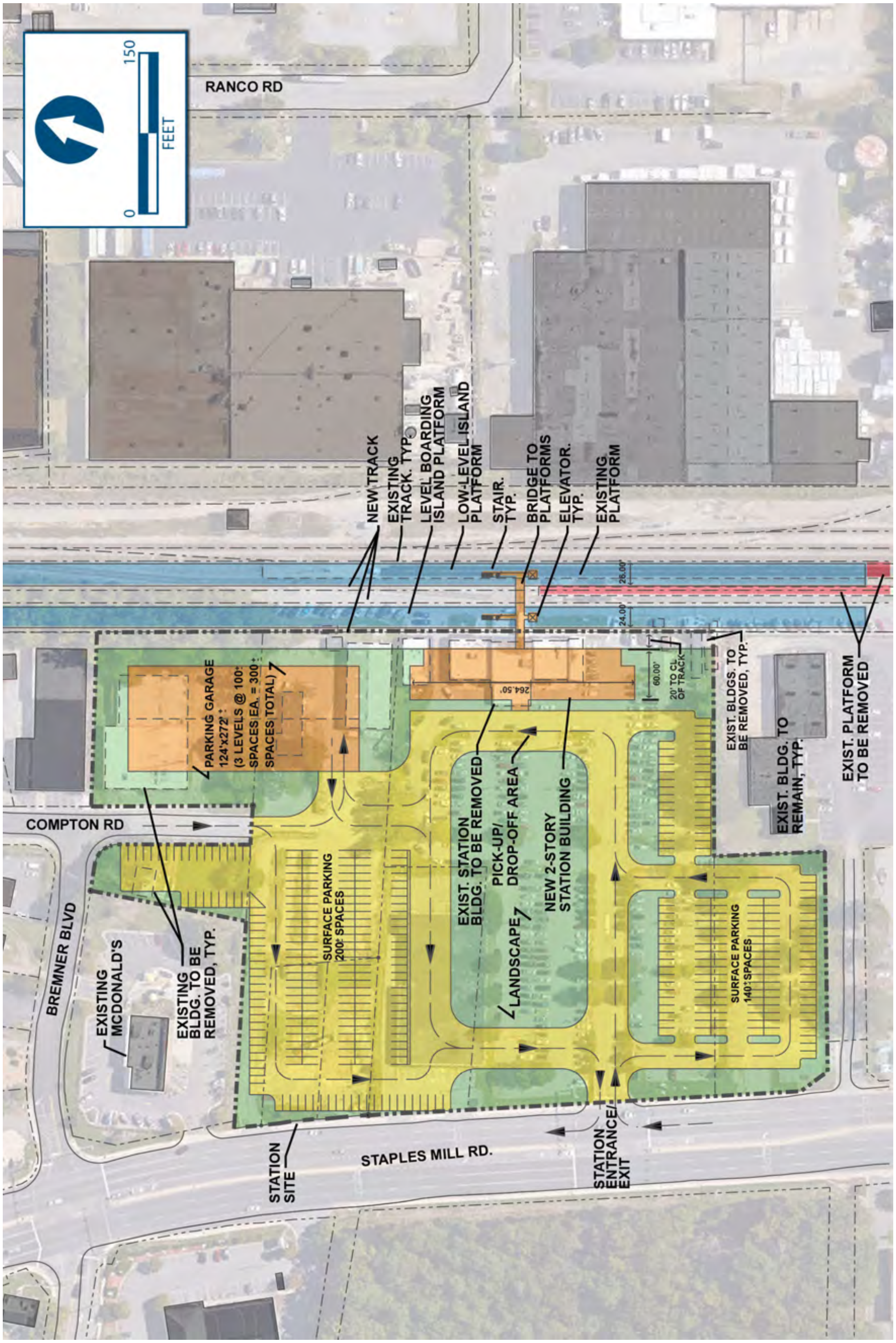


Figure 2-31: Staples Mill Road Station Improvements for Build Alternative 6A

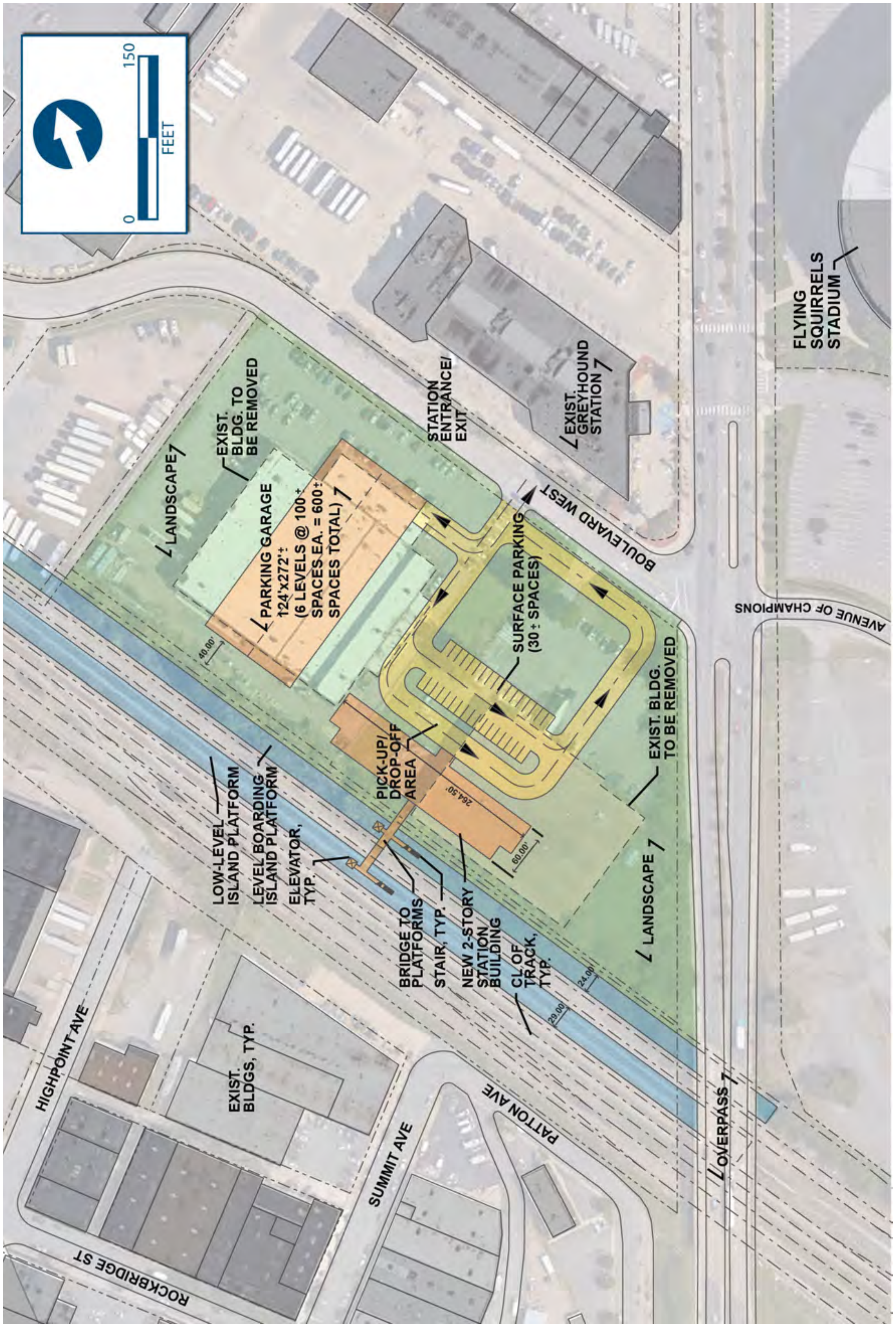


Figure 2-32: Boulevard Station Improvements for Build Alternatives 6B–A-Line and 6B–S-Line

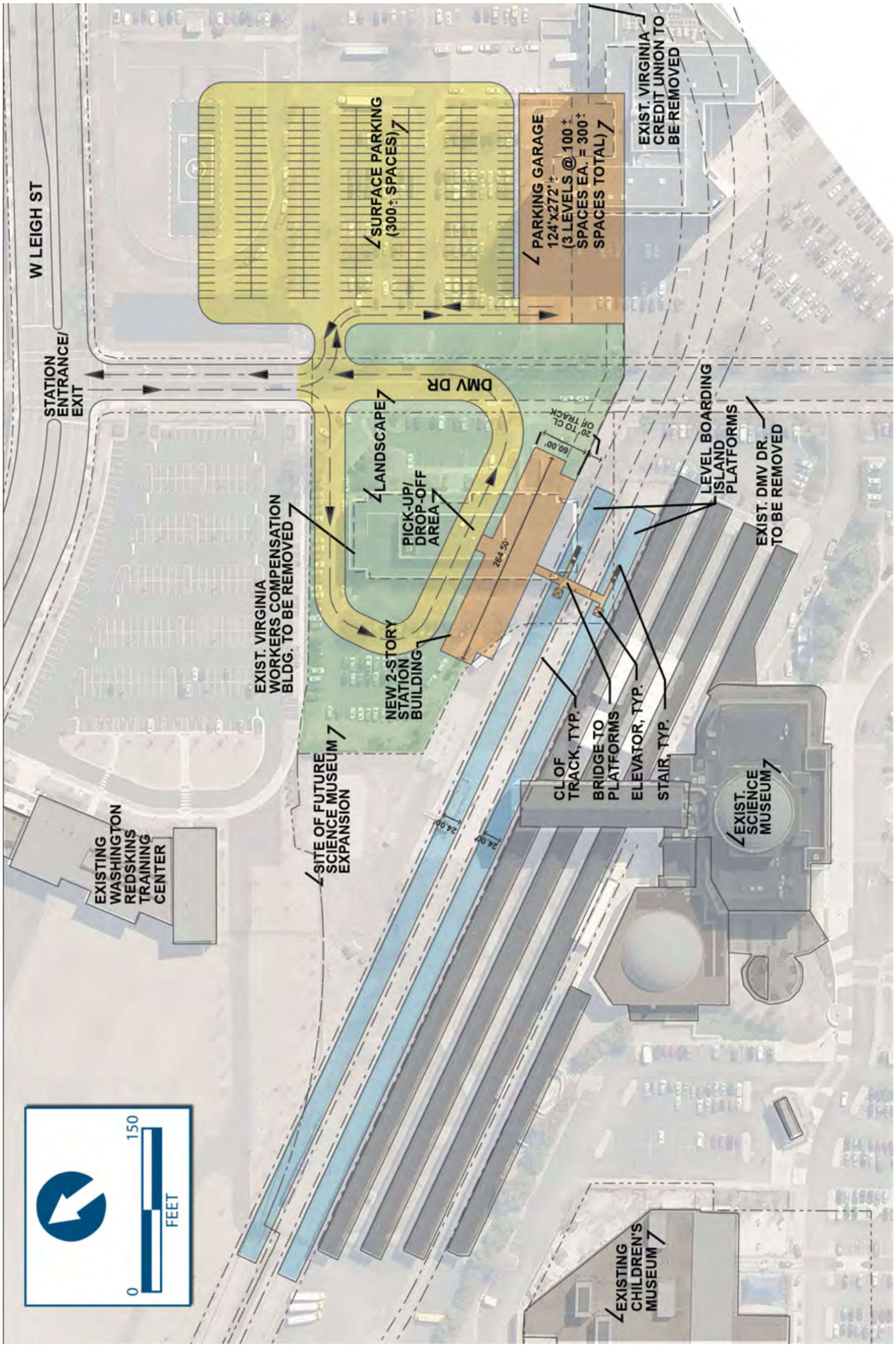


Figure 2-33: Broad Street Station Improvements for Build Alternative 6C

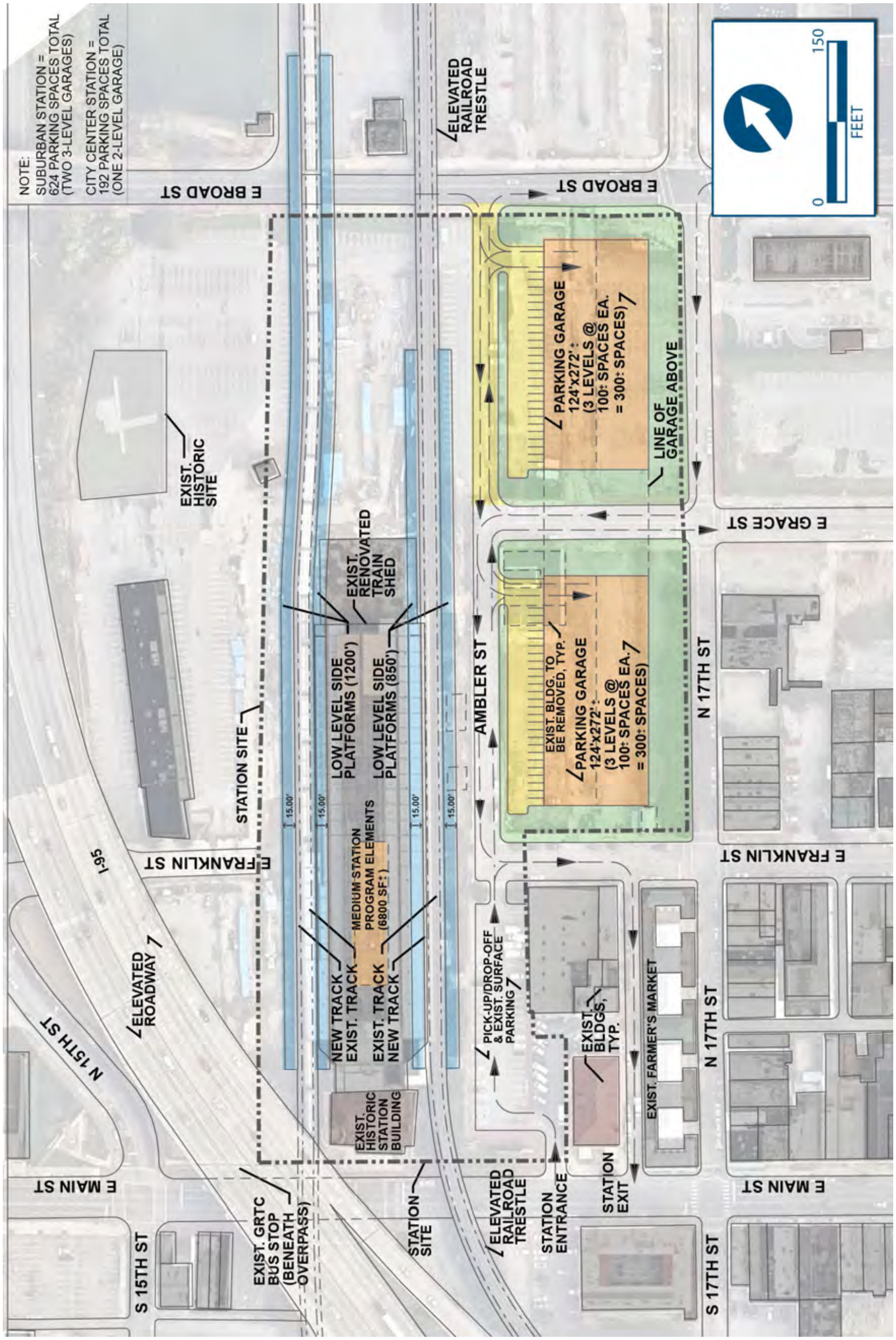


Figure 2-34: Main Street Station Improvements for Build Alternative 6D

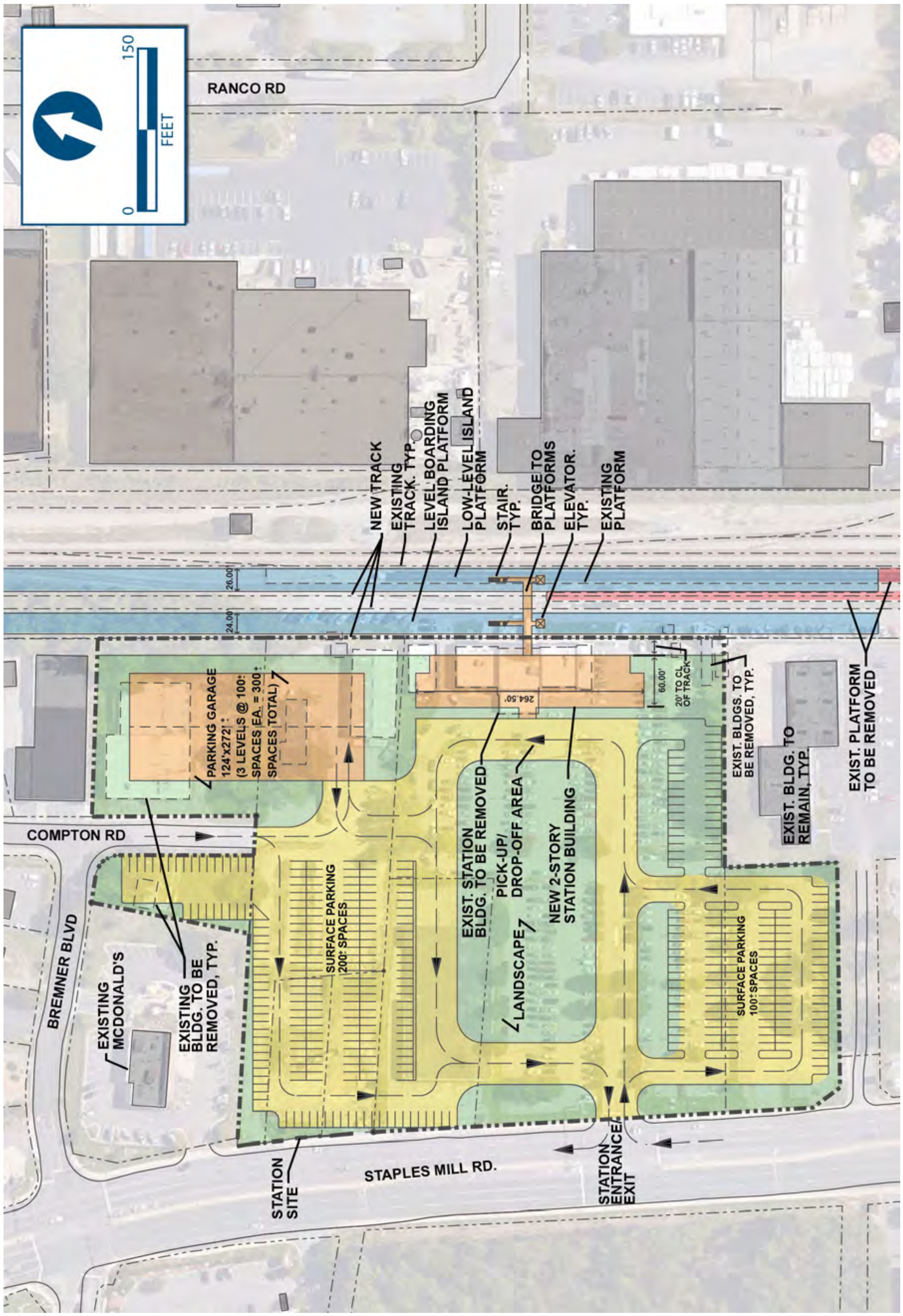


Figure 2-35: Staples Mill Road Station Improvements for Build Alternative 6E

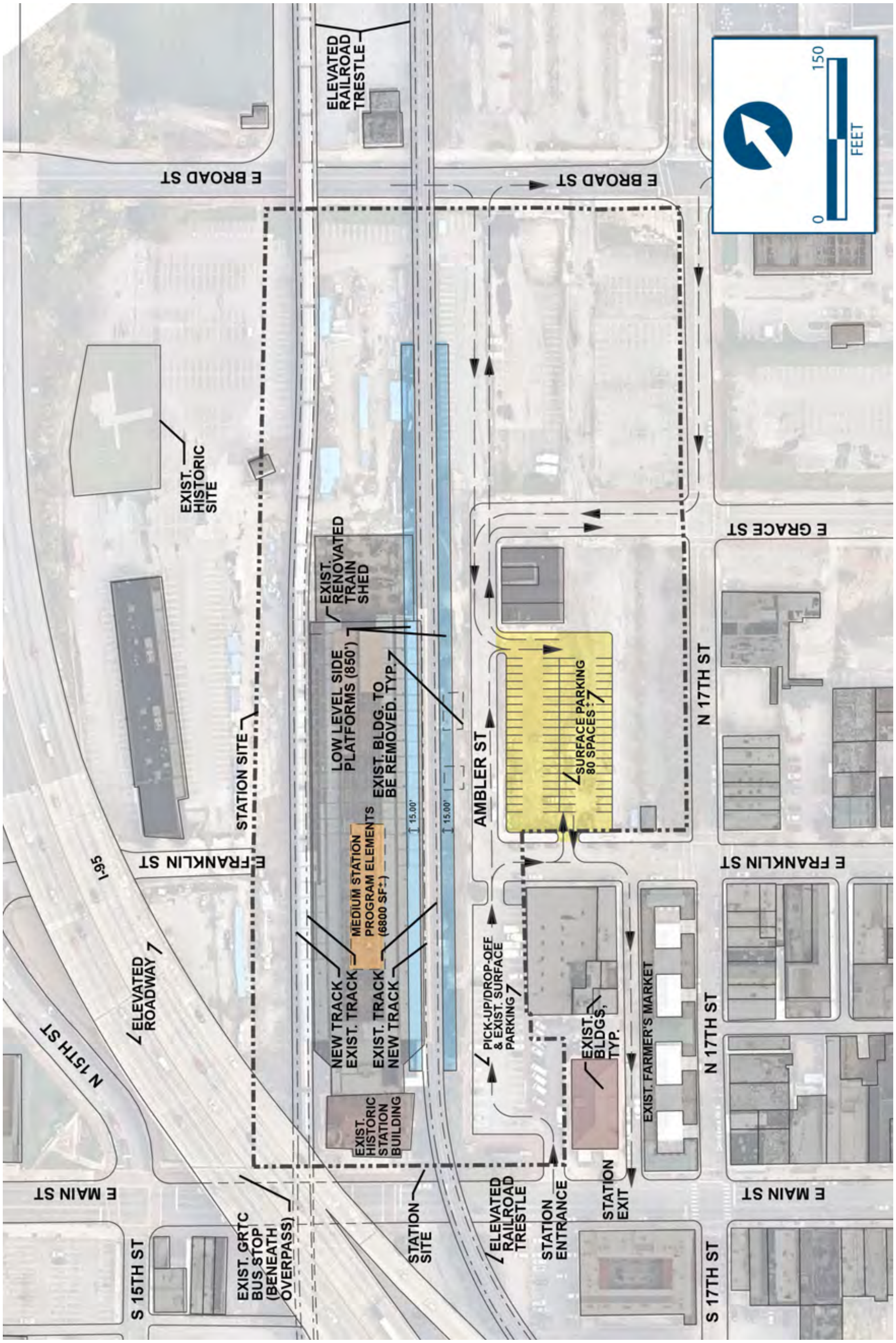


Figure 2-36: Main Street Station Improvements for Build Alternative 6E

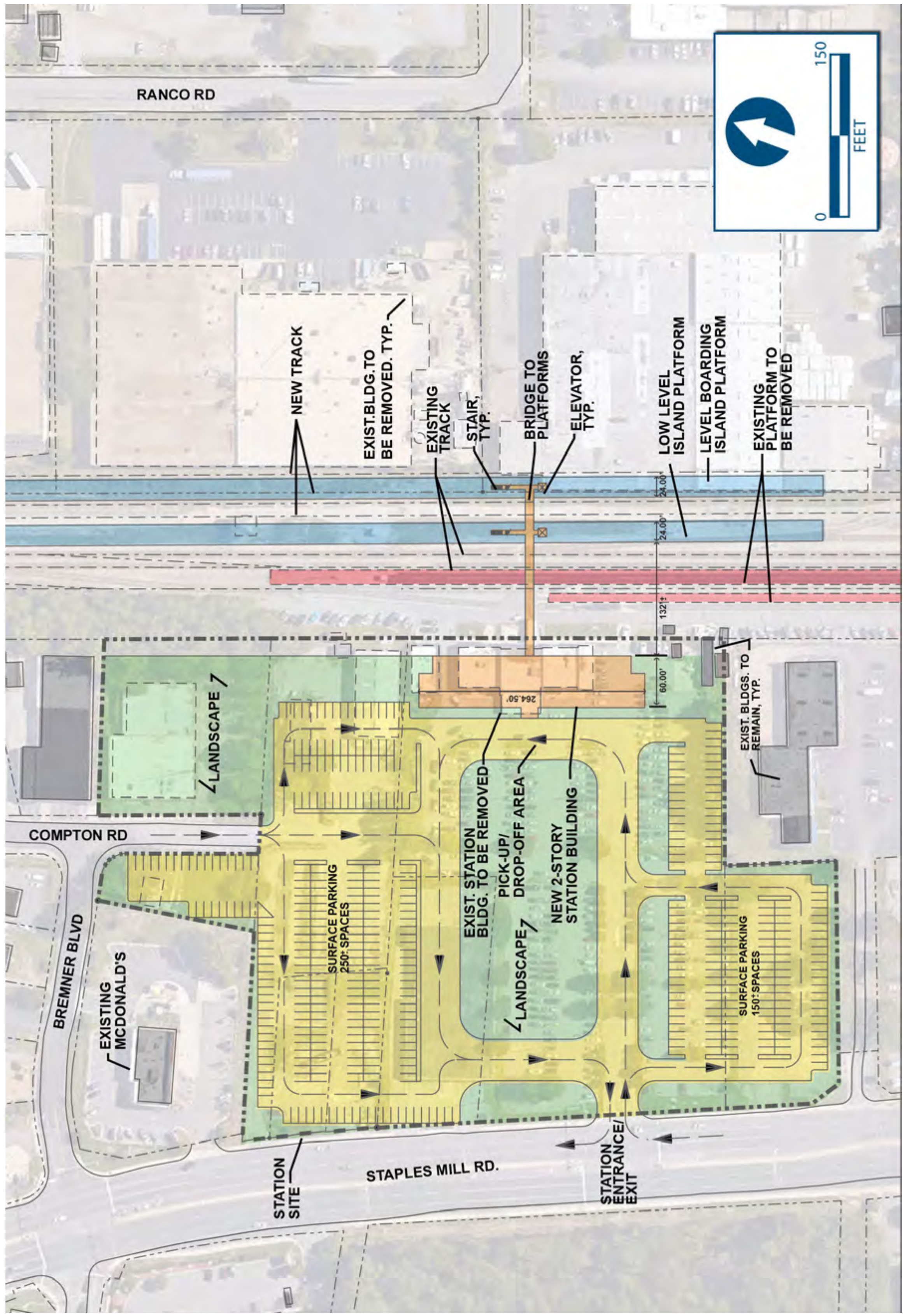


Figure 2-37: Staples Mill Road Station Improvements for Build Alternative 6F

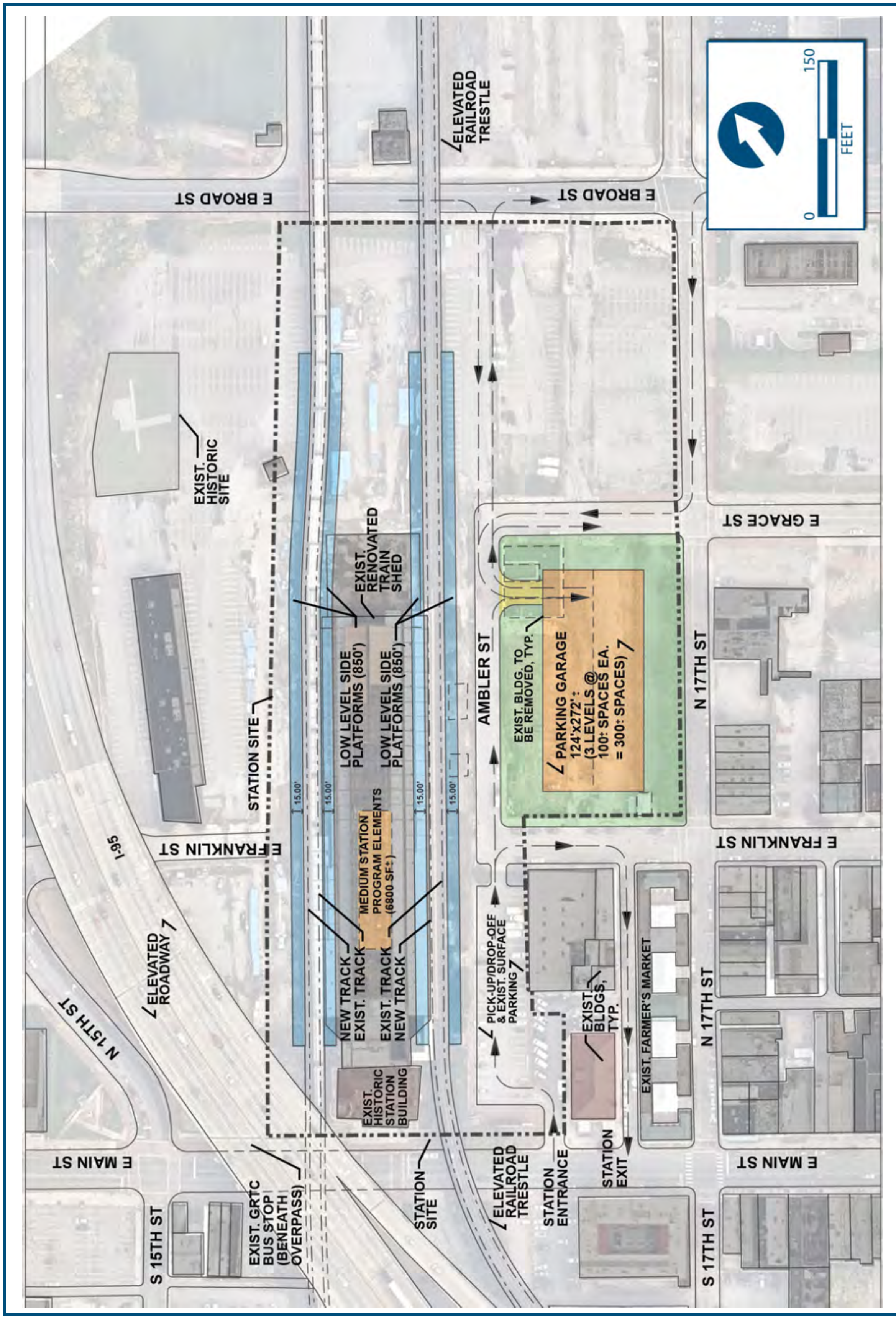


Figure 2-38: Main Street Station Improvements for Build Alternative 6F

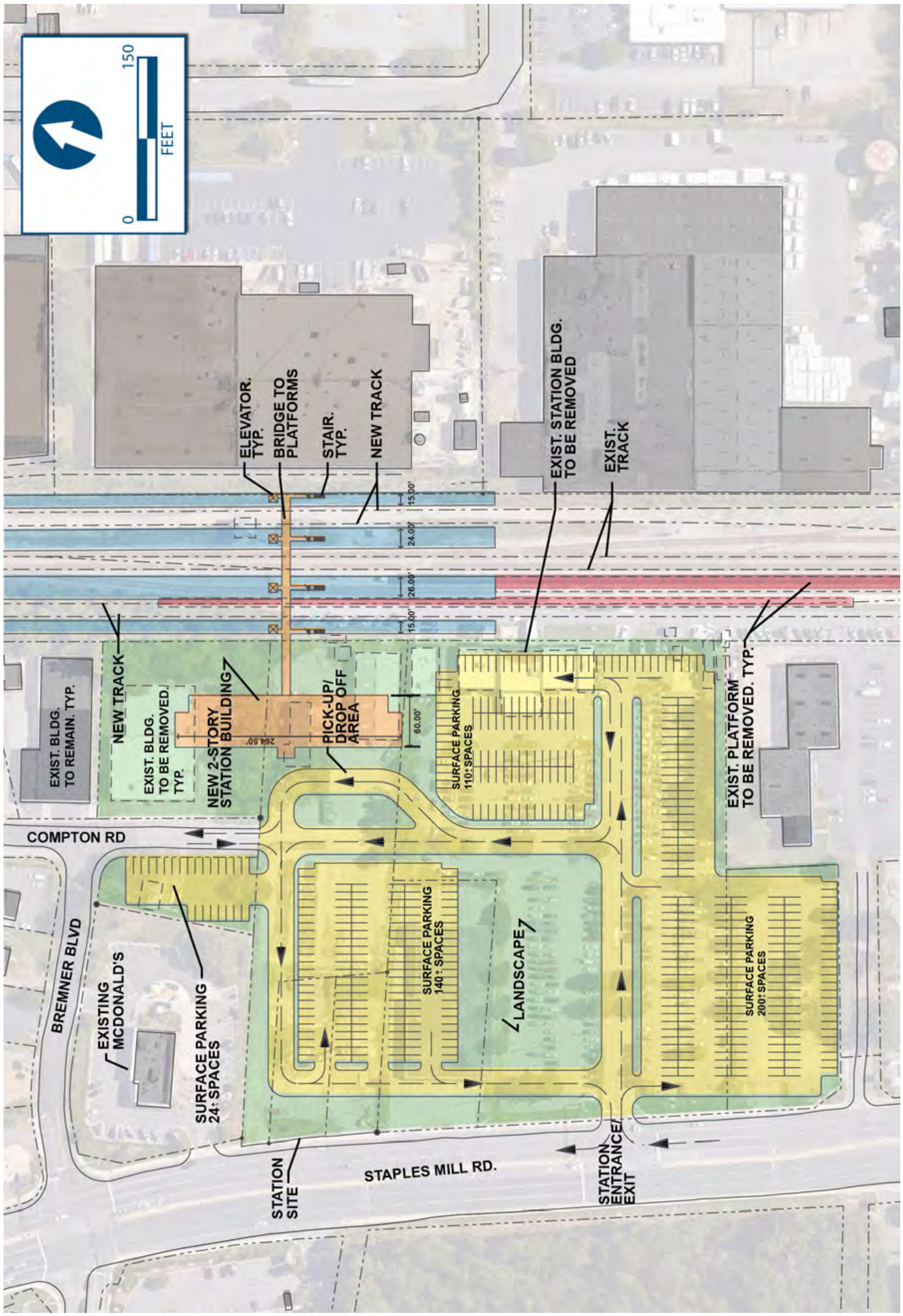


Figure 2-39: Staples Mill Road Station Improvements for Build Alternative 6G

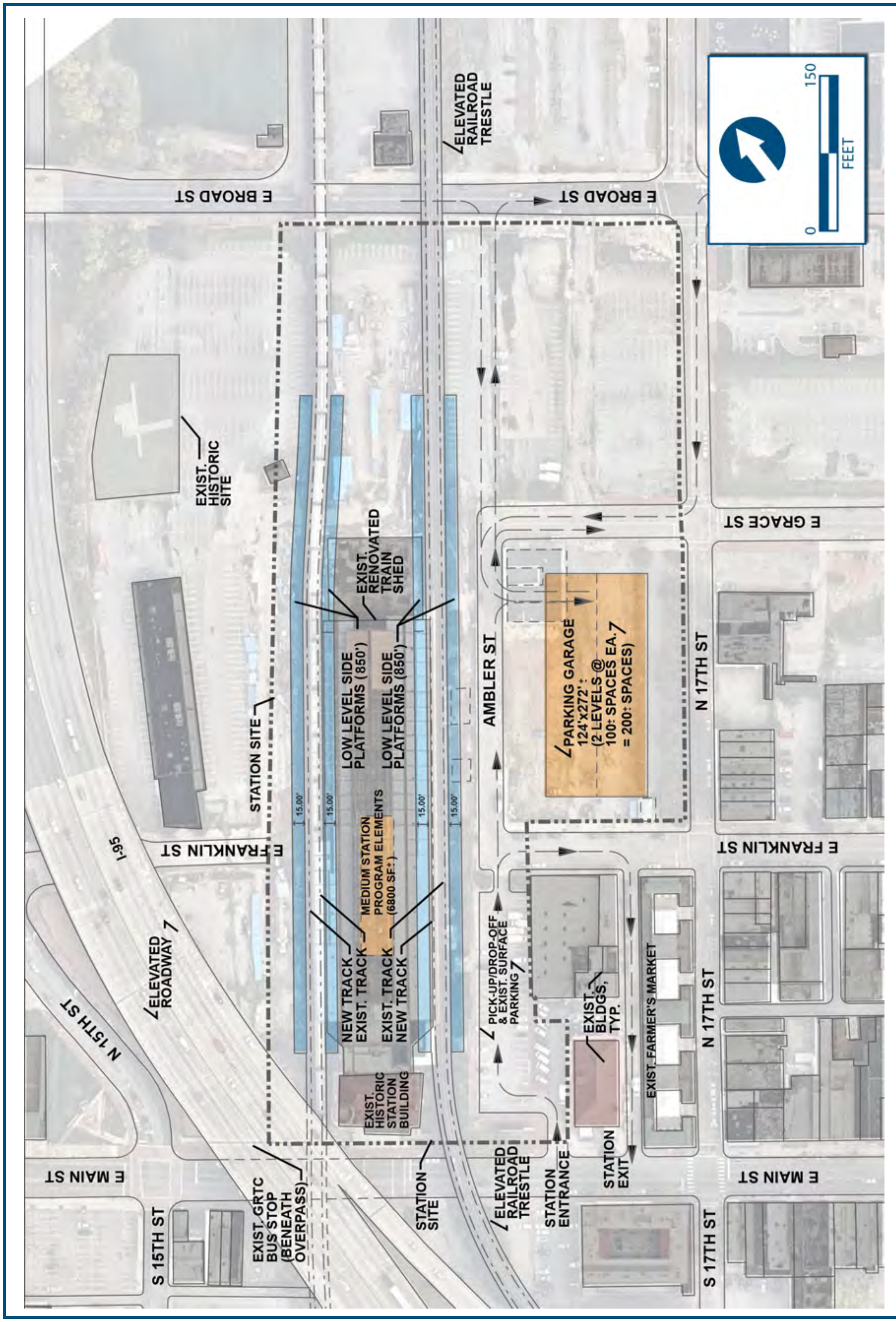


Figure 2-40: Main Street Station Improvements for Build Alternative 6G

3 AFFECTED ENVIRONMENT

Noise and vibration associated with construction and operation of the Project are subject to review by the Federal Railroad Administration (FRA). FRA has noise and vibration impact assessment methods (FRA, 2012) that are appropriate to evaluate noise and vibration from trains that travel at speeds of 90 miles per hour (mph) or higher. For train speeds lower than 90 mph, FRA endorses use of noise and vibration impact assessment methodologies published by the Federal Transit Administration (FTA) (FTA, 2006). The Maximum Authorized Speed for passenger trains for the DC2RVA corridor is 90 mph, and actual train speeds with the proposed improvements will generally be lower than 90 mph through much of the DC2RVA corridor; therefore, Project-related noise and vibration levels were determined using FTA methods. Even though FTA methods were used to calculate noise and vibration levels, certain aspects of the FRA guidelines were still used for this Project to assess noise and vibration effects, where applicable. Additionally, certain aspects of the FRA locomotive horn noise model were adapted for use on this Project. The study area for the noise and vibration analysis varies in size throughout the corridor to account for potential impacts and is as wide as approximately 3 miles through some sections. Detailed information on the noise and vibration analyses conducted for the Project can be found in Appendix P, *Noise and Vibration Technical Report*.

3.1 NOISE

Noise is usually defined as sound that is undesirable because it interferes with speech communication and hearing, or it is otherwise annoying. Under certain conditions, noise may cause hearing loss, interfere with human activities, and, in various ways, may affect people's health and well-being. Noise along a railroad corridor typically consists of noise from locomotives, noise from steel wheels operating over rails, and noise from train horns. Sound travels through the air as waves of tiny air pressure fluctuations caused by vibration. The intensity or loudness of a sound is an effect of how much the sound pressure fluctuates. The magnitude of fluctuation above and below the static atmospheric pressure is the amplitude of the sound wave. Characterizing the instantaneous pressure of the sound wave is not very informative, so sound is most often characterized by a Root-Mean-Square (RMS) sound pressure. Additionally, sound is quantified on the logarithmic decibel (dB) scale for convenience. Because of the logarithmic nature of the decibel unit, when two identical noise sources are added together, the resulting increase is 3 dB (not the arithmetic sum of the two noise levels).

3.1.1 Noise Descriptors

The dB is the accepted standard unit for measuring the amplitude of sound because it accounts for the large variations in sound pressure amplitude. When describing sound and its effect on a human population, A-weighted (dBA) sound pressure levels are typically used to account for the response of the human ear to different frequencies. The term "A-weighted" refers to a filtering of the noise signal in a manner corresponding to the way the human ear perceives sound. The A-weighted noise level has been found to correlate well with people's judgments of the noisiness of different sounds and has been used for many years as a measure of community noise. Figure 3-1 illustrates typical A-weighted sound pressure levels for various noise sources.

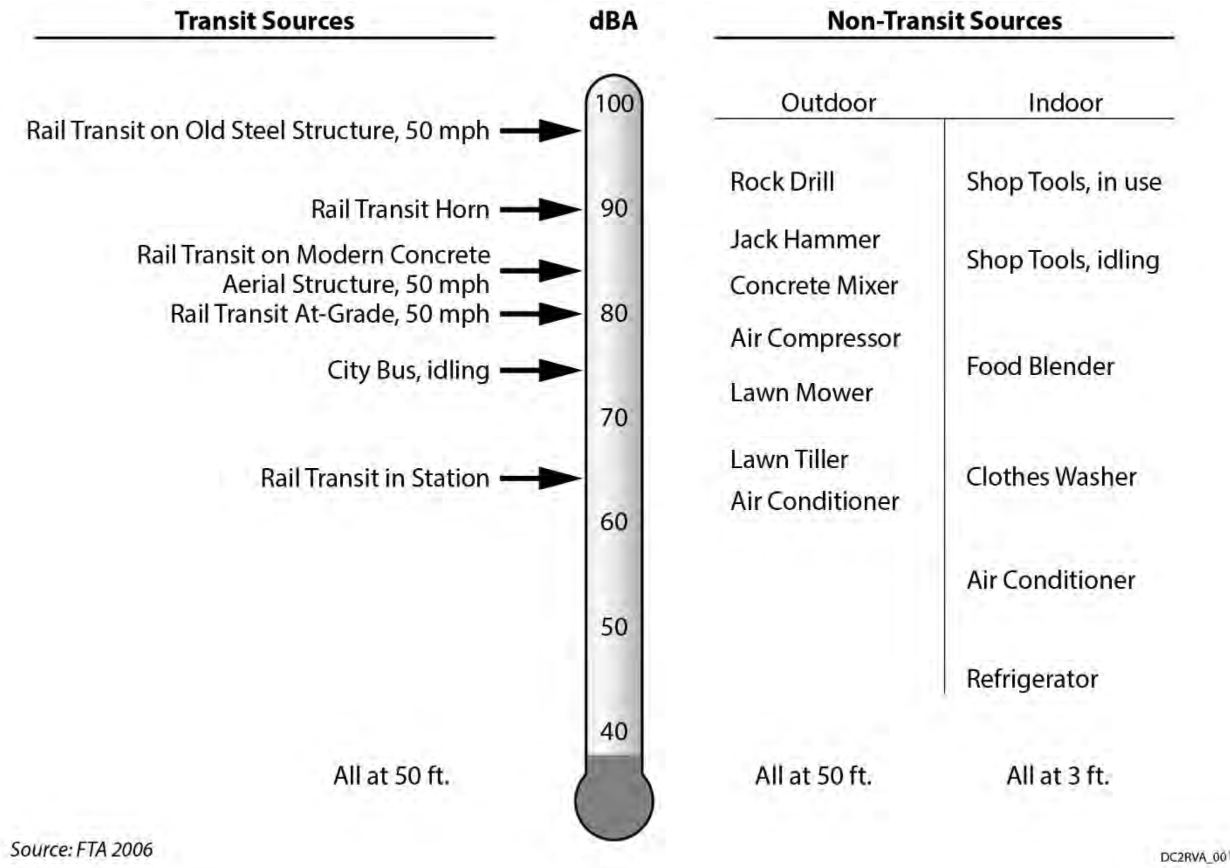


Figure 3-1: Typical Noise Levels

Community noise levels usually change continuously during the day. The equivalent continuous A-weighted sound pressure level (L_{eq}) is normally used to describe community noise. The L_{eq} is the equivalent steady-state A-weighted sound pressure level that would contain the same acoustical energy as the time-varying A-weighted sound pressure level during the same time interval. The maximum sound pressure level (L_{max}) is the greatest instantaneous sound pressure level observed during a single noise measurement interval.

Another descriptor, the day-night average sound pressure level (L_{dn}), was developed to evaluate the total daily community noise environment. The L_{dn} is a 24-hour average sound pressure level with a 10-dB time-of-day weighting added to sound pressure levels that occur during the nine nighttime hours from 10:00 p.m. to 7:00 a.m. This nighttime 10-dB adjustment is an effort to account for the increased sensitivity to nighttime noise events. FRA uses L_{dn} and L_{eq} to evaluate train noise effects at the surrounding communities (FRA, 2012).

3.1.2 Noise Measurements

In accordance with FRA and FTA noise assessment methodologies, existing noise levels were measured throughout the Project area. Existing noise levels were measured for a continuous 24-hour period at 29 residential locations. Noise levels were also measured for 1-hour durations at 8 institutional locations.

3.1.3 Existing Noise Levels

Table 3-1 presents the results of the 24-hour and 1-hour noise measurements. The table shows the measured L_{dn} at each residential measurement location (ML) and the L_{eq} at each institutional measurement location. Figure 3-2 shows the noise measurement sites. Land use adjacent to the railroad right-of-way varies throughout the DC2RVA corridor and can be broadly described as ranging from urban to suburban and rural. Ambient noise levels among those three categories of land use are typically highest in urban areas, where population density and the density of roadways and vehicular traffic are also highest among these three broad land use categories. In urban areas, human activities and traffic noise typically dominate the ambient soundscape. That is also true in suburban areas; however, the density of population and traffic is usually lower and that corresponds to noise levels generally being lower in suburban areas. Rural areas have the lowest population density of these three land use categories. The density of roadways and vehicular traffic is also lowest, and ambient noise levels are also generally lower than urban and suburban areas. Rural areas also exhibit noise from traffic and human activities; however, noise from agricultural activities is also common. Trains are a noise source that all three of these broad land use categories also have in common. Noise measurement results presented in Table 3-1 generally indicate higher noise levels in urban areas and lower noise levels in rural areas; however, the proximity between the measurement locations and the rail line or local roadways also influenced noise measurement results in urban, suburban, and even rural areas.

Table 3-1: Existing Train Noise Measurement Sites

Alternative Area	Location ID	Address	Measurement Type	L_{dn} (dBA)	$L_{eq}(h)$ (dBA)
Area 2: Northern Virginia	ML01	1801 Crystal Drive, Arlington	24-hour	66	
Area 2: Northern Virginia	ML02	301 Mt. Vernon, Alexandria	24-hour	68	
Area 2: Northern Virginia	ML03	DC Metro Church, 1100 N. Fayette Street, Alexandria	1-hour		61
Area 2: Northern Virginia	ML04	Summers Grove Homeowners Association, Alexandria	24-hour	65	
Area 2: Northern Virginia	ML05	6261 Franconia Station Court, Franconia	24-hour	63	
Area 2: Northern Virginia	ML06	6701 Jerome Street, Springfield	24-hour	75	
Area 2: Northern Virginia	ML07	8923 Milford Haven Court, Lorton	24-hour	69	
Area 2: Northern Virginia	ML08	Lorton Station Elem School, 9298 Lewis Chapel, Lorton	1-hour		64
Area 2: Northern Virginia	ML09	10526 Old Colchester Road, Lorton	24-hour	62	
Area 2: Northern Virginia	ML10	14726 Featherstone Road, Woodbridge	24-hour	69	
Area 2: Northern Virginia	ML11	333 3rd Avenue, Quantico	24-hour	68	
Area 2: Northern Virginia	ML12	945 Widewater Road, Stafford	24-hour	62	
Area 2: Northern Virginia	ML13	71 Mt. Hope Church Road, Stafford	24-hour	77	

Table 3-1: Existing Train Noise Measurement Sites

Alternative Area	Location ID	Address	Measurement Type	L_{dn} (dBA)	L_{eq}(h) (dBA)
Area 2: Northern Virginia	ML14	Andrew Chapel, Andrew Chapel Road, Stafford	1-hour		62
Area 3: Fredericksburg	ML15	7 Fairfax Circle, Falmouth	24-hour	63	
Area 3: Fredericksburg	ML16	432 Summit Street, Fredericksburg	24-hour	68	
Area 3: Fredericksburg	ML17	10235 Sunset Hill Lane, Fredericksburg	24-hour	77	
Area 3: Fredericksburg	ML18	9015 McAlister Street, Fredericksburg	24-hour	64	
Area 4: Central Virginia	ML19	Jackson Shrine, 12023 Stonewall Jackson Road, Woodford	1-hour		60
Area 4: Central Virginia	ML20	15503 Nelson Hill Road, Milford	24-hour	69	
Area 4: Central Virginia	ML21	11491 Chesterfield Road, Ruther Glen	24-hour	71	
Area 5: Ashland	ML22	14158 Independence Road, Ashland	24-hour	49	
Area 5: Ashland	ML23	Randolph Macon, 204 Henry Street, Ashland	1-hour		60
Area 5: Ashland	ML24	403 S. Center Street, Ashland	24-hour	74	
Area 5: Ashland	ML25	15503 Ashcake Road, Ashland	24-hr	60	
Area 5: Ashland	ML26	Gwathmey Church, Ashland	1-hour		68
Area 5: Ashland	ML27	Glen Allen Freewill Baptist Church, 11101 Old Washington Highway, Glen Allen	1-hour		61
Area 6: Richmond	ML28	2912 Allen's Crossing, Glen Allen	24-hour	69	
Area 6: Richmond	ML29	2733 Hungary Road, Richmond	24-hour	73	
Area 6: Richmond	ML30	1415 Chamberlayne Parkway, Richmond	24-hour	61	
Area 6: Richmond	ML31	1901 5th Avenue, Richmond	24-hour	77	
Area 6: Richmond	ML32	Hebrew Cemetery, N. 4th & Hospital Street, Richmond	1-hour		59
Area 6: Richmond	ML33	5516 Parker Street, Richmond	24-hour	77	
Area 6: Richmond	ML34	912 Hill Top Drive, Richmond	24-hour	75	
Area 6: Richmond	ML35	2290 Ruffin Road, Richmond	24-hour	75	
Area 6: Richmond	ML36	4405 Atlantic Avenue, Richmond	24-hour	71	
Area 6: Richmond	ML37	2900 Kingsland Road, Richmond	24-hour	73	

Note: *ML refers to "measurement location."

Figure 3-3 presents a graph of the 24-hour noise measurement results. Figure 3-4 presents a graph of the 1-hour noise measurement results.

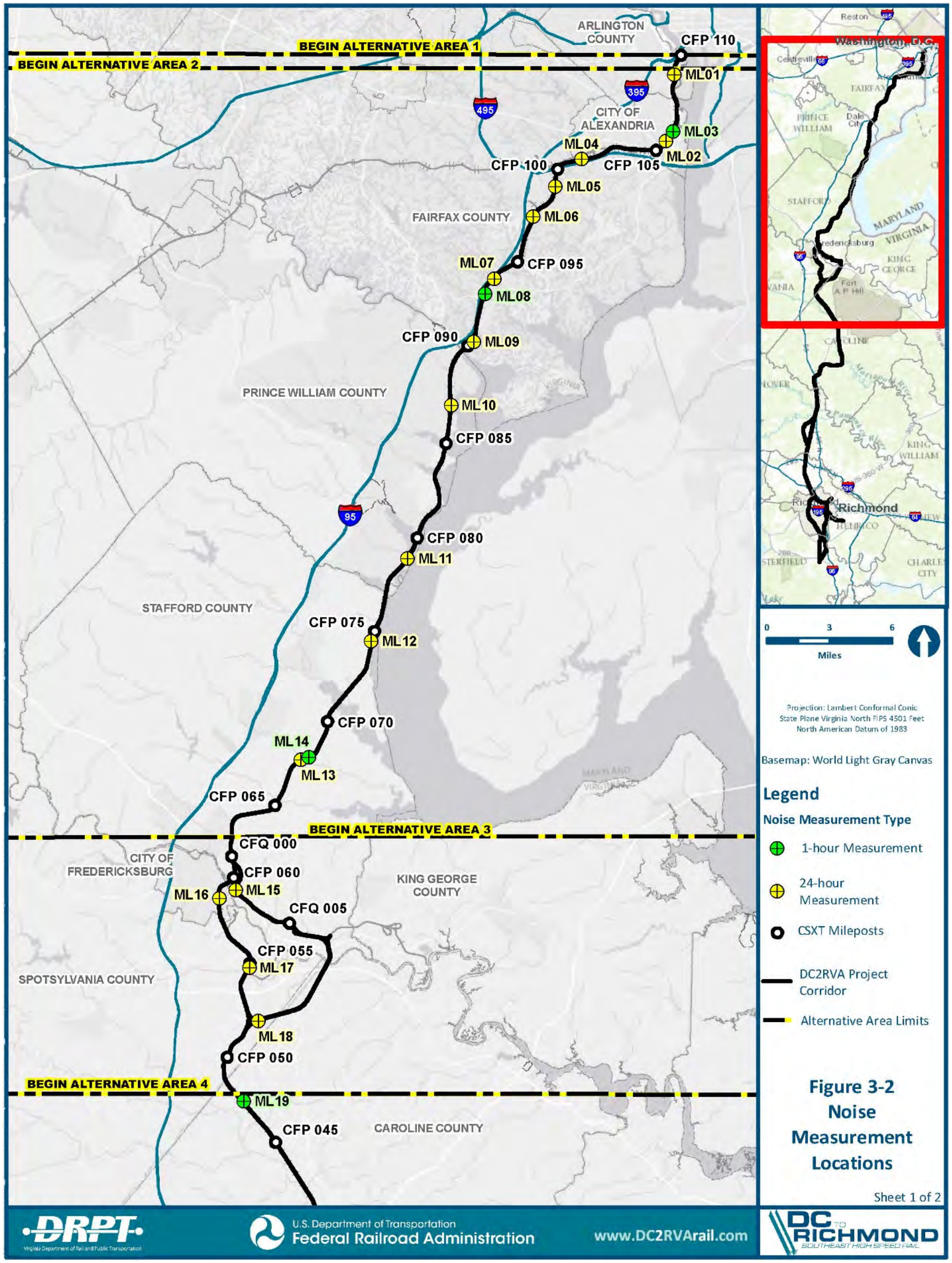


Figure 3-2 Noise Measurement Locations

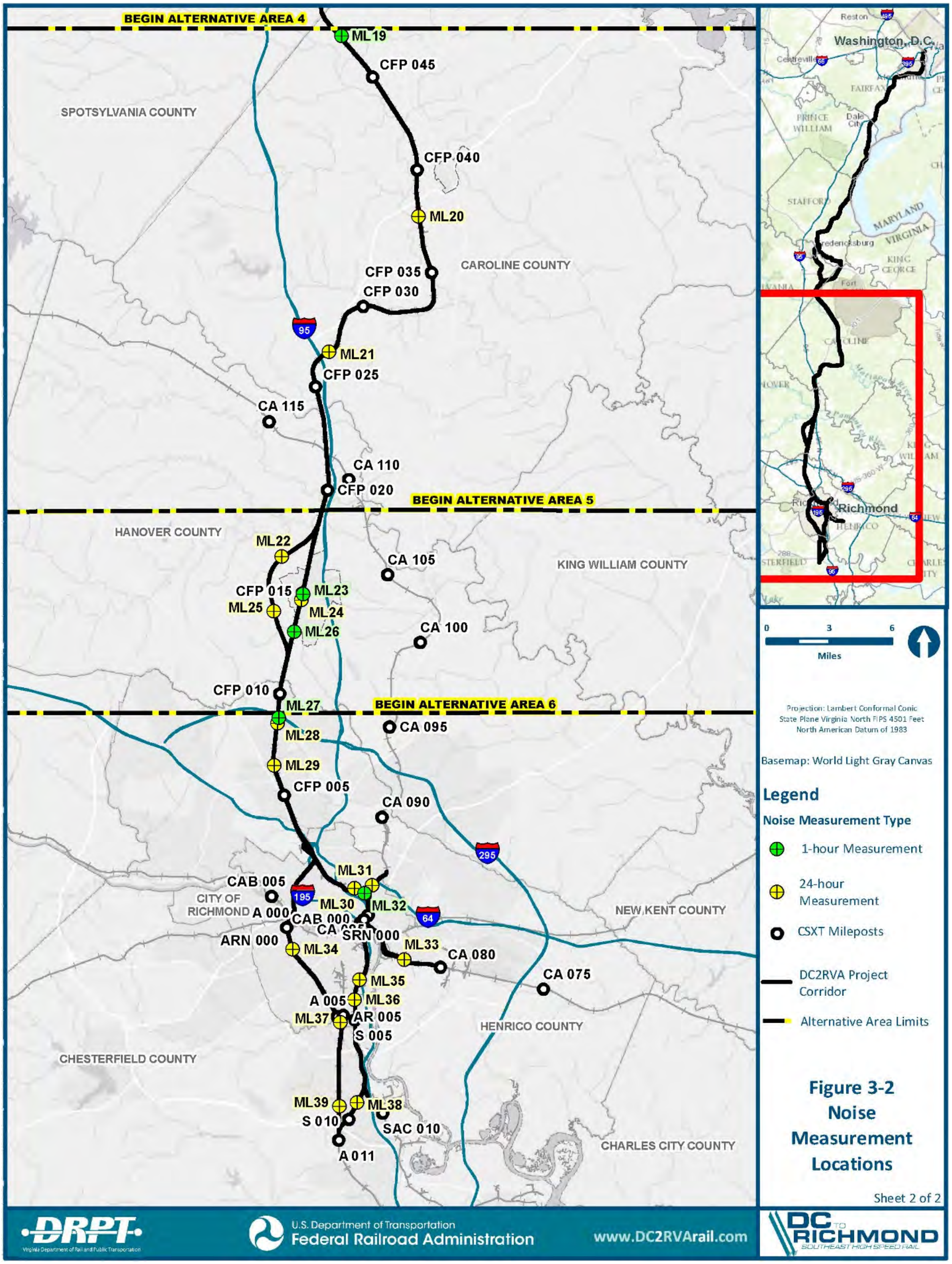


Figure 3-2 Noise Measurement Locations

Sheet 2 of 2

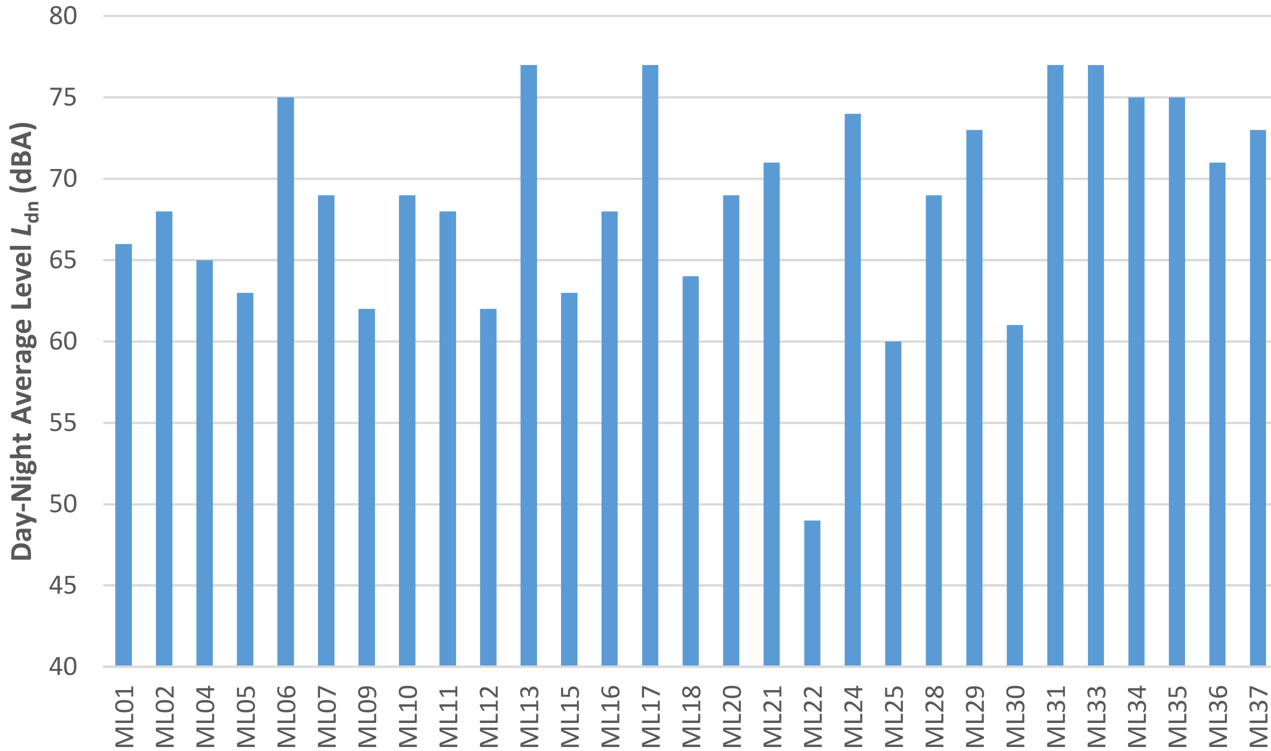


Figure 3-3: Measured Day-Night Noise Levels

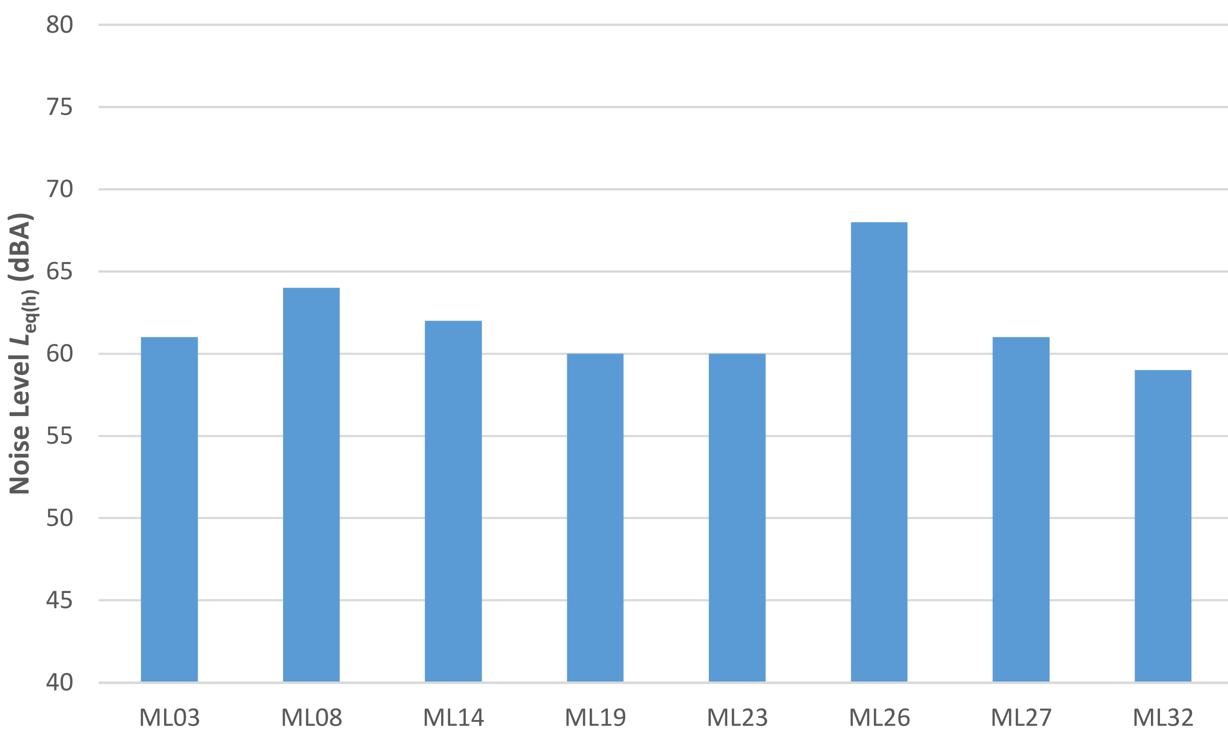


Figure 3-4: Measured Hourly Noise Levels

3.2 VIBRATION

Vibration is an oscillatory motion that can be described in terms of displacement, velocity, or acceleration. Displacement, in the case of a vibrating floor, is simply the distance that a point on the floor moves away from its static position. The velocity represents the instantaneous speed of the floor movement, and acceleration is the rate of change of the speed. The response of humans, buildings, and equipment to vibration is normally described using velocity or acceleration. Velocity will be used in describing ground-borne vibration.

Ground-borne vibration (GBV) can be a serious concern for residents or at facilities that are vibration-sensitive, such as laboratories or recording studios. The effects of GBV include perceptible movement of building floors, interference with vibration-sensitive instruments, rattling of windows, and shaking of items on shelves or hanging on walls. Additionally, GBV can cause the vibration of room surfaces resulting in ground-borne noise (GBN). GBN is typically perceived as a low-frequency rumbling sound.

3.2.1 Vibration Descriptors

Vibration amplitudes are usually expressed as either peak particle velocity (PPV) or the root mean square (RMS) velocity. PPV is used to evaluate the potential for building damage. It is defined as the maximum instantaneous peak of the vibration signal. PPV is not considered the appropriate measurement for evaluating the human response to vibration. RMS is used to evaluate human response because it takes some time for the human body to respond to vibration signals. The RMS of a signal is the square root of the average of the squared amplitude of the signal. For sources such as trucks or motor vehicles, PPV levels are typically 6 to 14 dB higher than RMS levels. FRA and FTA use the abbreviation "VdB" for vibration dBs for RMS and PPV to reduce the potential for confusion with sound dBs (FRA, 2012).

Decibel notation acts to compress the range of numbers required in measuring vibration. Similar to the noise descriptors, L_{eq} and L_{max} can be used to describe the equivalent vibration and the maximum vibration level observed during a single vibration measurement interval.

Figure 3-5 illustrates common vibration sources and the human and structural responses to ground-borne vibration. As shown in Figure 3-5, the threshold of perception for human response is approximately 65 VdB; however, human response to vibration is not usually significant unless the vibration exceeds 70 VdB.

In contrast to airborne noise, neither GBV nor GBN is an everyday experience for most people. The background vibration level in residential areas is usually 50 VdB or lower—well below the threshold of perception for humans. Levels at which vibration interferes with sensitive instrumentation can be much lower than the threshold of human perception, such as for medical imaging equipment or extremely high-precision manufacturing. Most perceptible indoor vibration is caused by sources within a building, such as the operation of mechanical equipment, movement of people, or slamming of doors. Typical outdoor sources of perceptible GBV are construction equipment, steel-wheeled trains, and traffic on rough roads; though in most soils, GBV dissipates very rapidly, and it is not a common environmental concern.

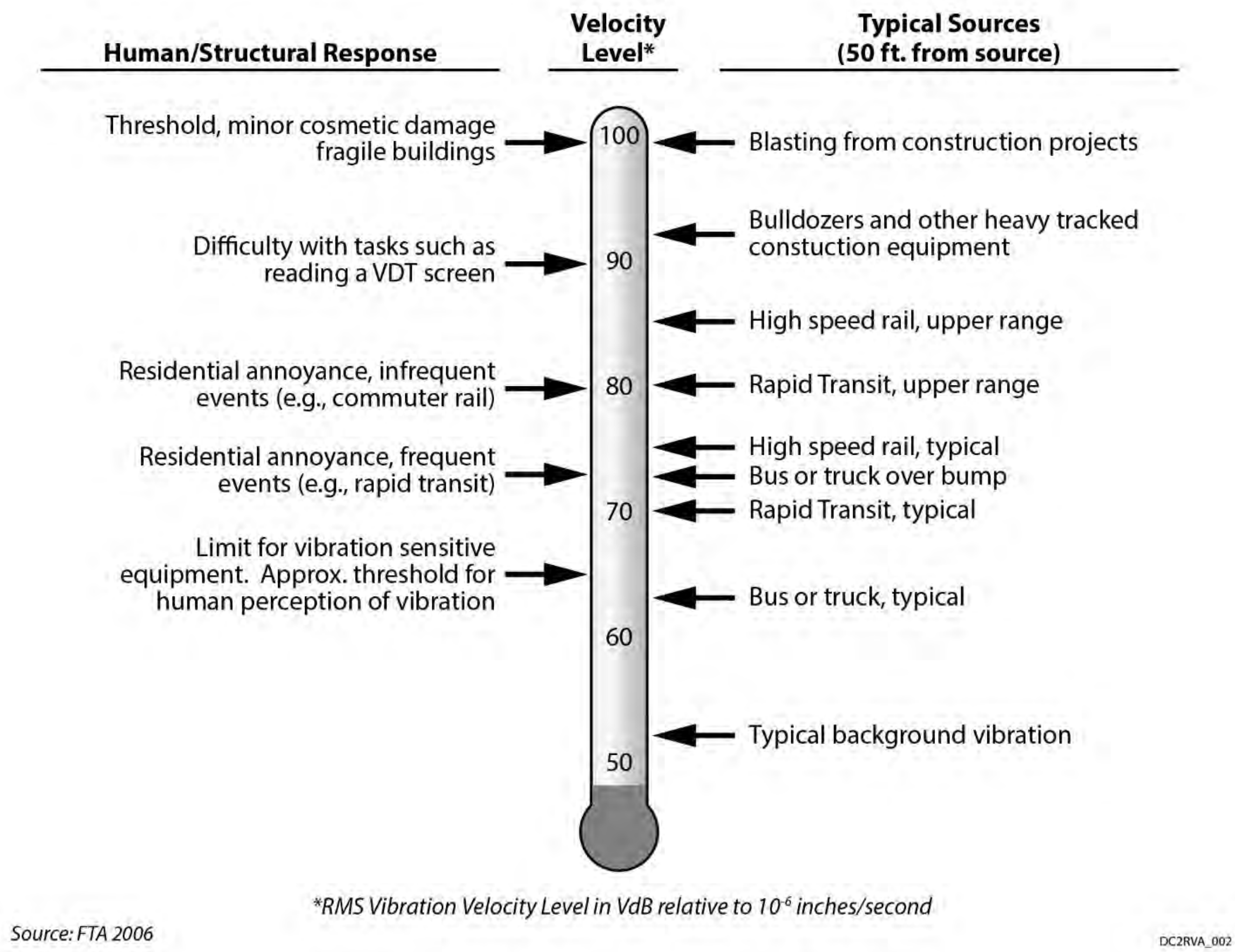


Figure 3-5: Example of Vibration Velocity Levels

3.2.2 Vibration Study Area

Evaluating the existing vibration conditions required establishing a vibration study area through a screening process. The screening process identified an area of potential influence from Project-related vibration and the set of vibration-sensitive receptors to evaluate. This vibration assessment used a two-step screening process. The first step consisted of identifying the vibration-sensitive land uses located within the FRA vibration screening distances (i.e., distances from the existing rail lines). Once this set of vibration-sensitive land uses was identified, the measurement data was analyzed to determine at what distance vibration impacts could be expected to occur under existing conditions.

Only certain land uses are considered vibration sensitive, and FRA guidance establishes three sensitive-use categories that resemble the noise land use categories but differ in a few important respects:

- Vibration Category 1—High Sensitivity: Where vibration would interfere with operations within the building, including levels that may be well below those associated with human annoyance, such as electron microscopes, high-resolution lithographic equipment, and magnetic resonance imaging devices.

- Vibration Category 2—Residential: Where people sleep, including hotels and hospitals.
- Vibration Category 3—Institutional: Where vibration has potential to interfere with activities within the building, but there is not particularly vibration-sensitive equipment present, such as schools, places of worship, quiet offices, and other institutions.

Table 3-2 shows the screening distances to identify which receptors should be evaluated for existing vibration, as well as future Project-related vibration. A total of 341 receptors were identified within the screening distances for the DC2RVA corridor.

Table 3-2: Distances to Establish Vibration Study Areas

Land Use	Train Frequency	Screening distance (ft.) by train speed (mph)		
		Less than 100 mph	100 to 200 mph	200 to 300 mph
Residential	Frequent or Occasional	120 feet	220 feet	275 feet
	Infrequent	60 feet	100 feet	140 feet
Institutional	Frequent or Occasional	100 feet	160 feet	220 feet
	Infrequent	20 feet	70 feet	100 feet

Source: FRA, 2012.

Soil types and other subsurface conditions affect GBV. For example, GBV can propagate more efficiently in areas where the soil is characterized by stiff shallow clay, or where there is shallow bedrock. This assessment briefly reviewed publicly available and reasonably obtainable soils and geologic data for the purpose of evaluating where GBV might propagate very efficiently. Based on this limited review, most of the soils in the corridor consist of coarse-grained unconsolidated deposits, which include regions with mixed combinations of gravel, sand, and silt. There are also limited areas of fine-grained unconsolidated deposits, which include alluvium, clay, or mud, although some of the clay or mud is mixed with sand. The coarse-grained unconsolidated deposits, which make up the majority of the soils along the alignment, as well as most of the fine-grained unconsolidated deposits generally propagate GBV less efficiently than highly efficient soils such as stiff clay. However, the soils data are relatively coarse and may not identify highly localized soil-type differences or geologic features.

4 ENVIRONMENTAL CONSEQUENCES

This section describes potential Project-related noise and vibration effects and identifies mitigation measures to offset Project-related impacts. These analyses only evaluated noise and vibration from the additional intercity trains proposed under this project, except where noted.

Noise and vibration effects were assessed based on the methods and criteria included in FRA's High Speed Ground Transportation Noise and Vibration Impact Assessment guidance manual (September 2012) for sections of the study corridor where passenger train speeds can reach 90 miles per hour (mph). On sections where all train speeds are below 90 mph, this assessment used the noise and vibration impact assessment methods published in the Federal Transit Administration (FTA) Transit Noise and Vibration Impact Assessment (May 2006) manual per FRA guidance. The assessment addresses both operational and construction effects from the proposed alternatives.

4.1 NOISE

4.1.1 Noise Impact Criteria

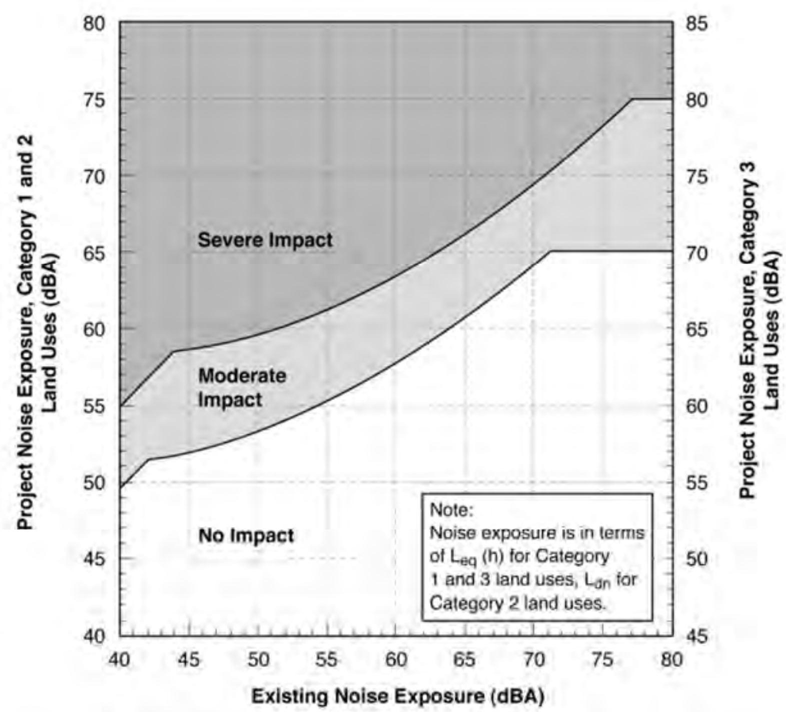
According to FRA and FTA, noise-sensitive land uses are divided into one of three categories.

- Category 1: Land where quiet is an essential element (e.g., amphitheaters and concert pavilions). This category includes lands set aside for serenity and quiet, and such land uses as outdoor amphitheaters and concert pavilions, as well as National Historic Landmarks (NHLs) with significant outdoor use.
- Category 2: Residences and buildings where people sleep. This category includes homes, hospitals, and hotels where a nighttime sensitivity to noise is assumed to be of utmost importance.
- Category 3: Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, and churches where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material. Buildings with interior spaces where quiet is important, such as medical offices, conference rooms, recording studios, and concert halls, fall into this category. Places for meditation or study associated with cemeteries, monuments, and museums. Certain historical sites, parks, and recreational facilities are also included.

Category 1 and 3 receptors are evaluated using the equivalent-average sound level (L_{eq}) from the noisiest hour of train-related activity during hours of noise sensitivity. The L_{eq} represents a constant sound that, over the hour, has the same acoustic energy as the time-varying signal. Category 2 receptors are evaluated using the day-night sound level (L_{dn}) because Category 2 receptors are sensitive to noise during all hours of the 24-hour day. The L_{dn} describes a receiver's cumulative noise exposure from all events over a full 24 hours, with events between 10:00 p.m. and 7:00 a.m. penalized by adding an additional 10 decibels (dB) to account for greater nighttime sensitivity to noise.

This analysis followed the FTA/FRA noise impact assessment methodology in which measurements of existing noise levels are used to determine the noise impact threshold. Project-related noise is then calculated using FTA and FRA methods, and the resulting noise levels are compared with the predetermined noise impact thresholds to determine if noise impacts are expected to occur.

Figure 4-1 from the FTA guidance manual shows the noise impact criteria used by both FTA and FRA, which are based on the land use category and the existing noise exposure in the area. No impact indicates Project noise levels are unlikely to cause annoyance. A moderate noise impact is a noise level increase that is noticeable to most people, yet generally not enough to cause adverse reactions. A severe noise impact is a noise level increase that could cause annoyance to a significant percentage of people. FTA guidance requires consideration and adoption of noise mitigation measures for moderate noise impacts when it is reasonable. When severe noise impacts are projected to occur, FTA assumes that mitigation measures will be implemented to reduce project noise levels below impact thresholds, unless there are truly extenuating circumstances which prevent it. In the context of environmental review under NEPA, severe noise impacts are considered significant impacts.



Source: Federal Transit Administration, https://www.transit.dot.gov/regulations-and-guidance/environmental-programs/fta-noise-and-vibration-impact-assessment

DC2RVA_083

Figure 4-1: FTA/FRA Noise Impact Criteria for Transit Projects

4.1.2 Noise Impact Assessment Methodology

The FRA and FTA noise impact assessment methodologies include the following basic components:

1. Identify noise-sensitive land uses
2. Measure existing outdoor noise levels
3. Measure train specific noise source levels
4. Define impact thresholds based on measured existing noise levels
5. Calculate Project-related outdoor noise levels using identified train and operations characteristics
6. Determine if Project-related noise levels exceed FRA and FTA defined noise impact thresholds.

4.1.2.1 Noise-Sensitive Land Use Identification

Noise-sensitive land uses throughout the corridor were identified according to FRA and FTA land use categories. Noise-sensitive land uses located within 1 mile of the rail centerline through the DC2RVA corridor, and beyond through some sections, were included in the noise impact assessment. Land use was identified from several sources, including GIS databases, digital aerial photographs, field surveys, and information on planned development from local planning departments where publicly available and reasonably obtainable.

Noise-sensitive land uses in the noise study area include Category 1, 2 and 3 receptors. Category 1 noise-sensitive land uses in the noise study area include recording studios. Category 2 noise-sensitive land uses in the study area primarily consist of single family homes, multi-unit residential buildings, and hospitals. Category 3 noise-sensitive land uses in the study area include schools, churches, and outdoor recreation facilities.

4.1.2.2 Existing Noise Environment for Noise Analysis

The track alignments were divided into noise and vibration analysis sections which were differentiated by changes in train traffic characteristics and changes in existing ambient sound environments. From collected monitoring data, average existing noise levels were calculated for each noise and vibration section. The existing noise level for Category 2 land uses was calculated based on the average day-night noise level at the 24-hour noise measurement locations within each section. Existing noise levels for Category 1 and 3 land uses were based on the average measured noise levels at institutional land uses in each section, where applicable. In sections where one-hour noise measurements were not performed, the existing peak hour L_{eq} was estimated based on the average noise levels recorded between 7:00 a.m. and 9:00 a.m. and between 11:00 a.m. and 9:00 p.m. at representative 24-hour noise measurement locations.

Table 4-1 summarizes the existing noise levels by noise and vibration analysis section.

Table 4-1: Existing Noise Environment for Noise Assessment

Section	Section Average Noise Level[2] (dBA)	
	L_{dn}	$L_{eq}(h)$
1	67	61
2[1]	64	61
3	65	64
4[1]	65	57
5[1]	65	60
6	77	62
7[1]	65	60
8[1]	72	66
9[1]	77	71
10	64	60
11[1]	69	60
12[1]	70	60
13	74	64
14	71	61
15[1]	67	61
16	61	59
17[1]	74	55
18[1]	73	63
19[1]	57	49
20[1]	77	73
21N[1]	63	58
21S[1]	64	44
22[1]	55	45

Notes: 1. 1-hour measurements were not performed in this section. The existing peak hour L_{eq} is based on the average noise levels recorded between 7:00 a.m. and 9:00 a.m. and between 11:00 a.m. and 9:00 p.m. at representative 24-hour measurement locations. 2. The average noise level, L_{dn} and $L_{eq}(h)$ for each section was used in the noise impact assessment.

4.1.2.3 Train Characteristics

Sound Exposure Level (SEL) is an acoustical descriptor that contains all acoustical energy associated with a single event such as the passby of a locomotive, railcar, or a locomotive horn use event. SEL values are used as the noise emissions terms in the train noise models; they are expressed in units of dBA (A-weighted decibel). Actual noise levels from passenger passenger trains between Poughkeepsie and Albany, New York (the Empire Line) that are similar to the trains proposed on this Project were measured to calculate projected noise levels on the DC2RVA corridor. Noise measurements were performed in areas where Empire Line trains were expected to reach speeds of 90 mph. Due to track maintenance and other unknown factors, none of the Empire Line trains were traveling at or above 90 mph during measurements of passby noise; therefore, SEL values measured along the Empire Line were used to calculate noise from all other passenger trains (at speeds below 90 mph). The SEL values for freight locomotives and railcars were obtained from FRA's *CREATE Noise and Vibration Assessment Manual* (FRA, 2013). The SEL for CSXT locomotive horns was obtained from the *Final EIS for the Acquisition of Conrail by Norfolk Southern Railroad and CSX Railroad* (United States Surface Transportation Board, 1998). Noise from freight trains on the proposed bypasses and passenger trains traveling at speeds below 90 mph were modeled using FTA's general noise assessment methods. SEL values for proposed trains traveling at 90 mph were obtained from Appendix E of the FRA guidance manual. This analysis used the maximum allowable speed on each rail section to calculate train noise.

Characteristics of the additional SEHSR passenger trains that were used in the noise analysis are shown in Table 4-2.

Table 4-2: Additional SEHSR Passenger Train Characteristics Used in the Noise Assessment

Characteristics	Proposed DC2RVA Train
Train speed (mph)(1)	90
Train length (feet)	665
Number of locomotives per train	2
Number of railcars per train	8
Throttle setting	8
Locomotive length (feet)	70
Length of train railcars (feet)	85

Notes: 1. Maximum train speed varies by rail section; the maximum allowable speed per section was modeled.

Growth in the passenger (non-SEHSR) and freight trains that currently use the corridor will occur independently from the proposed Project; therefore, the noise analysis only modeled the proposed additional intercity passenger trains on most rail sections in study area. The exceptions to this are the Fredericksburg Bypass (Build Alternative 3C) and the Ashland Bypass (Build Alternatives 5C and 5C–Ashcake). In these areas, the distribution of freight and/or passenger trains that currently use the corridor may change and was, therefore, modeled.

The proposed bypasses in Fredericksburg and Ashland are expected to have unique combinations of freight and intercity passenger trains and were modeled based on the way trains are proposed to use the bypasses. In Fredericksburg, only freight trains are expected to use the proposed bypass alignment (Build Alternative 3C); therefore, noise from freight trains was evaluated on that bypass alignment. The proposed additional intercity passenger trains that will bypass downtown Fredericksburg were also modeled on the existing alignment under the Fredericksburg Bypass alternative. In Ashland, under the bypass alternatives (Build Alternatives 5C and 5C–Ashcake), freight trains and intercity passenger trains that do not stop in Ashland are expected to use the bypass alignment while other passenger trains would use the existing alignment. This results in a net reduction in train noise on the existing alignment and is considered a benefit of the proposed Project. Noise from freight trains was not evaluated in areas other than on the proposed bypass alignments because freight train traffic would continue to operate and expand on the existing corridor in the Build Alternatives as it would in the No Build Alternative.

Trains operate on five different rail sections in each of the eight Richmond Build Alternatives. In addition to operating on different sections, sometimes passenger train length increases under different Richmond alternatives; therefore, each alternative was evaluated individually, and noise from all trains on all five sections was calculated for each alternative. Noise from freight trains was not included in the evaluation of Project-related noise under each Richmond alternative because freight trains currently operate on those lines (unlike the proposed bypass alternatives), and changes in freight train volume and size will occur based on market forces and in a manner that is unrelated to the proposed Project. Under FRA safety rules, locomotive horns are required to be used at public at-grade crossings. CSXT operating rules also require locomotive horns to be used when trains:

- Approach public crossings
- Approach tunnels, yards, or locations where railroad employees may be working
- Approach roadway workers
- Approach standing trains
- Approach passenger stations
- When warning people or animals near the track

This analysis utilized FRA methods to evaluate locomotive horn noise at public at-grade crossings, yards, and near passenger stations. FRA has studied locomotive horn noise and had determined that horn noise contours exhibit the general cone-like shape shown in Figure 4-2. Locomotive horn use increases as trains approach the crossing, and therefore, the noise contour flares outward at the crossing. The locomotive horn contours created during this noise analysis exhibit a similar shape; refer to the noise contour figures in Appendices A through O.

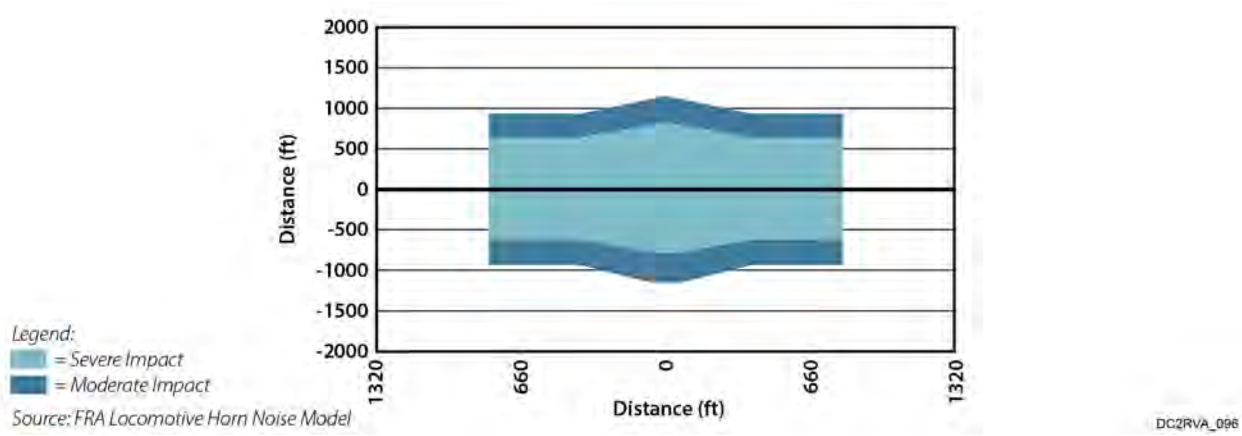


Figure 4-2: FRA Sample Train Noise Contour

Table 4-3 shows other train characteristics used to evaluate noise from trains on the proposed bypasses in Fredericksburg (Build Alternative 3C) and Ashland (Build Alternatives 5C and 5C–Ashcake) and on the eight Richmond Build Alternatives.

Table 4-3: Characteristics of Existing Trains Analyzed in the Noise Assessment

	Amtrak Auto Train	Amtrak Long Distance	Amtrak Interstate Corridor Carolinian	Interstate Corridor (SEHSR) and Regional (Virginia and SEHSR)	Freight Train(1)
SEL for locomotive at 50 feet(2)(3)	97	97	97	97	97(4)
SEL for railcar at 50 feet(2)(3)	82	82	82	82	100(4)
SEL for locomotive Horn at 50 feet(2)(3)	108	108	108	108	110(5)
Maximum train speed (mph)(6)	90	90	90	90	60(7)
Train length (feet)	4390	1075	750	992	7083
Number of locomotives per train	2	2	1	2	2
Number of railcars per train	50	11	8	10	73(8)
Throttle setting	8	8	8	8	8
Locomotive length (feet)	70	70	70	70	74
Length of train railcars (feet)	85	85	85	85	95

Notes:

1 Freight trains were only modeled on the proposed bypasses.

2 Source: HDR Engineering, Inc.

3 SEL for 90 mph trains from FRA (September 2012).

4 Source: FRA CREATE.

5 Source: United States Surface Transportation Board, 1998

6 Varies by rail section; the maximum allowable speed per section was modeled.

7 Maximum freight train speed is 60 mph.

8 Based on an average of cars on intermodal trains and coal and merchandise trains.

4.1.3 Predicted Noise Levels

Using the information in Tables 4-2 and 4-3, train noise levels under the Build Alternatives were calculated throughout the study area. These calculations accounted for wayside noise (locomotive and wheel-rail noise) and locomotive horn use at public at-grade crossings. FRA locomotive horn use rules do not require locomotive horn use at private at-grade crossings. The analysis assumed that freight trains would use the bypass in Fredericksburg Bypass (Build Alternative 3C), and the bypass in Ashland Bypass (Build Alternatives 5C and 5C–Ashcake) would be used by freight trains and passenger trains that do not stop in Ashland. Analysis results were used to determine the distance from the tracks at which train noise levels equal the noise impact thresholds for moderate and severe noise impacts at Category 1, 2, and 3 land uses. Noise impacts are identified at the noise-sensitive land uses within those distances to the track.

4.1.4 Noise Impact Assessment

This section presents the results of the assessment of Project-related noise during operation and construction. Appendices A through O include figures that show the noise impact contours.

4.1.4.1 Operational Noise Impacts

VDRPT plotted the distances-to-noise-impact contours and counted the receptors within the impact contours. The receptors inside the impact contours are considered noise impacts as defined by FRA/FTA. Figures in Appendices A through O show the contours and impacted noise-sensitive receptors for each alternative. The following sections discuss the noise impacts of each alternative in each area. The noise analysis did not account for terrain or buildings that block train noise from reaching noise-sensitive parcels; therefore, the results are considered to be conservatively high, over-estimating the number of likely train noise impacts. The values shown in Tables 4-4 through 4-8 represent the number of noise-sensitive land uses projected to experience noise impacts under the Build Alternatives. Category 1, Category 2, and Category 3 refer to land use categories evaluated in the noise assessment, as explained previously.

Build Alternatives 1A, 1B, and 1C (Arlington). DRPT does not anticipate that Build Alternatives 1A, 1B, and 1C will cause any noise impacts.

Build Alternative 2A (Northern Virginia). Build Alternative 2A is projected to cause noise impacts at 775 sensitive receptors (Table 4-4). The most severe impacts generally occur at residences located immediately adjacent to the DC2RVA corridor, including a trailer park just south of Woodbridge Station and several other residential neighborhoods in Prince William County.

Table 4-4: Build Alternative 2A Noise Impacts

County or Municipality	Noise Impacts						
	Category 1		Category 2		Category 3		Total
	Moderate	Severe	Moderate	Severe	Moderate	Severe	
Alexandria	0	0	91	2	1	0	94
Arlington	0	0	7	0	0	0	7
Fairfax	0	0	104	2	0	0	106
Prince William	0	0	404	91	3	0	498
Stafford	0	0	64	4	2	0	70
Total	**0**	**0**	**670**	**99**	**6**	**0**	**775**

Build Alternatives 3A, 3B, and 3C (Fredericksburg). Build Alternatives 3A and 3B that pass through town would impact 75 and 76 sensitive receptors, respectively (Table 4-5). Projected noise impacts along the Fredericksburg Bypass (Build Alternative 3C) are substantially higher due to noise from freight trains on the bypass, which would run through areas that currently have no train traffic.

Table 4-5: Build Alternatives 3A, 3B, And 3C Noise Impacts

Alternative	County or Municipality	Noise Impacts						
		Category 1		Category 2		Category 3		Total
		Moderate	Severe	Moderate	Severe	Moderate	Severe	
3A	Caroline	0	0	8	2	0	0	10
	Fredericksburg	0	0	50	3	0	0	53
	Spotsylvania	0	0	7	3	1	0	11
	Stafford	0	0	1	0	0	0	1
	Total 3A	**0**	**0**	**66**	**8**	**1**	**0**	**75**
3B	Caroline	0	0	8	2	0	0	10
	Fredericksburg	0	0	50	3	0	0	53
	Spotsylvania	0	0	7	3	1	0	11
	Stafford	0	0	2	0	0	0	2
	Total 3B	**0**	**0**	**67**	**8**	**1**	**0**	**76**
3C	Caroline	0	0	41	29	0	0	70
	Fredericksburg	1	0	538	63	0	0	602
	Spotsylvania	1	0	168	126	3	0	298
	Stafford	0	1	1645	1306	5	5	2962
	Total 3C	**2**	**1**	**2392**	**1524**	**8**	**5**	**3932**

Build Alternative 4A (Central Virginia). Build Alternative 4A is projected to cause noise impacts at 70 sensitive receptors (Table 4-6).

Table 4-6: Build Alternative 4A Noise Impacts

County or Municipality	Noise Impacts						
	Category 1		Category 2		Category 3		Total
	Moderate	Severe	Moderate	Severe	Moderate	Severe	
Caroline	0	0	40	18	1	0	59
Hanover	0	0	11	0	0	0	11
Total	**0**	**0**	**51**	**18**	**1**	**0**	**70**

Build Alternatives 5A through 5D (Ashland). Projected noise impacts are similar among Build Alternatives that pass through town (Build Alternatives 5A, 5A–Ashcake, 5B, 5B–Ashcake, and 5D–Ashcake), ranging from 154 to 159. Under the Ashland Bypass (Build Alternatives 5C and 5C–Ashcake), 329 noise impacts are projected (Table 4-7). The higher number of impacts is due to the addition of freight train noise along the proposed bypass, which runs through areas that do not have trains under existing conditions. This is one example where use of the highest train speed on each section results in conservatively high analysis results.

One of the severe Category 3 impacts is at the Ashland Library, located adjacent to the tracks; however, the proximity of the nearby station means that intercity passenger and freight trains would actually be traveling slower than modeled. This is one example where use of the highest train speed on each section results in conservatively high analysis results.

The impacts identified with the Ashland area alternatives assume that passenger trains would operate at 90 mph through the Town of Ashland. In reality, the trains would slow down through town, even if they are not stopping at the station. Any reduction in speed would reduce the noise impacts from the Project. As a result, the noise analysis results are conservative.

Table 4-7: Build Alternatives 5A, 5A–Ashcake, 5B, 5B–Ashcake, 5C, 5C–Ashcake, 5D–Ashcake Noise Impacts

Alternative	County or Municipality	Noise Impacts						
		Category 1		Category 2		Category 3		Total
		Moderate	Severe	Moderate	Severe	Moderate	Severe	
5A, 5A–Ashcake	Hanover	0	0	115	10	0	3	128
	Henrico	0	0	20	4	1	1	26
	Total 5A, 5A–Ashcake	**0**	**0**	**135**	**14**	**1**	**4**	**154**
5B, 5B–Ashcake	Hanover	1	0	113	16	0	3	133
	Henrico	0	0	20	4	1	1	26
	Total 5B, 5B–Ashcake	**1**	**0**	**133**	**20**	**1**	**4**	**159**
5C, 5C–Ashcake	Hanover	0	0	252	47	1	3	303
	Henrico	0	0	20	4	1	1	26
	Total 5C, 5C–Ashcake	**0**	**0**	**272**	**51**	**2**	**4**	**329**
5D–Ashcake	Hanover	1	0	115	14	0	3	133
	Henrico	0	0	20	4	1	1	26
	Total 5D–Ashcake	**1**	**0**	**135**	**18**	**1**	**4**	**159**

Build Alternatives 6A through 6G (Richmond). Projected noise impacts through Richmond range from 313 to 439 under Build Alternatives 6A through 6G (Table 4-8).

Table 4-8: Build Alternatives 6A, 6B–A-Line, 6B–S-Line, 6C, 6D, 6E, 6F, 6G Noise Impacts

Alternative	County or Municipality	Noise Impacts						
		Category 1		Category 2		Category 3		Total
		Moderate	Severe	Moderate	Severe	Moderate	Severe	
6A	Chesterfield	0	0	23	0	0	0	23
	Henrico	0	0	188	3	2	0	193
	Richmond	0	0	155	5	4	0	164
	6A Total	**0**	**0**	**366**	**8**	**6**	**0**	**380**
6B–A-Line	Chesterfield	0	0	23	0	0	0	23
	Henrico	0	0	195	3	2	0	200
	Richmond	0	0	168	6	4	0	178
	6B-A Total	**0**	**0**	**386**	**9**	**6**	**0**	**401**
6B–S-Line	Chesterfield	0	0	19	1	0	0	20
	Henrico	0	0	195	3	2	0	200
	Richmond	1	0	202	11	5	0	219
	6B-S Total	**1**	**0**	**416**	**15**	**7**	**0**	**439**
6C	Chesterfield	0	0	23	0	0	0	23
	Henrico	0	0	195	3	2	0	200
	Richmond	0	0	169	6	5	0	180
	6C Total	**0**	**0**	**387**	**9**	**7**	**0**	**403**
6D	Chesterfield	0	0	19	1	0	0	20
	Henrico	0	0	195	3	2	0	200
	Richmond	1	0	202	11	5	0	219
	6D Total	**1**	**0**	**416**	**15**	**7**	**0**	**439**
6E	Chesterfield	0	0	23	0	0	0	23
	Henrico	0	0	188	3	2	0	193
	Richmond	0	0	168	6	4	0	178
	6E Total	**0**	**0**	**379**	**9**	**6**	**0**	**394**
6F	Chesterfield	0	0	19	1	0	0	20
	Henrico	0	0	195	3	2	0	200
	Richmond	1	0	202	11	5	0	219

Table 4-8: Build Alternatives 6A, 6B–A-Line, 6B–S-Line, 6C, 6D, 6E, 6F, 6G Noise Impacts

Alternative	County or Municipality	Noise Impacts						
		Category 1		Category 2		Category 3		Total
		Moderate	Severe	Moderate	Severe	Moderate	Severe	
	6F Total	**1**	**0**	**416**	**15**	**7**	**0**	**439**
6G	Chesterfield	0	0	5	0	0	0	5
	Henrico	0	0	195	3	2	0	200
	Richmond	1	0	98	7	2	0	108
	6G Total	**1**	**0**	**298**	**10**	**4**	**0**	**313**

4.1.4.2 Construction Noise Impacts

Construction of the Build Alternatives would result in a temporary increase in noise levels. Equipment used to move soil and other earthen materials is often the loudest construction noise source.

Typical equipment used for different phases of railroad construction with typical noise levels, quantities, and estimated utilizations for each type of equipment used are presented in Table 4-9. The table shows the sound power level (SWL) used to determine sound pressure levels (SPL) at different distances.

Table 4-9: Estimated Construction Equipment Noise Levels

Construction Phase	Equipment	Number	Hours/day	Utilization	SWL/unit	Total SWL	SPL (dBA) at distance (feet)		
							100	500	1,000
Clearing	Off-Highway Trucks	4	6	50%	124	127	108	94	88
	Rubber Tired Dozers	3	8	67%	122	125	106	92	86
	Rubber Tired Loaders	2	6	50%	121	121	102	88	82
	Tractors/Loaders/Backhoes	3	5	42%	118	119	100	86	80
	Trenchers	2	4	33%	117	115	96	82	76
Utility Relocation	Cranes	1	6	50%	121	118	100	86	80
	Dumper/Tender	2	4	33%	110	108	89	75	69
	Off-Highway Trucks	2	6	50%	124	124	105	91	85
	Rubber Tired Dozers	3	8	67%	122	125	106	92	86
	Rubber Tired Loaders	2	6	50%	121	121	102	88	82
	Tractors/Loaders/Backhoes	3	5	42%	118	119	100	86	80
	Trenchers	2	6	50%	117	117	98	84	78
	Welders	3	6	50%	114	116	97	83	77

Table 4-9: Estimated Construction Equipment Noise Levels

Construction Phase	Equipment	Number	Hours/day	Utilization	SWL/unit	Total SWL	SPL (dBA) at distance (feet)		
							100	500	1,000
Earthwork	Excavators	2	8	67%	120	121	102	88	82
	Graders	1	8	67%	120	118	100	86	80
	Off-Highway Trucks	4	8	67%	124	128	109	95	89
	Off-Highway Trucks	1	4	33%	123	118	100	86	80
	Rollers	2	6	50%	117	117	98	84	78
	Rubber Tired Dozers	1	8	67%	122	120	101	87	81
	Rubber Tired Loaders	2	6	50%	121	121	102	88	82
	Scrapers	2	8	67%	123	125	106	92	86
	Signal Boards	3	8	67%	106	109	90	76	70
	Tractors/Loaders/Backhoes	3	6	50%	118	119	101	87	81
Bridge Construction for Overpasses	Cranes	1	7	58%	121	119	100	86	80
	Excavators	2	8	67%	120	121	102	88	82
	Forklifts	3	8	67%	117	120	102	88	82
	Generator Sets	1	8	67%	117	115	97	83	77
	Graders	1	8	67%	120	118	100	86	80
	Impact Pile Driver	1	6	50	n/a	n/a	95	81	75
	Pavers	2	8	67%	119	120	101	87	81
	Paving Equipment	2	8	67%	119	120	101	87	81
	Rollers	2	8	67%	117	118	99	85	79
	Rubber Tired Dozers	1	8	67%	122	120	101	87	81
	Scrapers	2	8	67%	123	125	106	92	86
	Tractors/Loaders/Backhoes	2	8	67%	118	119	100	86	80
	Welders	1	8	67%	114	113	94	80	74
Retaining Walls	Excavators	2	8	67%	120	121	102	88	82
	Forklifts	3	8	67%	117	120	102	88	82
	Generator Sets	1	8	67%	117	115	97	83	77
	Graders	1	8	67%	120	118	100	86	80
	Impact Pile Driver	1	6	50	n/a	n/a	95	81	75
	Rubber Tired Dozers	1	8	67%	122	120	101	87	81
	Rubber Tired Loaders	2	7	58%	121	121	103	89	83
	Scrapers	2	8	67%	123	125	106	92	86
	Tractors/Loaders/Backhoes	3	7	58%	118	120	101	87	81
Signals	Cranes	1	7	58%	121	119	100	86	80
	Forklifts	3	8	67%	117	120	102	88	82
	Generator Sets	1	8	67%	117	115	97	83	77

Table 4-9: Estimated Construction Equipment Noise Levels

Construction Phase	Equipment	Number	Hours/day	Utilization	SWL/unit	Total SWL	SPL (dBA) at distance (feet)		
							100	500	1,000
	Tractors/Loaders/Backhoes	2	8	67%	118	119	100	86	80
	Welders	1	8	67%	114	113	94	80	74
Track Installation	Air Compressors	1	6	50%	117	114	95	81	75
	Cranes	1	7	58%	121	119	100	86	80
	Forklifts	3	8	67%	117	120	102	88	82
	Generator Sets	1	8	67%	117	115	97	83	77
	Track Laying Machine	1	8	67%	129	128	109	95	89
	Track Tamper	1	8	67%	121	119	100	86	80
	Track Stabilizer	1	8	67%	126	124	106	92	86
	Tractors/Loaders/Backhoes	2	8	67%	118	119	100	86	80
	Welders	1	8	67%	114	113	94	80	74
Demolish Existing Bridge	Concrete/Industrial Saws	1	8	67%	117	115	96	82	76
	Excavators	2	8	67%	120	121	102	88	82
	Graders	1	8	67%	120	118	100	86	80
	Rubber Tired Dozers	1	8	67%	122	120	101	87	81
	Scrapers	2	8	67%	123	125	106	92	86
	Tractors/Loaders/Backhoes	2	8	67%	118	119	100	86	80
Signal Work	Cranes	1	7	58%	121	119	100	86	80
	Forklifts	3	8	67%	117	120	102	88	82
	Generator Sets	1	8	67%	117	115	97	83	77
	Tractors/Loaders/Backhoes	2	8	67%	118	119	100	86	80
	Welders	1	8	67%	114	113	94	80	74
Install Track and Subballast Over Bridge	Air Compressors	1	6	50%	117	114	95	81	75
	Cranes	1	7	58%	121	119	100	86	80
	Forklifts	3	8	67%	117	120	102	88	82
	Generator Sets	1	8	67%	117	115	97	83	77
	Track Laying Machine	1	8	67%	129	128	109	95	89
	Track Tamper	1	8	67%	121	119	100	86	80
	Track Stabilizer	1	8	67%	126	124	106	92	86
	Ballast Regulator	1	8	67%	119	118	99	85	79
	Tractors/Loaders/Backhoes	2	8	67%	118	119	100	86	80
	Welders	1	8	67%	114	113	94	80	74
Final Cut-Over and Removal of Turnouts	Cranes	1	7	58%	121	119	100	86	80
	Forklifts	3	8	67%	117	120	102	88	82
	Generator Sets	1	8	67%	117	115	97	83	77
	Tractors/Loaders/Backhoes	3	7	58%	118	120	101	87	81
	Welders	1	8	67%	114	113	94	80	74

The results presented in Table 4-9 conservatively overestimate actual expected construction noise levels by assuming that all equipment (i.e., all dump trucks or all pickup trucks) operate at the same location. Typically, construction equipment is spread throughout the construction work zone. Given the linear nature of the Project and relatively confined width of the railroad right-of-way, it is reasonable to assume that all equipment would not operate next to each other in the same (stationary) location for 1 hour. On this basis, construction noise levels in Table 4-9 somewhat overestimate noise levels for construction phases that would use more than one piece of equipment at a particular location. In all other cases, the results are assumed to be within 3 dBA of likely construction noise levels, if the equipment has been properly maintained and the mufflers are in good condition.

Construction noise analysis results shown in Table 4-9 indicate the total combined noise for all equipment types and construction phases never exceeds the 90 dBA threshold at 200 feet, even using a conservative approach to the evaluation. Because the calculated construction noise is not anticipated to exceed 90 dBA at 200 feet, construction noise is not expected to be adverse; however, DRPT will ensure that construction noise mitigation measures will be evaluated when an analysis of construction noise based on the actual construction plan can be completed. At the preliminary design phase, construction noise mitigation measures are not recommended due to the overly conservative nature of these calculation results.

FRA and FTA do not have standardized criteria for construction; however, FTA suggests reasonable criteria that can be used for assessment purposes. The criteria for residential land uses are 1-hour L_{eq} of 90 dBA during the day and 80 dBA during the night; therefore, it would be prudent to limit construction to daytime hours whenever feasible.

4.2 VIBRATION

This section describes potential Project-related vibration effects and identifies mitigation measures to offset projected impacts. Vibration effects were assessed based on the methods and criteria included in FRA's *High Speed Ground Transportation Noise and Vibration Impact Assessment* guidance manual (September 2012) as well as those included in the FTA's *Transit Noise and Vibration Impact Assessment* (May 2006) manual, where applicable.

4.2.1 Vibration Impact Criteria

The FRA and FTA vibration impact criteria are identical and are used to predict future vibration impacts from train operations. There are separate criteria for both ground-borne vibration (GBV) and ground-borne noise (GBN). GBN is a rumble sound created by GBV and is often masked by airborne-noise; therefore, GBN criteria are primarily applied to subway operations in which airborne noise is negligible. The basis for evaluating rail vibration impact thresholds is the highest expected root mean square (RMS) vibration levels for repeated vibration events from the same source. As presented in Table 4-10, the thresholds are differentiated between vibration sensitive land uses and the frequency of the events.

The Category 1 vibration impact threshold is acceptable for most moderately sensitive equipment; other highly sensitive equipment would require a detailed analysis to determine the acceptable vibration levels, and the effect of the Project on the equipment. There are no GBN impact thresholds for Category 1 land uses because equipment sensitive to GBV is generally not sensitive to GBN; however, other special Category 1 land uses, such as concert halls, television and recording studios, and theaters, can be very sensitive to GBV and GBN. FTA has developed special vibration impact thresholds for these land uses, but these land uses were not encountered in the potential zone of influence from train vibration.

Table 4-10: Ground-Borne Vibration (GBV) and Ground-Borne Noise (GBN) Impact Criteria for General Assessment

Land Use Category	GBV Impact Levels (VdB re 1 µin/s)			GBN Impact Levels (dBA re 20 µPa)		
	Frequent Events [1]	Occasional Events [2]	Infrequent Events [3]	Frequent Events [1]	Occasional Events [2]	Infrequent Events [3]
Category 1: Buildings where vibration would interfere with interior operations.	65 VdB [4]	65 VdB [4]	65 VdB [4]	n/a [5]	n/a [5]	n/a [5]
Category 2: Residences and buildings where people normally sleep.	72 VdB	75 VdB	80 VdB	35 dBA	38 dBA	43 dBA
Category 3: Institutional land uses with primarily daytime use.	75 VdB	78 VdB	83 VdB	40 dBA	43 dBA	48 dBA

Source: FRA, 2012.

Notes: 1. Frequent Events is defined as more than 70 vibration events of the same kind per day; 2. Occasional Events is defined as between 30 and 70 vibration events of the same kind per day; 3. Infrequent Events is defined as fewer than 30 vibration events of the same kind per day; 4. This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Vibration-sensitive manufacturing or research would require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the heating, ventilation, and air conditioning (HVAC) systems and stiffened floors; 5. Vibration-sensitive equipment is not sensitive to GBN.

4.2.2 Vibration Prediction Methodology

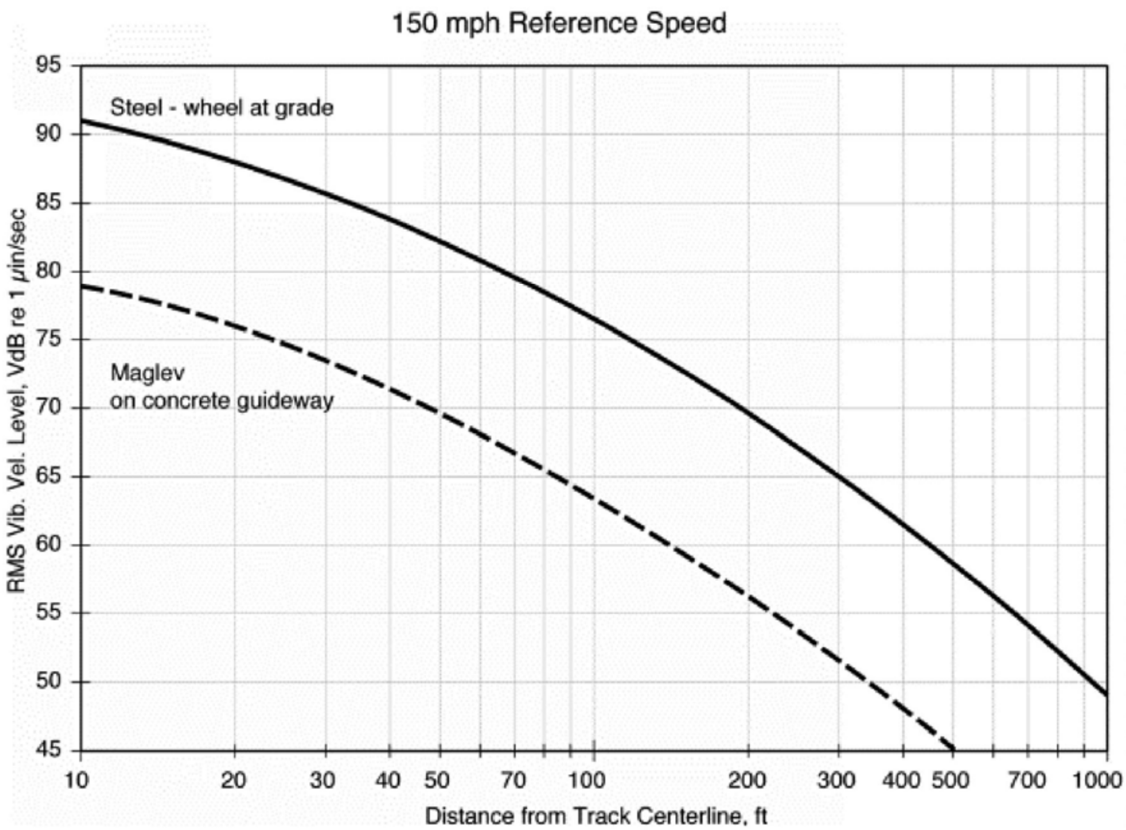
The vibration assessment consists of the following general steps:

1. Establish the study area and identify vibration-sensitive land uses.
2. Evaluate the railroad traffic conditions and set corresponding impact thresholds.
3. Select the base generalized vibration curve and apply appropriate adjustments.
4. Determine the propagation from Project-related vibration sources to the impact thresholds.
5. Identify receptors anticipated to experience vibration impacts.

The FRA and FTA General Assessment methodologies are nearly identical and are intended to predict approximate magnitude of impact, and those with the highest magnitude of impact may merit a more-detailed assessment during subsequent engineering phases. Noise and vibration-sensitive land uses within the study area were identified according to FRA categories. Land use was identified from GIS databases, field surveys, and information on planned development from local planning departments.

The vibration prediction begins with selection of a generalized base curve, depending on the mode considered. These curves represent typical ground-surface vibration as a function of distance from the source, based on many GBV measurements of numerous transit sources.

The generalized ground surface vibration curves suitable for assessing the high speed passenger trains are shown in Figure 4-3. They represent the upper range of the measurement data from equipment in good condition.



Source: FRA, 2006.

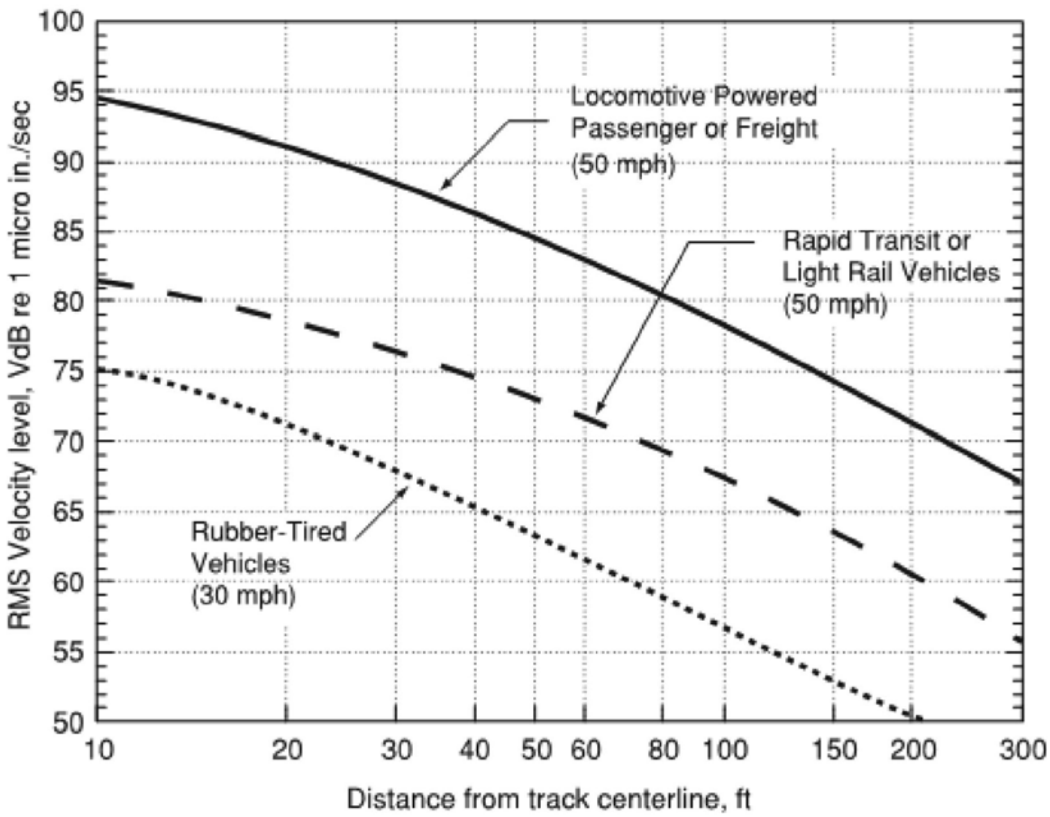
DC2RVA_088

Figure 4-3: FRA Generalized Ground Surface Vibration Curves

The generalized ground surface vibration curves suitable for assessing intercity passenger and freight trains are shown in Figure 4-4. These curves similarly represent the upper range of the measurement data from equipment in good condition. The top curve represents trains that are powered by diesel-electric locomotives, and the middle curve represents fixed-guideway steel-wheel transit vehicles such as light-rail vehicles and streetcars.

The base curves must then be adjusted to account for Project-specific vibration factors that differ from the conditions of the base curve. Adjustment parameters are given in the FRA and FTA guidance and include train speed, wheel and rail type and condition, and type of track support system, among other adjustments. The adjustment parameters are based on typical vibration spectra, and are given as generalized single numbers to be applied to the base curve.

The adjustments are arithmetically added to the reference vibration curve, and the resulting levels are compared to the impact thresholds. This is algebraically equivalent to subtracting the same adjustments from the impact threshold and comparing it to the unadjusted reference curve. In this way, the graphical curves shown in Figures 4-3 and 4-4 can be used to find the distance to vibration impact. For this assessment, the distance to vibration impact was determined by looking up the level of the adjusted criterion curve on the y-axis and then finding the distance on the x-axis from the generalized vibration curve.



Source: FRA, 2006.

DC2RVA_089

Figure 4-4: FRA Generalized Ground Surface Vibration Curves Suitable for Assessing Transit and Freight Trains

4.2.2.1 Computation Assumptions and Input Data

The vibration assessment used the same traffic data as the noise assessment. The FRA generalized vibration curve "Steel-wheel at-grade" was used as the base curve for the impact assessment of the proposed additional intercity passenger trains. Freight trains already run through the DC2RVA corridor and are not modeled for any of the track in the existing corridor; however, where freight trains are being introduced, such as on the proposed bypass sections, the FTA generalized vibration curve "Locomotive powered passenger and freight" was used as the base curve for the impact assessment of freight trains.

Specific modeling considerations for each Build Alternative are provided in Table 4-11.

Table 4-11: Vibration Analysis Modeling Assumptions

Alternative Area	Alternative	Modeling Assumption
Area 1: Arlington (Long Bridge Approach)	1A, 1B, and 1C	There are three alternatives, but no vibration-sensitive receptors within 500 feet of the Project; therefore, no vibration assessment was completed for Build Alternatives 1A, 1B, and 1C.

Table 4-11: Vibration Analysis Modeling Assumptions

Alternative Area	Alternative	Modeling Assumption
Area 2: Northern Virginia (Long Bridge to Dahlgren Spur)	2A	There is only one alternative along the existing passenger rail corridor. The additional intercity passenger trains were modeled using the FRA generalized vibration curve for steel-wheel at-grade high speed trains.
Area 3: Fredericksburg (Dahlgren Spur to Crossroads)	3A and 3B	Build Alternatives 3A and 3B would route Project-related trains through the existing passenger rail corridor. The additional intercity passenger trains were modeled using the FRA generalized vibration curve for steel-wheel at-grade high speed trains.
	3C	The Fredericksburg Bypass (Build Alternative 3C) would route freight trains and potentially some of the passenger trains along a new alignment that bypasses Fredericksburg. The additional intercity passenger trains were modeled through the existing corridor using the FRA generalized vibration curve for steel-wheel at-grade high speed trains. Even at a lower speed, the freight trains generate more vibration than the passenger trains; therefore, the freight trains were modeled in the bypass corridor using the FTA generalized vibration curve for locomotive-powered passenger or freight trains.
Area 4: Central Virginia (Crossroads to Doswell)	4A	There is only one alternative along the existing passenger rail corridor. The additional intercity passenger trains were modeled using the FRA generalized vibration curve for steel-wheel at-grade high speed trains.
Area 5: Ashland (Doswell to I-295)	5A, 5A–Ashcake, 5B, 5B–Ashcake, and 5D–Ashcake	Build Alternatives 5A, 5A–Ashcake, 5B, 5B–Ashcake, and 5D–Ashcake would route Project-related trains through the existing passenger rail corridor. The additional intercity passenger trains are modeled using the FRA generalized vibration curve for steel-wheel at-grade high speed trains.
	5C and 5C–Ashcake	Build Alternatives 5C and 5C–Ashcake would route the through passenger trains and the freight trains along a new alignment that bypasses the Town of Ashland, while passenger trains that stop in Ashland would use the bypassed area of the existing corridor. Even at a lower speed, the freight trains generate more vibration than the passenger trains; therefore, the freight trains were modeled in the bypass corridor using the FTA generalized vibration curve for locomotive-powered passenger or freight trains. The planned number of future passenger trains is the same as the number of passenger trains that currently use this portion of the DC2RVA corridor, and the planned future trains are on average shorter than the average length of existing trains, plus there would be no freight traffic. These changes represent a benefit to vibration effects; therefore, vibration contours were not calculated for the bypassed area of the existing corridor.
Area 6: Richmond (I-295 to Centralia)	6A, 6B–A-Line, 6C, and 6E	Alternatives 6A, 6B–A-Line, 6C, and 6E would route Project-related trains via the current CSXT North End Subdivision (sometimes referred to as the A-line) between West Acca Yard in Richmond and Centralia, VA. The CSXT Bellwood Subdivision (sometimes referred to as the S-line) between Control Point Hermitage in Richmond and Centralia, VA, would not see any increase in passenger train traffic, so the trains were not modeled as a consequence of this Project on that section. The additional intercity passenger trains are modeled using the FRA generalized vibration curve for steel-wheel at-grade high speed trains.
	6B–S-Line, 6D, 6F, and 6G	Alternatives 6B–S-Line, 6D, 6F, and 6G would route Project-related trains via the current S-line. The A-line would see a reduction in passenger trains, which represents a Project benefit, so the trains are not modeled as a consequence of this Project on that section. The additional intercity passenger trains were modeled using the FRA generalized vibration curve for steel-wheel at-grade high speed trains.

4.2.3 Predicted Vibration Levels

Estimates of Project-related, train-induced GBV were developed based on the methodology described above. The predicted vibration levels were used to develop distance-to-vibration-impact contours.

4.2.4 Vibration Impact Assessment

This section presents the results of the vibration impact assessment during operation and construction.

4.2.4.1 Operational Vibration Impacts

Using site-specific and project-specific data as explained above, DRPT conducted the vibration assessment by calculating the distance from the rail line at which train-induced vibration levels equal the FRA ground-borne vibration impact thresholds. Vibration impact contour lines were then overlaid upon digital aerial photographs to delineate the areas projected to experience vibration impacts (Appendices P through W). Vibration-sensitive land uses inside the vibration contours are projected to experience vibration impacts as defined by FRA.

Build Alternatives 1A, 1B, and 1C (Arlington). There are no vibration-sensitive receptors within 500 feet of Build Alternatives 1A, 1B, or 1C; therefore, vibration impact contours were not calculated, and there are no anticipated vibration impacts for these Build Alternatives.

Build Alternative 2A (Northern Virginia). Build Alternative 2A is projected to have 15 vibration impacts. Additionally, there is a structure on National Register of Historic Places (NRHP)—the historic Alexandria Union Station—which is within all vibration impact contours; however, this structure was designed to stand next to rail transportation. Furthermore, the vibration levels are currently being compared to human-comfort criteria, which is much lower than vibration levels necessary to cause damage to even old, fragile structures. Therefore, while this structure is within the vibration impact contours, it is not considered an impact and is not included in Table 4-12.

Table 4-12: Build Alternative 2A Vibration Impacts

County or Municipality	Vibration Impacts			
	Category 1	**Category 2**	**Category 3**	**Total**
Arlington	0	4	0	4
Prince William	0	6	0	6
Stafford	0	5	0	5
Total	**0**	**15**	**0**	**15**

Build Alternatives 3A, 3B, and 3C (Fredericksburg). No vibration impacts were identified for Build Alternatives 3A or 3B that pass through town. The Fredericksburg Bypass (Build Alternative 3C) would cause 43 vibration impacts as a result of freight trains operating along new alignment (Table 4-13).

Table 4-13: Build Alternative 3C Vibration Impacts

County or Municipality	Vibration Impacts			
	Category 1	**Category 2**	**Category 3**	**Total**
Caroline	0	1	0	1
Spotsylvania	0	11	0	11
Stafford	0	31	0	31
Total	**0**	**43**	**0**	**43**

Build Alternative 4A (Central Virginia). Two vibration impacts for Category 2 (residential) land uses were identified for Build Alternative 4A.

Build Alternatives 5A through 5D (Ashland). Vibration impacts for the Build Alternatives in the Ashland area range from 26 to 36 (Table 4-14). These impacts, including the Category 3 impact at the Ashland Library, are based on the assumption that passenger trains are operating at 90 mph through Ashland. In reality, trains would slow down through town, even if they are not stopping at the station. At this point, the tabulation of vibration impacts is considered a conservative overestimate. The addition of freight traffic on the proposed bypass alignment is the primary source of vibration impacts for Build Alternatives 5C and 5C–Ashcake.

Table 4-14: Build Alternatives 5A, 5A–Ashcake, 5B, 5B–Ashcake, 5C, 5C–Ashcake, 5D–Ashcake Vibration Impacts

Alternative	County or Municipality	Vibration Impacts			
		Category 1	**Category 2**	**Category 3**	**Total**
5A, 5A–Ashcake	Hanover	0	23	1	24
	Henrico	0	2	0	2
	Total 5A, 5A–Ashcake	**0**	**25**	**1**	**26**
5B, 5B–Ashcake	Hanover	0	28	1	29
	Henrico	0	2	0	2
	Total 5B, 5B–Ashcake	**0**	**30**	**1**	**31**
5C, 5C–Ashcake	Hanover	0	33	1	34
	Henrico	0	2	0	2
	Total 5C, 5C–Ashcake	**0**	**35**	**1**	**36**
5D–Ashcake	Hanover	0	28	1	29
	Henrico	0	2	0	2
	Total 5D–Ashcake	**0**	**30**	**1**	**31**

Build Alternatives 6A through 6G (Richmond). The projected number of vibration impacts in the Richmond area are the same for all Build Alternatives, although which receptors would be impacted varies by whether the A-Line or the S-Line would be used by the additional intercity passenger trains (Tables 4-15 and 4-16).

Table 4-15: Build Alternatives 6A, 6B–A-Line, 6C, 6E Vibration Impacts

County or Municipality	Vibration Impacts			
	Category 1	Category 2	Category 3	Total
Henrico	0	2	0	2
Richmond	0	6	0	6
Total	**0**	**8**	**0**	**8**

Table 4-16: Build Alternatives 6B–S-Line, 6D, 6F, 6G Vibration Impacts

County or Municipality	Vibration Impacts			
	Category 1	Category 2	Category 3	Total
Chesterfield	0	1	0	1
Henrico	0	2	0	2
Richmond	0	5	0	5
Total	**0**	**8**	**0**	**8**

4.2.4.2 Construction Vibration Impacts

Construction activity can result in varying degrees of ground vibration, depending on the equipment and methods employed. Operation of construction equipment causes ground vibrations that spread through the ground and diminish in strength with distance. Buildings near construction can respond to these vibrations, with varying results ranging from no perceptible effects at the lowest levels; low rumbling sounds and perceptible vibrations at moderate levels; and slight damage at the highest levels.

Ground vibrations from construction activities do not often reach the levels that can damage structures, but they can reach the range of perceptible vibration or audible sound in buildings very close to the site. A possible exception is the case of fragile buildings where special care must be taken to avoid damage. The construction vibration criteria include special consideration for fragile buildings. The damage criteria published by FTA, using units of peak particle velocity (PPV) expressed in inches per second, are presented in Table 4-17.

Table 4-17: Construction Vibration Damage Criteria

Building Category	Description	Damage Criteria, PPV (in./sec.)
I	Reinforced concrete, steel, or timber (no plaster)	0.5
II	Engineered concrete and masonry (no plaster)	0.3
III	Non-engineered timber and masonry buildings	0.2
IV	Buildings extremely susceptible to vibration damage	0.12

Ground vibrations from construction activities can be audible and perceptible in buildings near the construction limits. Some buildings are more sensitive to vibration than others; they might have recording or broadcast facilities or vibration-sensitive equipment in them. FRA advocates a separate set of vibration criteria for buildings with vibration-sensitive uses or equipment inside of them. The criteria used for vibration-sensitive equipment is presented in Table 4-18; however, as noted previously in this report, no vibration-sensitive land uses were identified in the study area.

Table 4-18: Construction Vibration Damage Criteria–Vibration-Sensitive Equipment

Type of Building or Room	Max Lv, VdB [1]
TV Studios	65
Recording Studios	65
Theaters	65
Vibration-Sensitive Lab	48

Notes: 1. RMS velocity in decibels (VdB) re 1 micro-inch/second.

PPVs associated with typical construction equipment, as published by FTA, are presented in Table 4-19. These vibration emission levels and factors represent a conservatively high usage because it is not anticipated that all this machinery is to be used at any one particular location at the same time.

Table 4-19: Construction Equipment PPV

Equipment		PPV at 25 ft (in./sec.)	Approx. Lv[1] at 25 ft.
Pile Driver (impact)	upper range	1.518	112
	typical	0.644	104
Pile Driver (sonic)	upper range	0.734	105
	typical	0.17	93
Clam shovel drop		0.202	94
Hydromill	in soil	0.008	66
	in rock	0.017	75
Vibratory Roller		0.21	94
Hoe Ram		0.089	87
Large bulldozer		0.089	87
Caisson drilling		0.089	87
Loaded trucks		0.076	86
Jackhammer		0.035	79
Small bulldozer		0.003	58

Source: FTA, May 2006.

Notes: 1. RMS velocity in decibels (VdB) re 1 micro-inch/second.

5 SUMMARY OF IMPACTS

5.1 NOISE

Table 5-1 summarizes the noise impact assessment results for each of the build alternatives.

Table 5-1: Noise Impact Summary by Alternative

Alternative Area	Alternative	Noise Impacts						
		Category 1		Category 2		Category 3		Total
		Moderate	Severe	Moderate	Severe	Moderate	Severe	
Area 1: Arlington (Long Bridge Approach)	1A	0	0	0	0	0	0	0
	1B	0	0	0	0	0	0	0
	1C	0	0	0	0	0	0	0
Area 2: Northern Virginia (Long Bridge to Dahlgren Spur)	2A	0	0	670	99	6	0	775
Area 3: Fredericksburg (Dahlgren Spur to Crossroads)	3A	0	0	66	8	1	0	75
	3B	0	0	67	8	1	0	76
	3C	2	1	2,392	1,524	8	5	3,932
Area 4: Central Virginia (Crossroads to Doswell)	4A	0	0	51	18	1	0	70
Area 5: Ashland (Doswell to I-295)	5A	0	0	135	14	1	4	154
	5A–Ashcake	0	0	135	14	1	4	154
	5B	1	0	133	20	1	4	159
	5B–Ashcake	1	0	133	20	1	4	159
	5C	0	0	272	51	2	4	329
	5C–Ashcake	0	0	272	51	2	4	329
	5D–Ashcake	1	0	135	18	1	4	159
Area 6: Richmond (I-295 to Centralia)	6A	0	0	366	8	6	0	380
	6B–A-Line	0	0	386	9	6	0	401
	6B–S-Line	1	0	416	15	7	0	439
	6C	0	0	387	9	7	0	403
	6D	1	0	416	15	7	0	439
	6E	0	0	379	9	6	0	394
	6F	1	0	416	15	7	0	439
	6G	1	0	298	10	4	0	313

5.2 VIBRATION

Table 5-2 summarizes the vibration impact assessment results for each of the build alternatives.

Table 5-2: Vibration Impact Summary by Alternative

Alternative Area	Alternative	Vibration Impacts			
		Category 1	Category 2	Category 3	Total
Area 1: Arlington (Long Bridge Approach)	1A	0	0	0	0
	1B	0	0	0	0
	1C	0	0	0	0
Area 2: Northern Virginia	2A	0	15	0	15
Area 3: Fredericksburg (Dahlgren Spur to Crossroads)	3A	0	0	0	0
	3B	0	0	0	0
	3C	0	43	0	43
Area 4: Central Virginia (Crossroads to Doswell)	4A	0	2	0	2
Area 5: Ashland (Doswell to I-295)	5A	0	25	1	26
	5A–Ashcake	0	25	1	26
	5B	0	30	1	31
	5B–Ashcake	0	30	1	31
	5C	0	35	1	36
	5C–Ashcake	0	35	1	36
	5D–Ashcake	0	30	1	31
Area 6: Richmond (I-295 to Centralia)	6A	0	8	0	8
	6B–A-Line	0	8	0	8
	6B–S-Line	0	8	0	8
	6C	0	8	0	8
	6D	0	8	0	8
	6E	0	8	0	8
	6F	0	8	0	8
	6G	0	8	0	8

6 MITIGATION

6.1 NOISE MITIGATION MEASURES

6.1.1 Noise Mitigation during Operation

Potential noise mitigation measures are broadly categorized as applied at the source, in the pathway (the path that sound travels), or at the receiver. The source of most train noise is the interaction of steel wheels and the steel rail; this is called wayside noise. In addition to wayside noise, railcars (particularly, freight cars) sometimes rattle and produce noticeable amounts of noise. Locomotives also emit noise from the engine casing and from the cooling and exhaust vents. Maintaining wheels and rails is an effective way to manage and reduce wayside noise. Use of continuously welded rail (CWR or rail with no joints) also minimizes wayside noise (joints and gaps in the rail produce noise when trains roll over them). As part of the Build Alternatives, DRPT assumes that all track will be CWR

Locomotive horns are another loud source of train noise; however, their use is mostly limited to at-grade crossings and other areas required by CSXT operating rules where they are used to warn people that trains are approaching. Locomotive horn use at public at-grade crossings is required under FRA safety regulations. FRA does not require locomotive horn use at private at-grade crossings. Grade crossing closure, grade separations, and installation of wayside horns (stationary horns located where trains cross public at-grade crossings, whose use eliminates the use of locomotive horns) are potential measures to mitigate locomotive horn use. These have been evaluated and are incorporated into the Project to the extent deemed reasonable and appropriate within the design, operating, and financial constraints of the Project. FRA regulations also allow the creation of quiet zones, where locomotive horn use at public at-grade crossings is not required due to the installation of supplemental safety measures. Under those regulations, municipalities can coordinate the design and development of quiet zones.

Noise barriers, while not commonly used on rail projects, can block train noise and reduce noise levels in areas behind them. To be effective, noise barriers must block the line of sight between the noise source and the receiver. Raising the height of the noise barrier above that line of sight increases the amount of noise reduction the noise barrier provides, but the cost of a noise barrier is directly related to the size of the barrier. Cost effectiveness is sometimes used to evaluate whether the noise reduction provided by a noise barrier justifies the expense of designing, constructing, and maintaining the barrier. This type of evaluation also considers the number of noise-sensitive land uses expected to experience a noise reduction due to the noise barrier. FRA does not have criteria for evaluating cost effectiveness of noise barriers. VDOT does, however, and their criteria could be useful for evaluating the cost effectiveness of noise barriers on this Project. At this early phase of Project development (Draft EIS and preliminary design), it is premature to discuss specific details of potential noise mitigation options before a recommended Preferred Alternative is selected.

Receiver-based mitigation is rarely implemented on rail projects because it is not cost effective to treat multiple individual locations across large areas.

6.1.2 Noise Mitigation during Construction

Practices to minimize the effects of construction noise would be in accordance with Section 107.14(c)(3) of VDOT's Road and Bridge Specifications.

While construction noise is unavoidable in most cases, steps can be taken to minimize the impact, such as the following:

- Keep all equipment well maintained, tuned, and properly lubricated to minimize at-source noise production.
- Use sound attenuation devices on exhaust ports.
- Substitute the use of flag persons to control construction vehicle movements, instead of using audible back-up alarms for vehicles.
- Minimize unnecessary idling of heavy equipment and machinery, especially diesel engines and generators, when not actively in use.
- Prohibit construction during sensitive nighttime, early evening, and early morning hours.

DRPT will evaluate construction noise mitigation measures in more detail when an analysis of construction noise based on an actual construction plan can be completed and will ensure that all appropriate mitigation measures are employed by including these measures in the contractors' contracts.

6.2 VIBRATION MITIGATION MEASURES

6.2.1 Vibration Mitigation during Operation

The impact assessment for operational vibration effects indicates where further study should investigate the vibration effects and potential mitigation measures. A more-thorough assessment of vibration effects will be conducted during the final design phases. Mitigation options are somewhat limited due to the presence of freight trains in the DC2RVA corridor. Mitigation strategies, such as floating slabs, are not feasible options for tracks that also carry freight. Where freight trains operate, the only feasible options for mitigation of the trains are track and wheel maintenance measures, strategic location of special trackwork, and buffer zones between the tracks and the receptors. DRPT has no control over the implementation of these mitigation measures by the freight railroads. Passenger train maintenance can also be implemented to reduce ground-borne vibration; modification of the passenger rail vehicle suspension is also a potential mitigation option. DRPT will identify the necessary mitigation measures during the final design process.

- **Track and wheel maintenance:** Maintenance procedures reduce vibration effects through regularly scheduled rail grinding, wheel truing programs, vehicle reconditioning programs, and implementation of flat-wheel detectors. These maintenance procedures minimize the vibration sources before they can affect vibration-sensitive receptors.

- **Location of special trackwork:** Effects of special trackwork has not been evaluated in this assessment because the locations are likely to change as Project design progresses. It is crucial that vibration effects on sensitive receptors are evaluated when locating special trackwork.
- **Buffer zones:** Creation of additional buffer zones is not a feasible mitigation measure along existing corridors; however, it may be feasible at some places along the bypass corridors.
- **Vehicle suspension:** Changing the vehicle suspension of the passenger trains is normally an option only when creating a new fleet of passenger trains. It is not feasible for the freight train traffic, and it is unlikely that the existing passenger train fleet will modify their suspension.

6.2.2 Vibration Mitigation during Construction

Construction-related vibration mitigation measures include BMP's such as equipment selection, finding alternatives to traditional impact pile driving, and limiting the hours of operation and locations where sources of construction-related vibration will occur. DRPT will develop the details of these BMPs during the final design process.

7 REFERENCES

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A NOISE IMPACTS AND IMPACT CONTOUR MAPS

Build Alternatives 1A, 1B, and 1C

B NOISE IMPACTS AND IMPACT CONTOUR MAPS

Build Alternative 2A

C NOISE IMPACTS AND IMPACT CONTOUR MAPS

Build Alternatives 3A and 3B

D

NOISE IMPACTS AND IMPACT CONTOUR MAPS

Build Alternative 3C

E NOISE IMPACTS AND IMPACT CONTOUR MAPS

Build Alternative 4A

F NOISE IMPACTS AND IMPACT CONTOUR MAPS

Build Alternatives 5A, 5A–Ashcake, 5B, 5B–Ashcake, 5D–Ashcake

G NOISE IMPACTS AND IMPACT CONTOUR MAPS

Build Alternatives 5C and 5C–Aschcake

H NOISE IMPACTS AND IMPACT CONTOUR MAPS

Build Alternative 6A

I NOISE IMPACTS AND IMPACT CONTOUR MAPS

Build Alternative 6B–A-Line

J

NOISE IMPACTS AND IMPACT CONTOUR MAPS

Build Alternative 6C

K NOISE IMPACTS AND IMPACT CONTOUR MAPS

Build Alternative 6E

L

NOISE IMPACTS AND IMPACT CONTOUR MAPS

Build Alternative 6B–S-Line

M NOISE IMPACTS AND IMPACT CONTOUR MAPS

Build Alternative 6D

N NOISE IMPACTS AND IMPACT CONTOUR MAPS

Build Alternative 6F

O NOISE IMPACTS AND IMPACT CONTOUR MAPS

Build Alternative 6G

P VIBRATION IMPACTS AND IMPACT CONTOUR MAPS

Build Alternative 2A

Q VIBRATION IMPACTS AND IMPACT CONTOUR MAPS

Build Alternatives 3A and 3B

R VIBRATION IMPACTS AND IMPACT CONTOUR MAPS

Build Alternative 3C

S VIBRATION IMPACTS AND IMPACT CONTOUR MAPS

Build Alternative 4A

T VIBRATION IMPACTS AND IMPACT CONTOUR MAPS

Build Alternatives 5A, 5A–Ashcake, 5B, 5B–Ashcake, and 5D–Ashcake

U VIBRATION IMPACTS AND IMPACT CONTOUR MAPS

Build Alternatives 5C and 5C–Ashcake

V VIBRATION IMPACTS AND IMPACT CONTOUR MAPS

Build Alternatives 6A, 6B–A-Line, 6C, and 6E

W VIBRATION IMPACTS AND IMPACT CONTOUR MAPS

Build Alternatives 6B–S-Line, 6D, 6F, and 6G