APPENDIX F

REFINED OPERATIONS ANALYSIS MODELING TECHNICAL MEMOS

D.C. TO RICHMOND SOUTHEAST HIGH SPEED RAIL

MEMO

Date:	November 7, 2017
To:	Virginia Department of Rail and Public Transportation
From:	DC2RVA Project Team
Subject:	Results of DRPT's Refined Operations Analysis to Satisfy FRA Requests and Enable FRA Support for Issuance of the DC2RVA Project Tier II Draft Environmental Statement

1.0 SUMMARY

This report describes the approach, assumptions, and results of a refined operations analysis undertaken by the Virginia Department of Rail and Public Transportation (DRPT) for the Federal Railroad Administration (FRA) in support of the Washington, D.C. to Richmond Southeast High Speed Rail Tier II Environmental Impact Statement and Service Development Plan (the DC2RVA Project). Table 1 contains a summary of the modeling results from the refined operations analysis simulations undertaken by DRPT (see table on page 2).

2.0 BACKGROUND AND PURPOSE

The DCRVA Project proposes to increase track capacity between Arlington, Richmond, and Centralia, Virginia, to improve passenger rail service frequency, reliability, and travel time in a corridor shared by increasing volumes of passenger, commuter, and freight rail traffic. The DC2RVA 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 and Newport News), VA and south to Raleigh, NC, and Charlotte, NC, and then continues west to Atlanta and south to Florida. The DC2RVA Project connects to the National Railroad Passenger Corporation (Amtrak) Northeast Corridor (NEC) at Union Station in Washington, D.C.

Table 1: Summary of Modeling Results from the Refined Operations Analysis Simulation

Case	DC2RVA 2045 NO BUILD	DC2RVA 2045 BUILD	DC2RVA 2045 BUILD 2ASH	DC2RVA 2045 BUILD 2ASH + TOS	DC2RVA 2045 BUILD XR2
Infrastructure Tested	No Build	3 Tracks south of Alexandria	3 Tracks south of Alexandria, except 2 tracks through Ashland	3 Tracks south of Alexandria, except 2 tracks through Ashland, and with 1 track out of service north of Fredericksburg	3 Tracks south of Alexandria, and 2 tracks south of Crossroads
Passenger Train End-Point On-Time Performance, Petersburg to Washington Union Station					
Amtrak Long-Distance Intercity Passenger Train OTP	69.6%	95.8%	97.2%	96.9%	97.1%
Amtrak Regional and Interstate Corridor Intercity Passenger Train OTP	76.9%	93.0%	93.0%	93.2%	92.6%
All Amtrak Intercity Passenger Trains Aggregated OTP	73.3%	93.8%	94.2%	94.3%	93.9%
Virginia Railway Express Commuter Train OTP	97.0%	98.5%	98.7%	94.1%	97.9%
Passenger Train All-Stations On-Time Performance, Petersburg to Washington Union Station					
Amtrak Long-Distance Intercity Passenger Train OTP	72.3%	94.9%	95.5%	96.1%	95.0%
Amtrak Regional and Interstate Corridor Intercity Passenger Train OTP	82.3%	96.7%	96.8%	96.7%	96.2%
All Amtrak Intercity Passenger Trains Aggregated OTP	78.7%	96.3%	96.5%	96.6%	95.9%
Virginia Railway Express Commuter Train OTP	99.7%	99.7%	99.9%	98.9%	99.5%
Freight Train Minutes of Delay per 100 Train-Miles					
All Freight Trains	30.8	24.8	28.4	31.2	42.2

The intent of this refined operations analysis was to use operations simulations (also known as operations modeling) to estimate the operational performance of passenger, freight, and commuter trains in the corridor under four different "build case" operations simulations identified by FRA and DRPT, as well as a No Build case to which the four build case simulations would be compared. The four build cases to be tested under this refined operations analysis include a three-track infrastructure alternative previously analyzed for the Tier II Draft Environmental Impact Statement (DEIS) for the DC2RVA Project, as well as three other infrastructure alternatives proposed by DRPT in a letter dated April 4, 2017, and agreed to by FRA in a letter dated April 7, 2017. This refined analysis builds upon operations simulation modeling work previously done by DRPT for the DC2RVA Project using the Rail Traffic Controller (RTC) model for the full length of the DC2RVA corridor from Washington, D.C. through Centralia, VA.

In a letter to DRPT dated March 27, 2017, FRA proposed the process for undertaking a refined operations analysis to support the forthcoming publication of the Tier II Draft Environmental Impact Statement for the DC2RVA Project. The March 27 letter from FRA identified four items for limited re-analysis:

- Revisions to the proposed DC2RVA corridor track infrastructure at specific locations identified by FRA. These revisions are detailed in Section 2.2 of this report.
- Development of a representative station platform (i.e., track) assignment plan for intercity passenger trains and commuter trains. The platform assignment plan is discussed in Section 2.3 of this report.
- Incorporation of the platform assignment plan into the operations simulation work undertaken in this analysis through adjustments to the RTC programming logic. The track assignment plan assessed in this refined operations analysis is discussed in Section 2.3 of this report.
- Inclusion of a constrained operating environment case that assesses the performance impact of track outages and maintenance windows. The representation of maintenance work developed for this refined operations analysis is discussed in Section 3 of this report.

In all operations simulation cases undertaken as part of this refined operations analysis, the infrastructure alternatives were tested for proposed operations in the year 2045, which represents the concluding year of a 20-year horizon for the Project, based on the Project's proposed implementation year of 2025.

The performance estimates produced by the operations simulation for each infrastructure alternative have been benchmarked against performance goals for freight and passenger trains that were established by FRA under the Passenger Rail Investment and Improvement Act (PRIIA), notably a passenger train on-time performance goal of 90% for both end-to-end and all-stations operations.

Operations simulation cases where performance estimates generated by the operations simulation software exceed the established goals will be considered confirmation that the infrastructure alternative assessed in that case will adequately support the level of passenger, commuter, and freight service presented in the forthcoming DC2RVA DEIS, and that the infrastructure alternative assessed is sufficient to deliver the DC2RVA Project's proposed 2045

full-build service plan with intercity passenger trains operating up to 90 mph with an "all stations" and "end-to-end" on-time performance goal of 90%, while sustaining planned growth in freight and commuter service through 2045.

This report describes the draft results of the refined operations analysis. The operations simulation portion of these results will require additional analysis.

3.0 ASSUMPTIONS AND PARAMETERS

The refined operations analysis work was conducted between April 17, 2017 and June 7, 2017. The work was conducted using a methodology, assumptions, and parameters outlined in "Change Order Request CR-0007 – Additional Operations Simulation Modeling (v2) to Satisfy FRA Requests," dated April 11, 2017. DRPT issued a Notice to Proceed with this work on April 17, 2017.

The most significant aspects of the operations simulation methodology, assumptions, and parameters outlined in the Change Order of April 11, 2017 are outlined below, some of which represent changes from the way previous DC2RVA Project operations simulation work was conducted under the DC2RVA Operations Modeling Methodology report dated January 2016.

3.1 Simulation Year

FRA-funded passenger rail projects require that operations analysis (and specifically operations simulation) demonstrate that the proposed project is sufficient to increase capacity to deliver the proposed passenger rail service and accommodate growth of freight rail service in an efficient and reliable multimodal rail corridor over a typical 20-year time horizon following the completion of the passenger project.

The operations simulations performed for all cases in this refined operations analysis were run for the simulation year of 2045. 2045 is the concluding year of the DC2RVA Project's 20-year planning horizon, based on the Project's proposed implementation year of 2025.

3.2 Infrastructure Assumptions

In FRA's letter to DRPT on March 27, 2017, FRA requested that specific modifications be made to the proposed DC2RVA track infrastructure and assessed as part of the refined operations analysis work. Subsequent calls and discussion between FRA and DRPT, specifically correspondence between FRA and DRPT dated April 26, 2017 and May 4, 2017, provided further clarification and revisions to the initial request made in the March 27, 2017.

The infrastructure modifications listed below represent all of the changes agreed to by FRA and DRPT, which were incorporated into the refined operations analysis work under DRPT's Change Order Request of April 11 and subsequent correspondence dated April 26, 2017 and May 4, 2017.

- The RO interlocking (milepost CFP 110.1) was modified from a full universal interlocking to a one-way interlocking providing access to all four mainline tracks only for northbound trains crossing from the westernmost track (Main Track 3) to the easternmost track (Main Track 0). Full universal access between main tracks 1, 2, and 3 was also provided at the RO interlocking.

- The Slaters Lane interlocking (milepost CFP 106.3) was modified from a full universal interlocking to a one-way interlocking providing access to all four mainline tracks only for southbound trains crossing from the westernmost track (Main Track 3) to the easternmost track (Main Track 0). Full universal access between main tracks 0 and 1 only, and full universal access between main tracks 2 and 3 only was also provided at the Slaters Lane interlocking.
- The Ravensworth interlocking (milepost CFP 97.3) was modified to provide full universal access to all tracks.
- The Crossroads interlocking (milepost CFP 53.2) was modified to provide full universal access to all tracks.
- A new 15,000-foot siding was added south of Fredericksburg to allow for the staging of freight trains mid-corridor during the VRE commuting period. This siding was added on the west side of the corridor, parallel to main track 3. The north end of the siding is accessed from main track 3 at a point just south of the Lansdowne Road grade crossing (approximately milepost CFP 57.44) and the south end of the siding is accessed from main track 3 just north of the Massaponax Creek bridge (approximately milepost CFP 54.47).
- The Elmont interlocking (milepost CFP 11.4) was modified to provide full universal access to all tracks.
- The Acca Yard East Bypass passenger tracks were extended farther north to milepost CFP 6.0 to accommodate the staging of full-length freight trains north of the North Acca interlocking (milepost CFP 3.4).
- The relocated Staples Mill Road passenger rail station (milepost CFP 4.6) was modified to reduce the number of platform tracks from four to three tracks.
- The track configuration of the Staples Mill Road Station was modified to allow for the platform tracks to be dedicated station tracks served by high-level platforms. This design prevents freight trains from use of the Staples Mill Road Station platform tracks. As a result, a new universal interlocking and connection between the Acca Yard East Bypass passenger tracks and an adjacent CSXT Acca Yard lead track was added south of the Staples Mill Road Station, at approximately milepost CFP 3.8, to allow for interoperability on the Acca Yard East Bypass passenger tracks.
- The Hermitage interlocking on the S-Line (milepost SRN 3.5) was modified to provide universal access to the two center main track and eastern main track of the three track S-Line, which become the East Acca Bypass passenger tracks, and also to provide access to and from Acca Yard for freight trains on the center main track and western main track of the three-track S-Line.
- Intermediate crossovers on the S-Line were removed in the vicinity of Lombardy Street (milepost SRN 2.9) and North Belvidere Street (milepost SRN 2.2).
- AM Junction interlocking in Richmond (milepost SRN 0.7) was modified to permit direct non-diverging moves by freight trains operating northward on the S-Line between Fulton and Acca Yards.

The track changes made in the RTC model also include subsequent modifications to the DC2RVA infrastructure requested by FRA during a June 9, 2017, meeting with DRPT.

3.3 Service Assumptions

3.3.1 DC2RVA Service Plan

The service plan tested in this refined operations analysis was the proposed DC2RVA Staples Mill/Main Street Station "Full Service" option, wherein Regional, Interstate Corridor, and Long Distance intercity passenger trains make station stops at both Richmond Staples Mill Road Station and Richmond Main Street Station. This service plan incorporates the nine additional roundtrip intercity passenger trains proposed by the DC2RVA Project, which will operate in addition to the ten existing roundtrip intercity passenger trains currently providing service in the corridor.

Access between the two Richmond stations is provided by the Project's proposed East Acca Bypass passenger tracks. The Amtrak Auto Train would continue to operate as a nonstop service that does not make stops at either station. The Auto Train was modeled using its current route along CSXT's A-Line between Richmond and Centralia.

In the operations simulations undertaken, Regional trains serving Richmond's Main Street Station bound to and from Newport News used the station's east side platform tracks, which provide the sole access to CSXT's Peninsula Subdivision linking Richmond and Newport News. Regional trains bound to and from Norfolk and all Interstate Corridor and Long Distance passenger trains used the station's west side platform tracks, which are part of the CSXT S-Line linking Richmond and Centralia, VA, the southern end of the DC2RVA Project limits and the junction with CSXT's A-Line. The one roundtrip Regional train that originates/terminates at Main Street Station and lays over at the Brown Street Yard also used the west side platform tracks.

3.3.2 Maximum Speed

The maximum authorized speed of intercity passenger trains was 90 mph, where feasible.

3.3.3 Freight and Commuter Operations Modeled

The refined operations analysis includes the operation of freight trains and VRE commuter trains. Freight growth was projected using the existing CSXT growth methodology to year 2045.

The 38 VRE commuter trains (19 round trips) taken into account by the DC2RVA Project also were modeled, using schedules provided by VRE for the DC2RVA Project operations simulation work.

To further ensure representational operation of VRE commuter trains in the refined operations analysis work, a station dwell time of 90 seconds for VRE station stops was programmed into the RTC software. The station dwell time used was provided by VRE.

3.3.4 Operations Plan: Platform Assignment Plan

For the refined operations analysis, a representative station platform assignment plan for intercity passenger trains and commuter trains was developed at FRA's request that assigned each commuter train and passenger train to a specific platform at station stops. This plan was developed to provide a consistent, predictable pattern of station platform usage for Amtrak intercity passenger trains and VRE commuter trains, to aid in passenger convenience when boarding trains.

Settings selected in the RTC software instructed the software to incorporate the platform assignment plan into each operations simulation case. The platform assignment plan defines the primary platform assignments for intercity passenger trains and VRE commuter trains during the morning and evening peak commuter periods, when corridor train volumes are predicted to be at their heaviest.

The platform assignment plan devised for this refined operations analysis encompasses the entire D2RVA corridor, from Washington through Spotsylvania and Richmond, to Centralia, for the morning and evening peak commuter periods. Figures 1 and 2 below show the platform assignment plan, which incorporates several minor modifications that were requested by FRA during a meeting with DRPT on June 9, 2017. Figure 1 shows the corridor's northern half, between Washington and Spotsylvania, and Figure 2 shows the corridor's southern half, between Spotsylvania and Centralia.

In the platform assignment plan used for the morning peak commuter period, VRE commuter trains used Main Track 1 (the easternmost track) between Crossroads and Dahlgren Junction and Main Track 3 (the westernmost track) between Dahlgren Junction and CP Virginia in Washington, D.C. Manassas Line VRE trains joining the corridor at AF interlocking in Alexandria also used Track 3 north to CP Virginia. Northbound intercity passenger trains and freight trains used Main Track 1 between Crossroads and CP Virginia, although Main Track 3 was utilized as an alternate track for northbound passenger trains, provided VRE trains were not delayed. Southbound intercity passenger trains and freight trains used Main Track 2 between CP Virginia and Spotsylvania.

In the platform assignment plan used for the evening peak commuter period, VRE commuter trains used Main Track 3 between CP Virginia and Dahlgren Junction and Main Track 1 between Dahlgren Junction and Crossroads. Manassas Line VRE trains also used Track 3 from CP Virginia to AF interlocking in Alexandria where they departed the corridor toward Manassas. Southbound intercity passenger trains also used Track 3 between CP Virginia and Crossroads, although Main Track 2 was utilized as an alternate track for southbound passenger trains when conflicts with freight trains could be minimized. Southbound freight trains used Main Track 2. Northbound intercity passenger trains and freight trains used Main Track 1 between CP Virginia and Spotsylvania.

In the Richmond area, the platform assignment plan for the two Richmond stations during both the morning and evening peak periods allows for passenger trains operating on the S-Line between Staples Mill Road and AM Junction (near Main Street Station) to operate on the two eastern tracks of the three-main-track S-Line, which provides a direct, non-diverging route for passenger trains between the S-Line and the Acca Yard East Bypass passenger tracks. Northbound freight trains from Fulton Yard operating on the S-Line to Acca Yard make a direct, non-diverging move through AM Junction to reach the westernmost of the S-Line's three main tracks, which provides a direct, non-diverging northward route to Acca Yard.

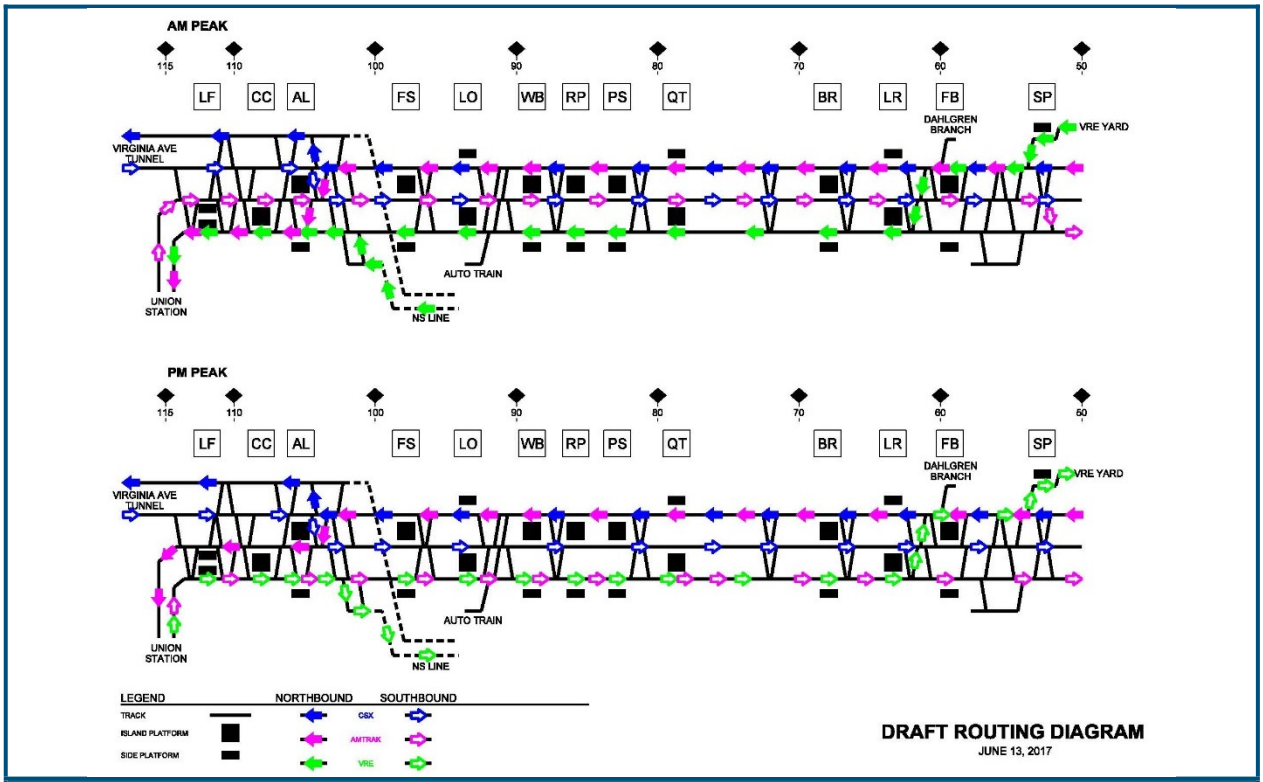

Figure 1: DC2RVA Refined Operations Analysis Platform Assignment Plan, Washington-Spotsylvania

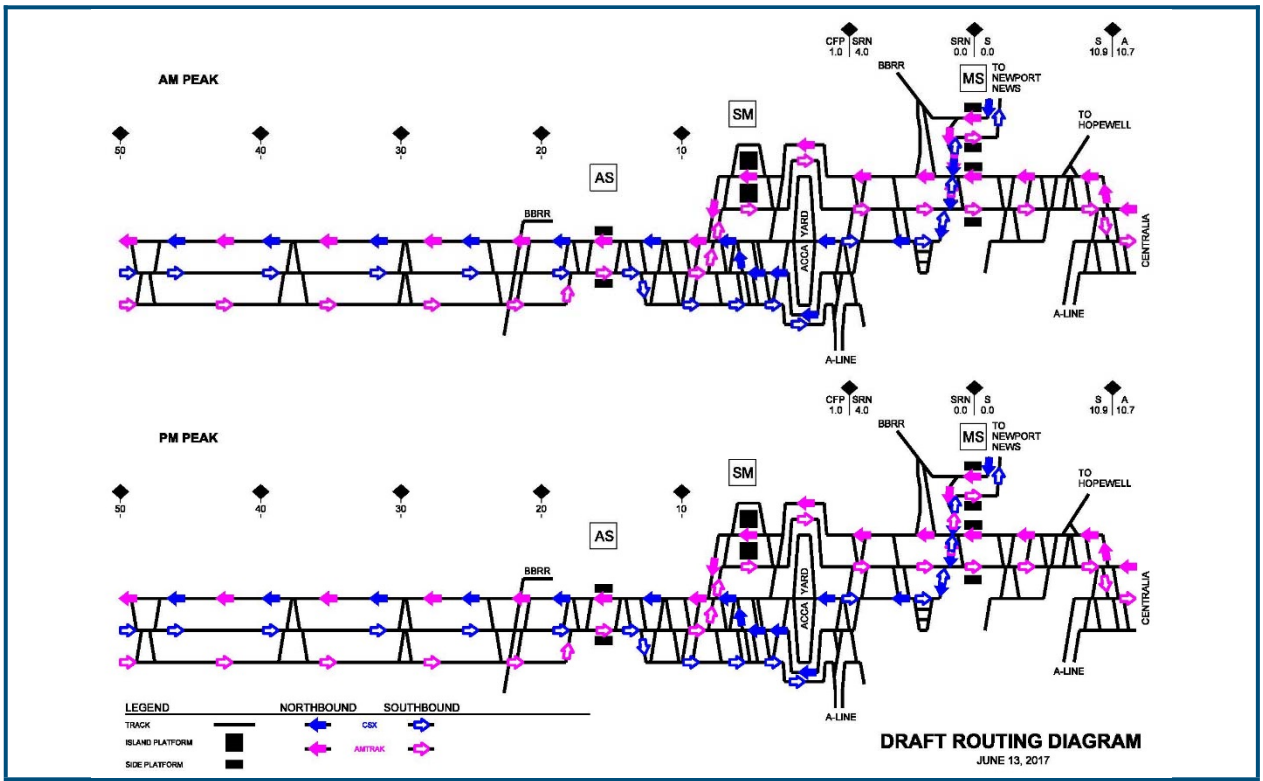

Figure 2: DC2RVA Refined Operations Analysis Platform Assignment Plan, Spotsylvania-Centralia

3.3.5 Operations Plan: Revised Operations Analysis Conceptual Schedule

Passenger train running times and recovery times between Washington Union Station and Petersburg Station in the refined operations analysis were modified from the initial DC2RVA conceptual schedule included in the DEIS to enable trains to achieve an all-stations and end-to-end on-time performance at a sufficient margin above 90%, such that the performance could be considered likely to be achieved in normal real-world operation of the DC2RVA corridor under the revised corridor infrastructure and platform assignment plan described above. It is important to note that an on-time performance of 90% represents a significant improvement over the existing realized passenger train on-time performance of 66% in the corridor.

Schedules were not modified uniformly, but rather adjusted on a train-by-train basis in consideration of the regularly expected operating conditions within the corridor at that time of day (i.e., peak commuter periods). Table 2 provides the range of travel times modeled in the refined operations analysis and the time savings achieved by intercity passenger trains in comparison with travel times in 2017.

In addition, the passenger train schedules in the refined operations analysis were further modified to incorporate an increase in station dwell times at Alexandria Station to 5 minutes for all northbound Amtrak long-distance trains to account for the possibility of a double stop at the short platform serving Main Tracks 2 and 1.

Table 2: Summary of Travel Time Adjustments made to DC2RVA Refined Operations Timetable, in comparison with DC2RVA DEIS Conceptual Schedule

Train	Long Distance	Long Distance	Interstate Corridor	Interstate Corridor	Regional	Regional
Direction	South	North	South	North	South	North
Washington to Richmond Staples Mill Road Station						
DC2RVA FRA Refined Operations Travel Times (hours:minutes)	1:59-2:04	2:15-2:34	1:55-2:05	2:05-2:12	2:05-2:21	2:06-2:25
Median Travel Time Savings Compared with June 2017 schedule (minutes)	5	4	14	8.5	11	9.5
Washington to Richmond Main Street Station						
DC2RVA FRA Refined Operations Travel Times (hours:minutes)	2:32-2:37	2:50-3:04	2:21-2:31	2:30-2:45	2:26-2:44	2:34-2:53
Median Travel Time Savings Compared with June 2017 schedule (minutes)	n/a	n/a	n/a	n/a	10	21

*Travel time reductions are the median of the reductions experienced by individual trains.

3.3.6 Performance Metrics and Thresholds

The performance of passenger trains and commuter trains in the refined operations analysis was measured against on-time performance standards for intercity passenger rail service developed by FRA and Amtrak in accordance with Section 207 of the Passenger Rail Investment

and Improvement Act (PRIIA). In all cases, passenger trains tested in the operations simulation were assumed to arrive into the modeled territory not more than 15 minutes late, using a triangular distribution of late departure from Washington Union Station or late arrival at Petersburg.

On-time performance for passenger and commuter trains was measured as follows:

- End-to-end (endpoint) on-time performance was measured between Washington Union Station in Washington, D.C. and Petersburg Station, VA, for passenger trains operating between Washington and Norfolk, North Carolina, or Georgia/Florida. Endpoint on-time performance was measured between Washington Union Station and Richmond Main Street Station for passenger trains operating between Washington and Newport News or Richmond. Endpoint on-time performance was measured between Washington Union Station and Spotsylvania station for VRE commuter trains. Endpoint on-time performance was measured as the percentage of times a train arrived at its endpoint terminal more than 10 minutes after its scheduled arrival time. The endpoint on-time performance threshold for passenger trains and commuter trains in the model was 90%.
- All-Stations on-time performance was measured at all station stops for all passenger and commuter trains using the DC2RVA corridor between Washington Union Station and Petersburg Station. All-Stations on-time performance was measured as the percentage of times a train departed from its origin station or arrived at all other stations within 15 minutes of its scheduled time. The All-Stations on-time performance threshold for passenger trains and commuter trains in the model was 90%.

Endpoint and All-Stations on-time performance was measured for four different passenger train types:

- Amtrak Long Distance
- Amtrak Regional and Interstate Corridor
- All Amtrak Trains Aggregated
- Virginia Railway Express

The performance of freight trains in the refined operations analysis was measured as follows:

- Freight train performance was measured between CP Virginia in Washington, D.C., and Centralia, VA as minutes of freight train delay per 100 train-miles.

4.0 OPERATIONS SIMULATION CASES

Four operations simulation Build cases were tested utilizing the DRPT recommended corridor alternative that provides Full Service to both Richmond Staples Mill Road and Main Street Stations. The four cases were modeled for the Year 2045 Full-Build (Horizon Year) incorporating the additional infrastructure changes, service changes, assumptions, and parameters described in Section 3.

All of the operations simulation cases performed for the refined operations analysis were conducted in the same modeled territory, from CP Virginia in Washington, D.C. to Petersburg, VA. Changes in infrastructure tested in each case are described below. All cases had a common track configuration between Richmond Staples Mill Road Station and Petersburg, VA, including

two main tracks along the S-Line across the James River. All cases were dispatched with the infrastructure modifications described in Section 3.2 and documented in the Version 9 track schematics included with this report. The only exceptions to the use of a common infrastructure in this operations analysis are described below, when a simulation case required a specific modification to the common infrastructure.

The following cases were developed and tested.

No Build 2045. This case measures performance on the DC2RVA corridor with the No Build infrastructure, as described in the DC2RVA DEIS, and does not include the new intercity passenger trains proposed by the DC2RVA Project.

Build 2045. This Build case measures performance on the DC2RVA corridor with three main tracks from Alexandria to Richmond Staples Mill Road Station. This case includes the new intercity passenger trains proposed by the DC2RVA Project.

Build 2045, 2 tracks Ashland. This Build case measures performance on the DC2RVA corridor with three main tracks from Alexandria to Richmond Staples Mill Road Station with the exception of a two-track segment through Ashland. The northern and southern limits of the two-main-track section through Ashland encompass a distance of approximately 2.01 miles, from a proposed interlocking north of Vaughan Road at milepost CFP 15.75 to a proposed interlocking south of Ashcake Road at milepost CFP 13.74. This case includes the new intercity passenger trains proposed by the DC2RVA Project. This case is programmatically a component of the Service Development Plan, but was brought forward to this refined operations analysis to satisfy FRA requests for operations simulation modeling that would support FRA's issuance of the DEIS.

Build 2045, 2 tracks Ashland + MOW Outage. This Build case measures performance on the DC2RVA corridor with three main tracks from Alexandria to Richmond Staples Mill Road Station with the exception of a two-track segment through Ashland, plus a randomly selected additional two-track segment of approximately 10 miles in length between Alexandria and Crossroads, in order to test the response of the network to a simulated maintenance-of-way outage. In this case, the two-main-track section through Ashland was identical to the one used in Case 2. In addition, a track outage was added to the corridor on Main Track 2 between North Possum Point (CFP 81.3) and Arkendale (CFP 72.1), a distance of 9.2 miles. This outage restricted trains from using Main Track 2 for a period of 7 hours, from 9:00 a.m. to 4:00 p.m., for all of the days modeled. This case includes the new intercity passenger trains proposed by the DC2RVA Project. This case is programmatically a component of the Service Development Plan, but was brought forward to this refined operations analysis to satisfy FRA requests for operations simulation modeling that would support FRA's issuance of the DEIS.

Build 2045, 2 tracks only Crossroads-Greendale. This Build case measures performance on the DC2RVA corridor with three main tracks from Alexandria to Crossroads, and two main tracks from Crossroads to Richmond Staples Mill Road Station. This case includes the new intercity passenger trains proposed by the DC2RVA Project. This case was not programmatically a component of the Service Development Plan, and has not been previously identified, but was incorporated in this refined operations analysis to satisfy FRA requests for operations simulation modeling that would support FRA's issuance of the DEIS.

5.0 DELIVERABLES

The deliverables for the refined operations analysis consist of the following elements, as specified in Change Order Request CR-0007 – Additional Operations Simulation Modeling (v2) to Satisfy FRA Requests, dated April 11, 2017:

1. Passenger train endpoint on-time performance data for each case, as measured at Washington Union Station, Petersburg Station (for trains headed to/from Norfolk, North Carolina, Georgia, and Florida) and Richmond Main Street Station (for trains headed to/from Newport News and Richmond). This data is presented in Section 6.0.
2. Passenger train all stations on-time performance data for each case, as measured at passenger rail stations on the DC2RVA corridor between Washington Union Station and Petersburg Station. This data is presented in Section 6.0.
3. Freight train delay per 100 train miles data for each case, measured in the DC2RVA corridor only. This data is presented in Section 6.0.
4. Modified passenger train schedules modeled in the refined operations analysis.
5. A schematic depiction of the infrastructure modeled in the refined operations analysis.
6. A platform assignment plan. This plan was presented in Section 3.3.5.
7. An operations plan describing the platform assignments for each train, and the modified timetable. This operations plan is described in Section 3.3.4 and 3.3.5.

6.0 RESULTS

This section presents the results of the operations simulations for the refined operations analysis. The metrics that are reported are as follows:

For passenger trains:

- On-Time Performance by train type. The train types measured were:
  - Amtrak Long-Distance
  - Amtrak Regional and Interstate Corridor
  - All Amtrak Trains Aggregated
  - Virginia Railway Express

- Passenger train On-Time Performance is reported by endpoint and at all station stops

For freight trains:

- Minutes of Delay per 100 Train-Miles

Minutes of Delay per 100 Freight Train-Miles is calculated by the RTC operations simulation model as follows:

- Adding all of the train miles of all of the trains that operate during the model's statistical capture period
- Adding all of the minutes of delay of all of the trains that operate during the model's statistical capture period
- Dividing the total delay by total train miles divided by 100.
- Displayed as a formula:

$$\frac{\Sigma \text{ Delay}}{\Sigma \text{ Train Miles}/100}$$

- Delay for each freight train that operates during the model's statistical capture period is calculated by the RTC model as the difference between the run time of each freight train in an unimpeded case and each train's actual run time in the model.

The results achieved to date are summarized below for each of the cases in the refined operations analysis.

- Passenger train On-Time Performance in all cases except the No Build 2045 case exceeds 90% for both end-point and all-stations measurements.
- Freight train minutes of delay per 100 train-miles for the Build 2045 and Build 2045 2 tracks Ashland are less than freight train minutes of delay per 100 train-miles for the No Build 2045 case.
- Freight train minutes of delay per 100 train-miles for the Build 2045 2 tracks Ashland + MOW Outage case and the Build 2045 2 tracks Crossroads-Greendale case are more than freight train minutes of delay per 100-train miles for the No Build 2045 case.

During the Service Development Plan phase of the DC2RVA project, additional seeds of operations simulation cases for the preferred alternative will be dispatched to fulfill randomization requirements described in the DC2RVA Operations Modeling Methodology report dated January 2016.

No Build 2045

Passenger Train End-Point On-Time Performance

- Amtrak Long-Distance – 69.6
- Amtrak Regional and Interstate Corridor – 76.9
- All Amtrak trains aggregated – 73.3
- Virginia Railway Express – 97.0

Passenger Train All-Stations On-Time Performance

- Amtrak Long-Distance – 72.3
- Amtrak Regional and Interstate Corridor – 82.3
- All Amtrak trains aggregated – 78.7
- Virginia Railway Express – 99.7

Freight Train Minutes of Delay per 100 Train-Miles

- 30.8 minutes

Build 2045

Passenger Train End-Point On-Time Performance

- Amtrak Long-Distance – 95.8
- Amtrak Regional and Interstate Corridor – 93.0
- All Amtrak trains aggregated – 93.8
- Virginia Railway Express – 98.5

Passenger Train All-Stations On-Time Performance

- Amtrak Long-Distance – 94.9
- Amtrak Regional and Interstate Corridor – 96.7
- All Amtrak trains aggregated – 96.3
- Virginia Railway Express – 99.7

Freight Train Minutes of Delay per 100 Train-Miles

- 24.8

Build 2045, 2 tracks Ashland

Passenger Train End-Point On-Time Performance

- Amtrak Long-Distance – 97.2
- Amtrak Regional and Interstate Corridor – 93.0
- All Amtrak trains aggregated – 94.2
- Virginia Railway Express – 98.7

Passenger Train All-Stations On-Time Performance

- Amtrak Long-Distance – 95.5
- Amtrak Regional and Interstate Corridor – 96.8
- All Amtrak trains aggregated – 96.5
- Virginia Railway Express – 99.9

Freight Train Minutes of Delay per 100 Train-Miles

- 28.4

Build 2045, 2 tracks Ashland + MOW Outage

Passenger Train End-Point On-Time Performance

- Amtrak Long-Distance – 96.9
- Amtrak Regional and Interstate Corridor – 93.2
- All Amtrak trains aggregated – 94.3
- Virginia Railway Express – 94.1

Passenger Train All-Stations On-Time Performance

- Amtrak Long-Distance – 96.1
- Amtrak Regional and Interstate Corridor – 96.7
- All Amtrak trains aggregated – 96.6
- Virginia Railway Express – 98.9

Freight Train Minutes of Delay per 100 Train-Miles

- 31.2

Build 2045, 2 tracks only, Crossroads-Greendale

Passenger Train End-Point On-Time Performance

- Amtrak Long-Distance – 97.1
- Amtrak Regional and Interstate Corridor – 92.6
- All Amtrak trains aggregated – 93.9
- Virginia Railway Express – 97.9

Passenger Train All-Stations On-Time Performance

- Amtrak Long-Distance – 95.0
- Amtrak Regional and Interstate Corridor – 96.2
- All Amtrak trains aggregated – 95.9
- Virginia Railway Express – 99.5

Freight Train Minutes of Delay per 100 Train-Miles

- 42.2

MEMO

Date:	November 7, 2017
To:	Virginia Department of Rail and Public Transportation
From:	DC2RVA Project Team
Subject:	Results of Network-Wide Refined Operations Analysis Modeling to Estimate Potential Freight Delay Outside the DC2RVA Corridor

1.0 SUMMARY

This memorandum describes the results of a Network-Wide Refined Operations Analysis to Estimate Potential Freight Delay Outside the DC2RVA Corridor (Network-Wide Analysis) undertaken by the Virginia Department of Rail and Public Transportation (DRPT). This additional operations analysis was conducted to help inform DRPT's work on the Washington, D.C. to Richmond Southeast High Speed Rail Tier II Environmental Impact Statement and Service Development Plan (the DC2RVA Project) by estimating the potential for freight train delays outside of the DC2RVA corridor that could be attributable to the increases in passenger train frequency proposed by the DC2RVA Project.

Table 1 contains a summary of the modeling results from the Network-Wide Analysis operations simulations undertaken by DRPT.

Table 1: Summary of Modeling Results from Network-Wide Analysis Operations Simulation (averaged results from 5 randomized cases)

Case	DC2RVA 2045 NO BUILD	DC2RVA 2045 BUILD	DC2RVA 2045 BUILD 2ASH	DC2RVA 2045 BUILD 2ASH + TOS	DC2RVA 2045 BUILD XR2
Infrastructure Tested	No Build	3 Tracks south of Alexandria	3 Tracks south of Alexandria, except 2 tracks through Ashland	3 Tracks south of Alexandria, except 2 tracks through Ashland, and with 1 track out of service north of Fredericksburg	3 Tracks south of Alexandria, and 2 tracks south of Crossroads
Passenger Train Endpoint On-Time Performance, Petersburg to Washington Union Station					
Amtrak Long-Distance Intercity Passenger Train OTP	71.32%	96.64%	95.77%	95.49%	95.57%

Table 1: Summary of Modeling Results from Network-Wide Analysis Operations Simulation (averaged results from 5 randomized cases)

Case	DC2RVA 2045 NO BUILD	DC2RVA 2045 BUILD	DC2RVA 2045 BUILD 2ASH	DC2RVA 2045 BUILD 2ASH + TOS	DC2RVA 2045 BUILD XR2
Amtrak Regional and Interstate Corridor Intercity Passenger Train OTP	77.87%	91.41%	91.90%	90.88%	90.58%
Virginia Railway Express Commuter Train OTP	96.97%	97.82%	98.88%	96.39%	98.60%
Freight Train Delay Minutes per 100 Train-Miles, Network-Wide, by Train Type					
All Freight Trains (cumulative)	42.9	43.4	45.5	46.2	48.0
Expedited Intermodal Freight Trains	16.8	31.3	34.3	33.8	37.0
Intermodal (non-expedited) Freight Trains	21.3	32.0	32.4	35.1	36.5
Merchandise Freight Trains	48.0	38.6	40.7	41.1	42.9
All Other Freight Train Types	65.1	64.6	67.5	68.1	69.0
Number of Freight Trains Delayed per Day, by Number of Hours, Network-Wide					
1 Hour	38.3	43.3	43.7	44.0	44.8
2 Hours	21.7	23.9	25.4	25.8	26.9
3 Hours	13.1	13.1	13.9	14.3	15.4
4 Hours	8.3	7.2	8.2	7.9	9.0
5 Hours	5.3	4.2	4.9	4.9	5.4
6 Hours	3.6	2.4	3.1	3.2	3.5
7 Hours	2.4	1.5	2.0	2.4	1.9
8 Hours	1.7	1.0	1.3	1.7	1.3
9 Hours	1.1	0.7	0.9	1.1	1.0
10 Hours	0.8	0.5	0.5	0.8	0.7
Cumulative Freight Train Hours of Delay, Over 12 Days, Network-Wide					
Cumulative Hours of Delay	1,532.9	1,550.6	1,631.0	1,655.0	1,711.1
Number of Trains Recrewed per Day, Network-Wide					
Number of Trains Recrewed per Day	19.4	13.8	13.4	21.6	18.3

2.0 BACKGROUND AND PURPOSE

The DCRVA Project proposes to increase track capacity between Arlington and Centralia, Virginia, to improve passenger rail service frequency, reliability, and travel time in a corridor shared by increasing volumes of passenger, commuter, and freight rail traffic. The DC2RVA Project, undertaken by DRPT in cooperation with the Federal Railroad Administration (FRA), 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 and Newport News), VA and south to Raleigh, NC, and Charlotte, NC, and then continues west to Atlanta and south to Florida. The DC2RVA Project connects to the National Railroad Passenger Corporation (Amtrak) Northeast Corridor (NEC) at Union Station in Washington, D.C.

Federal requirements established under the Passenger Rail Investment and Improvement Act of 2008 (PRIIA) set performance requirements for federally supported passenger rail projects such as DC2RVA:

- Intercity passenger trains must achieve a 90 percent or better on-time performance, on average, every day.
- The Project cannot unreasonably impact existing and anticipated future freight and commuter trains.

These requirements must be met for 20 years from the day the project is implemented. For planning purposes, DRPT has assumed that the DC2RVA Project would be implemented in 2025, and therefore the PRIIA performance requirements must be met through 2045.

The intent of DRPT's additional Network-Wide Analysis was to use operations simulations (also known as operations modeling) to estimate the potential for freight train delays both within and beyond the DC2RVA corridor (i.e., "network-wide" delays) in the year 2045 that could be attributable to the increases in passenger train frequency proposed by the DC2RVA Project. This work was carried out by measuring the operational performance of CSXT freight trains throughout the DC2RVA Project's "modeled territory" (described below in Section 3.1) as well as passenger and commuter trains that use the DC2RVA corridor. Operational performance was measured under four different "build case" operations simulations previously agreed upon in past Refined Operations Analysis work conducted by DRPT for FRA, as well as a No Build case to which the four build case simulations would be compared. The five cases modeled in the Network-Wide Analysis consist of:

- **DC2RVA 2045 No Build**: The DC2RVA corridor infrastructure in this case consists of the No Build infrastructure identified in the DC2RVA DEIS.
- **DC2RVA 2045 Build**: The DC2RVA corridor infrastructure in this case consists of three main tracks from Alexandria to Richmond Staples Mill Road.
- **DC2RVA 2045 Build, 2 tracks Ashland**: The DC2RVA corridor infrastructure in this case has been identified in other documents as "3-2-3" and consists of three main tracks from Ashland to Richmond Staples Mill Road, except at Ashland, will have two main tracks.
- **DC2RVA 2045 Build, 2 tracks Ashland + Track Out of Service North (MOW Outage)**: The DC2RVA corridor infrastructure in this case consists of three main tracks from Alexandria to Richmond Staples Mill Road, except at Ashland, which would have two main tracks, and a randomly selected additional segment of approximately 10 miles in length between Alexandria and Crossroads representing a daytime maintenance-of-way outage, which would have two main tracks during the maintenance-of-way outage and three main tracks at other times.

- **DC2RVA 2045 Build, 2 tracks south of Crossroads**: The DC2RVA corridor infrastructure in this case consists of three main tracks from Alexandria to Crossroads, and two main tracks from Crossroads to Richmond Staples Mill Road.

Section 4.0 contains full descriptions of all cases modeled in the Network-Wide Analysis. For this work, "network-wide" performance estimates were defined as performance estimates of trains operating within the modeled territory described in Section 3.1. The four build cases tested in the Network-Wide Analysis simulations included a three-track infrastructure alternative previously analyzed for the Tier II Draft Environmental Impact Statement (DEIS) for the DC2RVA Project, as well as three other infrastructure alternatives that were identical to those developed for previous FRA Refined Operation Analysis simulations carried out between April and June of 2017 and described in a memo to FRA dated June 9, 2017 titled "Draft Results of DRPT's Refined Operations Analysis to Satisfy FRA Requests and Enable FRA Support for Issuance of the DC2RVA Project Tier II Draft Environmental Statement".

In the previous operations simulations work done for FRA, as summarized in the June 9, 2017, draft results report, freight train performance impacts were estimated within the 123-mile DC2RVA project area between Control Point RO in Arlington, VA (CSXT milepost CFP 110) and Centralia, VA (CSXT milepost A 11). Performance impacts were also assessed along a contiguous segment of the CSXT mainline rail corridor adjacent to and south of the DC2RVA Project Area between Centralia and Petersburg, VA (CSXT milepost A 22), as well as a contiguous segment of the CSXT mainline rail corridor adjacent to and north of the DC2RVA Project Area between Arlington, VA and Control Point Virginia in Washington, D.C. (CSXT milepost CFP 112.2) (See Figure 1.)

In the additional Network-Wide Analysis conducted by DRPT, freight train performance impacts were estimated across the larger "modeled territory," which included not only all of the trackage in the DC2RVA Project Area, but all of the trackage in the DC2RVA Modeling Limits, as defined in the "D.C. to Richmond Southeast High Speed Rail Operations Modeling Methodology" dated January 15, 2016 (see Figure 2).

3.0 ASSUMPTIONS AND PARAMETERS

DRPT's additional Network-Wide Analysis work was conducted in August and September of 2017. The work was conducted using the same methodology, assumptions, and parameters used in the previous FRA Refined Operations Analysis modeling work conducted between April and June of 2017, and outlined in "Change Order Request CR-0007 – Additional Operations Simulation Modeling (v2) to Satisfy FRA Requests," dated April 11, 2017.

The most significant aspects of the operations simulation methodology, assumptions, and parameters used in the Network-Wide Analysis are outlined below.

3.1 Geographic Limits of the Modeled Territory

The modeled territory used to conduct the additional Network-Wide Analysis simulations encompasses all trackage in the DC2RVA Modeling Limits, as defined in the "D.C. to Richmond Southeast High Speed Rail Operations Modeling Methodology" dated January 15, 2016, as well as additional line segments subsequently added to the DC2RVA Modeling Limits at the request of host railroads during stakeholder review of the January 15, 2016, modeling methodology (see Figure 2).

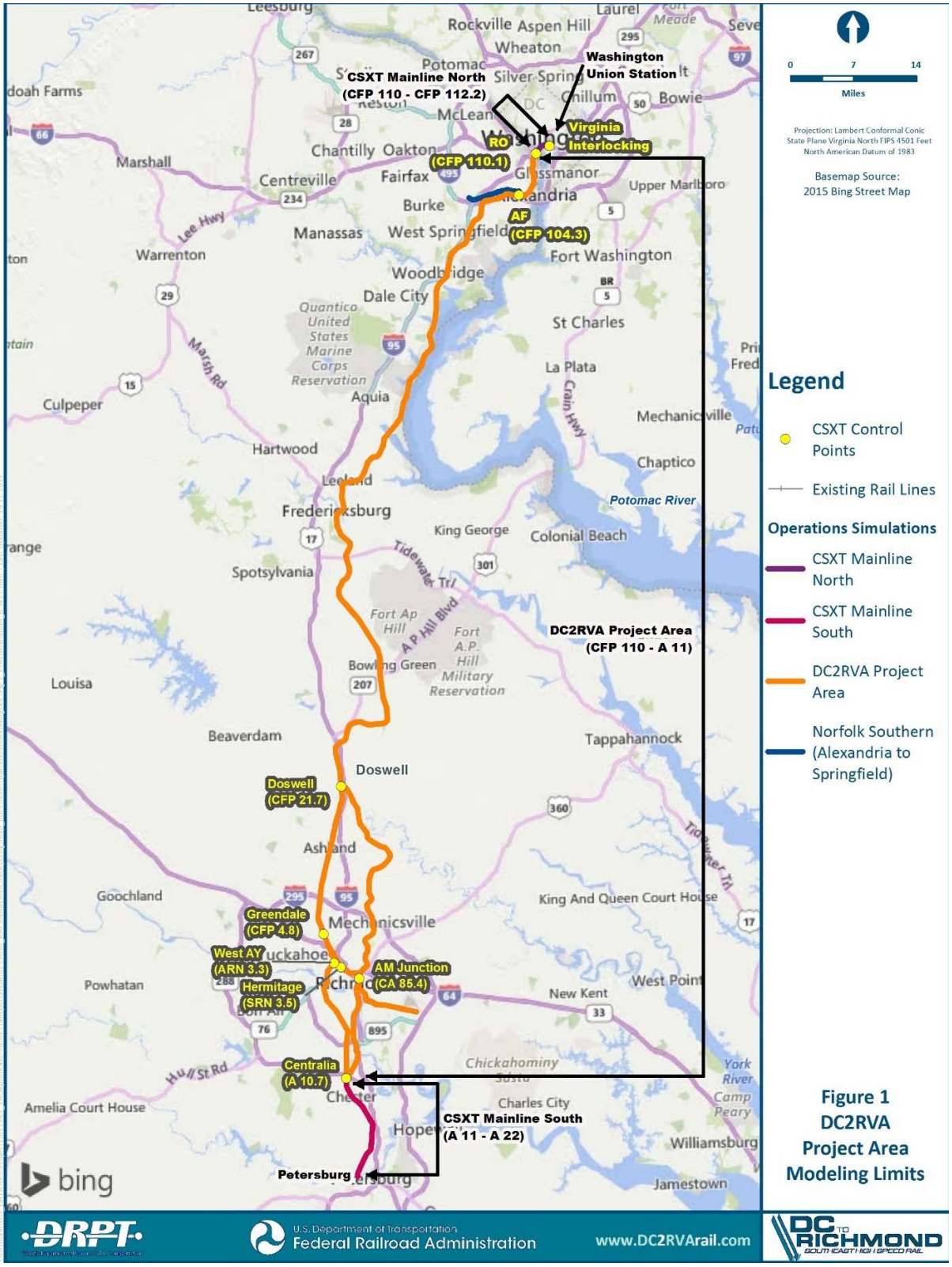

Figure 1
DC2RVA Project Area Modeling Limits

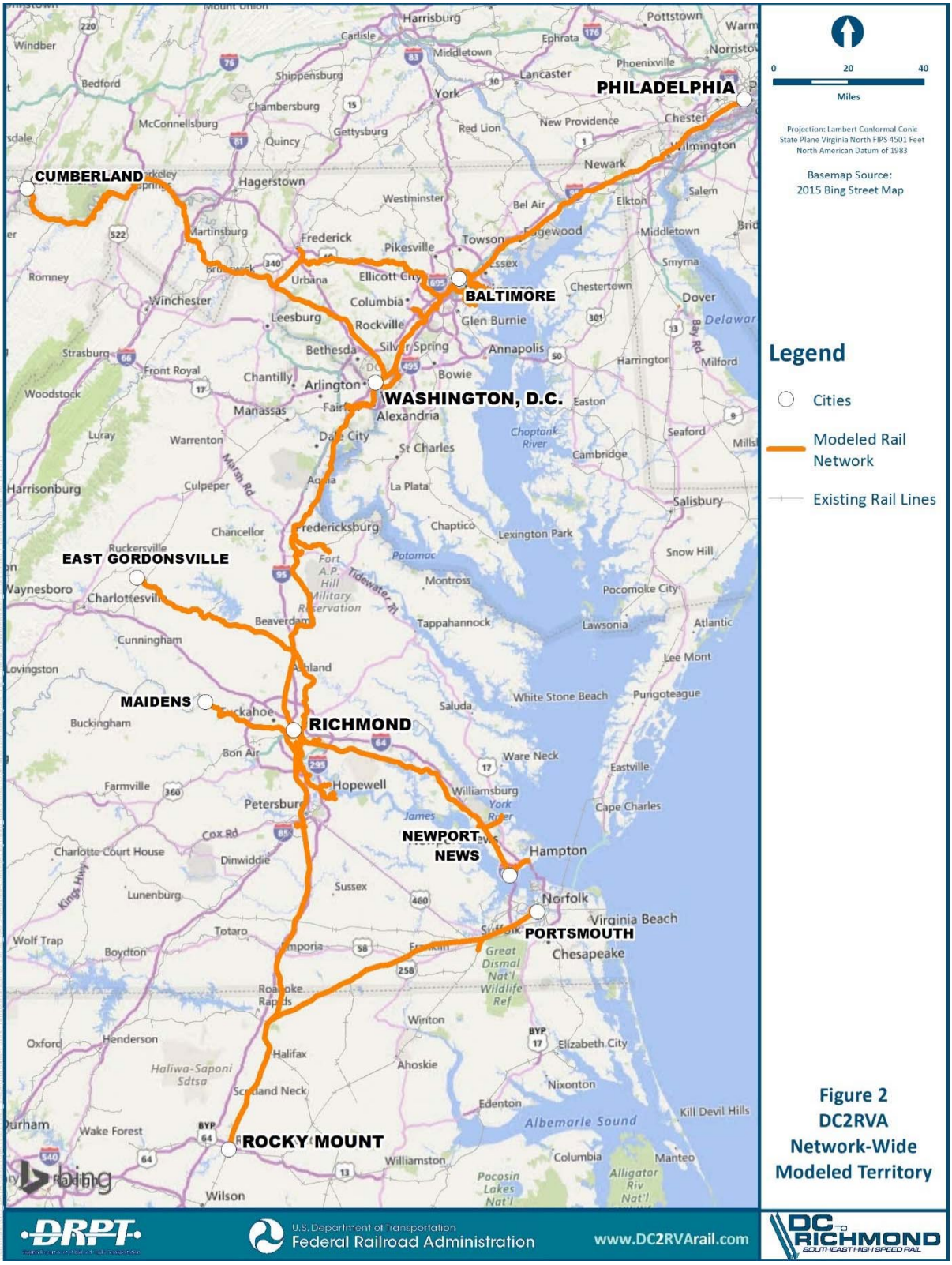

Figure 2
DC2RVA Network-Wide Modeled Territory

"Network-wide" performance estimates are defined as performance estimates of trains operating within the modeled territory described in this section. The modeled territory used in the Network-Wide Analysis simulations consists of the following line segments:

- The DC2RVA project limits, which extend approximately 123 miles from RO, milepost (MP) CFP-110, in Arlington, VA south to the CSXT A-Line/S-Line junction at MP A-11 in Centralia, VA (Chesterfield County). Additional segments of the project include approximately 8.3 miles of the CSXT Peninsula Subdivision CA-Line from Beulah Road (MP CA-76.1) in Henrico County to AM Junction in the City of Richmond, the approximately 14.4-mile CSXT Bellwood Subdivision (S-Line) from Hermitage (SRN 3.5) in the City of Richmond to Centralia (S 10.9), and the approximately 26-mile BBRR from AM Junction to the CSXT RF&P Subdivision crossing (MP CA-111.8) in Doswell, VA.
- Amtrak Washington Terminal District from the limits of Washington Union Station south to CSXT-owned trackage at CP Virginia in Washington, D.C.
- BBRR Piedmont Subdivision between Doswell and control point Bob near East Gordonsville, VA.
- CSXT Philadelphia Subdivision between Philadelphia, PA and Bay View, MD.
- CSXT Baltimore Terminal Subdivision between Bay View, MD and St. Denis, MD.
- CSXT Capital Subdivision between St. Denis, MD and C Tower in Washington, D.C.
- CSXT Landover Subdivision between Landover, MD and Washington, D.C.
- CSXT Capital Subdivision Alexandria Branch between Riverdale Park, MD (JD Tower) and M Street in Washington, D.C.
- CSXT Metropolitan Subdivision between F Tower in Washington, D.C. and Weverton, MD.
- CSXT Cumberland Subdivision between Weverton, MD and the Mexico interlocking in Cumberland, MD.
- CSXT Cumberland Terminal Subdivision between the Mexico interlocking and Beall Street in Cumberland, MD.
- CSXT Old Main Line Subdivision between St. Denis, MD and Point of Rocks, MD.
- CSXT Old Main Line Subdivision Frederick Branch between Frederick Junction, MD and Frederick, MD.
- CSXT RF&P Subdivision between M Street in Washington, D.C. and control point RO in Arlington, VA.
- CSXT RF&P Subdivision Dahlgren Branch between Dahlgren Junction, VA and Sealston, VA.
- CSXT Peninsula Subdivision between Beulah Road in Henrico County, VA and Newport News, VA.
- CSXT Hopewell Subdivision between Bellwood, VA and Hopewell, VA.
- CSXT North End Subdivision between Centralia, VA and control point Charlie Baker in Rocky Mount, NC.

- CSXT South End Subdivision between control point Charlie Baker in Rocky Mount, NC and control point DI in Rocky Mount, NC.
- CSXT Portsmouth Subdivision between Weldon, NC and Portsmouth, VA.
- CSXT Rivanna Subdivision between Rivanna Jct. in Richmond, VA and Maidens, VA.
- NS Washington District between Alexandria, VA and Springfield, VA.

The modeled territory consists of 2,209 track-miles, of which the DC2RVA project limits represent approximately 15%.

3.2 Simulation Year

FRA requirements for the DC2RVA Project include demonstration through operations analysis (and specifically operations simulation) that the Project has provided sufficient railroad capacity to deliver the proposed passenger rail service and accommodate growth of freight rail service in an efficient and reliable multimodal rail corridor over a 20-year time horizon following the completion of the passenger project.

For the operations simulations performed in the additional Network-Wide Analysis, all cases were run for the simulation year of 2045. The year 2045 is the concluding year of the DC2RVA Project's 20-year planning horizon, based on the Project's proposed implementation year of 2025.

3.3 Infrastructure Assumptions

All infrastructure modifications made within the DC2RVA Project limits for the FRA Refined Operations Analysis simulations were also included in the subsequent Network-Wide Refined Operations Analysis simulations. These infrastructure changes were summarized in DRPT's memo to FRA dated June 9, 2017, and titled "Draft Results of DRPT's Refined Operations Analysis to Satisfy FRA Requests and Enable FRA Support for Issuance of the DC2RVA Project Tier II Draft Environmental Statement".

In addition, the Network-Wide Refined Operations Analysis to Estimate Potential Freight Delay Outside the DC2RVA Corridor simulations includes subsequent modifications to the DC2RVA infrastructure requested by FRA during a June 9, 2017, meeting with DRPT.

For the railroad subdivisions outside of the DC2RVA corridor included in the "network-wide" modeling (identified in Section 3.1), the following infrastructure modifications were made to the original infrastructure files provided by CSXT in 2015 for the DC2RVA Project's operations simulation work, in accordance with the DC2RVA Operations Modeling Methodology and the DC2RVA Tier II DEIS:

- For all cases modeled, including the No Build and all Build cases, infrastructure improvements associated with the DC2RVA "No Build" case were added. These improvements include:
  - Reconstruction of the Virginia Avenue Tunnel in Washington, D.C. to provide two mainline tracks on CSXT's RF&P Subdivision from control point M Street in Washington, D.C. southward to control point Jersey in Washington, D.C. (Construction work on this project is currently underway.)

  - Construction of additional track capacity in Washington, D.C. to provide four mainline tracks on CSXT's RF&P Subdivision from control point Virginia in Washington, D.C. southward to control point L'Enfant in Washington, D.C. This work also included the reconstruction of VRE's L'Enfant commuter rail station platform as an island platform between the two westernmost tracks of the subdivision, with platform edges to serve each track. (Construction work on this project has not begun, but is assumed to have occurred before the DC2RVA Project is implemented.)
  - Construction of additional track capacity across the Potomac River to provide four mainline tracks on CSXT's RF&P Subdivision from control point L'Enfant in Washington, D.C. to control point RO in Arlington, VA, the north end of the DC2RVA Project limits. (Construction work on this project has not begun, but is assumed to have occurred before the DC2RVA Project is implemented.)

- For all 2045 Build cases (only) modeled: Construction of additional track capacity in central Virginia identified in the Southeast High Speed Rail Richmond, VA to Raleigh, NC Tier II Final Environmental Impact Statement dated August 2015 to provide three mainline tracks on CSXT's North End Subdivision from Centralia, VA, the south end of the DC2RVA Project limits, to control point South Collier near Petersburg, VA. South Collier is the diverging point where SEHSR passenger trains using the reconstructed "S-Line" to and from North Carolina enter and exit the CSXT freight rail network in the modeled territory. (Construction work on this project has not begun, but is assumed to have occurred before the DC2RVA Project is implemented.)

3.4 Service Assumptions

3.4.1 DC2RVA Service Plan

The service plan tested in the additional Network-Wide Analysis was the same plan that was used in the previous FRA refined operations analysis simulations: the proposed DC2RVA Staples Mill Road/Main Street Station "Full Service" option, wherein Regional, Interstate Corridor, and Long Distance intercity passenger trains make station stops at both Richmond Staples Mill Road Station and Richmond Main Street Station.

This service plan incorporates the nine additional roundtrip intercity passenger trains proposed by the DC2RVA Project, which will operate in addition to the ten existing roundtrip intercity passenger trains currently providing service in the DC2RVA corridor and presumed to continue providing service in the No Build case and all Build Cases modeled. The nine additional roundtrip intercity passenger trains proposed by the DC2RVA Project consist of:

- Four new Interstate Corridor (SEHSR) roundtrip passenger trains operating between New York and Raleigh or Charlotte, NC, operating via the reconstructed "S-Line" south of Petersburg, VA. These trains will supplement the service provided by one existing Interstate Corridor roundtrip passenger operating via the CSXT "A-Line" (which was modeled in the No Build case and all Build cases).
- Five new Northeast Regional (SEHSR) roundtrip passenger trains operating between Boston, New York, or Washington and destinations in Virginia.

- Three of the new Northeast Regional (SEHSR) roundtrip passenger trains will operate to Norfolk. In addition, three existing roundtrip passenger trains operating between Washington and Norfolk were modeled in the No Build case and all Build cases.
- One new Northeast Regional (SEHSR) roundtrip passenger train will operate to Newport News. In addition, two existing roundtrip passenger trains operating between Washington and Newport News were modeled in the No Build case and all Build cases.
- One new Northeast Regional (SEHSR) roundtrip passenger train will operate between Washington and Richmond Main Street Station.

All Build cases also included the rerouting of one existing roundtrip Long Distance intercity passenger train south of Collier, VA, away from its current routing via CSXT's A-Line and onto the reconstructed S-Line to serve North Carolina.

Access between the two Richmond stations is provided by the DC2RVA Project's proposed East Acca Bypass passenger tracks. (The Auto Train would continue to operate as a nonstop service that does not make stops at either station, consistent with its existing operation. As it does today, the Auto Train was modeled using CSXT's A-Line between Richmond and Centralia.) Regional trains serving Richmond's Main Street Station bound to and from Newport News use the station's east side platform tracks, which provide the sole access to CSXT's Peninsula Subdivision linking Richmond and Newport News. Regional trains bound to and from Norfolk, as well as all Interstate Corridor and Long Distance passenger trains use the station's west side platform tracks, which are part of the CSXT S-Line linking Richmond and Centralia, VA, the southern end of the DC2RVA Project limits and the junction with CSXT's A-Line. The one roundtrip Regional train that originates/terminates at Main Street Station and lays over at the Brown Street Yard also uses the west side platform tracks.

In all cases, crew changes and baggage-handling services occur only at Richmond Staples Mill Road Station, and station dwell times that allow for these activities were incorporated into the passenger train schedules used in the Network-Wide Analysis simulations.

3.4.2 Maximum Speed

The maximum authorized speed of intercity passenger trains in the DC2RVA Corridor between Washington and Richmond, with the exception of the Auto Train, was increased from the existing 70 mph maximum to 90 mph, where feasible, in all Build cases.

3.4.3 Freight and Commuter Operations Modeled

The Network-Wide Analysis included the operation of freight trains and VRE commuter trains. Freight growth was projected using the existing CSXT growth methodology to year 2045. The 38 VRE commuter trains (19 round trips) proposed by the DC2RVA Project were modeled using schedules provided by VRE for the DC2RVA Project operations simulation work.

To further ensure representational operation of VRE commuter trains in the Network-Wide Analysis work, a station dwell time of 90 seconds for VRE station stops was programmed into the RTC software. The station dwell time used was provided by VRE.

3.4.4 Operations Plan: Platform Assignment Plan

For the Network-Wide Analysis, a representative station platform assignment plan for intercity passenger trains and commuter trains was used. DRPT had initially developed a station platform assignment plan for the previous FRA refined operations analysis. However, the station platform assignment plan used in the Network-Wide Analysis simulations included modifications to the original plan as requested by FRA during a meeting with DRPT on June 9, 2017.

This plan assigns each commuter train and passenger train to a specific platform at station stops. Settings selected in the RTC software instructed the software to incorporate the platform assignment plan into each operations simulation case. The platform assignment plan defines the primary platform assignments for intercity passenger trains and VRE commuter trains during the morning and evening peak commuter periods, when corridor train volumes can be predicted to be at their heaviest. The platform assignment plan encompasses the entire D2RVA corridor, from Washington through Spotsylvania and Richmond, to Centralia, for the morning and evening peak commuter periods.

Figures 3 and 4 below show the modified platform assignment plan, incorporating revisions requested by FRA on June 9, 2017. Figure 3 shows the corridor's northern half, between Washington and Spotsylvania, and Figure 4 shows the corridor's southern half, between Spotsylvania and Centralia.

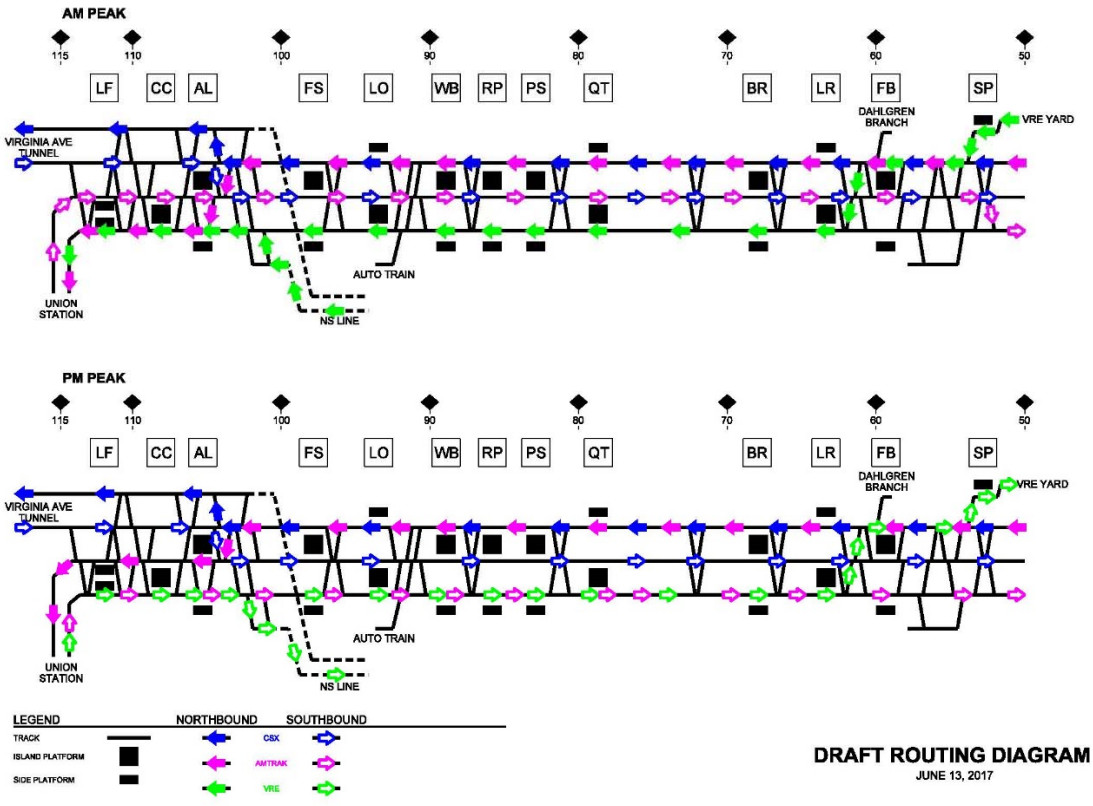

Figure 3: Modified DC2RVA Refined Operations Analysis Platform Assignment Plan Washington-Spotsylvania

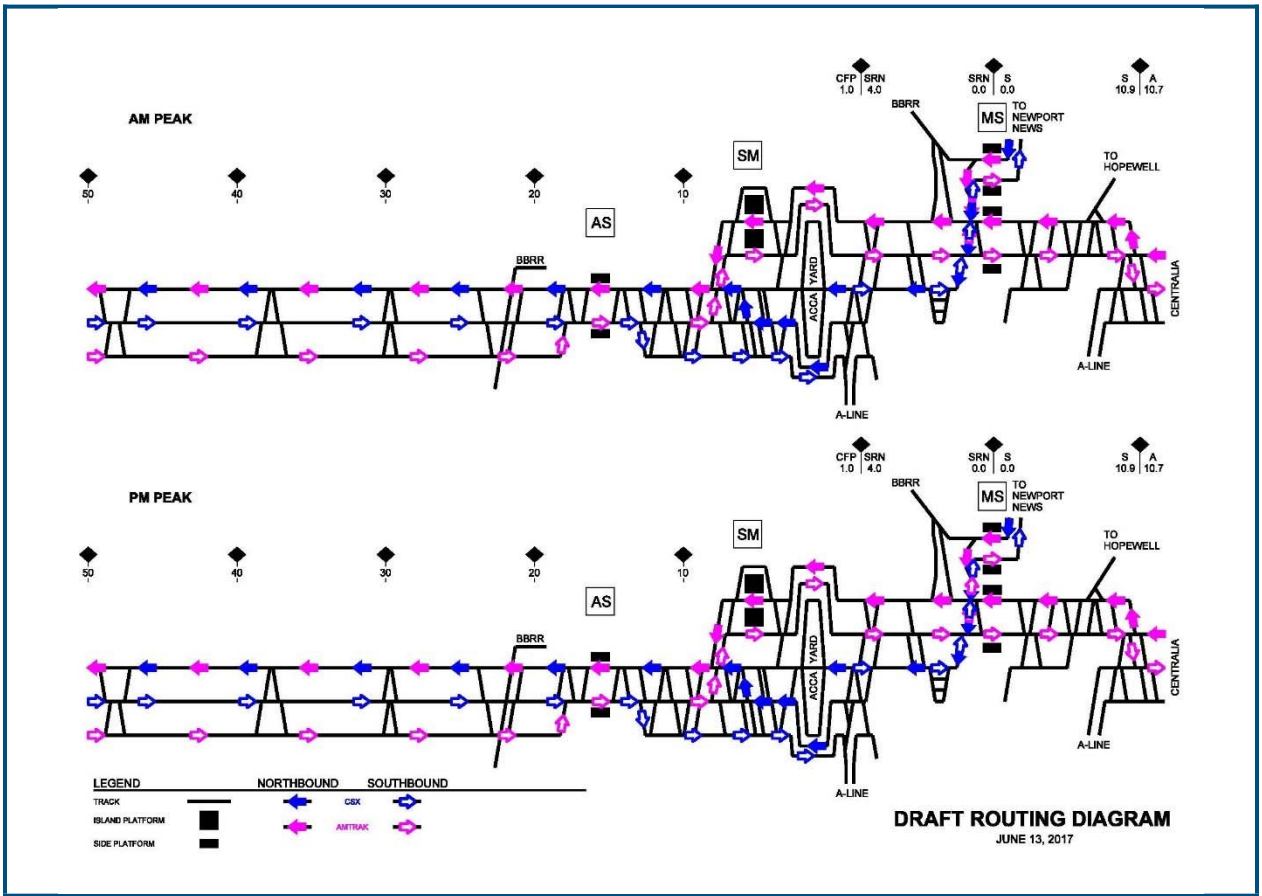

Figure 4: Modified Refined Operations Analysis Platform Assignment Plan Spotsylvania-Centralia

In the platform assignment plan used for the morning peak commuter period, VRE commuter trains used Main Track 1 (the easternmost track) between Crossroads and Dahlgren Junction and Main Track 3 (the westernmost track) between Dahlgren Junction and CP Virginia in Washington, D.C. Manassas Line VRE trains joining the corridor at AF interlocking in Alexandria also used Track 3 north to CP Virginia. Northbound intercity passenger trains and freight trains used Main Track 1 between Crossroads and CP Virginia, although Main Track 3 was utilized as an alternate track for northbound passenger trains provided VRE trains were not delayed. Southbound intercity passenger trains and freight trains used Main Track 2 between CP Virginia and Spotsylvania.

In the platform assignment plan used for the evening peak commuter period, VRE commuter trains used Main Track 3 between CP Virginia and Dahlgren Junction and Main Track 1 between Dahlgren Junction and Crossroads. Manassas Line VRE trains also used Track 3 from CP Virginia to AF interlocking in Alexandria where they departed the corridor toward Manassas. Southbound intercity passenger trains also used Track 3 between CP Virginia and Crossroads, although Main Track 2 was utilized as an alternate track for southbound passenger trains when conflicts with freight trains could be minimized. Southbound freight trains used Main rack 2. Northbound intercity passenger trains and freight trains used Main Track 1 between CP Virginia and Spotsylvania.

In the Richmond area, the platform assignment plan for the two Richmond stations during both the morning and evening allows for passenger trains operating on the S-Line between Staples Mill Road and AM Junction (near Main Street Station) to operate on the two eastern tracks of the three-main-track S-Line, which provides a direct, non-diverging route for passenger trains between the S-Line and the Acca Yard East Bypass passenger tracks. Northbound freight trains from Fulton Yard operating on the S-Line to Acca Yard make a direct, non-diverging move through AM Junction to reach the westernmost of the S-Line's three main tracks, which provides a direct, non-diverging northward route to Acca Yard.

3.4.5 Operations Plan: Revised Operations Analysis Conceptual Schedule

Passenger train running times and recovery times between Washington Union Station and Petersburg Station in the Network-Wide Analysis simulations were identical to those developed for the previous FRA refined operations analysis simulations. These schedules had been modified from the initial DC2RVA conceptual schedule included in the DEIS to enable trains to achieve an all-stations and end-to-end on-time performance at a sufficient margin above 90%, such that the performance could be considered likely to be achieved in normal real-world operation of the DC2RVA corridor under the revised corridor infrastructure and platform assignment plan incorporated into the FRA refined operations analysis simulation work. Details of the train schedule and running time modifications developed for this work were summarized in DRPT's memo to FRA dated June 9, 2017, and titled "Draft Results of DRPT's Refined Operations Analysis to Satisfy FRA Requests and Enable FRA Support for Issuance of the DC2RVA Project Tier II Draft Environmental Statement".

3.4.6 Performance Metrics and Thresholds

The performance estimates of passenger trains and commuter trains in DRPT's additional Network-Wide Analysis were measured against on-time performance standards for intercity passenger rail service developed by FRA and Amtrak in accordance with Section 207 of the Passenger Rail Investment and Improvement Act (PRIIA). In all cases, passenger trains tested in the operations simulation were assumed to arrive into the modeled territory not more than 15 minutes late, using a triangular distribution of late departure from Washington Union Station or late arrival at Petersburg.

On-time performance estimates for passenger and commuter trains were measured as follows:

- End-to-end (endpoint) on-time performance was measured between Washington Union Station in Washington, D.C. and Petersburg Station, VA, for passenger trains operating between Washington and Norfolk, North Carolina, or Georgia/Florida. Endpoint on-time performance was measured between Washington Union Station and Richmond Main Street Station for passenger trains operating between Washington and Newport News or Richmond. Endpoint on-time performance was measured between Washington Union Station and Spotsylvania station for VRE commuter trains. Endpoint on-time performance was measured as the percentage of times a train arrived at its endpoint terminal more than 10 minutes after its scheduled arrival time. The endpoint on-time performance threshold for passenger trains and commuter trains in the model was 90%.

Endpoint on-time performance estimates were measured for three different passenger train types:

- Amtrak Long Distance intercity passenger trains

- Amtrak Regional and Interstate Corridor intercity passenger trains
- Virginia Railway Express commuter trains

The performance estimates for freight trains in the Network-Wide Analysis were measured across the entire 2,209-track-mile modeled territory between Philadelphia, PA, Cumberland, MD, Newport News, VA, and Rocky Mount, NC, plus connecting lines, as described in Section 3.1. Specific freight train performance estimated assessed during the simulations included:

1. Freight train delay minutes per 100 train-miles, by train type, network-wide
2. Number of freight trains delayed per day, by number of hours, network-wide
3. Cumulative freight train hours of delay, over 12 days, network-wide
4. Number of freight trains recrewed per day due to Hours of Service, network-wide
5. Hours of total freight train delay, by location, where total train delays exceeded 3 hours in the 12-day model period, network-wide

4.0 OPERATIONS SIMULATION CASES

Four operations simulation Build cases were tested utilizing the DRPT recommended corridor alternative that provides Full Service to both Richmond Staples Mill Road and Main Street Stations. The four cases were modeled for the Year 2045 Full-Build (Horizon Year) incorporating the additional infrastructure changes, service changes, assumptions, and parameters described in Section 3.

All of the operations simulation cases performed as part of DRPT's Network-Wide Analysis were conducted in the same modeled territory between Philadelphia, PA, Cumberland, MD, Newport News, VA, and Rocky Mount, NC, plus connecting lines, as described in Section 3.1. All cases had a common track configuration throughout the modeled territory, except within the DC2RVA corridor where different infrastructure alternatives were tested in different cases, as described below. All cases were dispatched with the infrastructure modifications between Washington and Centralia that were described in Section 3.4. The only exceptions to the use of a common infrastructure in this operations analysis are described below, when a simulation case required a specific modification to the common infrastructure. The following cases were developed and tested.

DC2RVA 2045 No Build. This case measured network-wide freight train performance with the No Build infrastructure on the DC2RVA corridor, as described in the DC2RVA DEIS, and did not include the new intercity passenger trains proposed by the DC2RVA Project.

DC2RVA 2045 Build. This Build case measured network-wide freight train performance with three main tracks on the DC2RVA corridor from Alexandria to Richmond Staples Mill Road Station. This case included the new intercity passenger trains proposed by the DC2RVA Project.

DC2RVA 2045 Build, 2 tracks Ashland. This Build case measured network-wide freight train performance with three main tracks on the DC2RVA corridor from Alexandria to Richmond Staples Mill Road Station with the exception of a two-track segment through Ashland. The northern and southern limits of the two-main-track section through Ashland encompass a distance of approximately 2.01 miles, from a proposed interlocking north of Vaughan Road at milepost CFP 15.75 to a proposed interlocking south of Ashcake Road at milepost CFP 13.74. This case included the new intercity passenger trains proposed by the DC2RVA Project.

DC2RVA 2045 Build, 2 tracks Ashland + Track Out of Service North (MOW Outage). This Build case measured network-wide freight train performance with three main tracks on the DC2RVA corridor from Alexandria to Richmond Staples Mill Road Station with the exception of a two-track segment through Ashland, plus a randomly selected additional two-track segment of approximately 10 miles in length between Alexandria and Crossroads, in order to test the response of the network to a simulated maintenance-of-way outage. In this case, the two-main-track section through Ashland was identical to the one used in Case 2. In addition, a track outage was added to the corridor on Main Track 2 between North Possum Point (CFP 81.3) and Arkendale (CFP 72.1), a distance of 9.2 miles. This outage restricted trains from using Main Track 2 for a period of 7 hours, from 9:00 a.m. to 4:00 p.m., for all of the days modeled. This case included the new intercity passenger trains proposed by the DC2RVA Project.

DC2RVA 2045 Build, 2 tracks south of Crossroads. This Build case measured network-wide freight train performance with three main tracks on the DC2RVA corridor from Alexandria to Crossroads, and two main tracks from Crossroads to Richmond Staples Mill Road Station. This case included the new intercity passenger trains proposed by the DC2RVA Project.

5.0 RESULTS

This section presents the results of the Network-Wide Analysis conducted by DRPT. "Network-wide" performance estimates are defined as performance estimates for trains operating within the modeled territory described in Section 3.1. The metrics that are reported are as follows:

For passenger trains:

- Endpoint On-Time Performance by train type, between Petersburg and Washington Union Station (averaged results from 5 randomized cases).
- The passenger train types measured were:
  - Amtrak Long-Distance Intercity Passenger Trains
  - Amtrak Regional and Interstate Corridor Intercity Passenger Trains
  - Virginia Railway Express Commuter Trains

For freight trains:

- Minutes of Delay per 100 Train-Miles, Network-Wide (averaged results from 5 randomized cases)
- Number of Freight Trains Delayed per Day, by Number of Hours, Network-Wide (averaged results from 5 randomized cases)
- Cumulative Freight Train Hours of Delay, Over 12 Days, Network-Wide (averaged results from 5 randomized cases)
- Number of Freight Trains Recrewed per Day due to Hours of Service, Network-Wide (averaged results from 5 randomized cases)
- Hours of Total Train Delay, by Location, Where Total Train Delays Exceed 3 Hours in the 12-Day Model Period, Network-Wide (averaged results from 5 randomized cases)

- The freight train types measured were:
  - All Freight Trains (cumulative); the All Freight Trains category is a weighted average of all freight train types
  - Expedited Intermodal Freight Trains
  - Intermodal (non-expedited) Freight Trains
  - Merchandise Freight Trains
  - All Other Freight Train Types

Note that Minutes of Delay per 100 Freight Train-Miles is calculated by the RTC operations simulation model as follows:

- Adding all of the train miles of all of the trains that operate during the model's statistical capture period
- Adding all of the minutes of delay of all of the trains that operate during the model's statistical capture period
- Dividing the total delay by total train miles divided by 100.
- Displayed as a formula:

$$\frac{\Sigma \text{ Delay}}{\Sigma \text{ Train Miles}/100}$$

- Delay for each freight train that operates during the model's statistical capture period is calculated by the RTC model as the difference between the run time of each freight train in an unimpeded case to each train's actual run time in the model.

Passenger Train On-Time Performance

Table 2 shows the passenger train endpoint on-time performance in each case.

Table 2: Passenger train endpoint on-time performance, Petersburg to Washington Union Station (averaged results from 5 randomized cases)

CASE	DC2RVA 2045 NO BUILD	DC2RVA 2045 BUILD	DC2RVA 2045 BUILD 2ASH	DC2RVA 2045 BUILD 2ASH + TOS	DC2RVA 2045 BUILD XR2	Late Tolerance
Infrastructure Tested	No Build	3 Tracks south of Alexandria	3 Tracks south of Alexandria, except 2 tracks through Ashland	3 Tracks south of Alexandria, except 2 tracks through Ashland, and with 1 track out of service north of Fredericksburg	3 Tracks south of Alexandria, and 2 tracks south of Crossroads	
Amtrak Long-Distance Intercity Passenger Train OTP	71.32%	96.64%	95.77%	95.49%	95.57%	15 minutes
Amtrak Regional and Interstate Corridor Intercity Passenger Train OTP	77.87%	91.41%	91.90%	90.88%	90.58%	10 minutes
Virginia Railway Express Commuter Train OTP	96.97%	97.82%	98.88%	96.39%	98.60%	5 minutes

Freight Train Delay Minutes per 100 Train-Miles

Table 3 shows the freight train delay minutes per 100 train-miles, network-wide, incurred by five different freight train types in each case.

Table 3: Freight Train Delay Minutes per 100 Train-Miles, Network-Wide (averaged results from 5 randomized cases)

CASE	DC2RVA 2045 NO BUILD	DC2RVA 2045 BUILD	DC2RVA 2045 BUILD 2ASH	DC2RVA 2045 BUILD 2ASH + TOS	DC2RVA 2045 BUILD XR2
Infrastructure Tested	No Build	3 Tracks south of Alexandria	3 Tracks south of Alexandria, except 2 tracks through Ashland	3 Tracks south of Alexandria, except 2 tracks through Ashland, and with 1 track out of service north of Fredericksburg	3 Tracks south of Alexandria, and 2 tracks south of Crossroads
All Freight Trains (cumulative)	42.9	43.4	45.5	46.2	48.0
Expedited Intermodal Freight Trains	16.8	31.3	34.3	33.8	37.0
Intermodal (non-expedited) Freight Trains	21.3	32.0	32.4	35.1	36.5
Merchandise Freight Trains	48.0	38.6	40.7	41.1	42.9
All Other Freight Train Types	65.1	64.6	67.5	68.1	69.0

*Note: The All Freight Trains category is a weighted average of all freight train types

Number of Freight Trains Delayed per Day, by Number of Hours

Table 4 shows the number of freight trains delayed per day, by number of hours, within the entire modeled territory (network-wide) in each case.

Table 4: Number of Freight Trains Delayed per Day, by Number of Hours, Network-Wide (averaged results from 5 randomized cases)

CASE	DC2RVA 2045 NO BUILD	DC2RVA 2045 BUILD	DC2RVA 2045 BUILD 2ASH	DC2RVA 2045 BUILD 2ASH + TOS	DC2RVA 2045 BUILD XR2
Infrastructure Tested	No Build	3 Tracks south of Alexandria	3 Tracks south of Alexandria, except 2 tracks through Ashland	3 Tracks south of Alexandria, except 2 tracks through Ashland, and with 1 track out of service north of Fredericksburg	3 Tracks south of Alexandria, and 2 tracks south of Crossroads
Train Delay Per Day					
1 Hour	38.3	43.3	43.7	44.0	44.8

Table 4: Number of Freight Trains Delayed per Day, by Number of Hours, Network-Wide (averaged results from 5 randomized cases)

CASE	DC2RVA 2045 NO BUILD	DC2RVA 2045 BUILD	DC2RVA 2045 BUILD 2ASH	DC2RVA 2045 BUILD 2ASH + TOS	DC2RVA 2045 BUILD XR2
2 Hours	21.7	23.9	25.4	25.8	26.9
3 Hours	13.1	13.1	13.9	14.3	15.4
4 Hours	8.3	7.2	8.2	7.9	9.0
5 Hours	5.3	4.2	4.9	4.9	5.4
6 Hours	3.6	2.4	3.1	3.2	3.5
7 Hours	2.4	1.5	2.0	2.4	1.9
8 Hours	1.7	1.0	1.3	1.7	1.3
9 Hours	1.1	0.7	0.9	1.1	1.0
10 Hours	0.8	0.5	0.5	0.8	0.7

Cumulative Freight Train Hours of Delay, Over 12 Days

Table 5 summarizes the cumulative hours of delay incurred by freight trains, network-wide, over a 12-day model run in each case.

Table 5: Cumulative Freight Train Hours of Delay, Over 12 Days, Network-Wide (averaged results from 5 randomized cases)

CASE	DC2RVA 2045 NO BUILD	DC2RVA 2045 BUILD	DC2RVA 2045 BUILD 2ASH	DC2RVA 2045 BUILD 2ASH + TOS	DC2RVA 2045 BUILD XR2
Infrastructure Tested	No Build	3 Tracks south of Alexandria	3 Tracks south of Alexandria, except 2 tracks through Ashland	3 Tracks south of Alexandria, except 2 tracks through Ashland, and with 1 track out of service north of Fredericksburg	3 Tracks south of Alexandria, and 2 tracks south of Crossroads
Cumulative Hours of Delay	1,532.9	1,550.6	1,631.0	1,655.0	1,711.1

Number of Trains Recrewed per Day Due to Hours of Service

When a freight train crew reaches its federally regulated 12-hour on-duty time (known as hours of service), the train crew must cease operation and the freight train must be stopped until a new crew arrives. Table 6 shows the average number of trains that had to be recrewed per day, network-wide, in each case, in the 12-day model period, because a train crew exceeded its on-duty time.

Table 6: Numbers of Trains Recrewed per Day Due to Hours of Service, Network-Wide (averaged results from 5 randomized cases)

CASE	DC2RVA 2045 NO BUILD	DC2RVA 2045 BUILD	DC2RVA 2045 BUILD 2ASH	DC2RVA 2045 BUILD 2ASH + TOS	DC2RVA 2045 BUILD XR2
Infrastructure Tested	No Build	3 Tracks south of Alexandria	3 Tracks south of Alexandria, except 2 tracks through Ashland	3 Tracks south of Alexandria, except 2 tracks through Ashland, and with 1 track out of service north of Fredericksburg	3 Tracks south of Alexandria, and 2 tracks south of Crossroads
Number of Trains Recrewed per Day	19.4	13.8	13.4	21.6	18.3

Hours of Total Train Delay, By Location, Where Total Train Delay Exceeds 3 Hours in the 12-Day Model Period

Table 7 shows the hours of total freight train delay, by location (identified by subdivision and milepost), network-wide, where total freight train delay exceeds 3 hours in the 12-day model period. Delays were recorded by subdivision and field milepost. Freight train delays of more than 3 hours were recorded at 203 distinct locations, as seen in the table below. In 21 instances at eight different locations, freight trains experienced total delays exceeding 24 hours over the 12-day model period, including at Newport News (Peninsula Subdivision, milepost 11.75) where total train delays ranged between 4 days and 6 days.

Table 7: Hours of Total Train Delay, by Location, where Total Train Delay Exceeds 3 Hours in the 12-Day Model Period, Network-Wide (averaged results from 5 randomized cases)

CASE		DC2RVA 2045 NO BUILD	DC2RVA 2045 BUILD	DC2RVA 2045 BUILD 2ASH	DC2RVA 2045 BUILD 2ASH + TOS	DC2RVA 2045 BUILD XR2
Infrastructure Tested		No Build	3 Tracks south of Alexandria	3 Tracks south of Alexandria, except 2 tracks through Ashland	3 Tracks south of Alexandria, except 2 tracks through Ashland, and with 1 track out of service north of Fredericksburg	3 Tracks south of Alexandria, and 2 tracks south of Crossroads
Subdivision	**Field Milepost**	**dd:hh:mm:ss**	**dd:hh:mm:ss**	**dd:hh:mm:ss**	**dd:hh:mm:ss**	**dd:hh:mm:ss**
Baltimore Terminal	1.71	00:05:49:39	00:05:33:49	00:05:24:51	00:06:14:17	00:05:27:25
Baltimore Terminal	2.15			00:04:43:09		

Table 7: Hours of Total Train Delay, by Location, where Total Train Delay Exceeds 3 Hours in the 12-Day Model Period, Network-Wide (averaged results from 5 randomized cases)

CASE		DC2RVA 2045 NO BUILD	DC2RVA 2045 BUILD	DC2RVA 2045 BUILD 2ASH	DC2RVA 2045 BUILD 2ASH + TOS	DC2RVA 2045 BUILD XR2
Subdivision	Field Milepost	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss
Baltimore Terminal	3.825	00:12:44:51	00:11:57:02	00:13:51:08	00:15:25:48	00:15:36:14
Baltimore Terminal	6.525	00:04:23:22				
Baltimore Terminal	89.725	00:05:55:11	00:04:01:58		00:04:14:30	00:04:34:14
Baltimore Terminal	89.85	00:17:33:19	00:17:01:04	00:17:21:24	00:16:08:34	00:22:33:44
Baltimore Terminal	91.69	00:04:06:06			00:03:16:51	00:03:52:36
Baltimore Terminal	93.66	00:09:26:55	00:10:55:59	00:10:57:50	00:09:25:44	00:09:16:52
Baltimore Terminal	94.65	00:06:40:33	00:03:37:20			
Bellwood	0.41	00:06:47:38				
Bellwood	0.625				00:03:25:50	
Bellwood	1.24				00:04:50:20	
Bellwood	1.26				00:03:20:32	
Bellwood	1.96	00:03:29:12				
Bellwood	3.04	00:06:15:29				
Bellwood	3.20		00:04:39:07	00:04:20:12	00:04:07:14	
Bellwood	5.02	00:08:24:57	00:03:54:27		00:05:29:49	
Bellwood	7.16	00:05:26:42				
Bellwood	10.46				00:04:38:34	
Bellwood	10.75	00:0:10:15				
Capital	10.67		00:06:35:10	00:06:58:26	00:10:11:11	00:05:19:40
Capital	13.275		00:03:35:43	00:05:30:40	00:05:36:34	00:05:21:06
Capital	15.925	00:03:24:08	00:05:59:02	00:04:08:54		00:03:26:42
Capital	16.00	00:03:40:53				

Table 7: Hours of Total Train Delay, by Location, where Total Train Delay Exceeds 3 Hours in the 12-Day Model Period, Network-Wide (averaged results from 5 randomized cases)

CASE		DC2RVA 2045 NO BUILD	DC2RVA 2045 BUILD	DC2RVA 2045 BUILD 2ASH	DC2RVA 2045 BUILD 2ASH + TOS	DC2RVA 2045 BUILD XR2
Subdivision	Field Milepost	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss
Capital	19.45		00:03:09:56			
Capital	32.55	00:03:34:45				
Capital	33.65	00:14:57:21	00:05:56:57	00:05:37:45	00:07:11:33	00:07:48:16
Capital	114.825	00:03:26:41				00:03:15:29
Capital	117.40	00:06:50:20	00:04:19:08	00:04:45:47	00:04:23:41	00:06:27:33
Capital	118.55	00:11:03:22	00:04:18:04	00:05:29:21	00:04:48:43	00:04:35:42
Capital	120.45				00:03:04:16	
Cumberland	81.89			00:04:26:43	00:03:48:20	
Hopewell	7.575	00:03:14:40				
Hopewell	8.80	00:03:38:05				
Hopewell	10.59	00:04:02:21	00:07:10:31	00:07:57:11	00:08:18:20	00:08:52:38
Hopewell	11.88	00:03:21:36				
Hopewell	13.10				00:03:15:56	
James River	5.46	00:03:26:12				
Metropolitan	36.90			00:05:16:44		
Metropolitan	39.05			00:05:26:51		
Metropolitan	42.50	00:03:19:33				
Metropolitan	68.825	00:06:19:21				
Metropolitan	70.80	00:07:27:05				
Metropolitan	71.50	00:03:32:55				
Metropolitan	72.875	00:09:20:26				
Metropolitan	75.175				00:04:17:36	
Metropolitan	75.20		00:04:09:59		00:03:07:59	
Metropolitan	75.45	00:04:10:21			00:10:20:21	
Metropolitan	75.525	00:06:00:46				
Metropolitan	75.825			00:03:06:00		

Table 7: Hours of Total Train Delay, by Location, where Total Train Delay Exceeds 3 Hours in the 12-Day Model Period, Network-Wide (averaged results from 5 randomized cases)

CASE		DC2RVA 2045 NO BUILD	DC2RVA 2045 BUILD	DC2RVA 2045 BUILD 2ASH	DC2RVA 2045 BUILD 2ASH + TOS	DC2RVA 2045 BUILD XR2
Subdivision	Field Milepost	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss
Metropolitan	77.18				00:10:43:21	
North End	1.19				00:03:51:42	
North End	3.30	00:07:00:45	00:03:47:07	00:03:01:23	00:03:37:51	00:03:50:48
North End	3.82				00:04:35:12	
North End	5.575	00:03:27:09			00:05:21:50	00:04:14:29
North End	8.12				00:08:42:45	
North End	8.70				00:03:08:30	
North End	9.33			00:03:18:51	00:11:10:44	00:05:19:23
North End	13.13		00:06:40:16	00:07:53:39	00:08:59:51	00:04:02:36
North End	14.95		00:04:16:16	00:03:47:28		
North End	18.20	00:03:30:37				
North End	20.65				00:03:21:18	
North End	22.97	00:10:18:53	00:10:28:54	00:10:34:33	00:11:06:22	00:09:54:37
North End	26.65	01:05:42:52	00:04:23:35	00:03:12:52	00:09:00:45	00:09:32:54
North End	26.85				00:09:34:36	
North End	28.70		00:05:32:00	00:05:31:18	00:05:53:27	00:04:22:52
North End	28.725	00:06:32:42	00:08:01:35	00:07:38:13	00:08:59:42	00:08:35:09
North End	28.80				00:04:11:24	00:03:00:04
North End	29.95				00:04:32:00	00:05:53:10
North End	31.13	00:12:48:44				
North End	32.36		00:03:19:29			
North End	33.63			00:04:43:19	00:07:47:05	00:06:44:57
North End	34.88		00:03:04:27	00:05:02:04	00:04:17:09	00:07:40:38
North End	36.89		00:08:06:05	00:07:46:55	00:09:54:26	00:11:30:02
North End	37.84	00:03:35:31	00:11:06:05	00:08:32:10	00:10:10:47	00:13:51:56
North End	40.53			00:05:12:13	00:03:30:46	00:04:37:11

Table 7: Hours of Total Train Delay, by Location, where Total Train Delay Exceeds 3 Hours in the 12-Day Model Period, Network-Wide (averaged results from 5 randomized cases)

CASE		DC2RVA 2045 NO BUILD	DC2RVA 2045 BUILD	DC2RVA 2045 BUILD 2ASH	DC2RVA 2045 BUILD 2ASH + TOS	DC2RVA 2045 BUILD XR2
Subdivision	Field Milepost	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss
North End	41.37	00:07:37:25	00:17:29:15	00:20:53:28	00:23:28:44	01:02:20:17
North End	42.11	00:16:24:47	01:02:47:20	01:00:03:32	01:02:28:58	01:02:23:15
North End	51.17	00:12:00:02	00:12:57:20	00:12:50:14	00:15:47:13	00:12:51:17
North End	56.36			00:03:29:08		00:03:20:47
North End	57.67	00:04:46:03	00:13:19:37	00:10:09:55	00:08:35:27	00:14:54:52
North End	57.82	00:11:02:34	00:19:26:25	00:22:05:13	00:17:08:16	00:16:40:49
North End	64.65	00:13:47:30	00:21:01:23	00:19:59:06	00:21:20:37	00:18:27:09
North End	67.825		00:08:12:22	00:11:10:31	00:06:54:37	00:07:03:20
North End	67.875		00:06:16:25	00:08:32:09	00:05:07:45	00:04:37:52
North End	68.76		00:05:47:06	00:05:47:40		00:05:20:10
North End	71.87		00:06:29:34	00:04:55:46	00:05:57:07	00:05:26:58
North End	73.31	00:03:46;49	00:05:08:06		00:03:31:46	
North End	74.05	00:08:03:29	00:08:47:01	00:07:39:14	00:08:26:51	00:07:05:13
North End	76.93	00:04:03:34				
North End	78.59	00:10:16:02	00:20:59:20	00:19:29:41	00:17:56:30	00:18:08:51
North End	80.37			00:03:30:57		
North End	81.79	00:06:31:00	00:07:34:38	00:09:26:15	00:10:09:55	00:09:26:20
North End	81.89		00:03:49:01	00:04:18:54	00:03:41:16	00:05:11:34
North End	84.80	00:06:30:21	00:10:20:28	00:09:45:55	00:09:21:20	00:09:45:44
North End	85.95		00:04:03:37	00:06:27:05		00:05:11:57
North End	86.40	00:05:22:43	00:07:48:59	00:09:56:56	00:08:08:51	00:10:35:38
North End	86.525	00:03:03:11	00:04:04:05	00:04:19:21	00:04:48:04	00:05:54:06
North End	88.90	00:20:51:25	01:04:46:42	01:04:16:15	01:05:13:02	01:06:49:39
North End	97.34	00:17:20:22	01:00:48:49	01:07:02:11	01:01:16:14	01:05:34:58
North End	97.64		00:03:37:23	00:04:40:16	00:04:08:22	
North End	99.00			00:04:03:00	00:03:17:33	

Table 7: Hours of Total Train Delay, by Location, where Total Train Delay Exceeds 3 Hours in the 12-Day Model Period, Network-Wide (averaged results from 5 randomized cases)

CASE		DC2RVA 2045 NO BUILD	DC2RVA 2045 BUILD	DC2RVA 2045 BUILD 2ASH	DC2RVA 2045 BUILD 2ASH + TOS	DC2RVA 2045 BUILD XR2
Subdivision	Field Milepost	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss
North End	100.65			00:03:41:30		
North End	100.78		00:04:12:26	00:03:16:35	00:03:07:59	00:03:13:05
North End	101.08	00:03:58:29	00:05:10:29	00:05:52:32	00:06:48:15	00:04:47:56
North End	101.21		00:05:01:29	00:04:46:13	00:05:26:10	00:03:14:13
North End	101.31			00:07:15:01	00:04:54:25	00:04:13:35
North End	102.49			00:03:56:20		00:03:41:00
North End	104.98			00:04:52:59	00:04:05:21	
North End	105.05	00:09:03:32	00:12:35:14	00:14:32:29	00:11:05:00	00:14:34:17
North End	107.02			00:03:07:07		
North End	112.07	00:14:17:31	00:20:45:14	00:21:15:46	00:17:55:23	01:00:51:13
North End	115.90	00:03:20:44				00:03:24:44
North End	116.025	00:04:50:51		00:03:50:36		
North End	118.62	00:06:35:31				
Peninsula	11.75	04:11:09:48	05:08:35:46	05:11:33:33	05:05:19:46	05:11:39:36
Peninsula	13.75	00:04:01:57	00:08:10:16	00:08:50:23	00:07:01:13	00:09:56:56
Peninsula	14.025			00:03:01:13		
Peninsula	22.50	00:03:09:02	00:03:35:36	00:05:08:44	00:04:29:21	00:04:10:14
Peninsula	42.96			00:03:58:55		
Peninsula	58.66		00:04:31:12	00:05:09:54	00:03:09:41	00:04:57:47
Peninsula	76.16		00:03:30:39	00:04:09:27		
Peninsula	81.25			00:03:21:17		
Peninsula	82.85	00:08:27:36	00:18:43:22	00:18:56:28	01:06:26:57	00:15:11:31
Peninsula	82.875	00:03:08:54		00:03:31:02	00:06:54:14	00:10:55:19
Peninsula	82.90	00:05:29:10				
Peninsula	83.025	00:09:56:23	00:07:38:16	00:04:09:49	00:07:03:14	00:08:01:35
Peninsula	83.05			00:03:56:29		00:03:26:00

Table 7: Hours of Total Train Delay, by Location, where Total Train Delay Exceeds 3 Hours in the 12-Day Model Period, Network-Wide (averaged results from 5 randomized cases)

CASE		DC2RVA 2045 NO BUILD	DC2RVA 2045 BUILD	DC2RVA 2045 BUILD 2ASH	DC2RVA 2045 BUILD 2ASH + TOS	DC2RVA 2045 BUILD XR2
Subdivision	Field Milepost	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss
Peninsula	83.075	00:05:42:23	00:03:28:53	00:04:28:30	00:04:59:33	
Peninsula	83.25	00:11:24:58	00:05:33:28	00:03:14:10	00:08:28:06	00:03:22:42
Peninsula	83.325		00:06:12:17	00:06:34:24	00:06:06:23	00:06:25:16
Peninsula	84.325	00:04:41:01				
Philadelphia	1.36	00:09:00:47				
Philadelphia	4.72	00:11:19:54	00:05:57:49	00:09:16:16	00:06:23:18	00:06:11:49
Philadelphia	11.87	00:04:55:04	00:03:39:02			
Philadelphia	13.725	00:10:26:13	00:10:54:26	00:10:53:38	00:08:42:38	00:07:44:37
Philadelphia	27.30	00:09:49:53	00:07:23:52	00:08:11:22	00:07:15:27	00:06:05:49
Philadelphia	29.29	00:13:04:49	00:05:27:40	00:06:28:57	00:07:41:02	00:07:45:24
Philadelphia	41.56	00:09:44:50	00:05:12:07	00:04:12:54	00:05:33:46	00:06:06:31
Philadelphia	43.62	00:08:26:55	00:07:04:28	00:09:39:40	00:07:48:25	00:10:27:42
Philadelphia	54.50	00:07:25:05	00:03:05:47	00:03:40:54	00:03:17:43	00:04:14:57
Philadelphia	56.50	00:17:23:17	00:11:49:53	00:14:24:04	00:17:36:36	00:14:44:09
Philadelphia	70.29	00:08:15:26	00:05:44:44	00:06:03:18	00:06:39:14	00:06:19:35
Philadelphia	72.24	00:20:42:22	00:16:54:01	00:16:25:07	00:16:04:33	00:21:02:44
Philadelphia	84.54	00:11:02:00	00:04:44:13	00:06:14:07	00:06:42:45	00:06:44:39
Philadelphia	88.30	00:03:17:04				
Philadelphia	89.20	00:03:03:52				
Portsmouth	3.00	00:03:25:42				
Portsmouth	3.60				00:06:53:35	
Portsmouth	14.00		00:03:37:08	00:05:09:52	00:04:29:29	00:03:09:27
Portsmouth	15.07			00:03:22:14		
Portsmouth	20.31	00:03:17:09				00:03:03:45
Portsmouth	21.525	00:06:04:58	00:06:05:07	00:04:47:10	00:04:24:24	00:05:20:54
Portsmouth	22.30	00:10:07:25		00:03:23:42		

Table 7: Hours of Total Train Delay, by Location, where Total Train Delay Exceeds 3 Hours in the 12-Day Model Period, Network-Wide (averaged results from 5 randomized cases)

CASE		DC2RVA 2045 NO BUILD	DC2RVA 2045 BUILD	DC2RVA 2045 BUILD 2ASH	DC2RVA 2045 BUILD 2ASH + TOS	DC2RVA 2045 BUILD XR2
Subdivision	Field Milepost	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss
Portsmouth	22.65	00:05:18:45	00:05:27:34	00:06:24:47	00:04:53:47	00:03:52:16
Portsmouth	24.45				00:03:12:12	00:03:45:25
Portsmouth	24.50				00:03:03:04	
Portsmouth	43.15	00:03:03:44			00:03:25:46	
Portsmouth	57.08	00:06:06:02	00:09:27:17	00:05:15:01	00:07:27:37	00:05:28:17
Portsmouth	77.45		00:04:15:39	00:06:14:04	00:04:33:13	00:04:42:26
Portsmouth	81.79			00:03:54:27		00:04:15:35
RF&P	5.625	00:05:25:58				
RF&P	5.68		00:03:37:16			
RF&P	13.58			00:10:16:39	00:09:47:12	
RF&P	14.25			00:06:52:54		
RF&P	15.71		00:03:55:30			
RF&P	15.80			00:09:45:08	00:08:08:42	
RF&P	29.85				00:03:23:10	
RF&P	55.70		00:03:58:32	00:03:43:25	00:03:21:27	00:05:05:38
RF&P	55.825	00:04:37:28				
RF&P	58.02		00:04:34:22			
RF&P	58.73	00:03:40:38				
RF&P	72.40	00:03:04:00				
RF&P	79.75	00:04:11:03				
RF&P	82.40				00:12:00:39	
RF&P	92.20	00:21:51:51				
RF&P	93.25		00:03:09:44			00:05:56:13
RF&P	93.70	00:03:18:12				
RF&P	97.35	00:05:53:10				
RF&P	104.675	00:07:51:23				

Table 7: Hours of Total Train Delay, by Location, where Total Train Delay Exceeds 3 Hours in the 12-Day Model Period, Network-Wide (averaged results from 5 randomized cases)

CASE		DC2RVA 2045 NO BUILD	DC2RVA 2045 BUILD	DC2RVA 2045 BUILD 2ASH	DC2RVA 2045 BUILD 2ASH + TOS	DC2RVA 2045 BUILD XR2
Subdivision	Field Milepost	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss
RF&P	106.35		00:06:18:09			
RF&P	106.45			00:06:55:02	00:04:35:30	00:05:41:12
Richmond Terminal	1.80	00:11:02:31	00:05:32:57	00:04:55:42	00:06:54:31	00:08:14:49
Richmond Terminal	1.875				00:03:56:32	
Richmond Terminal	1.95	00:03:29:07	00:05:24:11			00:07:34:29
Richmond Terminal	1.975			00:03:55:12	00:03:11:15	
Richmond Terminal	2.00				00:03:17:03	
Richmond Terminal	3.30		00:03:26:45			
Richmond Terminal	3.45	00:14:00:37	00:06:41:05	00:05:07:53	00:06:25:02	00:06:46:15
Richmond Terminal	3.50	00:03:39:43				
Richmond Terminal	3.55		00:03:38:38			00:03:06:56
Richmond Terminal	3.60		00:06:20:48			00:05:55:57
Richmond Terminal	3.65	00:04:44:17				
Richmond Terminal	4.67			00:03:13:41		
Richmond Terminal	4.73	00:09:48:40				
Richmond Terminal	4.89		00:03:32:04			00:05:43:24
Rivanna	0.22		00:03:08:55	00:03:37:19	00:03:05:01	00:04:17:32
Rivanna	29.76	00:03:40:41				
South End	120.025	00:03:11:11				

Table 7: Hours of Total Train Delay, by Location, where Total Train Delay Exceeds 3 Hours in the 12-Day Model Period, Network-Wide (averaged results from 5 randomized cases)

CASE		DC2RVA 2045 NO BUILD	DC2RVA 2045 BUILD	DC2RVA 2045 BUILD 2ASH	DC2RVA 2045 BUILD 2ASH + TOS	DC2RVA 2045 BUILD XR2
Subdivision	Field Milepost	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss	dd:hh:mm:ss
South End	120.25		00:06:47:02	00:06:41:56	00:05:25:16	00:08:10:37
South End	121.00				00:06:09:32	00:05:20:45
South End	121.125			00:03:12:09		00:03:29:17
South End	121.475	00:08:26:42	00:16:02:42	00:17:51:17	00:15:25:50	00:17:06:13
South End	121.55	00:03:50:17				