2021 BRISTOL EXTENSION CAPITAL & OPERATING COST ANALYSIS

Virginia Department of Rail and Public Transportation

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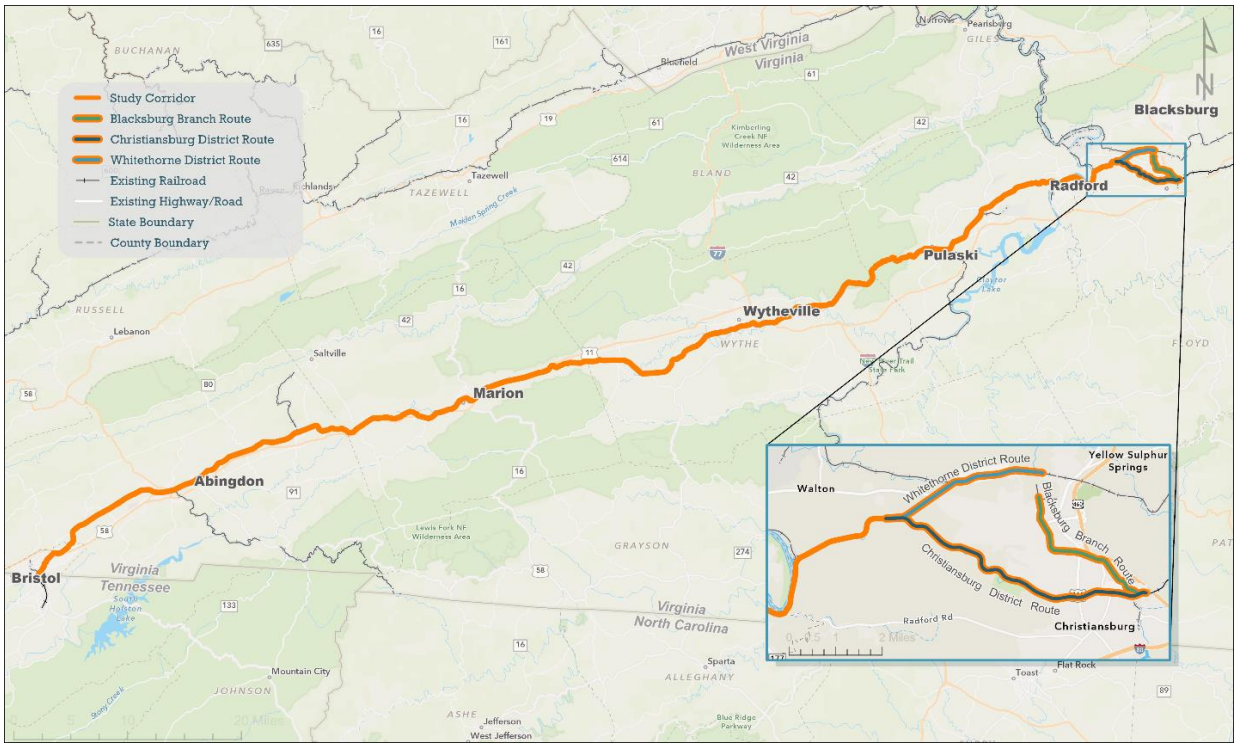
1. Executive Summary

The Virginia General Assembly, during the 2021 Session, passed Item 447.10 E. which tasked the Virginia Department of Rail and Public Transportation (DRPT) to "…provide an assessment of both the total project costs and incremental costs resulting from (i) the extension of intercity passenger rail to Bristol, Virginia; … to the Chairs of the House Committee on Appropriations and the Senate Committee on Finance and Appropriations no later than November 15, 2021." DRPT developed the 2021 Bristol Extension Capital & Operating Cost Analysis report (the 2021 Bristol Cost Analysis) to fulfill this requirement.

1.1. Project Description

Virginia currently contracts with Amtrak to operate passenger rail service between Roanoke and Washington, D.C., along Norfolk Southern Railway's (NSR) mainline and N-line. This corridor experienced increased ridership and revenue since the start of state-sponsored Lynchburg service in 2009 and a 16 percent growth in ridership since the service extension to Roanoke in 2017. Now the Commonwealth is committed to add a second frequency along this route and further extend Amtrak service to the New River Valley through the Transforming Rail in Virginia initiative. This study forecasts a further expansion southwest to Bristol. The 2021 Bristol Cost Analysis forecasts the capital cost in 2030 dollars, the ridership and revenue potential, and the operating and maintenance costs of a potential extension of the Washington-Roanoke Amtrak route (Route 46) between the New River Valley and Bristol, Virginia. Figure 1.1 shows the corridor considered for this service extension. The map shows two route alternatives to access a New River Valley Station, the location of which will be determined based on an alternatives analysis that is currently under development.

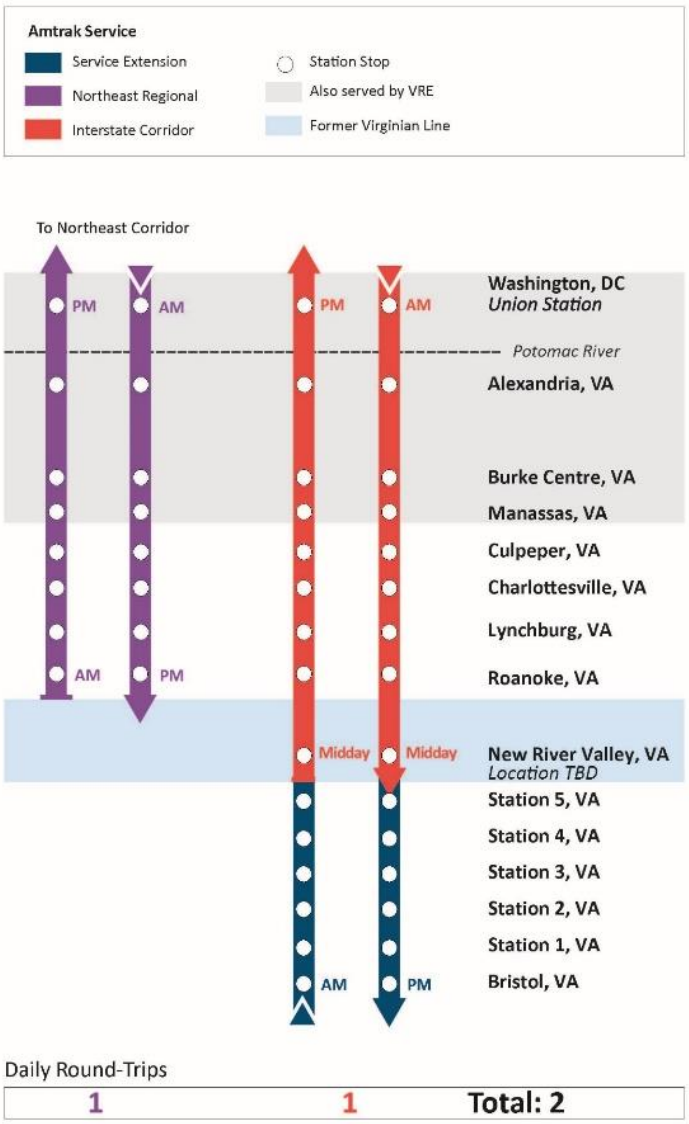
FIGURE 1.1: BRISTOL PASSENGER RAIL SERVICE EXTENSION (2030) CORRIDOR



Source: Moffatt & Nichol

A potential future service plan is required to develop improvements for the capital cost estimate and to forecast ridership and revenue for the operating and maintenance cost estimate. Figure 1.2 shows the potential future service plan used to develop the capital costs, ridership forecasts, revenue forecasts, and operating and maintenance costs for an extension of passenger rail service from the New River Valley to Bristol. The plan identifies the service as an Interstate Corridor frequency pending development of a detailed service plan. That detailed service plan will be developed using train performance modeling. The plan assumes that the second frequency planned for Roanoke would be extended to the New River Valley and on to Bristol.

FIGURE 1.2: POTENTIAL FUTURE SERVICE PLAN



Source: Moffatt & Nichol

1.2. Capital Cost Estimates

TABLE 1.1: CAPITAL COST ESTIMATES

Corridor	Construction Cost (2030 $M)	Indirect Costs (2030 $M)	Contractor's Mark-up + Bond (2030 $M)	Contingency 40% (2030 $M)	Total Construction Cost (2030 $M)
Bristol to Blacksburg Branch Route	$ 277	$ 19	$ 86	$ 153	$ 535
Bristol to Whitethorne District Route	$ 798	$ 51	$ 252	$ 440	$ 1,541

Source: Moffatt & Nichol

Total construction cost estimates in Table 1.1 include costs for track, stations, train control signals, positive train control, at-grade crossing protection, bridges, and earthwork. The estimates include costs for infrastructure optimization to maintain interoperability between freight and passenger trains. Overnight service and storage in Bristol will occur at the station for a single round trip service. Indirect costs include "soft costs" such as engineering, legal, permits, and review fees. Contractor's costs include "soft costs" such as bonds, insurance, profits, surveying, testing, and inspections.

Capital costs to extend service from the New River Valley to Bristol range from $535 million to more than $1.5 billion in 2030 dollars. The high-end estimate is due to an approximately 1.5-mile tunnel required to connect the NSR Whitethorne District to the NSR Christiansburg District. This tunnel would be necessary for a station along the Whitethorne District Route west of the Blacksburg Branch Route as shown in Figure 1.3.

FIGURE 1.3: TUNNEL BETWEEN NSR WHITETHORNE DISTRICT AND NSR CHRISTIANSBURG DISTRICT

Source: Moffatt & Nichol

A tunnel would not be necessary for an alternative along the Whitethorne District Route east of the Blacksburg Branch Route, along the Blacksburg Branch Route, or along the Christiansburg District Route.

1.3. Ridership Forecasts

DPRT developed the proposed Bristol-Roanoke-Washington service scenario in addition to the existing Roanoke-Washington-New York service. Passengers traveling between Roanoke and Washington would have two round trips per weekday (the existing service and the new service originating in Bristol).

The annual demand forecasts compare results from ridership modeling based on a spreadsheet diversion model developed using inputs from the Virginia Statewide Transportation Model (VSTM) to ridership modeling from the Amtrak incremental model for a horizon year of 2030. Model results are shown in **Error! Reference source not found.**. Incremental ridership with at least one end of the trip between Radford and Bristol (i.e., beyond New River Valley) was the focus of this study.

DRPT used the following growth rates to scale model outputs to a horizon year of 2030:

- Market size: Average growth of 1.86 percent per year across the study area, based on county-level Woods & Poole 2019 forecasts for population/employment/income and the demographic growth elasticities within the Amtrak incremental model. The growth rate was calculated on a station catchment basis, providing each station zone with a unique growth rate (which averages out to 1.86 percent across the study area).
- Ticket and Food & Beverage revenue: Inflation assumption of 2.3 percent per year (The Economist Intelligence Unit - EIU).

TABLE 1.2: SUMMARY OF 2030 RIDERSHIP FORECASTS

Model used	Market	Annual ridership (one-way trips) 2030	Annual ticket revenue 2030 dollars[1]	Comments
N/A	Trips within WAS-RNK	130,100	$5.08 million	Amtrak FFY2019 Actuals, inflated to 2030 using an average 1.86 percent growth rate.
VSTM-based spreadsheet model	Trips south of NRV (**net new riders**)	12,000 - 15,500	$0.47 million - $0.68 million	Ranges allow for variations in travel time between NRV and Bristol.
Amtrak incremental model	Trips south of NRV (**net new riders**)	9,700 - 12,100	$0.63 million - $0.79 million	Ranges allow for variations in travel time between NRV and Bristol.

1.4. Operations and Maintenance (O&M) Cost Estimates

DRPT estimated the annual operating and maintenance cost for the proposed Bristol-Roanoke-Washington service at between $5.01 million and $5.56 million for base year FFY 2030. These are costs

[1] Fare policy based on Amtrak FFY2019 fares, grown at an inflation rate of 2.3 percent per year.

limited to the expenses necessary for Amtrak to provide the proposed service between New River Valley and Bristol. Third Party costs accounted for 18 percent of total expenses, on average. Route costs accounted for 63 percent of total expenses, and additives for 19 percent of total expenses. **Error! Reference source not found.** presents the estimated O&M costs.

TABLE 1.3: O&M COSTS, FFY 2030 (IN $MILLIONS)

Cost Categories	Operating Cost
Third Party Costs	0.9 - 1.0
Route Costs	3.1 - 3.5
Additives	1.0 - 1.1
Total Expenses	**5.0 - 5.6**

Source: Operating and Maintenance Cost Model

O&M costs per train mile is a measure of operating efficiency. DPRT calculated operating cost incurred between $56 and $62 for each mile of train service on the proposed Bristol-Roanoke-Washington service. DRPT found that operating and maintenance costs per train mile were estimated to be lower for the proposed extension than the $74 to $88 per mile range for other passenger rail services in the state of Virginia. This difference in cost is to be expected given that the proposed service is an extension of an existing service. A significant portion of the operating and maintenance costs do not increase proportionately with additional miles of train service.

1.5. Operating Revenue

DRPT compared revenue and operating costs to determine the operating revenue for the Low Case and the High Case scenarios. This provides a clearer picture of the future annual O&M budget. DRPT used the ticket revenue figures output by the VSTM ridership model and assumed food and beverage revenue is proportional to ticket revenue. Other revenue was calculated within the O&M model, driven by ticket revenue, and reduced by 20 percent to account for the portion of other revenue that does not vary with ridership.

TABLE 1.4: OPERATING REVENUE, FFY2030

2030 $	Revenue
Ticket Revenues	475,000 – 680,000
Food & Beverage Revenues	16,000 – 25,000
Other Revenues	6,000 – 9,000
Total Revenues	**500,000 – 715,000**

Source: VSTM Revenue Model and Operating and Maintenance Cost Model

1.6. Conclusions

DRPT used proven methodologies to forecast the capital costs and operating and maintenance costs to provide passenger rail service between New River Valley and Bristol.

- Capital costs $ 0.54B to $ 1.5B in 2030 dollars
- Ridership 9,700 to 15,500 per year (depending on model)
- O&M costs $ 5.0M to $ 5.6M per year
- Revenue Could offset O&M cost by up to $ 0.5M to $ 0.7M per year

1.7. Next Steps

The FRA's 2020 SE Regional Rail Plan acknowledged a route from Bristol to Knoxville to Chattanooga as a "Network Independent Corridor" that has minimal effects on the network performance but is necessary to include in the plan to provide additional connections throughout the Southeast Network. See map below.

Continued coordination with Tennessee is needed to gauge interest in this route as part of the Virginia Statewide Rail Plan currently underway. Ongoing collaboration with Amtrak and FRA is also needed to explore the feasibility of this route given its unique advantages in an area of the region that faces economic challenges and is currently underserved by transportation networks.

FIGURE 1.4: FRA'S 2020 SE REGIONAL RAIL PLAN

Source: https://hsrail.org/sites/default/files/images/Southeast_Region_Map_from_SEC_Report.jpg

2. Infrastructure

Passenger rail service between the proposed New River Valley passenger station and Bristol will use an existing NSR corridor. Currently, the existing track that forms this proposed passenger rail corridor serves freight trains only. To serve passenger trains, existing infrastructure will need to be improved to increase train speed, which will also reduce travel time.

The proposed passenger rail corridor includes the following portions of the NSR network:

- Blacksburg Branch Route (CA-line) from MP CA-0.5 to CA-4.0
- Christiansburg District Route (N-Line) from MP N-289.3 to N-297.63
- Pulaski District (NB-line) from MP NB-297.63 to NB 408.38
- Whitethorne District Route (V-line) from MP V-278.2 to V-280.0

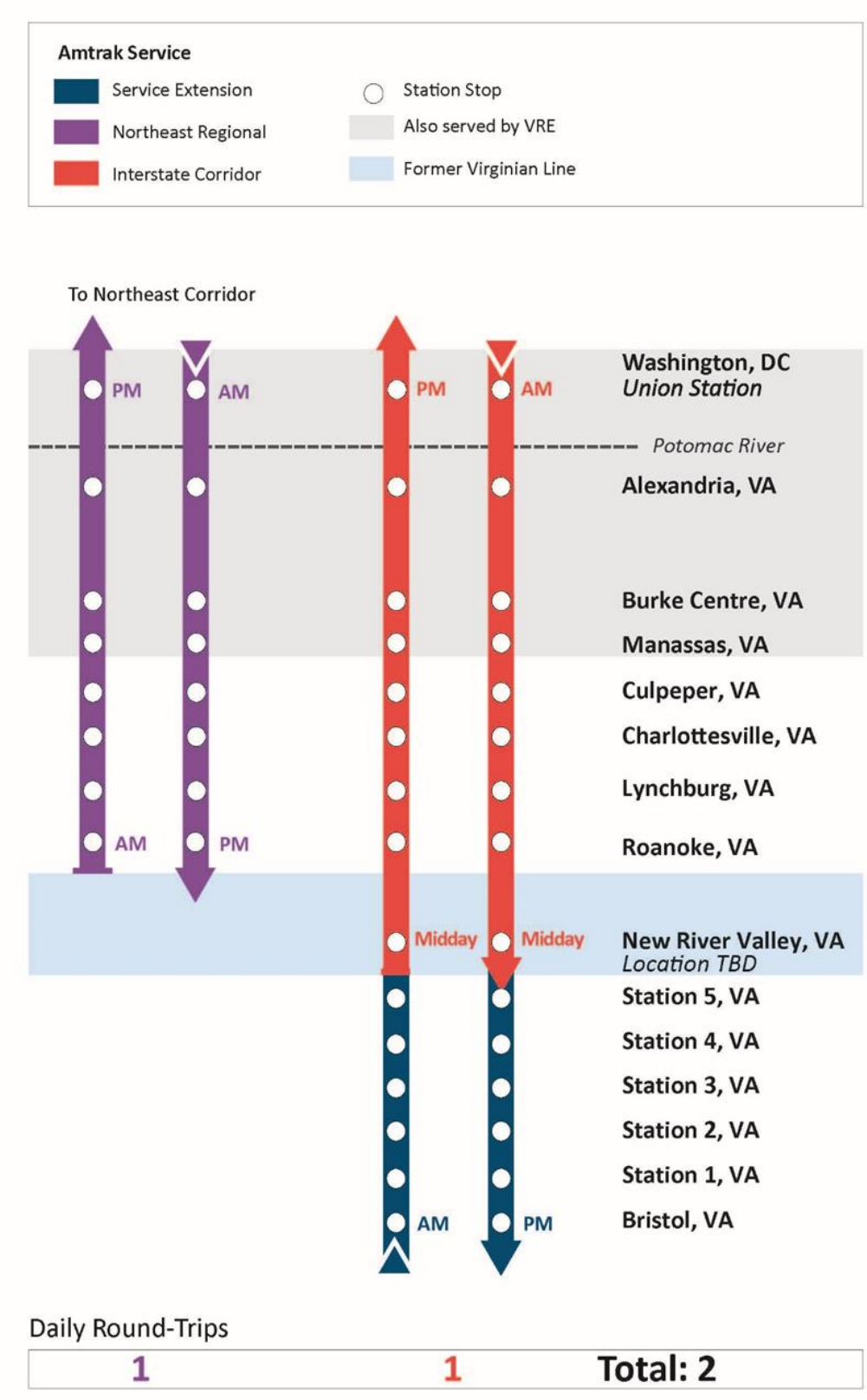
NSR track charts from 2009 were used to identify existing track infrastructure. Infrastructure elements were verified and updated using aerial imagery and FRA crossing databases where possible.

Improved track alignments are required in order for passenger trains to use this currently freight-only corridor. The exact route is dependent on the yet-to-be determined station location in the New River Valley. A separate study is currently underway to analyze potential New River Valley station location and feasibility.

2.1. Proposed Interim Stations

Figure 2.1 shows five unstaffed stations and one staffed passenger station that are proposed from NRV to Bristol, inclusive. Station locations were identified in the 2007 TransDominion Express Status Update Study. TransDominion station locations were incorporated in this study as a potential maximum number of stations along this corridor. Conservative travel time estimates were generated using the maximum number of station locations. Fewer stations reduce travel time thereby increasing ridership and revenue.

FIGURE 2.1: PROPOSED STATIONS



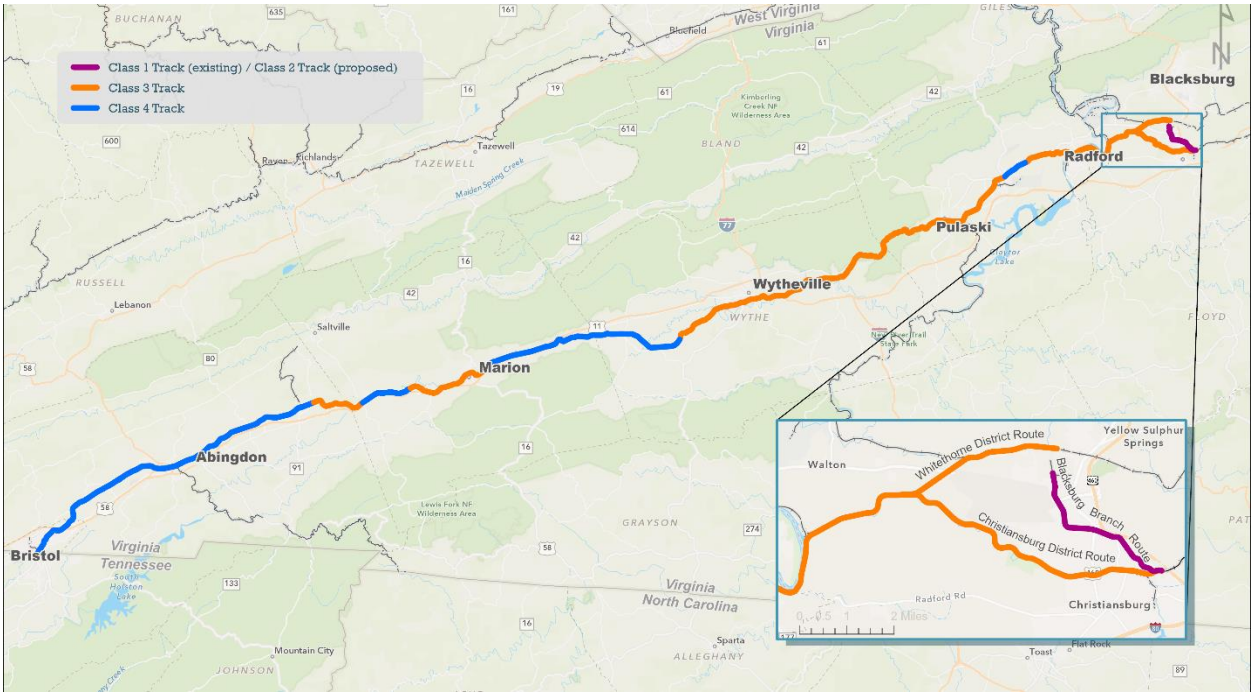
Source: Moffatt & Nichol

2.2. Network Modeling

Data for freight train speeds was obtained from FRA databases. Passenger train speeds are not part of the FRA database for the corridor.

Maximum allowable operating speeds (MAS) for each class of track are defined by CFR 49 §213.9*. Figure 2.2 shows the locations of the class of track along the corridor. Table 2.1 relates the freight train speed to the MAS speed for passenger trains operating on a given class of track.

FIGURE 2.2: CLASS OF TRACK ALONG CORRIDOR



Source: Moffatt & Nichol

TABLE 2.1: TRAIN SPEEDS BY CLASS OF TRACK

Over track that meets all the requirements prescribed in this part for:	The maximum allowable operating speed (MAS) for freight trains is:	The maximum allowable operating speed (MAS) for passenger trains is:	Speed difference between Passenger MAS and Freight MAS:
Excepted track	10	N/A	N/A
Class 1 track	10	15	5
Class 2 track	25	30	5
Class 3 track	40	60	20
Class 4 track	60	80	20
Class 5 track	80	90	10

**All speeds are in miles per hour (MPH).*

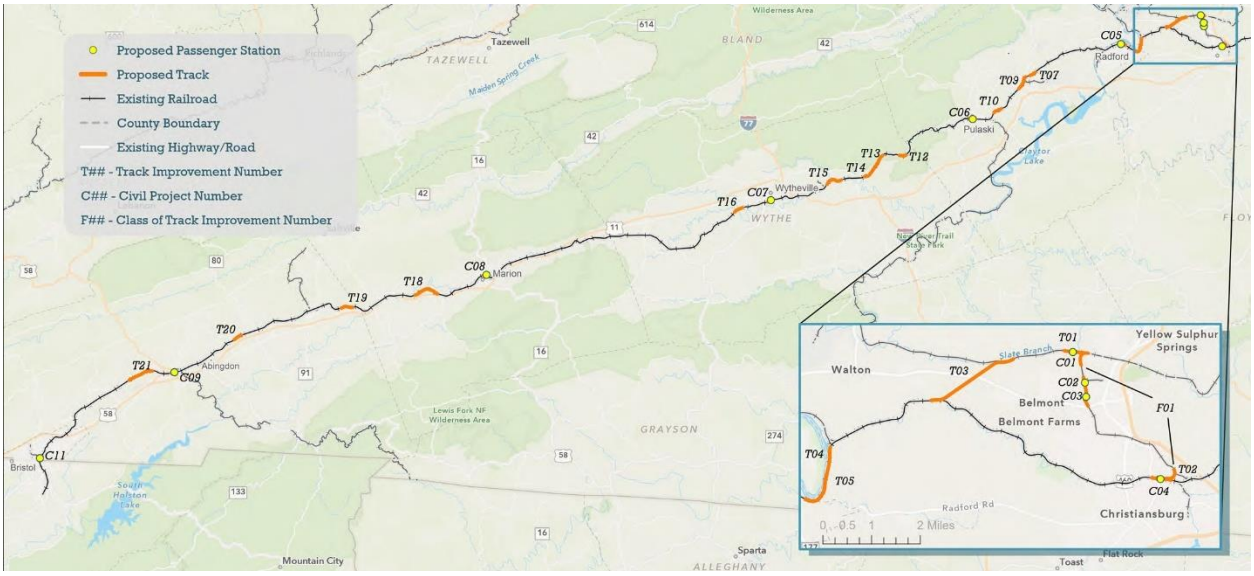
2.3. Modeling Process

Passenger train speeds were calculated using the maximum allowable speeds of the freight trains. For each track class shown in Table 2.1, passenger train speeds are faster than freight train speeds. A passenger train speed for a given segment of track is the difference between the maximum allowable speed (MAS) for the class of track shown in column four.

As an example, a segment of track with freight trains operating at a speed of 35 mph is operating on Class 3 track or higher. The speed difference between passenger train MAS and freight train MAS operating on Class 3 track is 20 mph. Therefore, a passenger train operating on this segment of track will operate at 55 mph.

Improving existing track conditions will increase passenger train speeds, thereby reducing passenger travel times. Proposed track improvements are recommended to eliminate speed restrictions in curves, to maintain freight train operations during passenger train operations by adding sidings, to increase train speeds by improving the class of track, and to maintain freight fluidity at stations by adding a station track. Figure 2.2 shows the proposed track improvements from which capital costs, ridership, and operations and maintenance (O&M) costs were derived.

FIGURE 2.3: PROPOSED TRACK IMPROVEMENTS



Source: Moffatt & Nichol

TABLE 2.2: PROPOSED CORRIDOR IMPROVEMENTS

Improvement Designation	Description	Total Cost (2030 $)	Included in Route Cost (Table 3.2)
T01	Connecting Track between Blacksburg Branch Route and Whitethorne District Route	$16,270,000	No[2]
C01	Whitethorne District Route Terminus	$10,000	No[2]
F01A	Blacksburg Branch Route – Improve Class of Track, Connecting Track to Christiansburg District Route for Single-Locomotive Train	$28,990,000	Yes
F01B	Blacksburg Branch Route – Improve Class of Track, Connecting Track to Christiansburg District Route for Two-Locomotive Train	$28,990,000	Yes
C02	Blacksburg Branch Route Terminus – North Alternative	$0	No[2]
C03	Blacksburg Branch Route Terminus – South Alternative	$0	No[2]
T02	Connecting Track between Blacksburg Branch Route and Christiansburg District Route	$6,260,000	
C04	Christiansburg District Route Terminus – East Alternative	$0	No[2]
C04A	Christiansburg District Route Terminus – West Alternative	$0	No[2]
T03	Proposed Vickers Branch – Connecting Track between Whitethorne District Route and Christiansburg District Route including Tunnel	$1,043,200,000	Yes
T04	Track Extension – Double main tracks	$10,070,000	Yes
T05	NB Line MP 299 Proposed Curve Realignment	$2,360,000	Yes
C05	Proposed Station 5	$15,230,000	Yes
T06	NB Line MP 300 Proposed Crossover	$1,150,000	Yes

[2] Part of New River Valley passenger rail service extension

Improvement Designation	Description	Total Cost (2030 $)	Included in Route Cost (Table 3.2)
T07	NB Line MP 310 Proposed Curve Realignment	$1,240,000	Yes
T09	NB Line MP 310.5 Proposed Second Track	$26,610,000	Yes
T10	NB Line MP 313.4 Proposed Curve Realignment	$1,280,000	Yes
C06	Proposed Station 4	$19,180,000	Yes
T12	NB Line MP 323.6 Proposed Curve Realignment	$1,720,000	Yes
T13	NB Line MP 323.6 Proposed Passing Siding	$27,420,000	Yes
T14	NB Line MP 327.7 Proposed Curve Realignment	$1,150,000	Yes
T15	NB Line MP 330.5 Proposed Curve Realignment	$691,000	Yes
C07	Proposed Station 3	$17,000,000	Yes
T16	NB Line MP 339.6 Proposed Curve Realignment	$4,772,000	Yes
C08	Proposed Station 2	$17,000,000	Yes
T18	NB Line MP 369.7 Proposed Siding and Curve Realignment	$23,950,000	Yes
T19	NB Line MP 377.2 Proposed Curve Realignment	$2,330,000	Yes
T20	NB Line MP 387.5 Proposed Curve Realignment	$691,000	Yes
C09	Proposed Station 1	$16,810,000	Yes
T21	NB Line MP 395.5 Proposed Siding	$18,500,000	Yes
C11	Proposed Bristol Passenger Station	$16,040,000	Yes
E00	Signaling Costs for Pulaski District	$194,260,000	Yes
E01	Signaling Costs for Whitethorne District Route	$9,980,000	Yes
E02	Signaling Costs for Blacksburg Branch Route	$20,460,000	Yes

Improvement Designation	Description	Total Cost (2030 $)	Included in Route Cost (Table 3.2)
E04	Signaling Costs for Christiansburg District Route East Terminus	$13,950,000	Yes
E05	Signaling Costs for Christiansburg District Route West Terminus	$12,380,000	Yes
X-CDR	Christiansburg District Route – At-Grade Crossings	$3,600,000	Yes
X-PD	Pulaski District – At-Grade Crossings	$62,120,000	Yes

Source: Moffatt & Nichol

Notes:

1. Improvements designated T08, T11, and T17 were proposed track improvements that were considered and dismissed due to lack of benefits related to cost of improvements.
2. Improvement designated C10 was a proposed station in the 2007 TransDominion Express Status Update Study that was considered and dismissed due to not meeting the Virginia or Amtrak station location criteria.
3. Improvement designated E03 was a proposed signaling improvement that was considered and dismissed due to the close proximity of potential termini on the Blacksburg Branch Route.

Passenger train travel times were calculated by dividing the length of a segment of track by the speed for that segment of track. As an example, it will take 2.2 minutes for a passenger train operating at 55 mph to travel the length of a 2-mile segment of track. Adding the time to travel each track segment between NRV/Christiansburg and Bristol gives the total train travel time. Building in additional time for stopping and starting the train at each station gives the total passenger travel time. By calculating these travel times from station to station, a potential service plan was developed to support ridership forecasts. Schedules were developed to provide a crew transfer at Roanoke to prevent a transfer south of Washington, DC.

On time performance (OTP) is critical to ridership. For the purposes of this study, DRPT prepared potential service plans for 100 percent OTP and 90 percent OTP as shown in Figures 2.3 and 2.4. The '100 percent OTP' timetable has lower travel times (no time allowance for delays at stations or along the corridor) than the '90 percent OTP' timetable. Where the travel time between stations takes 49 minutes in the 100 percent OTP, it takes 54 minutes in the 90 percent OTP to allow for delays such as a late departure from the previous station, a reduced speed due to conditions along the route, or a speed reduction caused by meeting or passing another train. The following schedules do not reflect those developed for proposed service to the New River Valley as they were unavailable at the time these were prepared.

FIGURE 2.4: SERVICE PLAN FOR 100 PERCENT OTP

DRAFT M-F SCHEDULES (100% OTP)

MONDAY - FRIDAY

STATION	SOUTHBOUND SCHEDULE	
	ARRIVAL	DEPARTURE
Washington, DC		8:45 AM
Roanoke	1:45 PM	1:47 PM
New River Valley	2:34 PM	2:39 PM
Station 5	2:53 PM	2:55 PM
Station 4	3:01 PM	3:03 PM
Station 3	3:37 PM	3:39 PM
Station 2	4:06 PM	4:08 PM
Station 1	4:35 PM	4:37 PM
Bristol	4:52 PM	

MONDAY - FRIDAY

STATION	NORTHBOUND SCHEDULE	
	ARRIVAL	DEPARTURE
Bristol		9:24 AM
Station 1	9:39 AM	9:41 AM
Station 2	10:08 AM	10:10 AM
Station 3	10:37 AM	10:39 AM
Station 4	11:13 AM	11:15 AM
Station 5	11:21 AM	11:23 AM
New River Valley	11:37 AM	11:42 AM
Roanoke	12:29 PM	12:31 PM
Washington, DC	5:31 PM	

DRAFT Sa-Su SCHEDULES (100% OTP)

SATURDAY

STATION	SOUTHBOUND SCHEDULE	
	ARRIVAL	DEPARTURE
Washington, DC		10:45 AM
Roanoke	3:45 PM	3:47 PM
New River Valley	4:34 PM	4:39 PM
Station 5	4:53 PM	4:55 PM
Station 4	5:01 PM	5:03 PM
Station 3	5:37 PM	5:39 PM
Station 2	6:06 PM	6:08 PM
Station 1	6:35 PM	6:37 PM
Bristol	6:52 PM	

SUNDAY

STATION	NORTHBOUND SCHEDULE	
	ARRIVAL	DEPARTURE
Bristol		9:24 AM
Station 1	9:39 AM	9:41 AM
Station 2	10:08 AM	10:10 AM
Station 3	10:37 AM	10:39 AM
Station 4	11:13 AM	11:15 AM
Station 5	11:21 AM	11:23 AM
New River Valley	11:37 AM	11:42 AM
Roanoke	12:29 PM	12:31 PM
Washington, DC	5:31 PM	

Source: Moffatt & Nichol

FIGURE 2.5: SERVICE PLAN FOR 90 PERCENT OTP

DRAFT M-F SCHEDULES (90% OTP)

MONDAY - FRIDAY

STATION	SOUTHBOUND SCHEDULE	
	ARRIVAL	DEPARTURE
Washington, DC		8:45 AM
Roanoke	2:18 PM	2:20 PM
New River Valley	3:12 PM	3:17 PM
Station 5	3:33 PM	3:35 PM
Station 4	3:41 PM	3:43 PM
Station 3	4:21 PM	4:23 PM
Station 2	4:53 PM	4:55 PM
Station 1	5:25 PM	5:27 PM
Bristol	5:44 PM	

MONDAY - FRIDAY

STATION	NORTHBOUND SCHEDULE	
	ARRIVAL	DEPARTURE
Bristol		9:15 AM
Station 1	9:31 AM	9:33 AM
Station 2	10:03 AM	10:05 AM
Station 3	10:35 AM	10:37 AM
Station 4	11:15 AM	11:17 AM
Station 5	11:24 AM	11:26 AM
New River Valley	11:41 AM	11:46 AM
Roanoke	12:38 PM	12:40 PM
Washington, DC	6:14 PM	

DRAFT Sa-Su SCHEDULES (90% OTP)

SATURDAY

STATION	SOUTHBOUND SCHEDULE	
	ARRIVAL	DEPARTURE
Washington, DC		10:45 AM
Roanoke	4:18 PM	4:20 PM
New River Valley	5:12 PM	5:17 PM
Station 5	5:33 PM	5:35 PM
Station 4	5:41 PM	5:43 PM
Station 3	6:21 PM	6:23 PM
Station 2	6:53 PM	6:55 PM
Station 1	7:25 PM	7:27 PM
Bristol	7:44 PM	

SUNDAY

STATION	NORTHBOUND SCHEDULE	
	ARRIVAL	DEPARTURE
Bristol		9:24 AM
Station 1	9:40 AM	9:42 AM
Station 2	10:12 AM	10:14 AM
Station 3	10:44 AM	10:46 AM
Station 4	11:24 AM	11:26 AM
Station 5	11:33 AM	11:35 AM
New River Valley	11:50 AM	11:55 AM
Roanoke	12:47 PM	12:49 PM
Washington, DC	6:23 PM	

Source: Moffatt & Nichol

3. Capital Costs

DRPT generally followed the FRA Capital Cost Estimating Guidance to prepare an order of magnitude opinion of probable capital costs in 2030 dollars. These capital costs originated from the network model and infrastructure improvements proposed for the passenger rail service. Estimates of capital costs are based on the conceptual designs of the infrastructure improvements shown in Figure 1.1.

3.1. Overview & Methodology

Capital cost estimates for each improvement include conceptual design systems applicable to that improvement and location. Conceptual design systems included in the capital cost estimates are:

- Track, including:
  - Roadbed
  - Ballast
  - Ties
  - Rails
  - Other track materials
  - Shifting or realigning track
- Turnouts and other specialty trackwork
- Earthwork, including:
  - Clearing
  - Grubbing
  - Rough grading
  - Fine grading
  - Compaction
- At-grade crossings and crossing protection systems
- Improving class of track from Class 1 to Class 2
- Station site development, including:
  - Earthwork
  - Retaining walls
  - Paving
  - Utilities
  - Station building
  - Platform
  - Parking
- Railroad bridges
- Railroad tunnel
- Roadway bridges
- Pedestrian bridges
- Communications and signals systems
- Positive train control systems

Each of these design systems are composed of cost categories and subcategories. Unit costs for design systems were totaled using these cost categories and subcategories. DRPT estimated capital costs based on quantities estimated from the conceptual designs. These quantities were multiplied by the unit costs to develop a total cost for a given improvement.

3.2. Base Year

Base year dollars provide a method for analyzing and comparing capital cost estimates. This study used available 2020 unit costs and escalated those costs at a rate of three percent per year to calculate 2030 implementation year costs.

3.3. Contingencies and Other Percent-Based Costs

DRPT estimated additional capital costs that are considered on a percent of total construction costs at this level of design. FRA determined levels of contingency at the “Completion of Planning and Concept Design” range between 30 percent and 40 percent. DRPT set the contingency for this pre-planning study at 40 percent. Those costs and the associated percentages are shown in Table 3.1.

TABLE 3.1: PERCENT-BASED COSTS

Cost Category	Percent of Construction Cost (%)
Indirect cost	6
Contractor's Mark-up & Bond	30
Contingency	40

Source: Moffatt & Nichol

3.4. Anomalies Due to COVID-19 Impacts on Economy

Direct construction impacts due to COVID-19 have ranged from a shortage of available construction materials and labor to the suspensions and/or terminations of entire projects.

Sufficient data has neither been collected nor analyzed to fully determine the near-term or long-term impacts of the COVID-19 pandemic on capital costs or construction activities related to this potential passenger rail service extension. These impacts and associated government recovery efforts to offset the impacts will need to be evaluated once the recovery programs are completed.

3.5. Maintenance and Storage Facility Cost Estimates

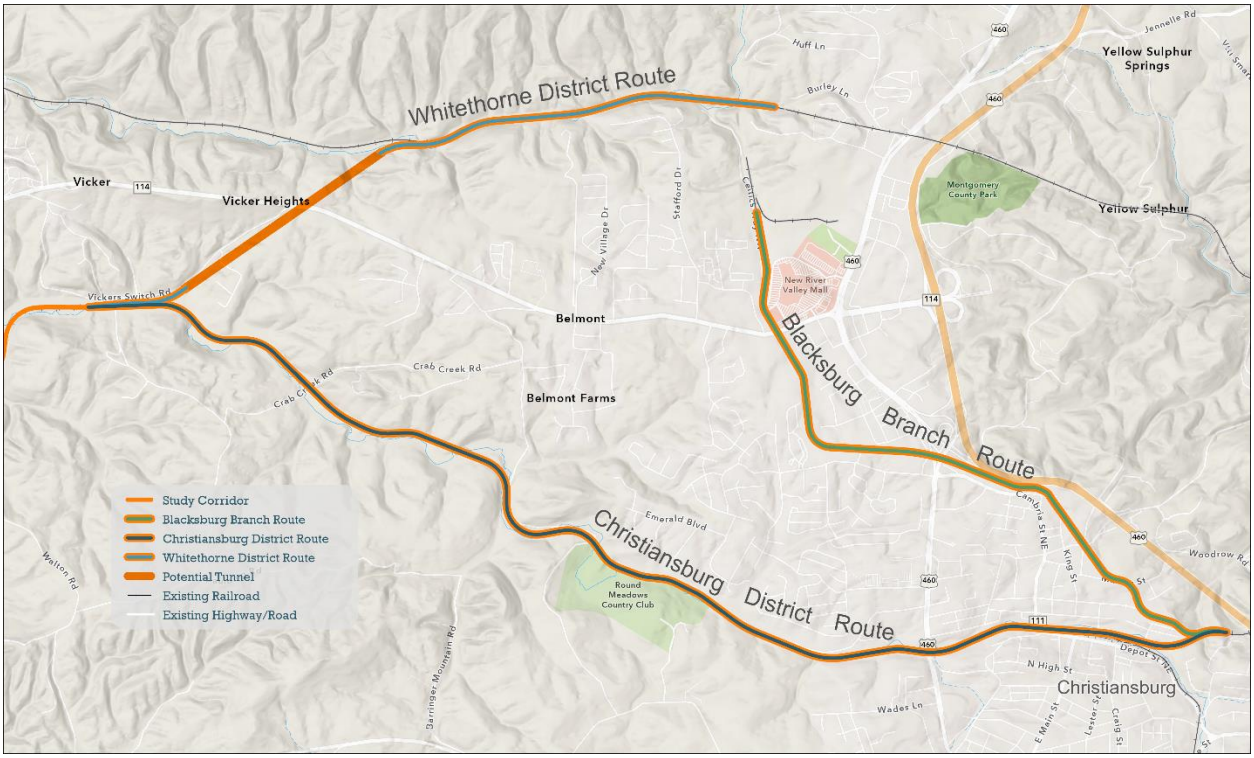
This study did not include the cost of constructing a maintenance and storage facility (MSF). A more cost-effective option for a single train would be to service the train on the station track from the platform. Overnight services generally consist of cleaning the interior and exterior of the passenger cars, refueling the locomotive(s), purging waste tanks, refilling potable, and grey-water tanks, and removing trash and other waste from onboard receptacles.

DRPT will revisit the feasibility of an MSF as service plans are further developed and additional frequencies are considered.

3.6. Results

Based on the methodology and process described in this section, DRPT estimated capital costs could range from $535 million to $1,541 million in 2030 dollars as shown in Table 3.2. The wide range of costs is due to the cost of the railroad tunnel required to connect the Whitethorne District route with the Christiansburg District corridor to continue to Bristol as shown in Figure 3.1.

FIGURE 3.1: TUNNEL BETWEEN WHITETHORNE DISTRICT AND CHRISTIANSBURG DISTRICT



Source: Moffatt & Nichol

TABLE 3.2: CAPITAL COST ESTIMATES BY CORRIDOR

Corridor	Construction Cost (2030 $M)	Indirect Costs (2030 $M)	Contractor's Mark-up + Bond (2030 $M)	Contingency 40% (2030 $M)	Total Construction Cost (2030 $M)
Bristol to Blacksburg Branch Route	$ 277	$ 19	$ 86	$ 153	$ 535
Bristol to Whitethorne District Route	$ 798	$ 51	$ 252	$ 440	$ 1,541

Source: Moffatt & Nichol

Notes:

1. This cost estimate represents 2030 year of construction costs.
2. This cost estimate is an opinion of probable construction cost made by the Consultant. In providing opinions of probable construction cost, it is recognized that neither the Client nor the Consultant has control over the costs of labor, equipment, materials or over the Contractors' methods of determining prices and bids. This opinion of probable construction cost is based on the Consultant's reasonable professional judgment and experience. This estimate does not constitute a warranty, expressed or implied, that the Contractors' bids or negotiated prices of work will correspond with the Owner's budget or the opinion of probable construction cost prepared by the Consultant.
3. Opinions of recommended projects are made without the benefit of design and exclude property acquisition, utilities, geotechnical considerations, and/or other details discovered in a design process.

4. Signal costs for the NRV-Bristol corridor assume a complete system upgrade. Actual system costs will vary depending on the modifications required to the existing signal system.
5. NRV Station Alternative 1 is on the Virginian Line at Merrimac.
6. It is assumed that is that by 2030, passenger rail service on the Virginian Line from Roanoke will use push-pull consists.
7. It is assumed passenger service to NRV is either underway or will be implemented as part of the Bristol Extension project. Note that Signals cost in this OPCC account for signaling beginning at NRV.
8. It is understood that passenger station will exist at Christiansburg/NRV prior to Bristol Extension.

4. Operating and Maintenance Costs

4.1. Overview & Methodology

DRPT developed the methodology and analysis to calculate estimates for annual operating and maintenance (O&M) costs for a potential passenger rail service extension from NRV to Bristol. Historical costs and operating metrics on current Amtrak routes in Virginia served as a starting point for this 2021 Cost Analysis. DRPT limited its analysis to the FFY2018-2019 period to avoid statistical anomalies associated with the COVID-19 shutdowns that impacted FFY2020-2021 data.

DRPT designed the O&M cost model to be consistent with Amtrak's line-item cost breakdown. Costs were based on Amtrak cost allocation categories. This model structure is consistent with Section 209 of the Passenger Rail Investment and Improvement Act of 2008.

DRPT developed a Low Case and a High Case as shown in Table 4.1 to represent a potential range of costs. These two cases are based on the following assumptions:

- Schedules developed and detailed in Section 3
- Inflation to adjust cost estimates from FFY 2019 to base year 2030
    - FFY 2019-2022 used Amtrak inflation curves
    - 2022 – 2030 used the US inflation estimate of 2.3 percent for the Low Case and 3.5 percent for the High Case
- Train hours associated with the 90 percent OTP service plan as the more conservative plan
- Revenue associated with the Virginia Statewide Travel Model output for 90 percent OTP for the Low Case and 100 percent OTP for the High Case

TABLE 4.1: OPERATING METRICS, FFY 2030

Operating Metric	Low Case	High Case	Source
Total Passengers	12,000	15,500	Ridership model outputs – net new riders
Total Passenger Miles	1,335,000	2,068,000	Ridership model outputs – net new riders
Frequency of Train Trips (TUS)	730	730	Calculated from proposed schedules
Total Operated Train Miles	89,700	89,700	Calculated from proposed service plan
Average Locomotives and Cars Used per Day (Units Used) TUS Route	9	9	Input based on service plan fleet needs: Assumed one consist with same rail vehicles as current Route 46 service.
Total OBS Labor Hours	2,920	2,920	OBS FTE positions * Shift hours in year
OBS Full Time Equivalent (FTE) positions	1	1	1 OBS crew FTE, based on crew needs
Train Hours	1,790	1,790	Calculated from proposed schedules
Total Stations	7	7	Calculated from proposed service plan
Ticket Revenue	473,600	679,500	Ridership model outputs – net new riders
Food & Beverage Revenue	15,900	22,800	Ridership model outputs – net new riders

Source: Steer Group Operating and Maintenance Cost Model

4.2. Results

The 2021 Cost Analysis separated O&M costs into three categories for each case as shown in Table 4.2.

TABLE 4.2: O&M COSTS, FFY 2030

2030 $ million	Low Case[3]	High Case[4]
Third Party Costs	0.92	1.01
Route Costs	3.14	3.50
Additives	0.95	1.05
Total Expenses	5.01	5.56

Source: Steer Group Operating and Maintenance Cost Model

DRPT then divided these total annual O&M costs by the length of the corridor to get an annual cost per train mile that ranged from $56 for the Low Case to $62 for the High Case. Operating and Maintenance Cost per Train Mile is a standard measure of operating efficiency. DPRT calculated operating cost incurred for each mile of train service on the proposed Bristol Extension. DRPT found that operating and maintenance costs per train mile were estimated to be lower for the proposed extension than comparable operations in the state of Virginia. This difference in cost on a per train-mile basis is to be expected given that the proposed service is an extension of an existing service because a significant portion of costs do not vary directly with train miles. For example, costs that vary with passengers, such as commissary, reservations and call centers, commissions and certain marketing costs would not be expected to rise significantly on a service extension with lower ridership. Similarly, station costs will vary broadly with station staffing and Amtrak's allocation of shared station costs, which is based in part by ticket sales. Other costs, including insurance, regional and local police, fleet maintenance and terminal yard operations are more fixed and should be expected to vary little with train miles of service.

[3] Lower bound of the 90 percent OTP Case
[4] Upper bound of the 100 percent OTP Case

5. Ridership

DRPT reviewed eight previous studies of potential passenger rail service to Bristol, Virginia with a focus on the ridership estimates and methodology. The reviewed studies are:

- Report of the Virginia DRPT on the Study of Rail Passenger Service to the Governor and the General Assembly of Virginia, House Document No. 51 (1996)
- Bristol Rail Passenger Study Phase 2 Final Report, prepared for DRPT by a team led by Frederic R. Harris Inc. (1998)
- Phase II Bristol, Roanoke, and Richmond Passenger Train Study, prepared for DRPT and NSR by the Woodside Consulting Group, Inc. (2002)
- TransDominion Express Status Update Study, report by the DRPT to the Governor and General Assembly of Virginia, House Document No. 2[5] (2007)
- New River Valley Passenger Rail Study[6] (2016)
- Bedford, VA Intercity Passenger Rail Service Study, prepared by WSP | Parsons Brinckerhoff[7] (2016)
- New River Valley Ridership Study, prepared for DRPT by AECOM and Moffatt & Nichol (2020)
- Bedford Regional Passenger Rail Stop Study Report, prepared by Moffatt & Nichol (2020)

Ridership forecasting methodologies used in these studies ranged as follows:

- A proprietary in-house ridership forecasting tool by consultant Transportation Economics & Management Systems, Inc. (TEMS)
- A Gravity model approach based on expected trip production / trip attraction rates of each zone, and impedances between zones
- Amtrak's incremental forecasting model
- Estimates based on Amtrak's "Station Program and Planning Guide", supplemented by benchmarking information

DRPT concluded that, with the exception of the 1998 study, the ridership projected by the previous studies fell within a broad order of magnitude range of each other, although differences in scope and methodology prevented meaningful analysis and comparisons.

5.1. Ridership Forecasts

DRPT used the following potential service plan and operating parameters to develop ridership potential:

- One daily round trip between Bristol, Virginia and Washington, D.C.
- Intermediate stops at:
  - Up to five stations between Bristol and the New River Valley
  - New River Valley
  - Roanoke
  - Lynchburg
  - Culpeper
  - Manassas
  - Burke Centre
  - Alexandria

[5] http://drpt.virginia.gov/media/1142/tdx-update-2007-1.pdf
[6] https://nrvrc.org/nrvpassengerrailstudy/resources/NewRiverValleyPassengerRailStudy-FullDocumentFeb2016.pdf
[7] http://drpt.virginia.gov/media/1979/drpt-bedford-feasibility-study.pdf

- The study focused on passengers with an origin or destination within the service area of the Bristol passenger rail corridor. Passengers whose origin and destination are within the portion of the route already operating or committed (Washington DC-New River Valley) were excluded.
- The study assumed that the extension would have a similar fare policy as Amtrak's Washington-Roanoke train in FFY19.
- Both potential timetables were evaluated in the study – '100% OTP' and '90% OTP', with the latter having higher run times.

DRPT used two methodologies to forecast potential ridership along the corridor:

1. Diversion model based on trip tables from the Virginia Statewide Transportation Model (VSTM) and asserted parameters calibrated against observed mode shares at existing rail stations; and
2. Amtrak's Virginia incremental model, which DRPT has used in previous studies, including the recent Bedford extension study.

These two proven models provided a range of potential ridership that increased the confidence level of the forecasts. A summary of the ridership forecasts is shown in Table 4.3.

The forecasts do not take into account the impact of COVID-19 on demand. In the context of COVID-19, DRPT recognizes that any ridership forecast at this time necessarily carries a much higher degree of uncertainty. At this stage, DRPT believes it is inappropriate to attempt to quantify that impact, but important to acknowledge it.

TABLE 5.1: RIDERSHIP FORECASTS

Model Used	Scenario Name	Market	Annual ridership (one-way trips), 2030	Annual ticket revenue, 2030 dollars[8] ($M)	Comments
N/A	**No Action (FFY2019)**	Trips within WAS-RNK	130,100	$ 5.08	Amtrak FFY2019 Actuals, inflated to 2030 using an average 1.86 percent growth rate.
VSTM-based spreadsheet model	**100 percent OTP**	Trips with at least one end south of NRV (net new riders)	15,500	$ 0.68	
	90 percent OTP	Trips with at least one end south of NRV (net new riders)	12,000	$ 0.47	The '90 percent OTP' timetable has higher run times (i.e., slower trains / more padding) than the '100 percent OTP' timetable, resulting in fewer passengers.
Amtrak Incremental Model	**100 percent OTP**	Trips with at least one end south of NRV	12,100	$ 0.79	
	90 percent OTP	Trips with at least one end south of NRV	9,700	$ 0.63	The '90 percent OTP' timetable has higher run times (i.e., slower trains / more padding) than the '100 percent OTP' timetable, resulting in fewer passengers.

Source: Steer Group Ridership Forecasting Models

The 2021 Cost Analysis used this ridership data to develop a comparison between annual revenues and O&M costs for this potential passenger rail service. Based on this comparison, the revenues could offset O&M costs between $4.5 million and $4.9 million annually.

[8] Fare policy based on Amtrak FFY2019 fares, grown at an inflation rate of 2.3 percent per year.

TABLE 5.2: ANNUAL REVENUE FORECASTS

REVENUE CATEGORY	REVENUE (2030 $)
Ticket Revenues	475,000 – 680,000
Food & Beverage Revenues	16,000 – 25,000
Other Revenues	6,000 – 9,000
TOTAL REVENUES	**500,000 – 715,000**

6. Conclusion

DRPT concluded that the costs to extend passenger rail service from the New River Valley to Bristol, VA are as follows:

- Based on a single round-trip per weekday and a Saturday / Sunday round trip
- Based on forecasted annual one-way net new riders of between 9,700 and 15,500
- Capital costs range between $535 million and $1,541 million in 2030 dollars
- O&M costs range between $5.01 million and $5.56 million annually
- Based on projected revenue forecasts, annual O&M costs could be offset by between $4.5 million and $4.9 million annually

7. Next Steps

The FRA's 2020 SE Regional Rail Plan acknowledged a route from Bristol to Knoxville to Chattanooga as a "Network Independent Corridor" that has minimal effects on the network performance but is necessary to include in the plan to provide additional connections throughout the Southeast Network as shown in Figure 7.1.

Next steps may include the following:

- Coordinate with Tennessee to gauge interest in this route as part of the Virginia Statewide Rail Plan currently underway.
- Continue work with Amtrak and FRA to explore the feasibility of this route given its unique advantages in an area of the region that is economically challenged and is underserved by transportation networks.
- Coordinate with regional and local municipalities to determine number and location of stops between the New River Valley and Bristol, if any.

FIGURE 7.1: FRA'S 2020 SE REGIONAL RAIL PLAN

Source: https://hsrail.org/sites/default/files/images/Southeast_Region_Map_from_SEC_Report.jpg