Prepared for

Hampton Roads Transportation Planning Organization

Hampton Roads Passenger Rail Study
Data Collection - Phase 2A
Norfolk-Richmond Corridor

March 2013

Prepared by

TEMS

Transportation Economics & Management Systems, Inc.

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APPENDICES

1 INTRODUCTION

This section provides a description of the purpose of the Norfolk-Richmond corridor Phase 2A Data Collection study, the scope of the study, and the organization of the report.

1.1. PURPOSE OF STUDY

The Virginia Department of Rail and Public Transportation (DRPT) developed the Richmond/Hampton Roads Passenger Rail Project Tier I Draft Environmental Impact Statement (EIS) in accordance with the National Environmental Policy Act (NEPA) to develop conventional passenger rail service to the I-64/CSX corridor and the US Route 460/Norfolk Southern corridor. The state's draft NEPA document was released for public review and comment in December 2009. In February 2010, based on the evaluation and public comments received, the Commonwealth Transportation Board selected Alternative 1 as the preferred alternative for enhanced passenger rail service between Richmond and Newport News and higher-speed passenger rail service between Petersburg and Norfolk. DRPT has completed the Tier I Final EIS document and was approved in August 2012. The Record of Decision (ROD) was approved by the Federal Railroad Administration (FRA) in January 2013.

The Tier 1 Final EIS proposes 6 trains per day at 90 mph from Norfolk to Richmond and Washington, and 3 trains per day from Newport News to Richmond and Washington. To support and develop further the Commonwealth's efforts, the Hampton Roads Transportation Planning Organization (HRTPO) Board approved a resolution in October 2009, endorsing the designation of a "high-speed rail" corridor along the Norfolk Southern/Route 460 (Norfolk-Richmond) corridor designated ultimately at speeds of more than 110 mph and the enhancement of the intercity passenger rail service along the CSX/I-64 corridor (Newport News-Richmond).

TEMS was commissioned to develop a Vision Plan for passenger rail service for the Hampton Roads region to implement the HRTPO objectives. TEMS completed an initial phase (Phase 1) of work in July 2010, and the Phase 2A Data Collection work is designed to build a database for the future Norfolk-Richmond corridor Phase 2B Passenger Rail Alternatives Analysis study to be completed in 2013. The current study, Phase 2A[1], intends to collect all the data needed to complete the Norfolk-Richmond corridor Vision Plan and the Service Development Plan (SDP) assessment needed by U.S. Department of Transportation (USDOT) FRA to support further planning work on high speed rail for the Norfolk-Richmond corridor.

1.2. DEVELOPMENT STEPS – NORFOLK-RICHMOND CORRIDOR

Exhibit 1-1 shows that Development Step 1 and Step 2 (79-90 mph) come under the DRPT's focus on conventional rail service while Step 3 and Step 4 show the higher and high speed rail focus of the HRTPO. In terms of Step 1 and Step 2, DRPT has made good progress in starting an Amtrak 79 mph service to Norfolk. The service was started in December 2012 and provides a daily direct connection from Petersburg, Washington, DC, and connections to the Northeast corridor. Development Step 3 and Step 4 are the focus of this report for the Norfolk-Richmond corridor.

[1] Hampton Roads Passenger Rail Study: Data Collection (for the Norfolk-Richmond corridor).

Exhibit 1-1: Proposed System Development Steps for the Norfolk-Richmond Corridor

Steps	Route	Max Speed	No. of Trains	Infrastructure	Station
Step 1	Route 460/ Norfolk Southern**	79 mph	1-3*	Shared Track NS	Staples Mill Only Norfolk
Step 2 (FEIS Alt 1)	Route 460/ Norfolk Southern	79-90 mph	4-6	Shared Track V Line	Main Street Bowers Hill
Step 3	Norfolk-Richmond along Route 460	110 mph	8-12	Dedicated Track V Line	Main Street Bowers Hill
Step 4	Norfolk-Richmond along Route 460	150 mph	12-16	Dedicated Electric Track V Line	Main Street Bowers Hill

* Two additional trains are planned in the near future by DRPT.
** Norfolk Southern (NS) does not permit passenger train maximum authorized speed in excess of 79 mph on any NS track. Where the V-line (former Virginian Railway) has existing freight services, maximum authorized speed for passenger trains will be 79 mph. Along the Algren – Kenyon portion of the V-line (over which NS freight rail service has been formally abandoned), passenger rail planners may consider speeds above 79 mph.

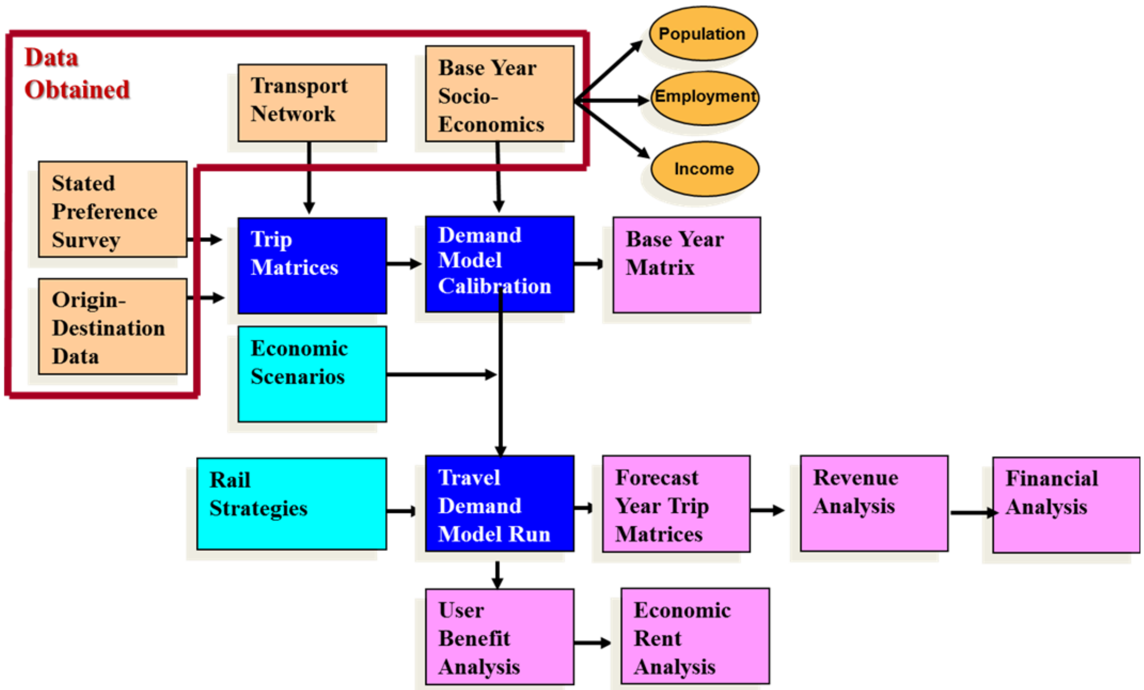
1.3. SCOPE OF THE STUDY

The most vital and initial stage of high speed passenger rail is the data collection. Four key databases are required –

- Market Database – Hampton Roads to Washington and Raleigh
- Technology Database – Hampton Roads to Washington and Raleigh
- Engineering Database – Norfolk to Richmond only
- Environmental Database – Norfolk to Richmond only

A key driver of high speed rail studies is the Market Database. A key factor is to understand the full competitive environment for auto, air, rail and intercity bus travel between Hampton Roads and the Northeast and Southeast corridors. Given the potential competition between the Norfolk-Richmond and Newport News-Richmond, both corridors are included in the data collection for the Market Database. As such, a thorough understanding of the responsiveness of a corridors population and its opportunity to use the system provides the critical element in the ability to evaluate and potentially justify the system. As seen in Exhibit 1-2, the final outcome of demand forecasting analysis is dependent on the base-year socioeconomic, transportation networks, stated preference survey, and the origin destination database.

Exhibit 1-2: Market Database Requirements for *COMPASS*™ Model Ridership and Revenue Analysis

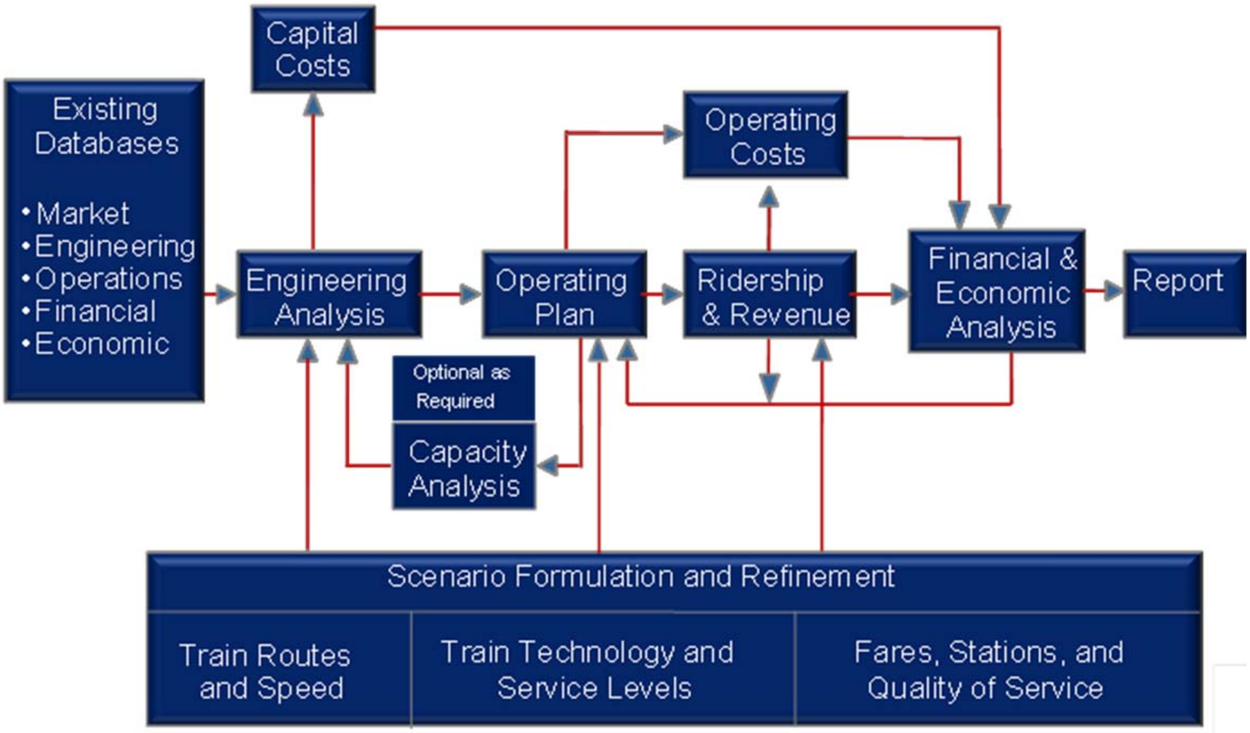


For a comprehensive travel demand model to be developed, data must be collected on the latest socioeconomic data, traffic volumes (air, bus, auto, and rail) by purpose and updated network data (e.g., gas prices) to test likely ridership response to service improvements over time. To develop ridership and revenue demand estimates, using the *COMPASS™* demand modeling system, data is needed on the quality of the service frequencies, travel times, fares, fuel prices, congestion and other trip attributes.

The second step in the process once the market data is assessed is an Interactive Analysis to identify the optimum high speed rail system for the market based on FRA criteria. Exhibit 1-3 shows the interaction of the databases and the Interactive Analysis process needed to develop the critical FRA performance metrics required to show the value of the project[2].

[2] Value of the project will be assessed by financial and economic analysis, this measures the cost benefit ratio and operating ratio.

Exhibit 1-3: Interactive Analysis Process



With respect to the quality of service offered by a high speed rail system a detailed interactive analysis is needed between the potential alignment and the technologies being proposed for the higher and high speed rail Systems. To effectively model the market, the technology analysis assesses the potential technologies that will be used in both the Norfolk-Richmond and Newport News-Richmond corridors. As a result, the study will need to investigate the interaction between alignments and technologies to identify optimum trade-offs between capital investments in track, signals, other infrastructure improvements, and operating speed. The engineering assessment must include aerial and/or ground inspections of significant portions of track and potential alignments, station evaluations, and identification of potential locations and required maintenance facility equipment for each option. For the purpose of this study the TEMS *TRACKMAN™* is used to catalog the base track infrastructure and improvements and provides a database that will allow the full range of technology and train service options to be assessed. Once the track data is collected the *LOCOMOTION™* train performance program provides the next step in assessing various train technologies on the track at different levels of investment. The *LOCOMOTION™* program requires that different train operating characteristics (train acceleration, curving and tilt capabilities, etc.) are developed during the technology assessment. Given that the train options are defined, the Interactive Analysis can assess the infrastructure requirements and costs (on an itemized segment basis) necessary to achieve high levels of performance for the train technology options evaluated.

The Technology Database will therefore need to include all the different technologies to be appraised including the existing 79 mph conventional rail, as well as the 110 mph technology associated with "higher" train speed performance and the 125 mph plus technologies associated with true high speed rail operation.

The Engineering Database will include data on existing and potential rights-of-way and alignment. The data to be assembled in *TRACKMAN™* includes rights-of-way, FRA speeds, curves, speeds, grades, rail and highway crossings, signaling facilities, and potential restrictions such as bridges and track limitations.

In terms of an Environmental evaluation a Service NEPA[3] at the landscape level[4] of documentation is needed for Step 3 and Step 4. (The current Tier I EIS only covers Steps 1 and 2 phases of system development.) This includes the environmental data collection at the landscape level for the envelope of the Study Area. This document is an environmental database provided in preparation of Service NEPA Environmental Assessment for the Petersburg to Norfolk Corridor. Service NEPA leads to a potential supplemental Tier 1 EIS[5], Environmental Assessment (EA)[6], Finding of No Significant Impact (FONSI), or Categorical Exclusion, followed by Tier 2 EA[7] or EIS site specific analysis. Depending on the impact findings, either the EIS is prepared followed by a ROD in case of Tiered analysis or FRA approval is required for a Categorical Exclusion. The process of Environmental Database collection and final outcome are shown in Exhibit 1-4.

Throughout this report, particularly in Chapters 3 and 5, a number of maps suggest possible conceptual northern and southern options for new High Speed Rail lines connecting Suffolk with Petersburg. This parallels the approach that was taken by the US-460 highway EIS. However, since the primary focus of this report is only on database development, the reason for suggesting two potential options at this time is only to support a definition of the required environmental study area, e.g., the region in which potential greenfield options are most likely to lie. A preliminary analysis suggests that the most likely locations for new rail lines lie beyond the boundaries of the original US-460 environmental study area, and so it has been necessary to expand the environmental study area to encompass an area larger than that which the highway study considered.

At this point in time, an expanded study region has been defined and preliminary environmental data has been collected. Using this data, it will be possible to develop actual possible alignments to optimize the environmental footprint of the project. The detailed environmental work needed to precisely locate prospective alignments within the study area has yet to be completed. These will be more fully developed, with appropriate levels of community input, in the next phase of work 2(B).

[3] Service NEPA as defined in the guidance of FRA is an essential first step for corridors providing an overview of the level of improvements that are needed to implement significantly expanded conventional or high-speed rail services. This document provides an environmental database that will be used in preparation of Service NEPA Environmental Assessment for the Petersburg to Norfolk Corridor. The Service NEPA EA typically addresses the broader environmental questions relating to the type of service being proposed, Communities being served, types of operations (speed, electric, or diesel powered), ridership projections and major infrastructure components, improvement alternative being proposed and measures taken to minimize harm to the corridor. http://www.fra.dot.gov/Page/P0262

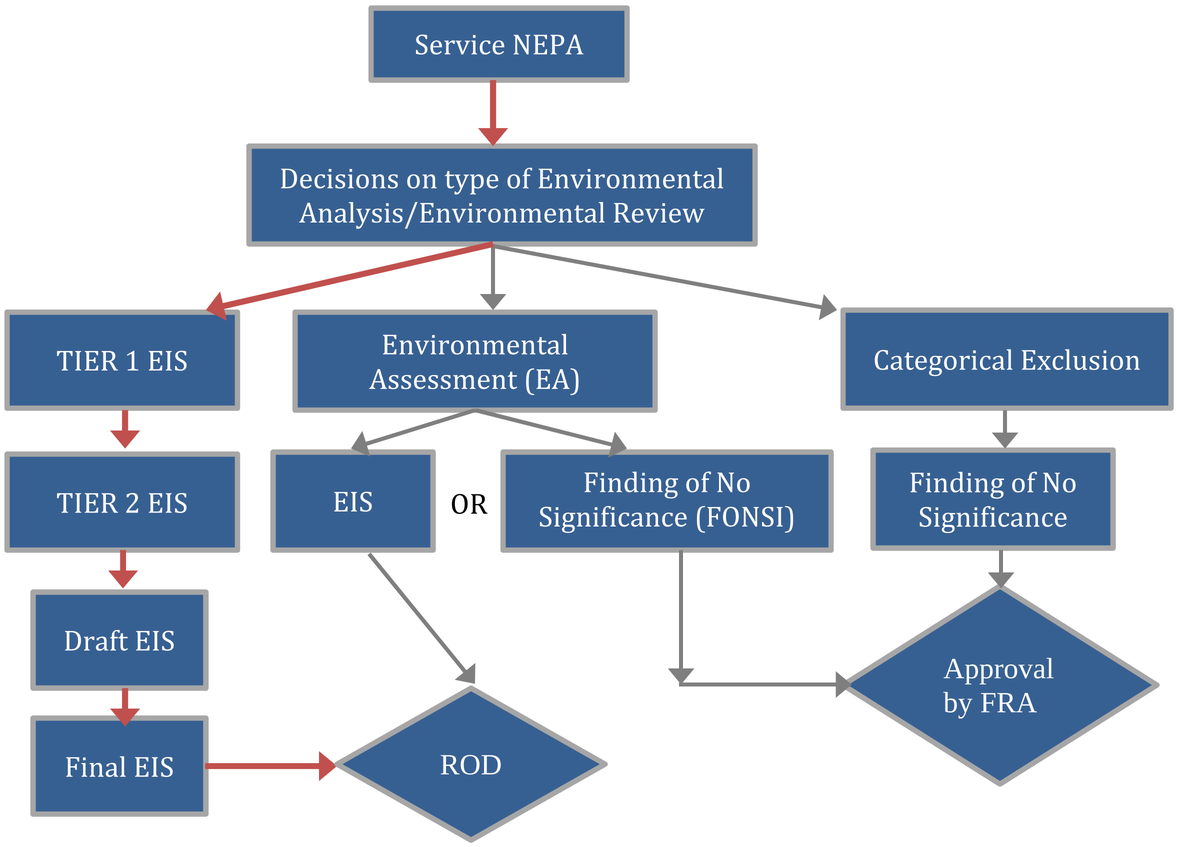
[4] Landscape level in this report refers to preliminary overview of the process i.e., inspection of an area by aerial and on site photographs without any detailed inspection.

[5] TIER 1 would be typical to large expansive projects like for example, EISs that FRA has prepared with the California High Speed Rail Authority for the state's proposed high speed rail project. http://www.fra.dot.gov/Page/P0262

[6] An EA would be appropriate only for a more limited corridor development program where no significant environmental impacts are anticipated. http://www.fra.dot.gov/Page/P0262

[7] TIER 2 or EA would be typically for corridor programs with smaller scope and narrower range of reasonable alternatives. http://www.fra.dot.gov/Page/P0262

Exhibit 1-4: FRA Environmental Process[8]



[8] Prepared by TEMS, based on HSIPR NEPA Guidance and Table http://www.fra.dot.gov/Page/P0262

1.4. REPORT ORGANIZATION

This report is organized in the following way:

- **Chapter 1 – Introduction:** Chapter 1 discusses the purpose of the Norfolk-Richmond corridor Phase 2A Data Collection study, the scope of the study, and the organization of the report..
- **Chapter 2 – Market Database:** This chapter is divided into subsections of introduction of the chapter, zone system, socioeconomic data, transportation network data, origin-destination data, stated preference survey process, results and analysis. This chapter describes the steps of developing the market data which includes developing a zone system, socioeconomic database of the Study Area, how the transportation networks were developed, how the origin and destination databases were obtained and validated, methodology used to conducting stated preference survey and analysis of the results.
- **Chapter 3 – Engineering Database:** This chapter is divided into subsections of introduction of the chapter, *TRACKMAN™* database for identifying the speed curves, grades, rail and highway crossings, and other potential speed restrictions, required for the preliminary infrastructure analysis of the existing and proposed envelope of area with pictures of railroad crossings of existing and abandoned lines, and presentation of typical capital unit costs.
- **Chapter 4 – Technology Database:** This chapter is divided into subsections of introduction of the chapter, business models that have been used in different parts of the country, range of technologies that are typically used and also those of future potential, speed profiles typically obtained with the proposed speed and technology and discussion on the typical operating unit costs.
- **Chapter 5 – Environmental Database:** This chapter is also divided into subsections, discussing the purpose for developing the environmental database and definition of Service National Environmental Policy Act (NEPA), list of databases such as geographic boundaries, cultural resources, ecology, hazardous material sites, and air quality in the proposed Study Area envelope, and the conclusion of the chapter on the mitigations.
- **Chapter 6 – Conclusions:** This chapter assesses the results of the data collection process, and the providing direction for the next stage of analysis.
- **Appendices:**
  - Appendix A – Socioeconomic Data
  - Appendix B – Stated Preference Survey Forms
  - Appendix C – *TRACKMAN™* Files

2 MARKET DATABASE

This chapter is divided into subsections of introduction of the chapter, zone system, socioeconomic data, transportation network data, origin-destination data, stated preference survey process, results and analysis. This chapter describes the steps of developing the market data which includes developing a zone system, socioeconomic database of the Study Area, how the transportation networks were developed, how the origin and destination databases were obtained and validated, and the methodology used to conducting stated preference survey and analyze the results.

2.1. INTRODUCTION

A key element in evaluating the feasibility of high speed passenger rail service is an accurate assessment of the total travel market in the corridor under study, and how well a new rail service might perform in that market in the future. This market assessment will be accomplished using a four-step process. The first two steps have been accomplished in the data collection process; and the second two steps will be accomplished in the next stage of study:

1. Gather information on the total market and travel patterns in the corridor for auto, air, bus and passenger rail travel.
2. Identify and quantify factors that influence travel choices, including current and forecast socioeconomic characteristics.
3. Build and calibrate a model to test different travel choice scenarios; in particular, identify the likely modal shares under each scenario.
4. Forecast travel, including total demand and modal shares.

This chapter documents the data gathering effort from primary (e.g., direct survey) and secondary (e.g., U.S. Census Bureau) sources and summarizes the results.

2.2. ZONE SYSTEM

A major step in developing a study database (network, socioeconomic and origin-destination) is to construct the fundamental unit of analysis, the zone system. The zone system provides a reasonable representation of the market area where travel would occur between origins and destinations. The zones developed for this study are predominantly County-based, in rural areas, and TAZ (traffic analysis zone) and community level based in urban areas as shown in Exhibit 2-1. Zones are defined relative to the passenger rail network. As zones move away from stations, they are aggregated to form larger zones. These county based zones are compatible with the zones used by Bureau of Economic Analysis (BEA), U.S. Census Bureau and Woods & Poole Economics which provide the baseline and forecast of socioeconomic data. The networks and zone systems developed for the Hampton Roads Passenger Rail Study were enhanced with finer zone detail in urban areas. For these urban areas, TAZ and community level zones were derived from Metropolitan Planning Organization (MPO) data. This included for the Hampton Roads Transportation Planning Organization (HRTPO) "Hampton Roads 2000 and 2034 Socioeconomic Data by TAZ" December 2004, and the latest TAZ maps and data from relevant MPOs such as Richmond Regional Planning District Commission, Crater Planning District Commission, Metropolitan Washington Council of Governments, and Baltimore Metropolitan Council. Exhibit 2-2 shows the finer zones in the Hampton Roads and Richmond-Petersburg-Norfolk regions. The zone system contains 333 zones within the Study Area boundaries.

Exhibit 2-1: Study Area

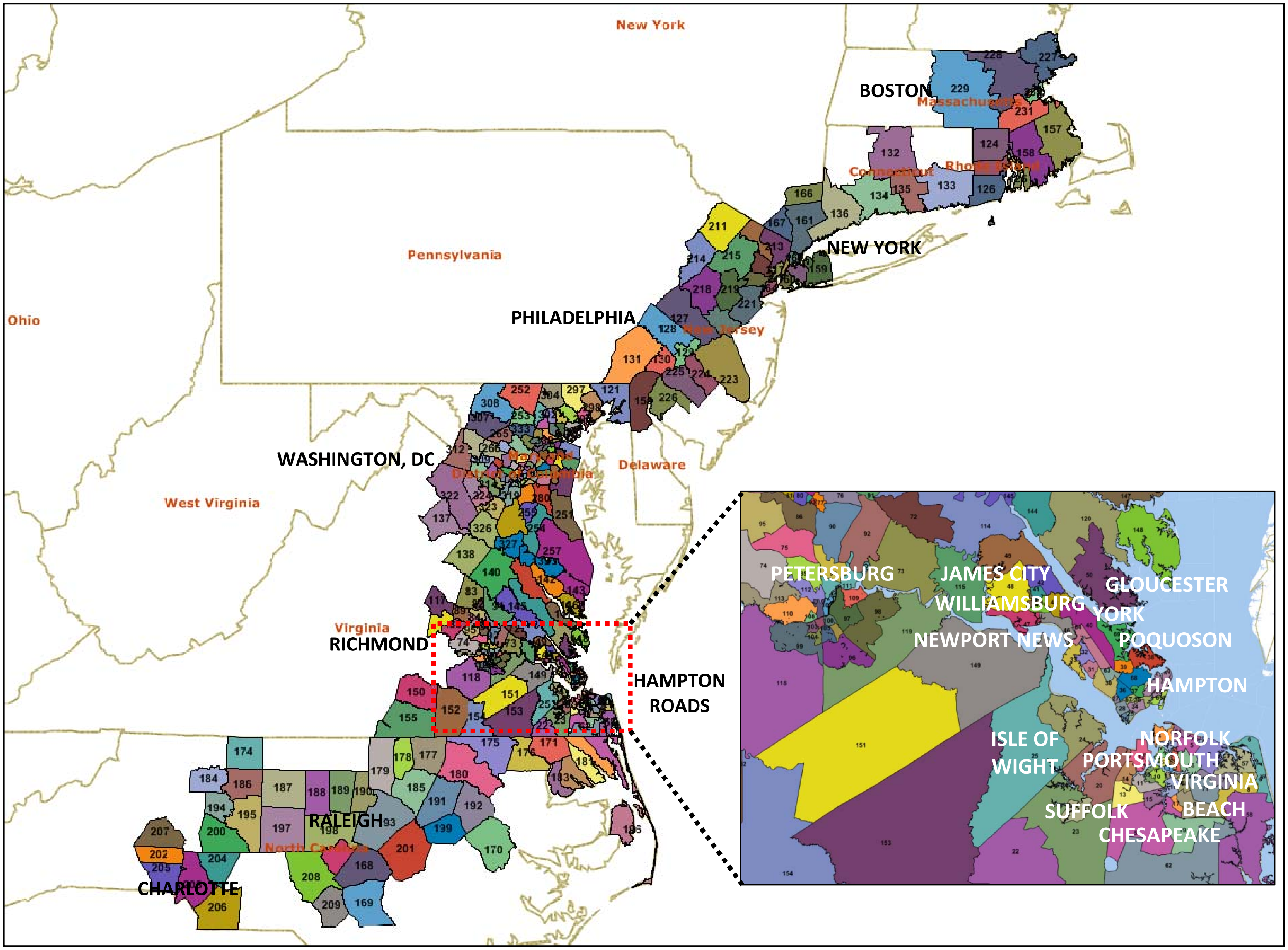
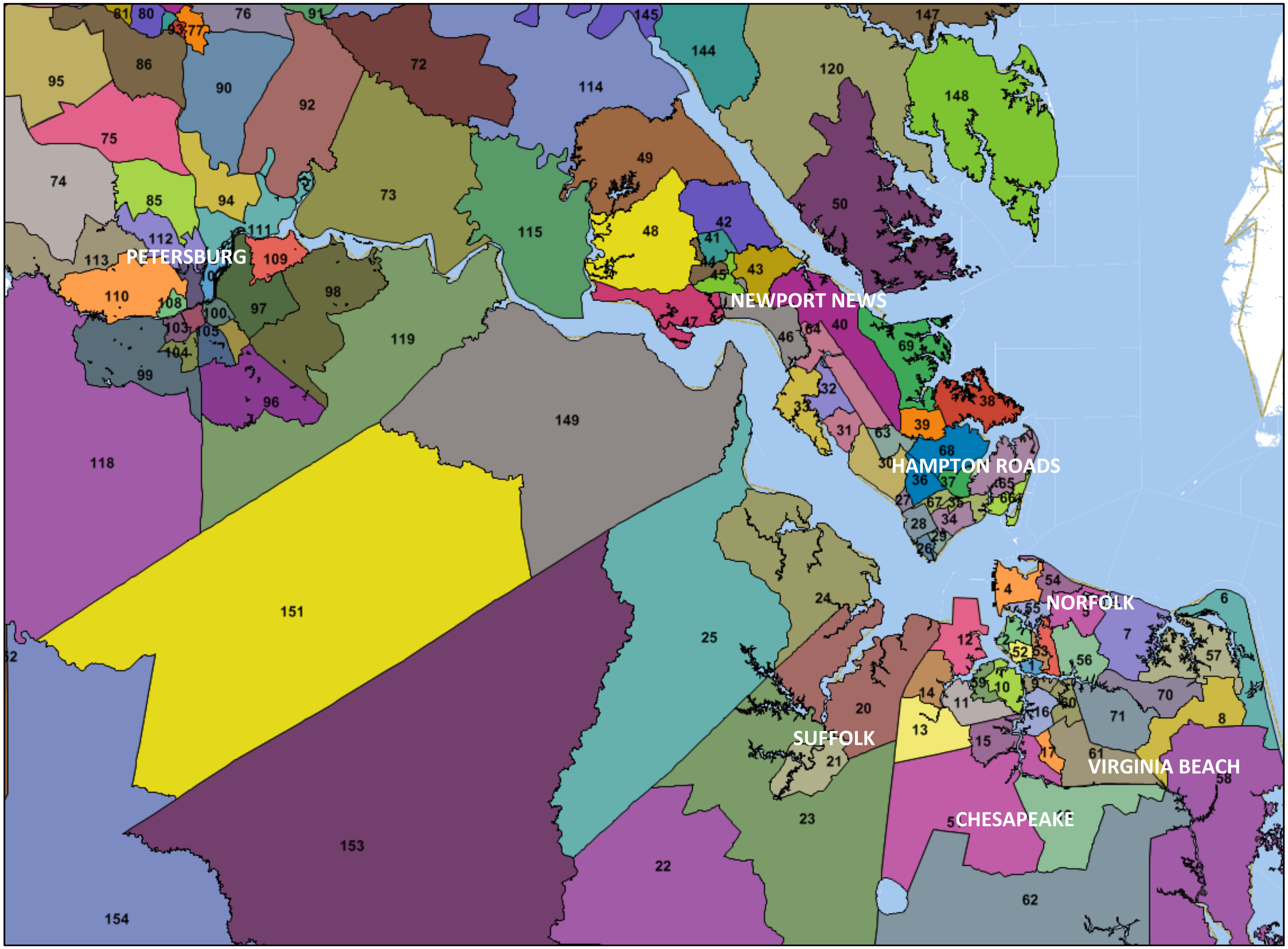


Exhibit 2-2: Zone Map of Petersburg to Norfolk - Zoom in Area



2.3. SOCIOECONOMIC DATABASE

In order to understand the current and future market, socioeconomic data, which includes population, employment and per capita income plays a major role for each zone in the Study Area. The Socioeconomic Database for the base year 2010 and the forecast years up to 2050 at five year intervals were developed using most recent data and the latest economic forecast information of county-level, TAZ-level, and community-level from the following sources:

- US Census Bureau
- Bureau of Economic Analysis
- Hampton Roads Transportation Planning Organization
- Richmond Regional Planning District Commission
- Crater Planning District Commission
- Metropolitan Washington Council of Governments
- Baltimore Metropolitan Council
- Woods & Poole Economics

The average annual growth rate of population, employment and per capita income from 2010 to 2050 for the entire Study Area, Hampton Roads, Richmond, Petersburg, and Washington-Baltimore metropolitan area are shown in Exhibits 2-3 through 2-7. It can be seen that for the entire Study Area, Washington-Baltimore and Hampton Roads sub areas the annual rate of growth for employment and per capita income are higher than that of population, whereas for Richmond and Petersburg sub areas the employment and population's annual growth is higher than per capita income. It is also observed that employment and population almost doubles in Richmond and Petersburg sub areas while for the rest of the study area, the annual increase is closer to 1%. The socioeconomic projections for each zone is given in Appendix A.

Exhibit 2-3: Socioeconomic Projections of the Entire Study Area

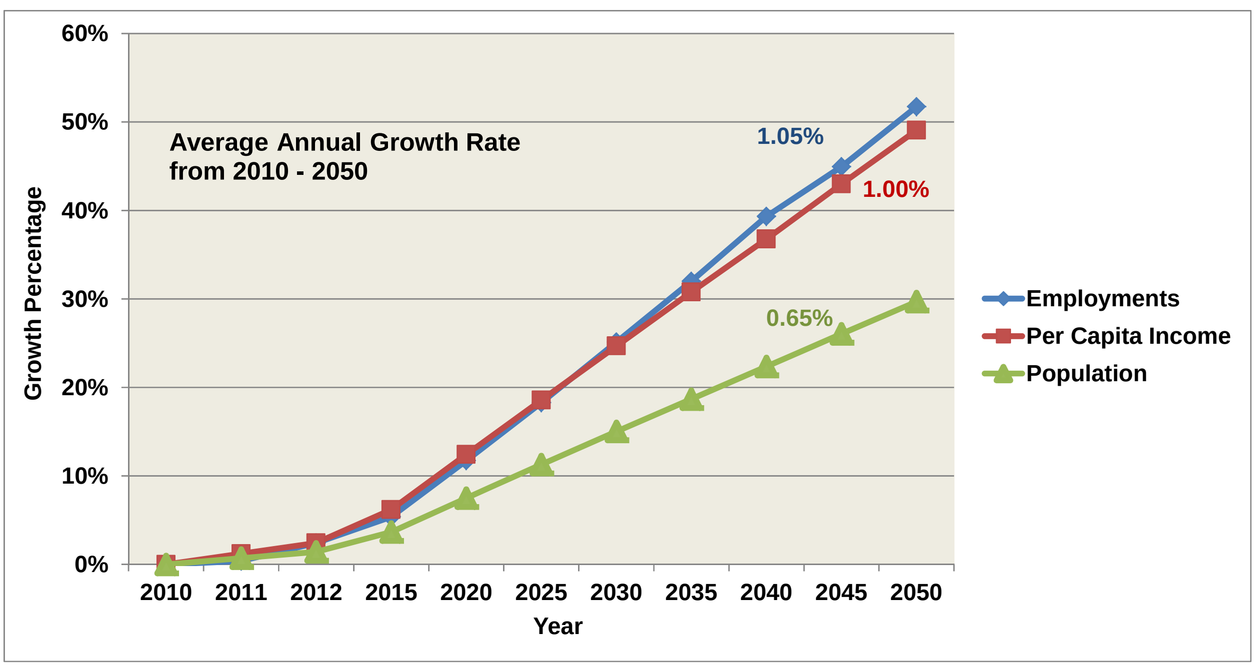


Exhibit 2-4: Socioeconomic Projections of Hampton Roads Sub Area

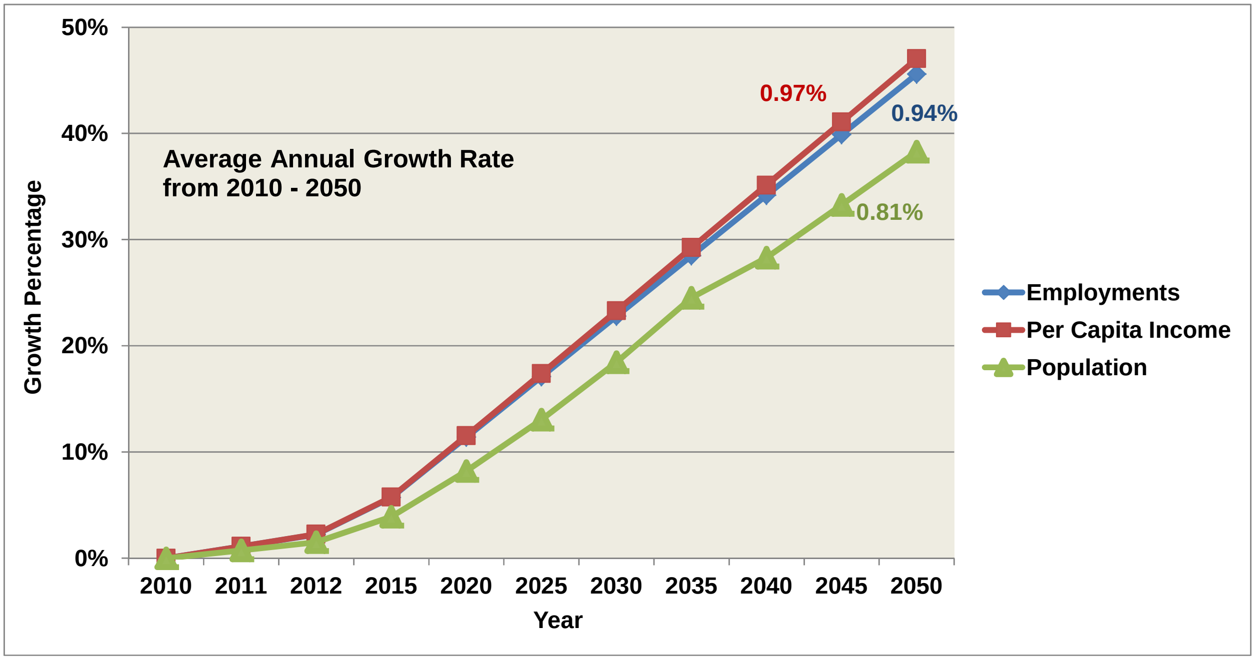


Exhibit 2-5: Socioeconomic Projections of Richmond Sub Area

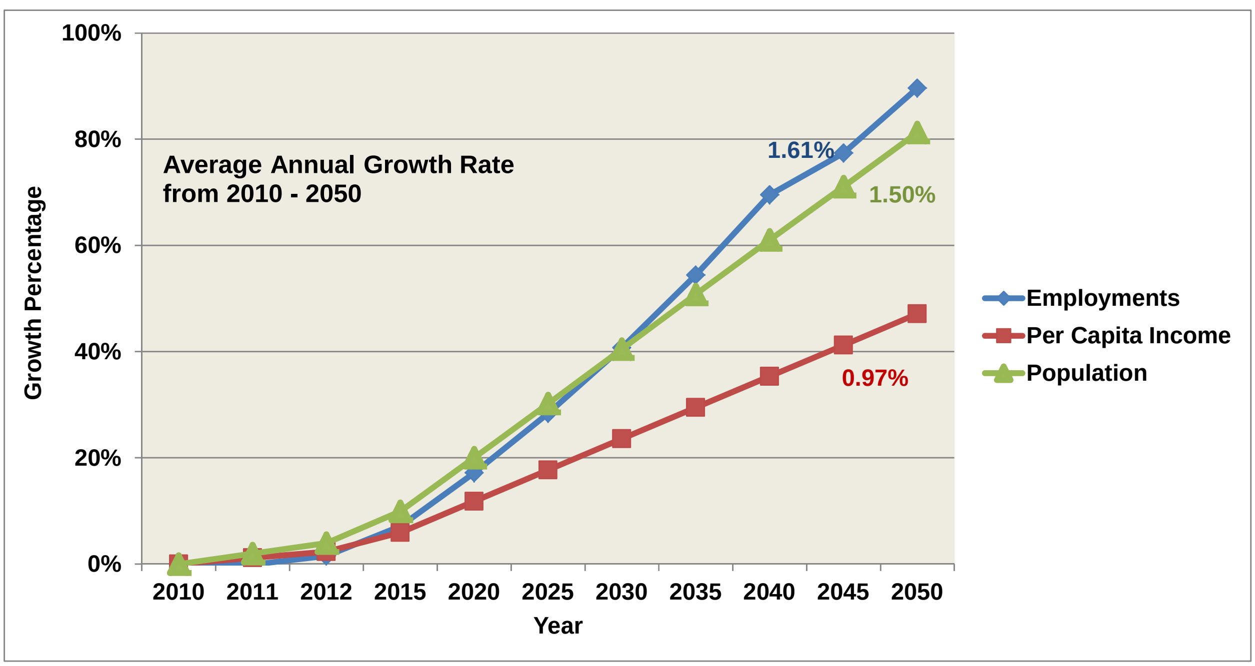


Exhibit 2-6: Socioeconomic Projections of Petersburg Sub Area

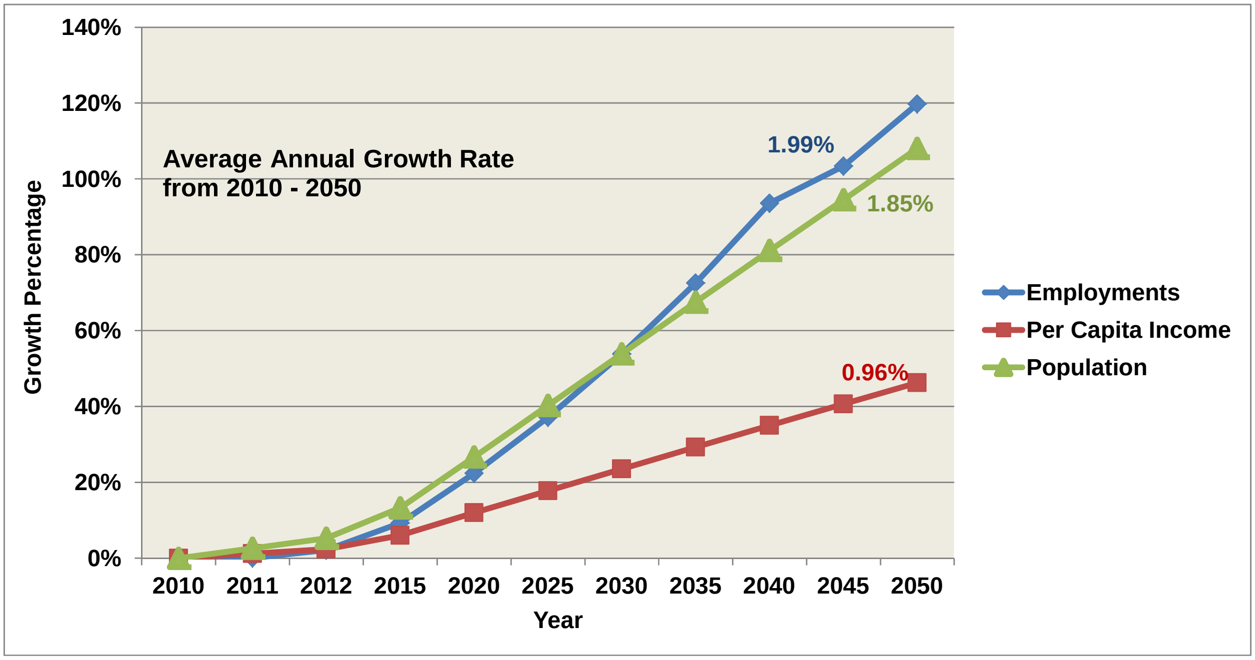
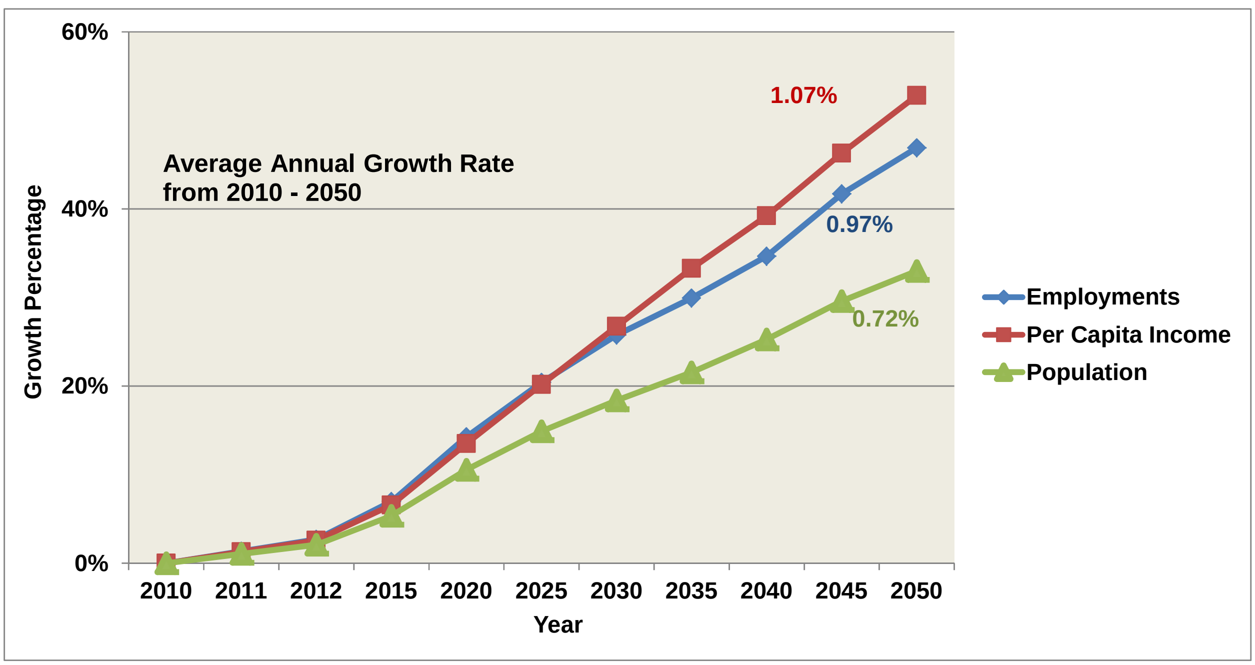


Exhibit 2-7: Socioeconomic Projections of Washington Baltimore Sub Area



2.4. TRANSPORTATION NETWORKS

Industry-standard procedures were implemented to develop the auto, rail bus and air access networks that represented travelers' route choices. Travel attraction is measured in terms of cost and time. These variables are incorporated into the basic network elements. Correct representation of the networks is vital for accurate forecasting. Basic network elements are called nodes and links. Each travel mode consists of a database comprised of zones, stations or nodes, and existing connections or links between them in the Study Area. Each node and link is assigned a set of attributes. The network data assembled for the study included the following attributes for all the zone pairs.

- For public travel modes (air, rail and bus):
  - Access/egress times and costs (e.g., travel time to a station, time/cost of parking, time walking from a station, or time/cost of taking a taxi to the final destination, etc.)
  - Waiting at terminal and delay times
  - In-vehicle travel times
  - Number of modal interchanges[1] and connection times
  - Fares
  - On-time performance
  - Frequency of service
- For private mode (auto):
  - Travel time, including rest time
  - Travel cost (vehicle operating cost)
  - Tolls

Auto, bus, air access and rail networks are shown in Exhibits 2-8 through 2-11 and were developed from a variety of sources. The state and local departments of transportation highway network[2], and National Highway System (NHS) databases were used for developing the auto network for the Study Area. Bus Networks were developed from exiting bus service schedules such as Greyhound, and Megabus for the entire Study Area along with Hampton Roads Transit for the Hampton Roads region. Air Networks were developed from airline schedules, domestic air fares and On-Time Performance (OTP) data were obtained from the ten percent sample of airline tickets. Rail Network schedules, fares, and OTP data were developed from Amtrak, MARC and VRE services.

[1] Interchange means number of transfers that occur during travel.

[2] State and local agencies include Hampton Roads Transportation Planning Organization (HRTPO), Crater Planning District Commission, Richmond Regional Planning District Commission, Metropolitan Washington Council of Governments, Baltimore Metropolitan Council, Virginia Department of Transportation (DOT), Maryland DOT, North Carolina DOT, Delaware DOT, Pennsylvania DOT, New Jersey DOT, New York DOT, Connecticut DOT, Rhode Island DOT and Massachusetts DOT.

Exhibit 2-8: Auto Network

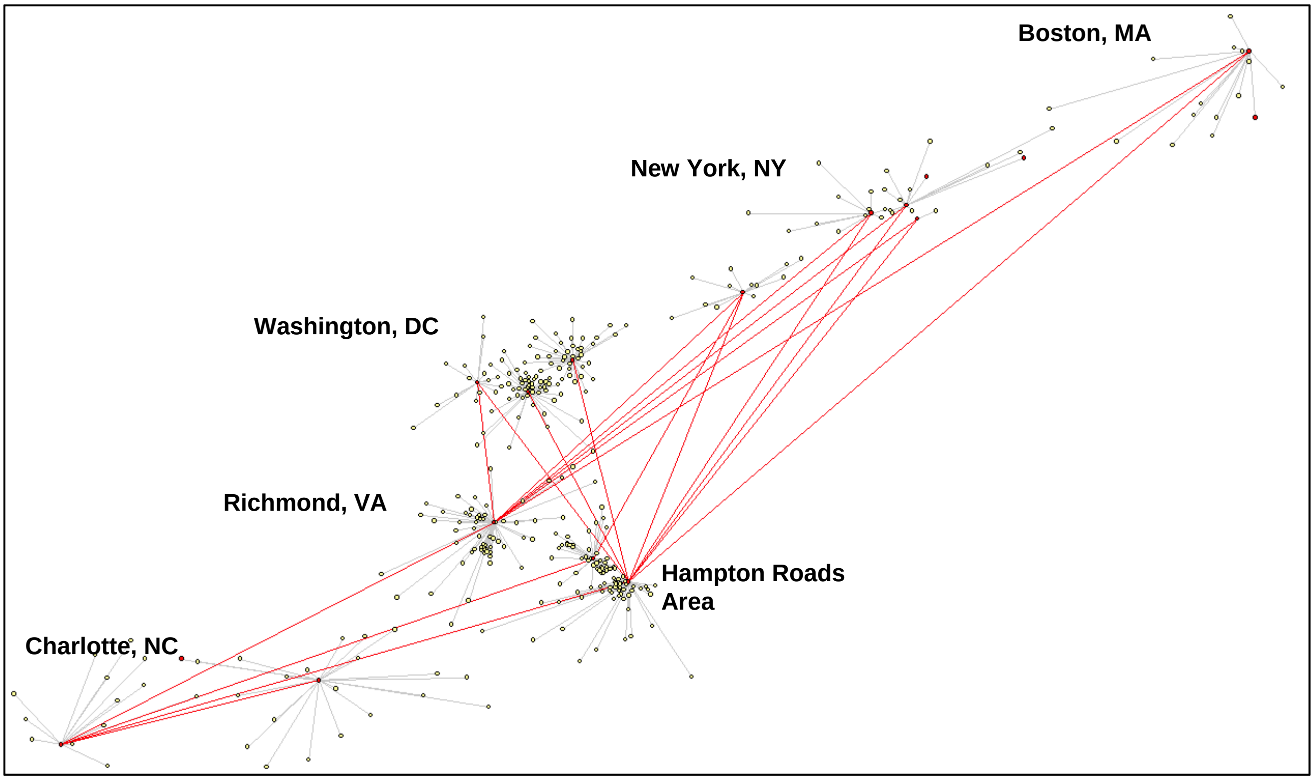


Exhibit 2-9: Bus Network

Exhibit 2-10: Air Access Network

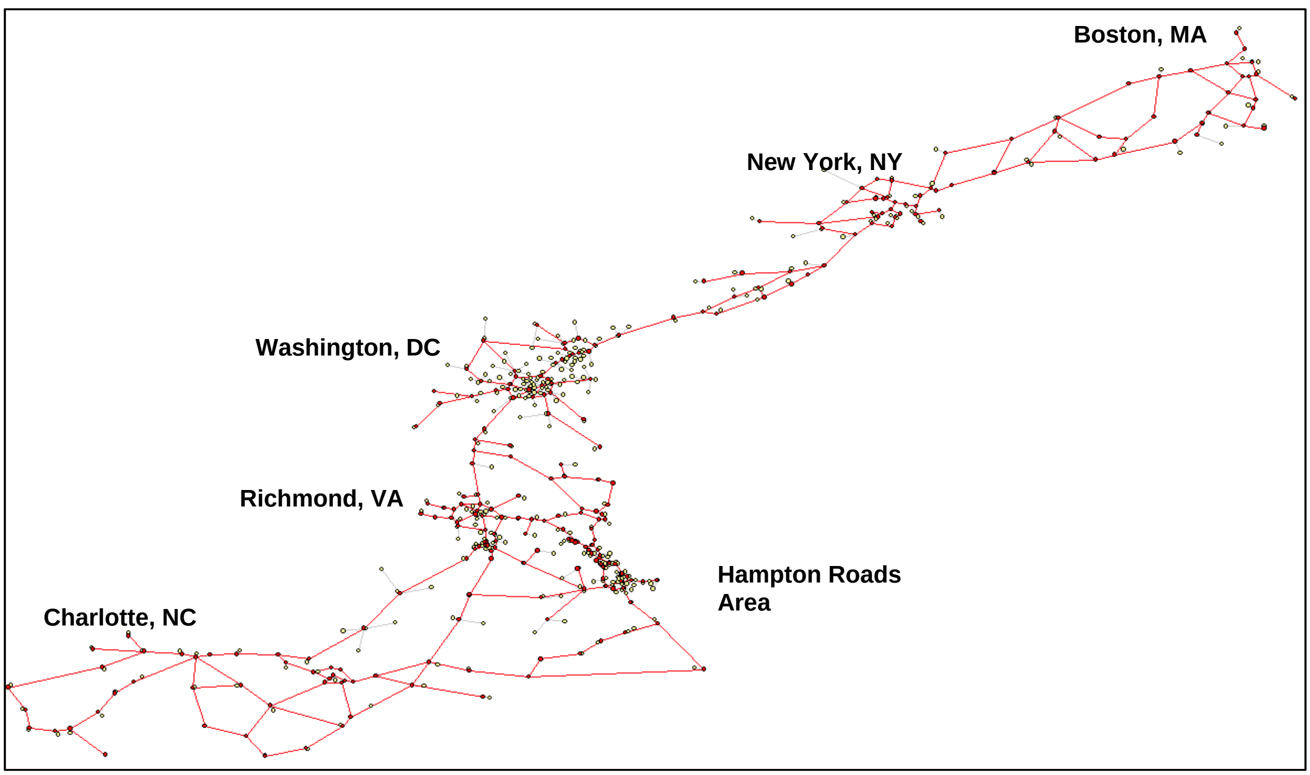


Exhibit 2-11: Rail Network

2.5. ORIGIN DESTINATION DATABASE

TEMS extracted, aggregated and validated data from the following sources in order to estimate base travel between city pairs. Data was collected by State and by mode. Preliminary estimates of travel were generated based on socioeconomic and trip attribute data, then validated with actual modal data counts. The Origin-Destination travel data sources and validation data sources are listed below:

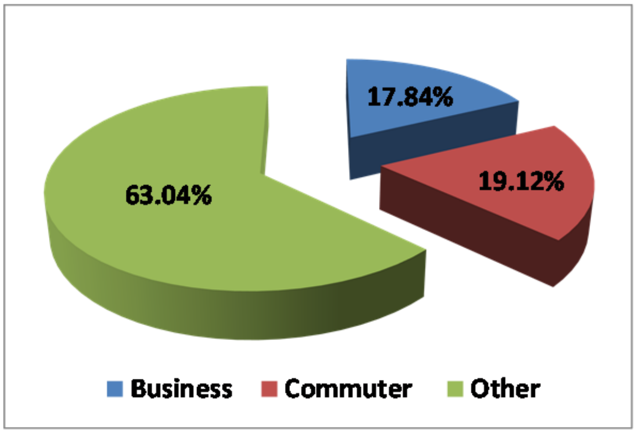
- The Airline Origin and Destination Survey (DB1B) Air Ticket Database[3]
- T-100 Air Market and Segment Database
- Greyhound and Megabus Schedules
- Previous travel origin-destination surveys
- State department of transportation (Virginia, Maryland, Washington, DC, North Carolina, Delaware, Pennsylvania, New Jersey, New York, Connecticut, Rhode Island and Massachusetts) highway traffic volume Average Annual Daily Traffic (AADT) data
- Amtrak passenger rail ridership data
- Amtrak station volume data
- TEMS 2012 Virginia Travel Survey

[3] The Airline Origin and Destination Survey (DB1B) is a 10% sample of airline tickets from reporting carriers collected by the Office of Airline Information of the Bureau of Transportation Statistics.

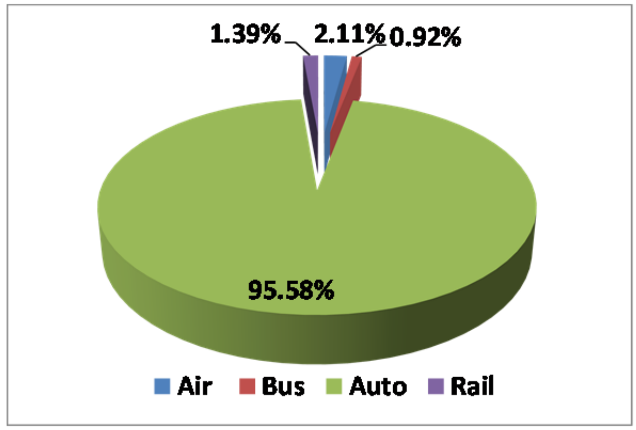
Exhibit 2-12 shows the Hampton Roads to Richmond corridor-based person trips. The data with this corridor shows that individuals traveling for purposes other than business and commuting are more than half of the total trips and the majority of trips are made by auto users. (See Exhibit 2-12)

Exhibit 2-12: Trip Purpose and Trip Mode Split

Trip Purpose



Trip Mode Split



2.6. STATED PREFERENCE SURVEY

The Stated Preference Analysis was based on results from a broad range of collected stated preference survey forms. Stated Preference Survey method uses a quota sampling approach as a fast and effective way of gathering consumer information on the importance of different travel decisions. This includes such issues as how travelers value travel time (for auto and transit modes) and how they value frequency of service and access time (for transit modes). A quota survey, as opposed to a random survey or a focus group study, is particularly effective in ensuring that all the important travel attributes are measured for the whole population at minimum cost. The quota survey, which has been widely adopted for public opinion surveys, is based on the development of representative "quotas" of the traveling public. The TEMS analysis requires that, two sets of data be collected: (1) the data that define the "travel behavior" quota and (2) the data that define the "personal profile" quota for the individuals surveyed. This allows the data to be stratified by such factors as trip length, income, and group size.

This section describes the stated preference survey process including the methodology used, sample size, survey forms, target locations, and dates of survey deployment along with survey results and analysis.

2.6.1. SURVEY PROCESS

The essence of the stated preference technique is to ask people making trips in the corridor to make a series of trade-off choices based on different combinations of travel time, frequency and cost. Stated preference analysis has been used extensively by TEMS to assess new travel options relating to time, fares, frequency, comfort and reliability for rail, air, and bus services. Tests of the technique in a series of before and after evaluations in North America have produced exceedingly good results. In particular, these tests found that the use of "abstract mode" questions in conjunction with "trade-off analysis" produced reliable results.

Two specific trade-offs were analyzed and used for this study:

- Choices between travel times and travel costs to derive incremental Values of Time for all modes
- Choices between headway times (frequency of service) and travel costs to derive incremental Values of Frequency for transit users. (See Appendix B for Exhibits B-1 through B-3 for the survey forms).

One part of the survey contains revealed preference questions while the other part contains questions that aim on defining the travel behavior of the surveyed individuals. The revealed preference questions which are the profile data collected from the surveys are used in conjunction with origin-destination and census data to ensure that the stated preference survey can be effectively expanded to properly represent the total population. The collected travel behavior data provides the critical part of the data needed to estimate the generalized cost of travel.

Generalized cost of travel between two zones estimates the impact of improvements in the transportation system on the overall level of trip making. It.is typically defined in travel time (i.e., minutes) rather than dollars. Costs are converted to time by applying appropriate conversion factors, as shown in Equation 1. The generalized cost (GC) of travel between zones i and j for mode m and trip purpose p is calculated as follows:

Equation 1:

$$GC_{ijmp} = TT_{ijm} + \frac{TC_{ijmp}}{VOT_{mp}} + \frac{VOF_{mp} * OH * \exp(\alpha * F)}{VOT_{mp} * \alpha * F^2_{ijm}}$$

Where,

TT_{ijm} = Travel Time between zones i and j for mode m (in-vehicle time + station wait time + connection wait time + access/egress time + interchange penalty), with waiting, connect and access/egress time multiplied by a factor (greater than 1) to account for the additional disutility felt by travelers for these activities[4]

TC_{ijmp} = Travel Cost between zones i and j for mode m and trip purpose p (fare + access/egress cost for public modes, operating costs for auto)

VOT_{mp} = Value of Time for mode m and trip purpose p

VOF_{mp} = Value of Frequency for mode m and trip purpose p

F_{ijm} = Frequency in departures per week between zones i and j for mode m

α = Frequency damping factor

OH = Operating hours per week

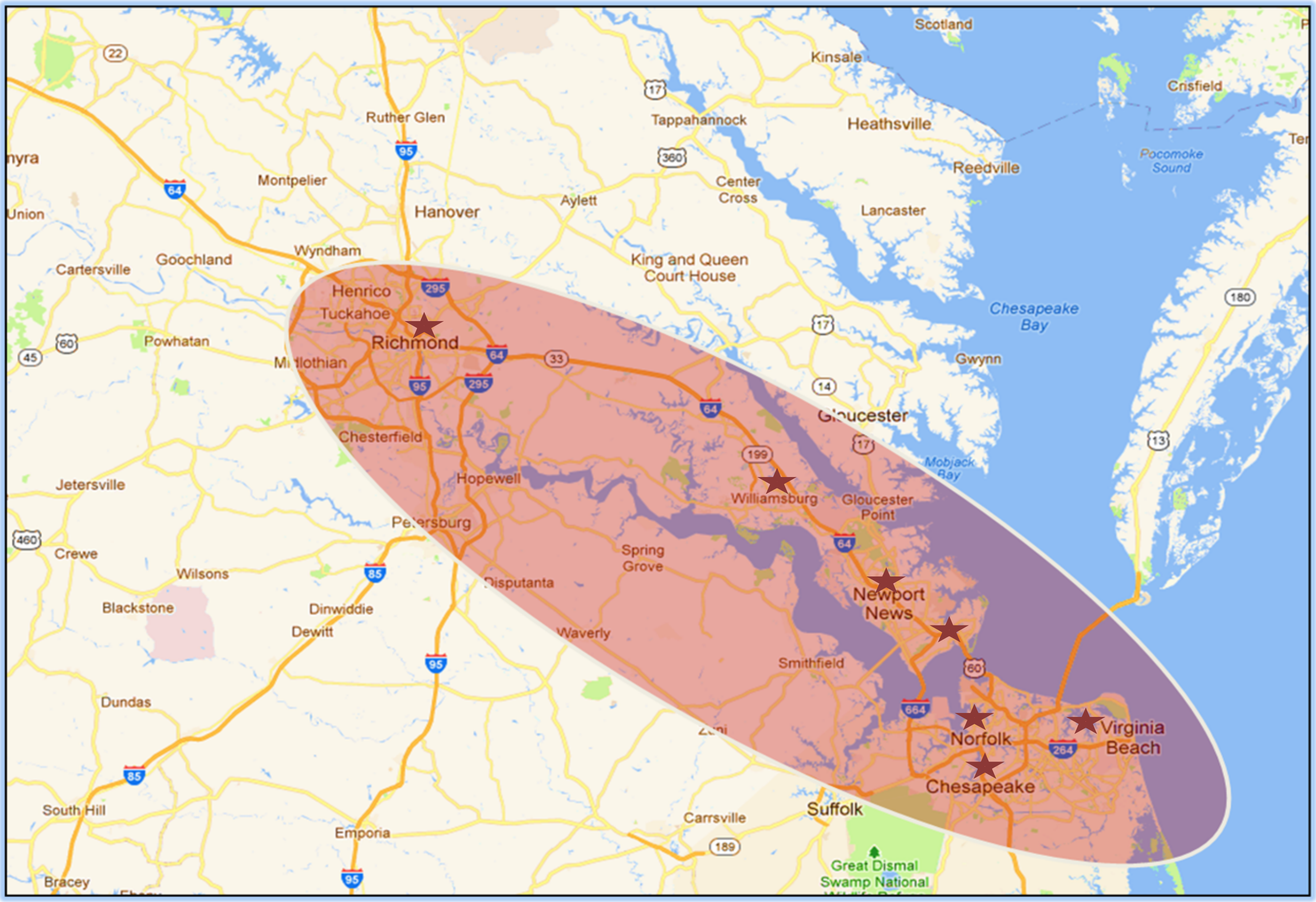
Value of time is the amount of money (dollars/hour) an individual is willing to pay to save a specified amount of travel time, the value of frequency is the amount of money (dollars/hour) an individual is willing to pay to reduce the time between departures when traveling on public transportation, and the value of access is the amount of money (dollars/hour) an individual is willing to pay for the access time to a mode (e.g. the airport, HSR station, railroad station, bus station) to gain easier access to someplace (e.g., an airport). Station wait time is the time spent at the station before departure and after arrival. On trips with connections, there would be additional wait times incurred at the connecting station. Wait times are weighted higher than in-vehicle time in the generalized cost formula to reflect their higher disutility as found from previous studies.

In terms of the size of the survey for each of the quota groups identified - usually up to 12 primary groups. It has been shown that a sample as small as 20 individuals[5] is statistically significant to define the behavioral choices of each group. These primary groups are based on 4 mode groups - auto and transit (that includes air, rail and bus) to 3 purpose groups commuter, business, and other (that includes shopping and social). To improve statistical reliability, TEMS typically seeks 40 to 100 respondents per quota. This means that between 500 and 1,500 surveys are needed for a stated preference survey analysis. The minimum of 1,200-2,000 surveys was set as a goal.

A very important part of the survey process is to identify the desirable survey locations. Exhibit 2-13 shows the Stated Preference Survey locations map covering Richmond, Williamsburg, Newport News, Hampton, Norfolk, Chesapeake, and Virginia Beach. The surveys were conducted both electronically and also in the field. The main aim of the surveys was to target all 12 quota groups (i.e., Business, Commuters, and for other purpose such as shopping and other social events for both auto and transit users).

[4] Travel time includes the rest time if travel is by private auto.
[5] According to Stirrings Approximation where the ratio of the actual value (n) and.its factorial (n!) is closer to 1.

Exhibit 2-13: Survey Area



The field Stated Preference Survey captured:

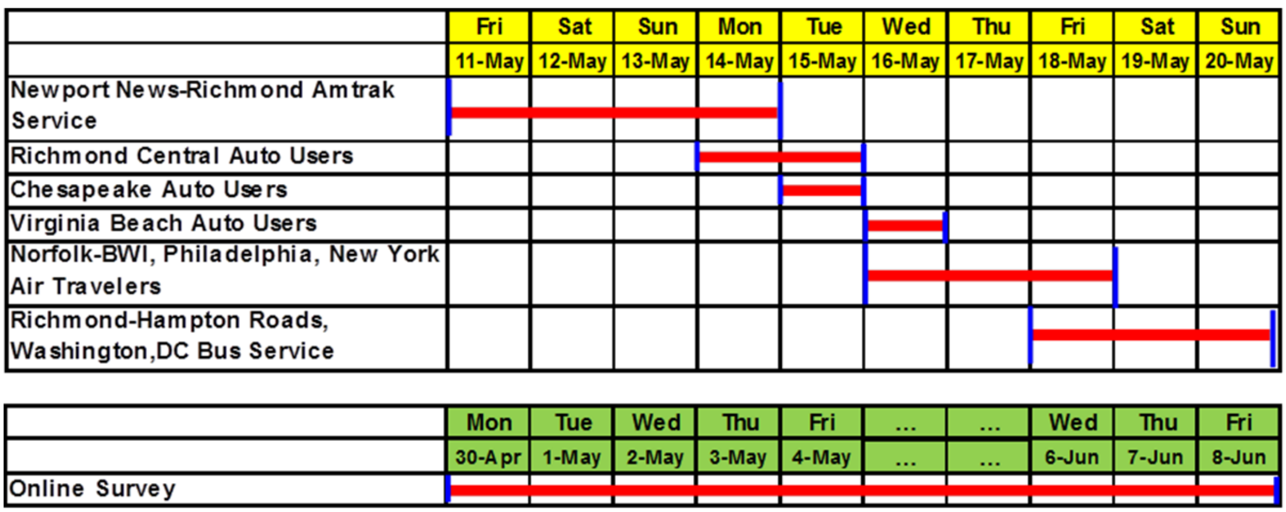
- Rail Users: With the help of Amtrak officials approval, a survey was conducted inside the train station at Richmond, VA capturing both boarding and departing passengers from Newport News to Richmond Amtrak service users and vice versa. The boarding passengers were captured while they were waiting for the train arrivals and departing passengers were captured while they were waiting for their ride;
- Auto Users: With the help of the Virginia Department of Motor Vehicles authority, a survey was conducted at their facilities located at Richmond central, Chesapeake, and Virginia Beach. Patrons were interviewed at these facilities by approaching only those who were seated and were waiting to be called;
- Air Mode Users: With the help of Norfolk International Airport Authority, the air travelers from Norfolk to BWI (Baltimore –Washington Area), to Philadelphia and to New York were interviewed at the baggage claim areas, lobby and outside the security clearance areas;
- Bus Users: With the help of Megabus officials, bus passengers traveling from Richmond to Hampton Roads and Richmond to Washington, DC were interviewed; and
- All Four Mode Users: With the help of Public and Private Organizations such as Virginia Beach Vision, Inc., Greater Williamsburg Chamber & Tourism, Hampton Roads Economic Development

Alliance (HREDA) and U.S. NAVY, online survey responses were collected from individuals located in Hampton Roads area, Williamsburg and Newport News area.

Pilot surveys were also conducted prior to actual field and online surveys to test the survey questionnaire. This provided a validation of the survey design and helped the scaling of the Stated preference questions so that respondents did "trade" time and cost when filling in the survey forms. Minor adjustments to wording of questions and format were made to improve the readability of the forms. The surveys were kept to one-page, one-side only. Most interviewees filled out the form themselves in 5-10 minutes.

Field and online survey deployment are shown in Exhibit 2-14 The survey was conducted in May 2012 with interviews between May 11, 2012 and May 20, 2012 TEMS collected 2,736 surveys, and exceeded their target range and these results will be discussed in the following section.

Exhibit 2-14: On-Site Survey Team Actual Deployment & Online Survey



2.6.2. SURVEY RESULTS AND ANALYSIS

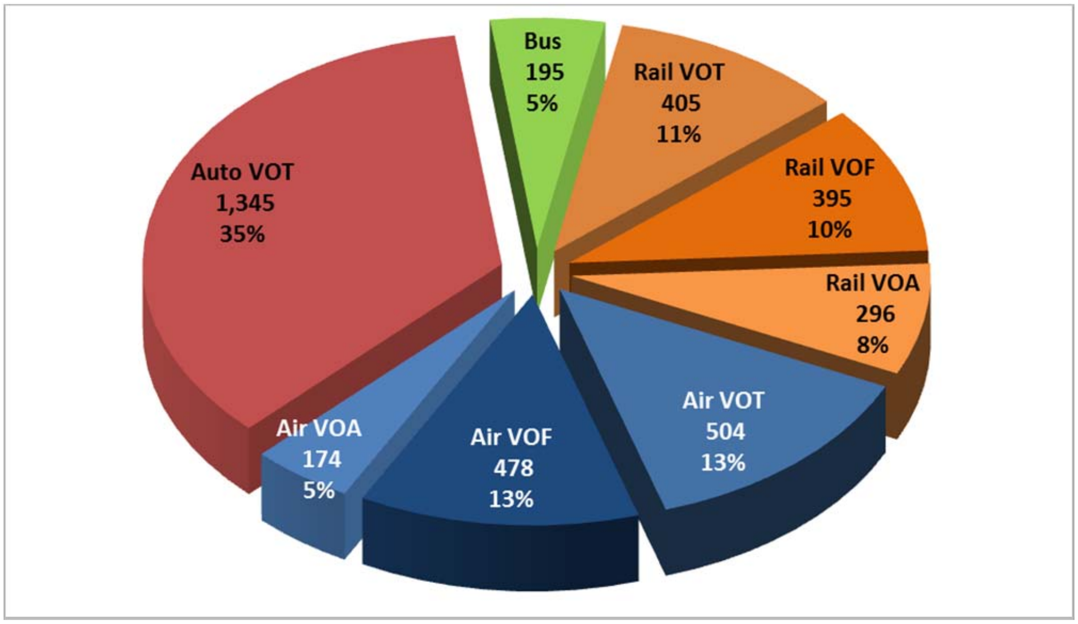
TEMS collected 2,736 surveys, and exceeded their target of 1,900 as shown in Exhibit 2-15 showing exceeded actual survey counts against the survey targets for each location except for bus locations, which almost achieved the target.

Exhibit 2-15: Target vs. Actual Survey Count per Location-

Location	Survey Target	Field+online Count (Actual)
DMV	800	1,377
Airport	500	573
Amtrak	500	690
Bus	100	96
TOTAL	**1,900**	**2,736**

Behavioral attributes reflect the behavior of the respondent when travel conditions change. For the purpose of this study, stated preference surveys collected the information necessary to identify the Value of Time (VOT)[6] for all travelers, the Value of Frequency (VOF)[7] and the Value of Access (VOA)[8]. As seen in Appendix B, there were separate forms for each mode and questions were unique for VOT, VOF and VOA. Exhibit 2-16 shows that a total of VOT, VOF and VOA responses for all modes were 3,792.

Exhibit 2-16: VOT, VOF, VOA Counts per Mode[9]



The responses captured by the revealed part of the questionnaire, show that 9% of responses were from commuters and travel to/from school, 14% from business travelers, 77% response was from leisure travelers for all modes as shown in Exhibit 2-17. Other as indicated by the respondents include visit family, friends, graduation, baseball game, etc.

[6] Value of Time (VOT) is the amount of money (dollars/hour) an individual is willing to pay to save a specified amount of travel time.

[7] Value of Frequency (VOF) is the amount of money (dollars/hour) an individual is willing to pay to reduce the time between departures when traveling on public transportation.

[8] Value of Access (VOA) is the amount of money (dollars/hour) an individual is willing to pay for the improved access time to a mode (e.g. the airport, HSR station, railroad station, bus station) to gain easier access to someplace (like airport).

[9] This total count of VOT, VOF and VOA per mode equals 3,792 and these counts are not equal to total survey counts as each transit respondent (most of them) filed out two stated preference questionnaires.

Exhibit 2-17: Purpose of Travel Responses

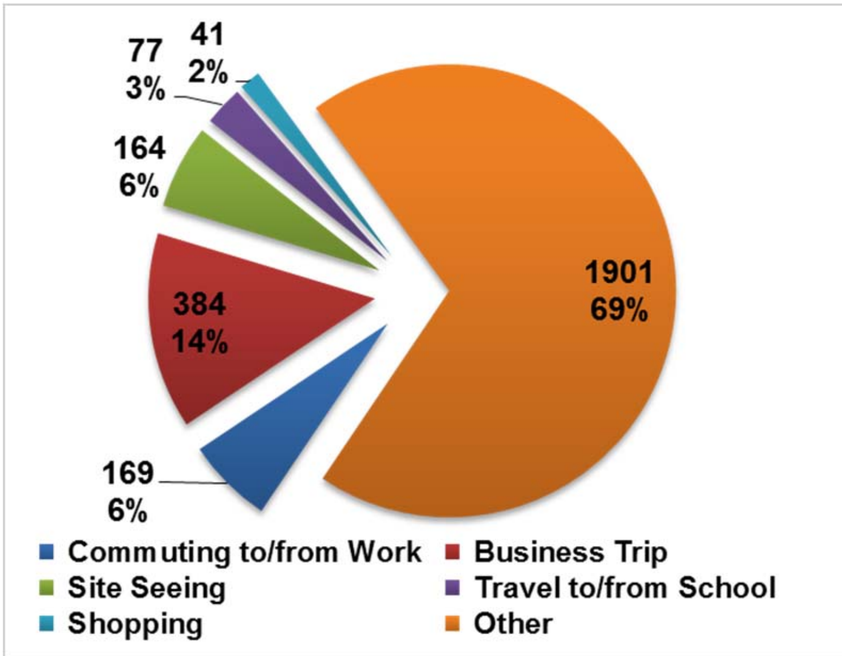
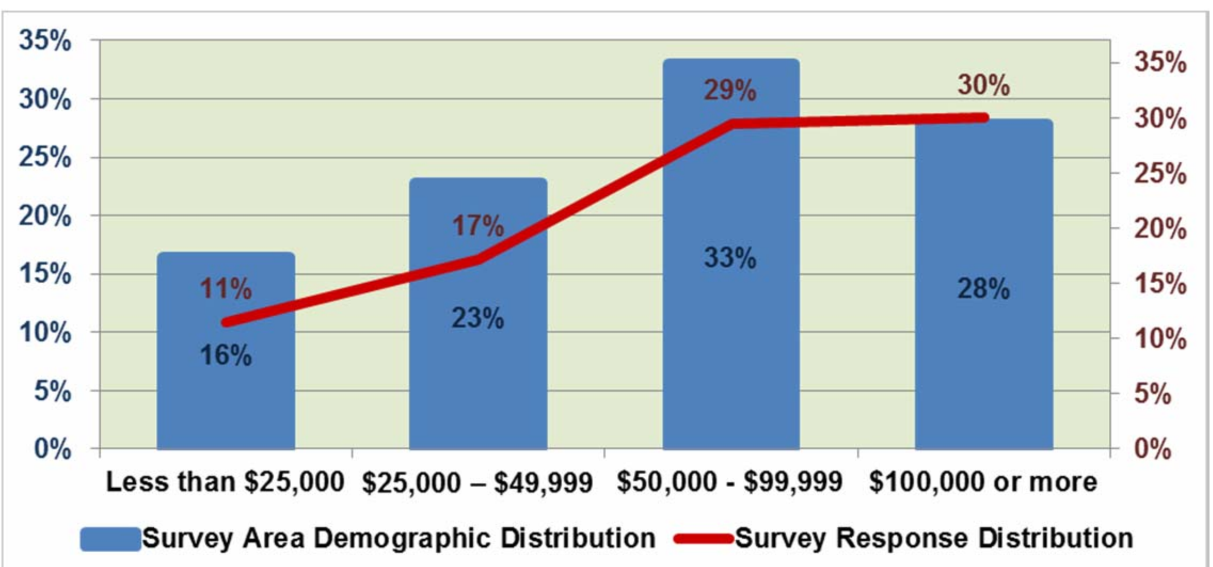


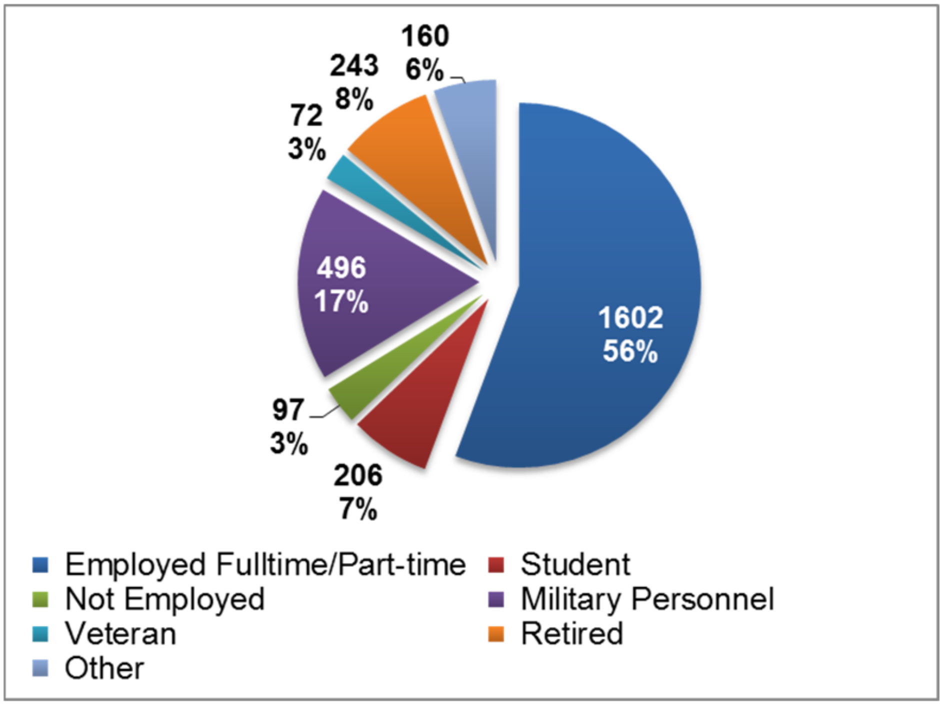
Exhibit 2-18 illustrates distribution of average number of household by income groups along the survey Study Area corridor in comparison with statistical and survey data. It is seen in the Exhibit that survey responses closely followed most of the demographic distribution with a very slight increase of greater than $100,000 income group. This shows that the survey responses were effectively represented, and the margin of error is only ±6%.

Exhibit 2-18: Distribution of Average Number of Households by Income



The employment type responses from the survey as shown in Exhibit 2-19 was that 56% of the responses were from employed individuals, 17% were from military personnel's, 8% were from retired individuals, 7% were from students, 3% were from veterans, 3% were from unemployed individuals, and 6% were from other where other as indicated by individuals were home-maker, self-employed, etc.

Exhibit 2-19: Employment Type Responses[10]



[10] The total count in Exhibit 2-19 is 2,876 which is more than the actual survey count. The reason being respondents with more than one response were counted separately. For example, student respondents who are employed are counted twice.

BEHAVIORAL ATTRIBUTES

Each of these three variables (VOT, VOF and VOA) has been analyzed using the "trade-off' method. The Trade-Off Analysis identifies how individuals choose between time and money in selecting travel options. Two trade-off analysis methods, Binary Logit Method and Direct Comparison Method, were employed to analyze the Attitudinal Survey Data and determine Values of Time (VOT's), Values of Frequency (VOF's), and Values of Access (VOA's).

In the Comparison Method, the trade-off choices made by individuals are ranked in descending or ascending (VOT, VOF or VOA) order, along with the individual's choice between time and money and the degree of preference the individual had for that specific trade-off choice. The individual's VOT, VOF or VOA is then determined by identifying the point of inflection, or the point at which an individual changes from spending more time to save money or preferring to spend more money to save time in making a given journey. The Comparison Method provides a clear and detailed understanding of how travelers react to the series of binary choice trade-off questions. Once the individual trade-off values are determined, the results are averaged to give overall population values.

The Binary Logit Method uses a logit curve to calculate the coefficients of the time and cost variables. The individual's VOT, VOF or VOA is derived as the ratio of time and cost coefficients. While this method is a less subjective and more automatic process than the Comparison Method, the statistical rigidity of the Binary Logit Method frequently provides less understanding of travel behavior and less ability to interpret behavior effectively. Furthermore, because this method cannot incorporate the results for individuals who quite rationally do not make a trade-off (preferring time or money options consistently over the whole range of trade-off choices), the Binary Logit Method can only be used at most aggregate level.

Exhibit 2-20 and 2-21 provides an example of the respondent's trading behavior and illustrates how VOT is calculated using 'trade-off' method. Exhibit 2-23 provides an example of the respondent's non trading behavior[11]. The VOT is calculated for the 'neutral point' located in the intersection between the line indicating 'no preference' and the line connecting the points indicated by the respondent. As seen in Exhibit 2-20 the neutral point or no preference line is located at the fourth row indicating that the respondent is willing to spend $12 more for 45 minutes less. This implies the respondent is willing to spend $16 more for one hour of time saving. Thus, the respondent has a VOT value of $16 per hour.

[11] These examples (Exhibit 2-20, 2-21, and 2-23) are drawn from previous TEMS Stated Preference Surveys, and are designed to show how travelers 'trade-off' or 'do not trade-off' between time and cost options.

Exhibit 2-20: VOT calculation based on "Trade-Off" Method: "Trading Behavior"- Example #1

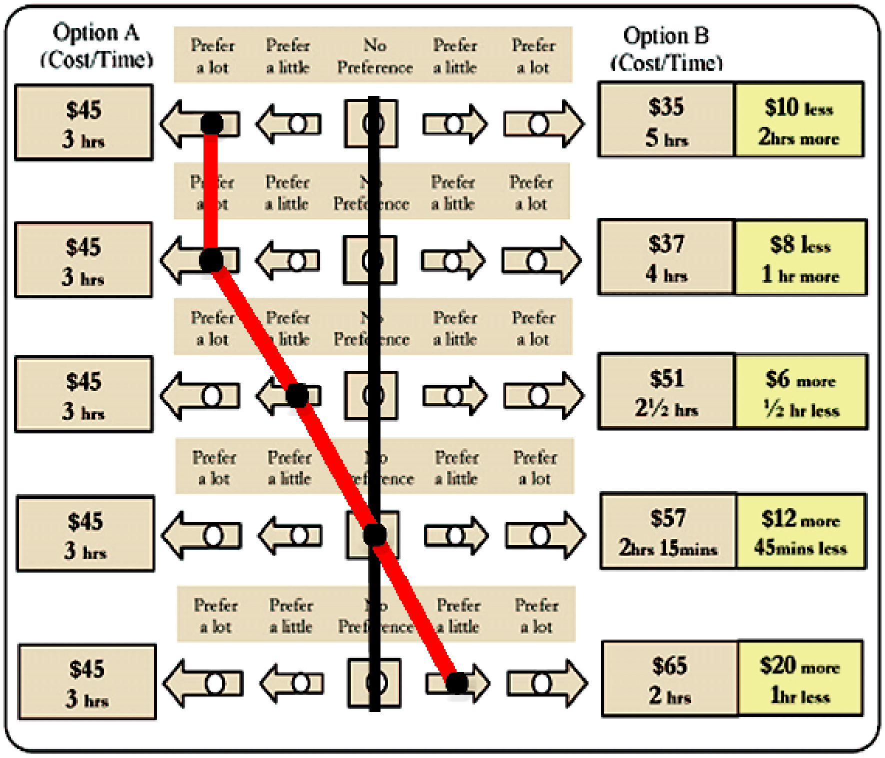
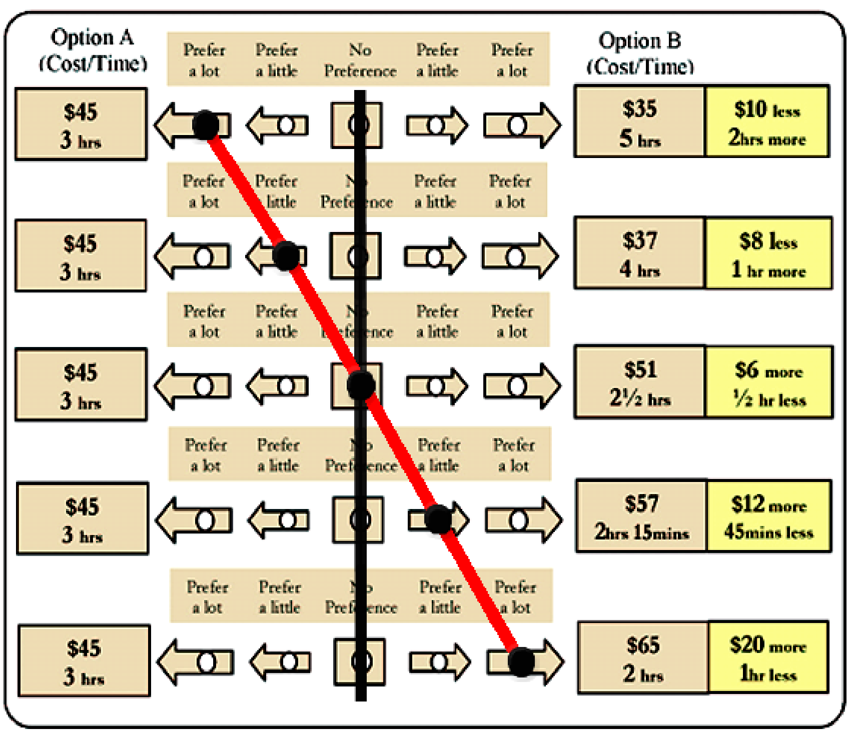
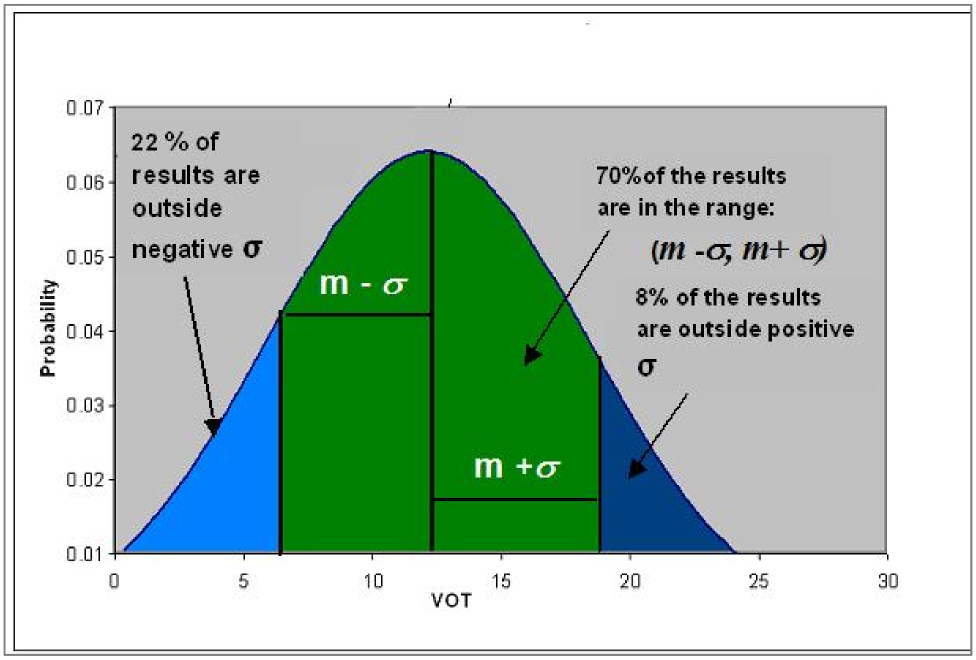


Exhibit 2-21: VOT calculation based on "Trade-Off" Method: "Trading Behavior" - Example # 2



Not all survey respondents illustrated perfect trading behavior (similar to those shown in Exhibit 2-20 or 2-21). For the data collected, about 30% of the respondents were identified as 'non-traders'. This is shown in Exhibit 2-22, where the 30% (i.e. 22% of very low values of time and 8% of very high values of time) non-traders are equally proportioned between individuals with either very high values of time or very low values of time. The survey is intended to obtain VOT's from the 70% in the middle (i.e., one standard deviation). This is illustrated in Exhibit 2-22.The 30% non-trading behavior example is shown in Exhibit 2-23.

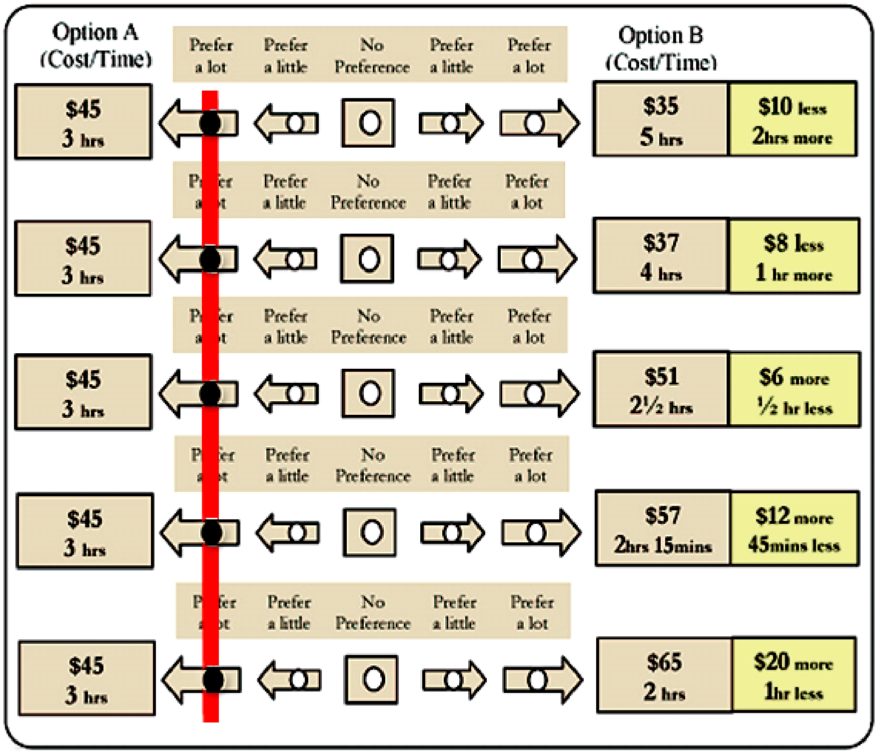
Exhibit 2-22: Distribution of the Non Respondent Error in the Trade-off Analysis of the Collected Survey Data[12]



VOT calculated based on the example shown in Exhibit 2-23 is assumed to be $45 for three hours ($15 per hour) or less as there is no trading, and the individual is showing a preference to spend time rather than money.

[12] Normal distribution with one standard deviation above the mean.

Exhibit 2-23: VOT calculation based on "'Trade-Off' Method: "Non Trading Behavior"



The Stated Preference Survey results of VOT, VOF and VOA calculated for four modes (auto, rail, bus, and air) and three types of purpose (commuter, business and other) are presented in Exhibits 2-24 through 2-26. Based on the calculations, the following observations were made:

- The hierarchical order of VOT is higher for Air access, rail, auto and then bus users., which is the typical trend;
- Business trips have larger VOT, VOF and VOA values than commuter and other trips;
- The VOT, VOF and VOA values are consistent with those of previous studies (e.g., Bay Bridge Travel Survey, 2006, Rocky Mountain Rail Authority (RMRA), 2008) after adjusting to 2012 dollars for similar trip length.

Exhibit 2-24: VOT values by Mode and Purpose of Travel

Value of Time VOT	Business	Commuter	Social
Auto	$19.42	$14.80	$16.88
Bus	$11.07	$7.15	$8.54
Rail	$22.51	$18.80	$17.88
Air Access	$44.45	_	$31.76

Exhibit 2-25: VOF values by Mode and Purpose of Travel

Value of Frequency VOF	Business	Commuter	Social
Bus	$7.33	$6.50	$7.75
Rail	$18.58	$13.67	$16.13
Air Access	$28.81	_	$26.28

Exhibit 2-26: VOA values by Mode and Purpose of Travel

Value of Access VOA	Business	Commuter	Social
Bus	-	$8.89	$10.77
Rail	$42.73	$29.15	$37.66
Air Access	$62.91	-	$47.94

Appendix B shows survey form used for all different modes.

3 ENGINEERING DATABASE

This chapter is divided into five subsections: an introduction describing the content of the work; the TRACKMAN™ database defining the speed curves, grades, rail and highway crossings, and other potential speed restrictions; a preliminary infrastructure analysis of the existing rail right-of-way and the proposed Environmental Study Area (Envelope) to be considered in the analysis for potential greenfield[1] routes; and a presentation of the capital unit costs to be used to develop study costs for the Norfolk-Richmond corridor.

3.1. INTRODUCTION

One of the key elements in evaluating higher and high speed intercity passenger rail service for the Petersburg to Norfolk Corridor is the review of the existing rail infrastructure and the development of an understanding of the potential corridor constraints and opportunities for improvements for supporting high speed and intercity passenger rail service. For the purpose of the preliminary analysis, this assessment was accomplished by using the following process:

- Gathering of information from a route review of the rail corridor from Petersburg to Suffolk to the Norfolk area.
- Gathering of information from prior Engineering analyses of the Norfolk – Richmond – Washington, DC and Newport News – Richmond – Washington, DC rail corridors and Preliminary Vision Plan including a review of available right-of-way documentation and cost data.
- Identification of typical corridor infrastructure issues and constraints.
- Identification of the design standards typically applied for the various classes of passenger rail service.
- Development of an initial conceptual capital cost estimate of rail improvements to support the various steps of passenger rail service.

It should be noted that for the purposes of this preliminary analysis no detailed corridor mapping or route specific inspection of the potential Greenfield rail corridors was completed.

This chapter documents the Engineering Database that includes the *TRACKMAN*™ databases, and the preliminary infrastructure analysis collected for the high speed and intercity passenger rail assessment. It presents the preliminary results of the overview of existing conditions of the rail infrastructure between Petersburg/Richmond and the Norfolk area, typical design standards used for the development of the various speeds of passenger rail service and the preliminary unit costs that will be used to estimate the various development Steps of passenger rail service for the Norfolk-Richmond corridor.

3.2. POTENTIAL HIGH SPEED ROUTES

To support the data collection effort, it was clear that at least a preliminary definition of the Environmental Study Area would be needed. The Environmental Study Area is considered to be the potential region or envelope within which potential rail alignments might lie. This contrasts with a broader "Study Area" or Zone System that is used for ridership forecasting. Because of the ability to use auto as an access mode, the "Ridership Study Area" encompasses a much larger territory than does the "Environmental Study Area." The Environmental Study Area defines the geographic boundaries of the

[1] A Greenfield is a brand-new proposed rail line where no rail line ever has existed. This contrasts with upgrades to an existing rail corridor, or the restoration of an abandoned rail corridor, since the locations of existing or abandoned alignments are known for sure. We have identified potential corridors for conceptual Greenfield alignments both north and south of the existing NS rail line, but have not located the alignments precisely.

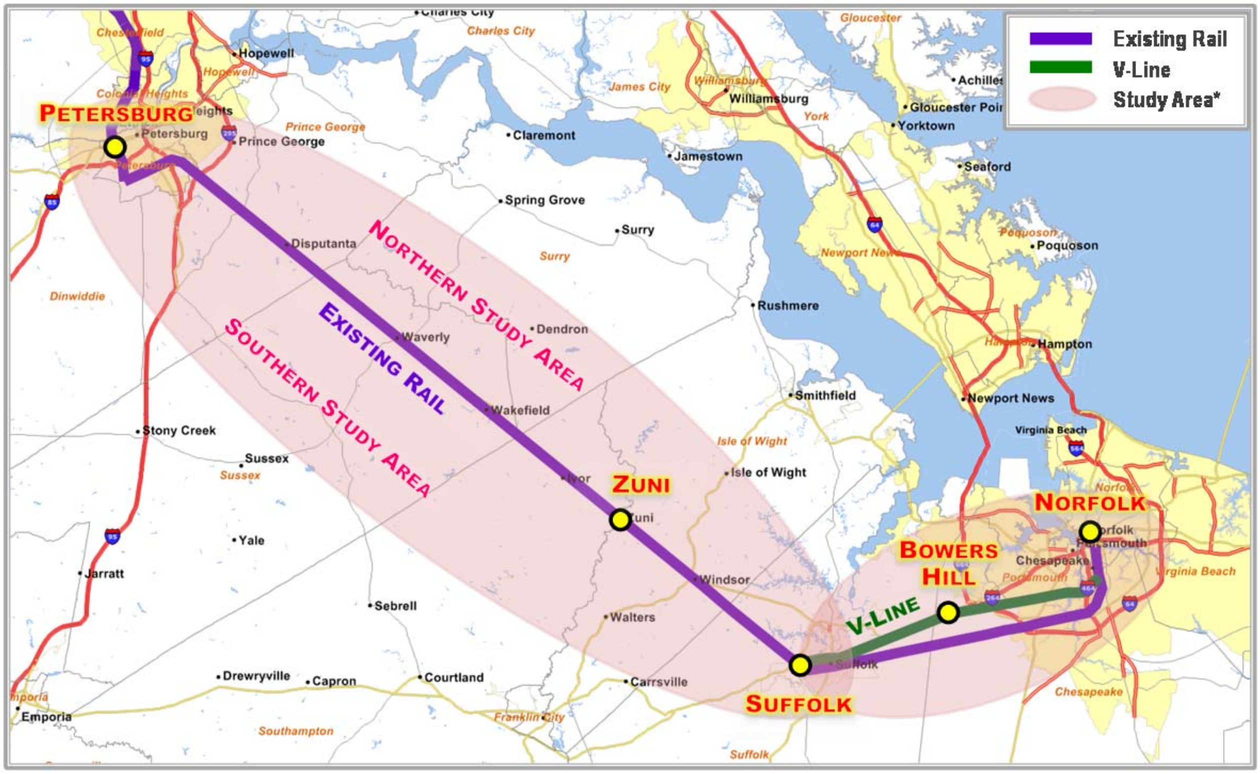
area within which engineering and environmental data must be collected and reviewed. Three study area alignment possibilities have been identified to support the data collection effort for the Norfolk-Richmond corridor. These include the Norfolk Southern (NS) existing alignment from Petersburg to Suffolk and V-line from Suffolk to Norfolk; and possible northern and southern greenfield corridors for developing a new High Speed Rail alignment.

These three options allow a great deal of flexibility for locating the final alignments between Petersburg and the west end of Suffolk within a broad envelope. All options assume that the existing “V-line” right of way will be used through downtown Suffolk to Norfolk. However, it might be possible to avoid Suffolk entirely by following Route 460 directly from Windsor to the proposed Bowers Hill station. Particularly in the context of the northern greenfield, this route option would shorten the distance and may prove to be attractive. A Suffolk bypass would eliminate right of way conflicts at Prentis Street in downtown Suffolk, but it would bypass any possible Suffolk station stop; and may cause other environmental concerns, such as the need for crossing wetlands and the Nansemond River several miles north of town. Further discussion with the affected communities is needed to determine whether developing such an option would even make sense.

Clearly, one possible option is to develop a High Speed rail service paralleling the existing Norfolk Southern tracks. Presumably the existing tracks would not be used because they are needed for the current freight service, and Norfolk Southern has a policy of not permitting speeds above 79-mph on tracks they own. Therefore, the task is to assess the corridor in close proximity, either within the existing right-of-way or closely paralleling the right-of-way, for the ability to add High Speed tracks to the corridor. In a general sense, since the existing rail alignment is straight, geometry is not the challenge, but there are a number of instances (particularly in small towns) where adjacent development closely hugs the right-of-way. The need for potential property displacement is a definite challenge for the development of this alignment – although any greenfield alignments will also likely require some displacements. Therefore it is not possible at this early stage of project development to tell whether the needed displacements along the existing rail line would be any more or less than those required for a new greenfield corridor. Another possibility may be to develop a new freight rail line in the programmed new US-460 median and upgrade the existing, very straight NS alignment for passenger rail service. The recommendation at this point, therefore, is to keep this option “in play” as well as the potential generic northern and southern greenfield routes until more detailed environmental assessment can be performed of all the options. (Chapter 5 discusses the preliminary environmental data collection assessment).

As seen in Exhibit 3-1 an envelope has been created to define the Study Area. The engineering, environmental databases are focused within this envelope. The major areas of concern along the existing rail alignment are Disputanta, Waverly, Wakefield, Ivor, Zuni and Windsor. These areas are discussed in the following sections.

Exhibit 3-1: Existing and Greenfield Routes from Petersburg to Norfolk



*Alignment will not be determined until the Tier II Environmental Process is complete.

3.3. *TRACKMAN™* DATABASE

The *TRACKMAN™* Track Management System was used in this analysis to provide a milepost-by-milepost record of the rail gradients and track geometry of the existing right-of-way. The data that has been compiled from existing sources includes railroad timetables, track charts, ordinance survey maps, and land stat photometry for the existing NS alignment and will be complied for the possible greenfield alignments to be developed in the next phase of the study. The following has been assessed for the NS route alignment and will similarly be used to assess the other possible corridor options:

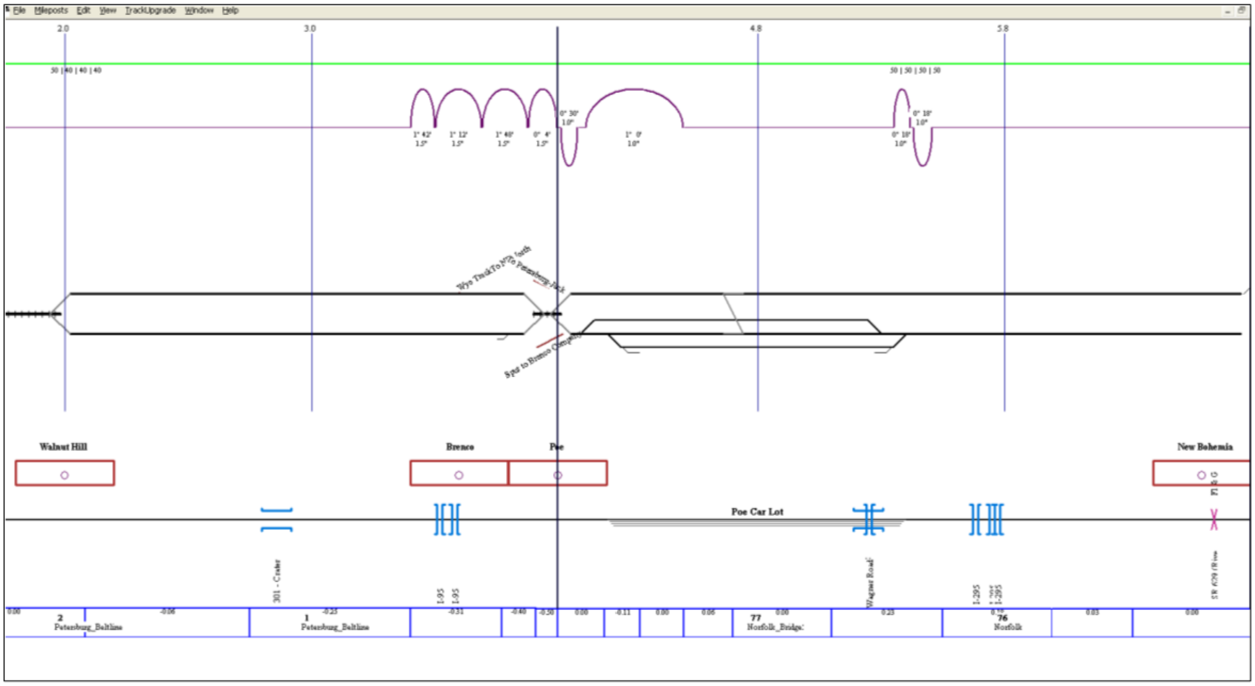
- Potential track upgrades
- Improvements for different passenger rail speeds
- Operations

The possible alternatives will be derived from the preliminary analysis of the environmental data and engineering standards required for each technology. The options are at the conceptual landscape level of route assessment and will serve as preliminary options. However, entirely new options could be selected in the Tier I Environmental Alternative Analysis in the Analysis Phase of the project.

Engineering notes were developed and entered into the *TRACKMAN™* program, which is used to maintain the database, to provide a clear understanding of basic track conditions, and the upgrades needed to support higher passenger rail speeds. *LOCOMOTION™* and *MISS-IT™* are used for operation simulations.

A sample output from *TRACKMAN™* is given below in Exhibit 3-2. The full *TRACKMAN™* file is given in Appendix C.

Exhibit 3-2: Sample NS Petersburg Data



3.4. PRELIMINARY INFRASTRUCTURE ANALYSIS

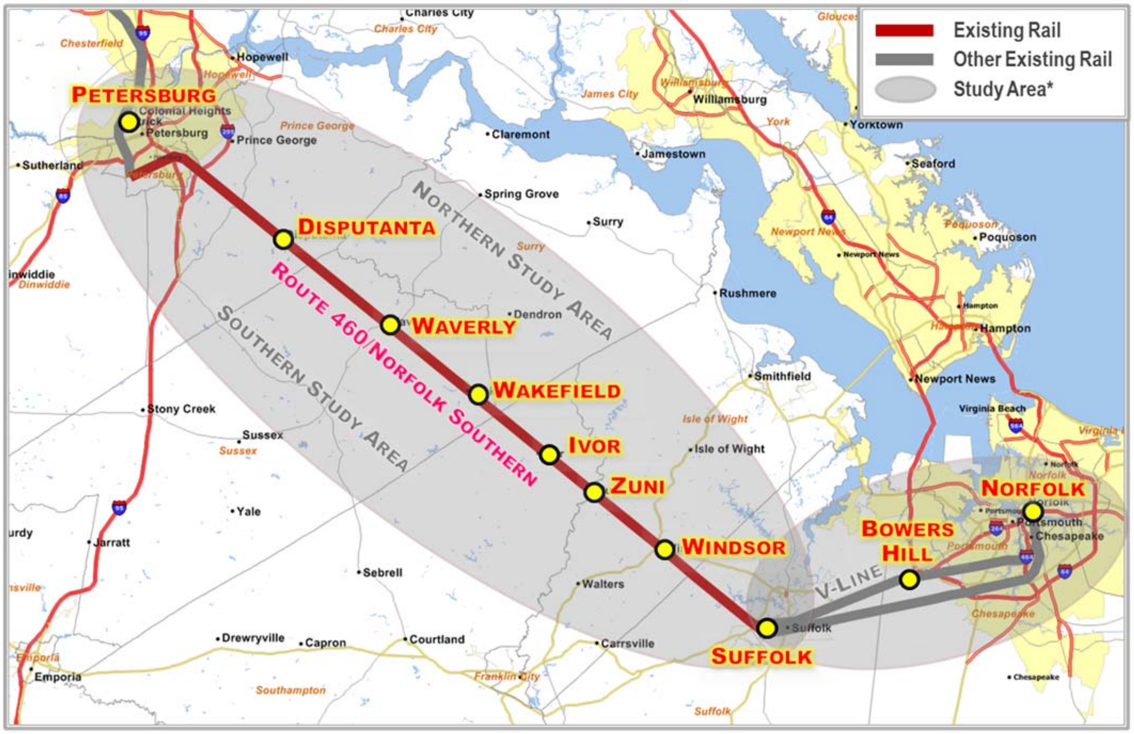
In the earlier phase of the study of the preliminary Vision Plan, existing passenger rail conditions were examined for the NS Railroad line and the CSX Transportation (CSXT) rail lines between Richmond and the Hampton Roads area along with field review of the section of the rail lines south of the Amtrak Staples Mill Station. In this phase of the study, possible northern and possible southern greenfield options from the Petersburg area to Norfolk were reviewed. The earlier inspection of the existing NS corridor from Petersburg to Norfolk was updated and a thorough inspection (as is possible from publicly accessible locations) was conducted. The existing conditions review was completed by a survey of the potential rail corridors together with detailed Google mapping. The existing conditions review was accomplished by driving to access crossing (intersecting streets, overpasses) of the rail lines and seeing the rail corridors at these access points.

The following photos provide an overview of the existing conditions along the rail corridor alternatives between Petersburg and Norfolk. In addition, Harbor Park Station in Norfolk was reviewed.

3.4.1. NORFOLK SOUTHERN EXISTING RAILROAD– PETERSBURG TO SUFFOLK

From Petersburg to Suffolk, one alternative is to follow the existing NS rail alignment. (See Exhibit 3-3) As part of Step 1 this has been recently upgraded to allow 79-mph passenger rail from Petersburg to Norfolk.

Exhibit 3-3: NS Existing Alignment from Petersburg to Suffolk



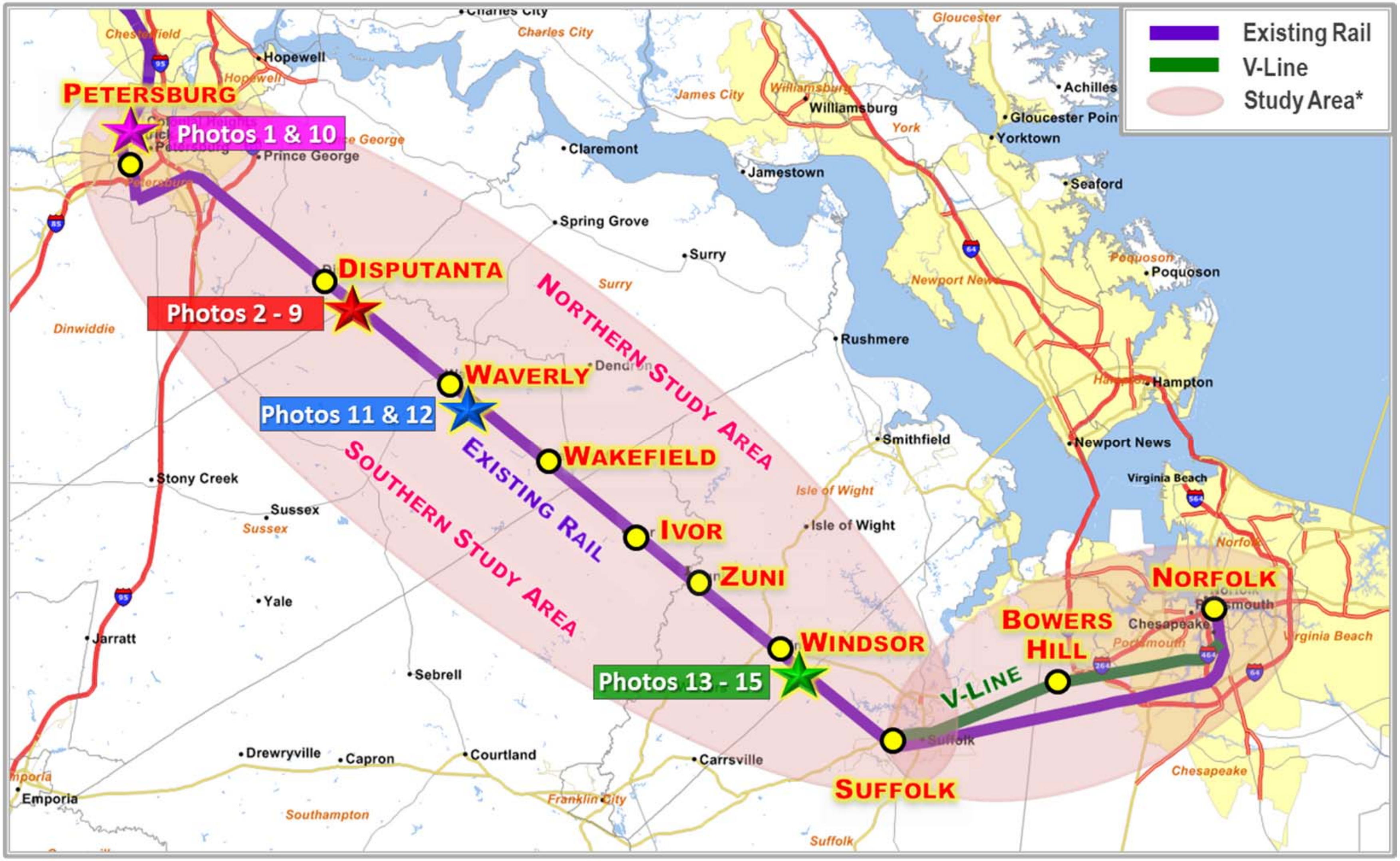
*Alignment will not be determined until the Tier II Environmental Process is complete.

The improvements that have been made from the new connection at Collier (in south Petersburg) to Norfolk include:

- New bidirectional signaling system
- New crossovers
- Track speed improvements

Some of the improvements can be seen in Photos 1 and 2 below that show the new CSXT/NS connection at Collier, and the new bidirectional signaling system.

Exhibit 3-4: Photo Locations along NS Existing Alignment from Petersburg to Suffolk



*Alignment will not be determined until the Tier II Environmental Process is complete.

Photo 1: New Collier connection near Halifax Road south of Petersburg.

Photo 2: New Bi-directional signaling system at Disputanta, VA.

The assumption is that in order to run high speed service at least one or two new tracks must be added to the corridor separate from the existing rail lines. Norfolk Southern's policy does not allow trains with speeds greater than 79-mph[2]. The Federal Railroad Administration (FRA) only requires 14 feet of track separation but according to *Adjacent Track Rule*[3] the track separation should be at least 25 feet to avoid interference with track maintenance operations. Increased spacing even beyond 25 feet will be considered where practical.

For adding track to the rail corridor, photos 3 through 15 (also located in Exhibit 3-4) show the area adjacent to the NS existing track with major areas of concerns being Disputanta, Waverly, Wakefield, Ivor, Zuni, and Windsor. Some of the issues along the existing NS tracks in these areas were:

- The presence of small towns with residential property, historic places

[2]Norfolk Southern to increase maximum speeds for Amtrak trains between Norfolk and Petersburg. http://www.nscorp.com/nscportal/nscorp/Media/News%20Releases/2012/ns_amtrak_speed.html

[3] http://www.gpo.gov/fdsys/pkg/FR-2011-11-30/pdf/2011-30250.pdf

- Presence of wetlands very close to the existing NS tracks
- Presence of over and under bridges which narrow downs the track separation distance, or else requires replacement of the bridges
- Highway crossing to develop grade separations for a high speed rail
- Access to private lands across tracks must be maintained
- Rail-served industry access must be maintained
- Rail access to connecting lines and junctions must be maintained

Photo 3: Railroad crossing at Disputanta, VA would require grade separation.

Photo 4: Industrial development near tracks at Disputanta, VA

Photo 5: Overhead rail bridge on Golf Course Drive at Disputanta, VA would have to be widened or replaced.

Photo 6: On south side of the NS Tracks Prince George Golf Course entrance at Disputanta, VA.

Photo 7: On south side of the NS tracks Bakers Pond at Disputanta, VA.

Photo 8: Private grade crossing at Disputanta, VA.

Another track may be added under the bridge, which should be at least 25 feet away according the FRA adjacent track rule for not interfering with freight operations.


Photo 9: Bridge at Disputanta, VA allows room for one track at 14 feet center, but not two tracks or wider separation. This bridge may have to be replaced.


Photo 10: Junction to Old NS Mainline at Poe, near Petersburg. Room for new track on the south side here would not interfere with the junction on the north side.

Photo 11: Old building in close proximity to tracks at Waverly, VA.

Photo 12: Room to add track north of existing rail alignment at Waverly, VA.

Photo 13: Industrial access at Windsor, VA.

Photo 14: Streets on both sides of tracks at Windsor, VA.

Photo 15: Railroad crossover at Windsor, VA.

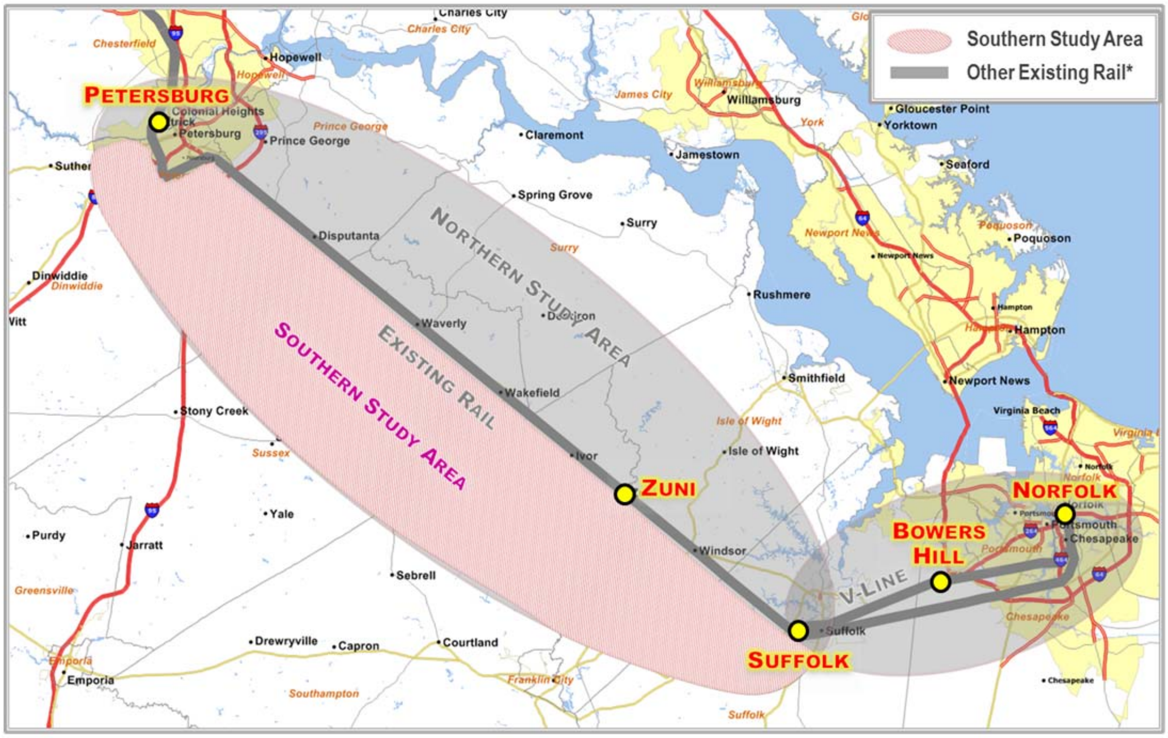
The purpose of this inspection effort was to provide data for use in the preliminary engineering and environmental work for the next phase of the Vision Plan Study. The example photographs show the specific kinds of measures that will be needed to implement High Speed Rail service while avoiding freight operations interference.

3.4.2. POSSIBLE SOUTHERN GREENFIELD – PETERSBURG TO SUFFOLK

A possible southern greenfield option from Petersburg to Suffolk has been also reviewed (See Exhibit 3-5). The original concept was to follow the abandoned Virginian right-of-way as far as possible, to the vicinity of Walters. From Walters a new greenfield would head straight towards Collier to meet CSX. But this has two problems: at the east end, this would pass through the middle of the town of Walters. At the west end, Photo 16 shows a residential community and Photo 17 shows Richard Bland College which lie along this direct path between Walters and Collier. However, these obstacles can be avoided by shifting the conceptual option. The revised greenfield would pass north of Walters, rather than directly through it. At the west end, the option is shifted south to meet CSX at the south end of Collier Yard, (near the SEHSR's[4] Burgess Connection) rather than at the north end. This eliminates any conflicts with the college and golf course community. See Exhibit 3-6 for photo locations within the possible southern greenfield study area.

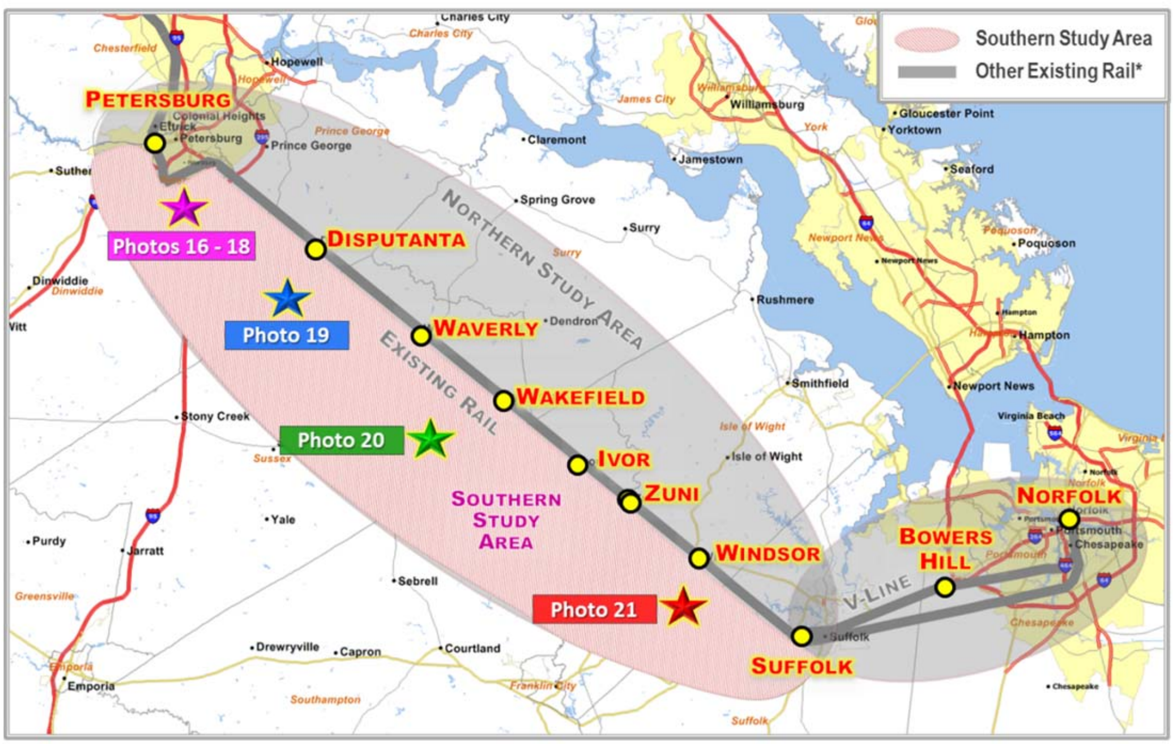
[4] SEHSR – Southeast High-Speed Rail

Exhibit 3-5: Greenfield Option 2 from Petersburg to Suffolk



*Alignment will not be determined until the Tier II Environmental Process is complete.

Exhibit 3-6: Photo Locations along Possible Greenfield Option 2 from Petersburg to Suffolk



*Alignment will not be determined until the Tier II Environmental Process is complete.

Photo 16: Golf course and residential community at Halifax Road near Petersburg.

Photo 17: Richard Bland College at Petersburg

From Burgess north to Petersburg, the SEHSR and Norfolk services could share a dedicated passenger track around Collier yard. From Burgess, the southern high speed line would head southeast towards Suffolk, Photo 18 shows the open countryside looking east from Burgess. Photos 19 through 21 show open country side along the southern alignment, which would connect the south end of the Collier Yard to the western outskirts of Suffolk.

The greenfield right-of-way would skirt the Warwick Swamp heading through generally open countryside (cotton fields and scrub forest) to meet the abandoned "Virginian" rail right-of-way somewhere in the vicinity of Walters, VA. The alignment would then continue along the abandoned "V-Line" right-of-way into downtown Suffolk.

Photo 18: Open country side looking east, from the south end of Collier Yard.

Photo 19: Pine Scrub Forest territory to be traversed near Disputanta.

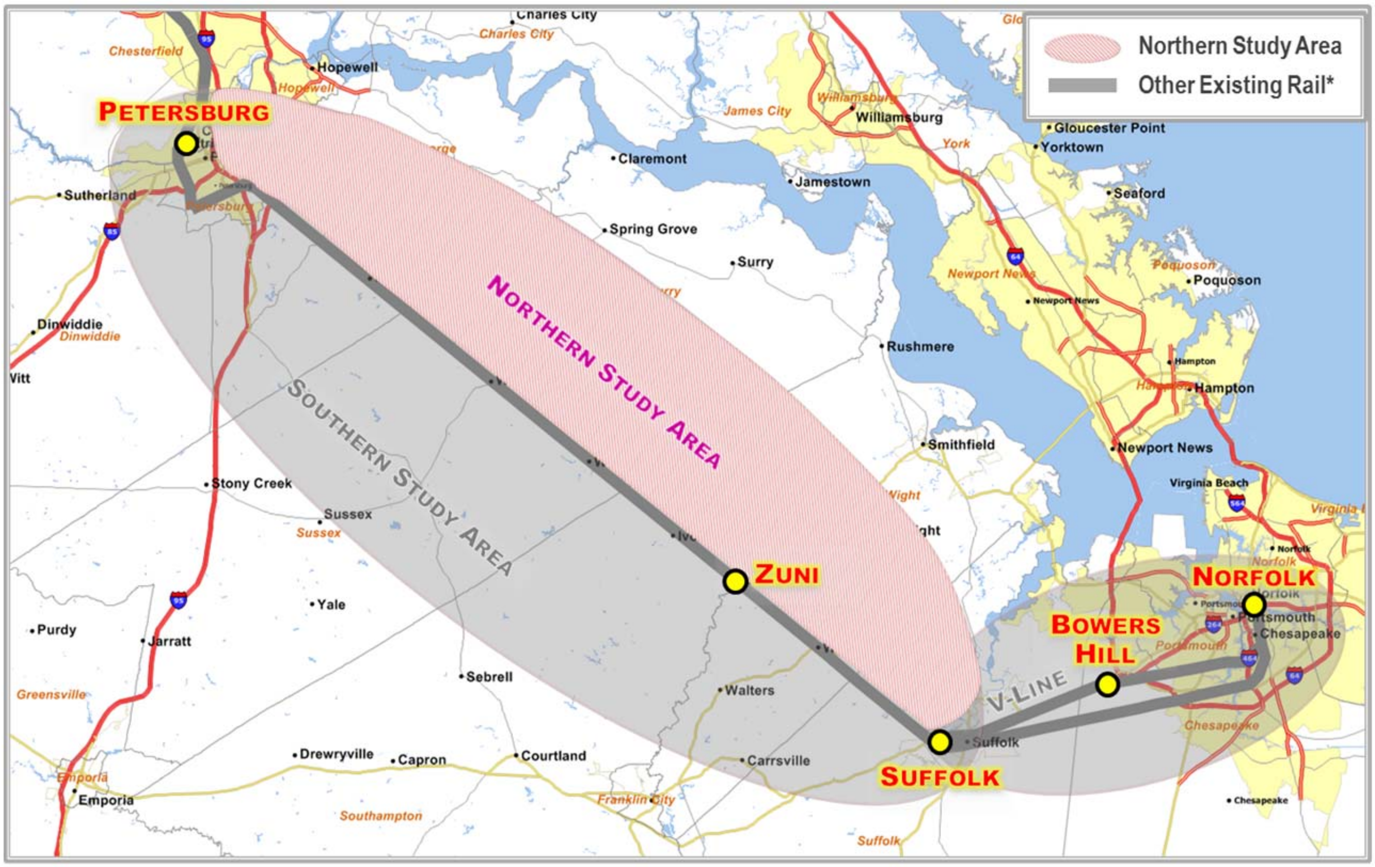
Photo 20: Cotton field in general area to be traversed near Wakefield.

Photo 21: Section of abandoned "Virginian" railroad right-of-way from Suffolk to Walters.

3.4.3. POSSIBLE NORTHERN GREENFIELD – PETERSBURG TO SUFFOLK

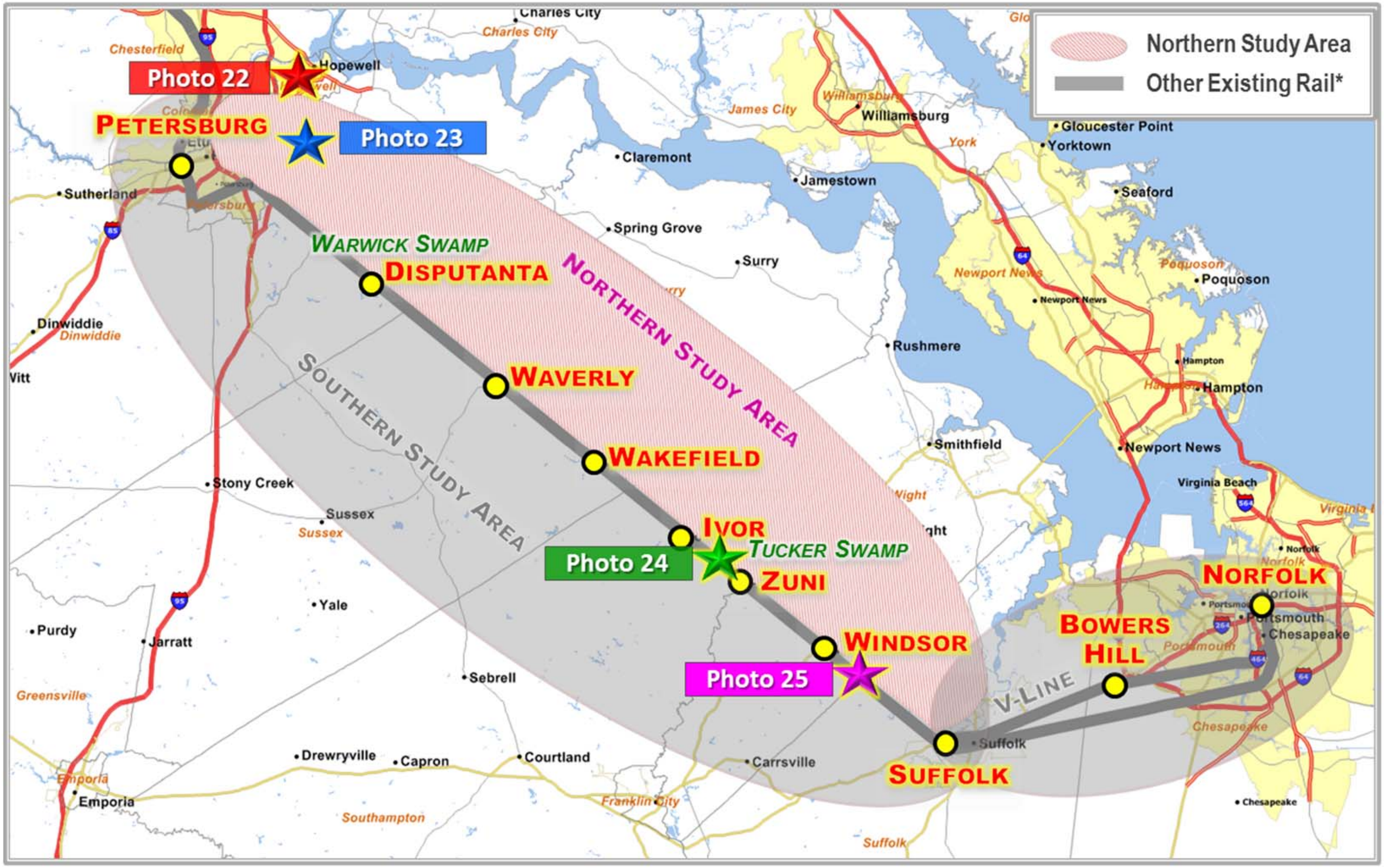
A northern greenfield from Petersburg to Suffolk (see Exhibit 3-7) might roughly parallel route 10 from south of James River Bridge near Hopewell to Zuni and then parallel the utility line and NS rail line from Zuni to Suffolk. Photos 22-25 show the bridge over James River on I-295 near Hopewell, the Median on Interstate I-295 near Prince George which has room to add track, Tucker Swamp which was identified as a potential environmental concern, and the utility line which is parallel to NS alignment/US Route 460. These photos are identified in Exhibit 3-8. The generic Greenfield would be located by identifying and avoiding the Tucker Swamp area, and utilizing the I-295 median to pass through the Petersburg/Hopewell community.

Exhibit 3-7: Northern Greenfield from Suffolk to Hopewell



*Alignment will not be determined until the Tier II Environmental Process is complete.

Exhibit 3-8 Photo Locations along Northern Greenfield from Suffolk to Hopewell



*Alignment will not be determined until the Tier II Environmental Process is complete.

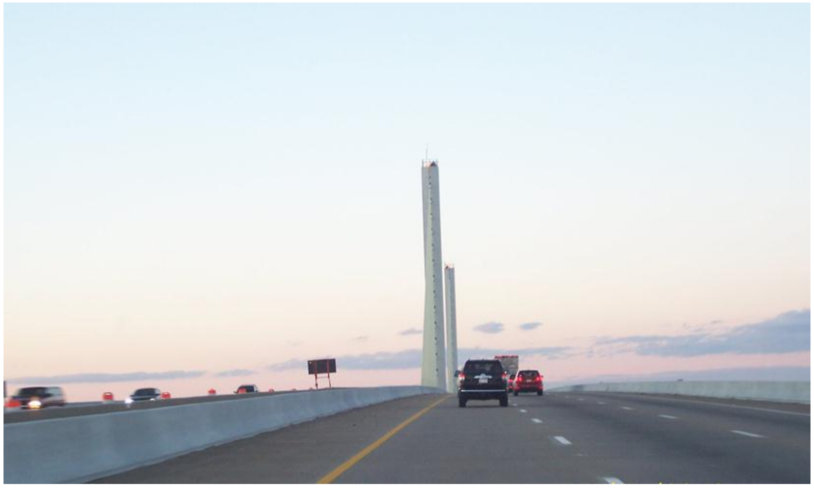


Photo 22: Bridge on I-295 near Hopewell James River.

Photo 23: Median on I-295 near Prince George.

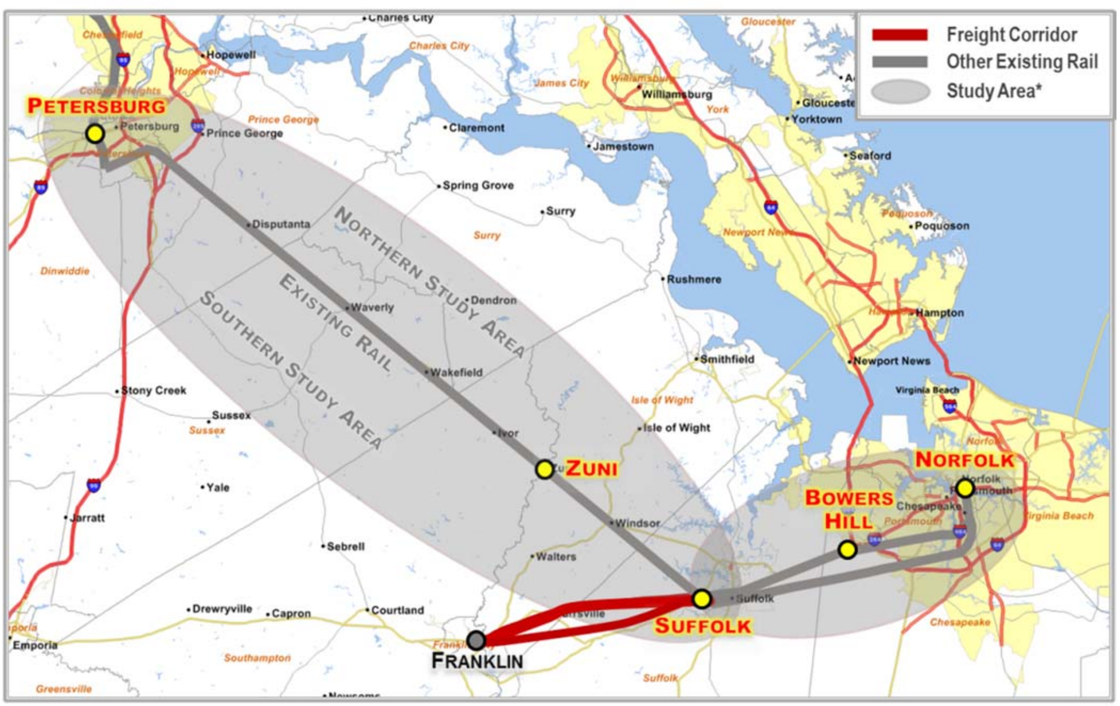
Photo 24: Tucker Swamp at the NS alignment.

Photo 25: Northern greenfield - utility line corridor at Windsor.

3.4.4. EXISTING RAIL – FRANKLIN TO SUFFOLK, AND DOWNTOWN SUFFOLK

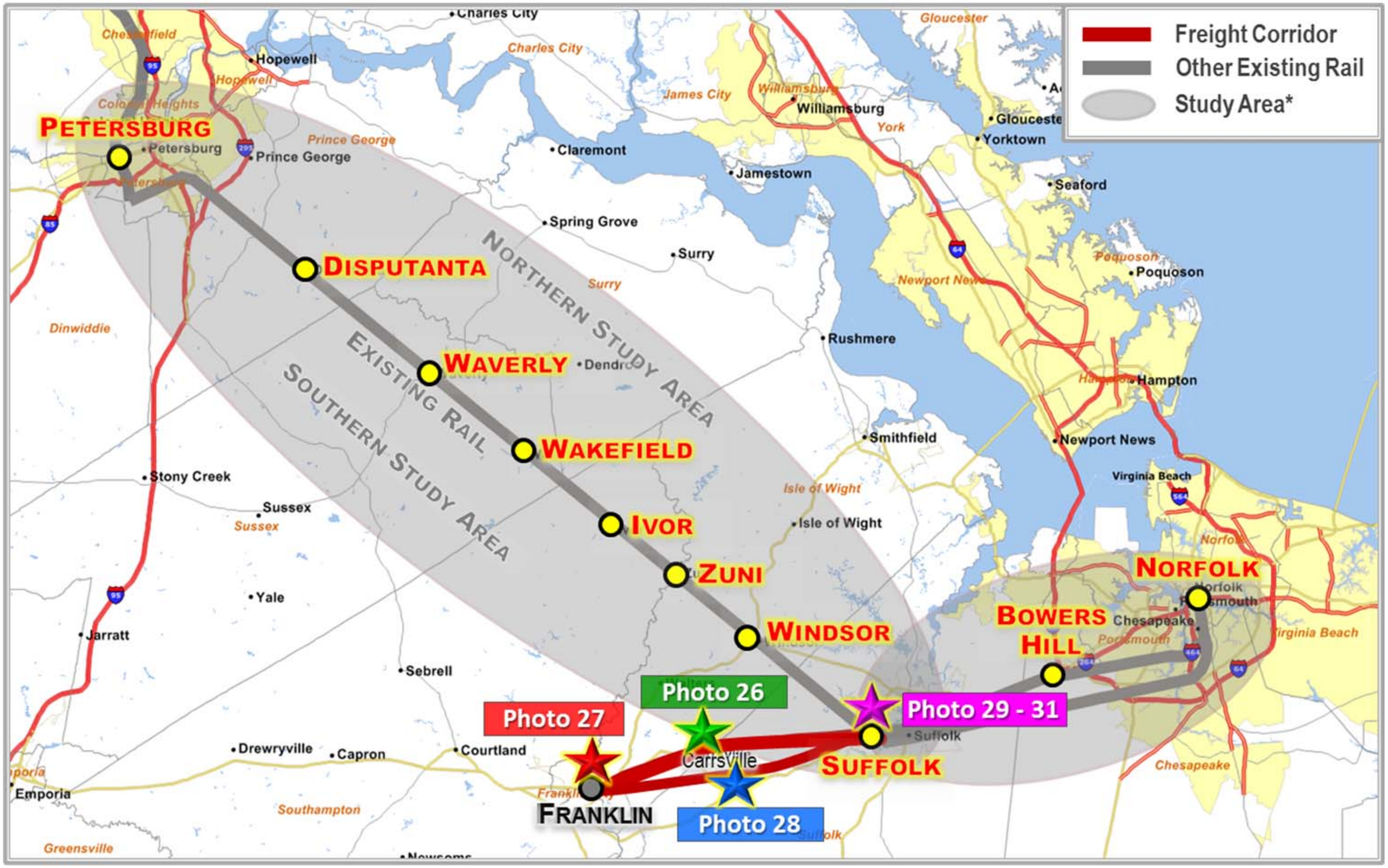
A possible freight rail alternative for developing a dedicated passenger line through downtown Suffolk could alleviate potential conflicts with CSXT double track container trains that now use the CSX Portsmouth subdivision through downtown Suffolk on their way to VPA container port. It is intended for the development of an alternative rail access for CSXT container trains, to avoid conflict with passenger trains through downtown Suffolk on the proposed "V-Line alignment". The existing CSXT and NS freight lines from Franklin to Suffolk (See Exhibit 3-9) have been reviewed in the following photos from 26 through 28. These photos show that the NS line is in good condition, and could be a practical alternative to the CSXT line through downtown Suffolk. Exhibit 3-10 shows the location of these photos along the existing rail line Franklin to Suffolk and downtown Suffolk.

Exhibit 3-9: Franklin to Suffolk Freight Alternative



*Alignment will not be determined until the Tier II Environmental Process is complete.

Exhibit 3-10: Photo Locations along Franklin to Suffolk Freight Alternative



*Alignment will not be determined until the Tier II Environmental Process is complete.

Photo 26: CSXT Portsmouth subdivision near Franklin. This is current route for CSXT double stack trains.

Photo 27: NS Bridge over CSXT in Franklin.

Photo 28: Welded rail on NS line from Franklin to Suffolk.

Photo 29 shows the roadway that has displaced about 0.8 miles of railroad right-of-way in downtown Suffolk. It extends from the junction of W Constance road/Prentis Street to the Suffolk Seaboard Station. This was a recently constructed roadway which can be seen in Photo 30. In the vicinity of this old seaboard Suffolk station, there is a development on the other side of the CSXT tracks while there is more room to add track if necessary, on the station side. This suggests that the station be shifted back from its current place to make room for added tracks if the CSXT freight traffic cannot be relocated.

Photo 29: Rail right-of-way taken over by Highway close to Suffolk Old Station.

Photo 30: Seaboard Suffolk Old Station.

To implement the Franklin to Suffolk rerouting of CSXT trains, a grade separation may be needed at the rail junction in downtown Suffolk, as shown in Photo 31.

Photo 31: Part of Franklin to Suffolk freight reroute.

3.4.5. "V" LINE EXISTING RAIL – SUFFOLK TO NORFOLK

The corridor from Suffolk to Norfolk is heavily built up, and there are only a limited number of ways of getting between the two cities because of the significant environmental obstacles as well, particularly, the Dismal Swamp.

- Currently NS has a double tracked mainline from Suffolk to Norfolk which carries heavy freight traffic and additionally, the Virginia Department of Rail and Public Transportation (DRPT) has purchased up to three slots for operating Amtrak passenger service over this line into downtown Norfolk.
- However, NS also has a parallel, partially abandoned line, the "V Line" which could provide a dedicated passenger access route into downtown Norfolk separate from the current freight line. DRPT's Hampton Roads Tier I FEIS has selected this route.

As a result, this analysis assumes that the "V" line alternative will be followed, for the following reasons. The "V" line alternative follows the US Route 460 alignment north of the Dismal Swamp, whereas the existing NS mainline goes directly across the swamp. Adding tracks to the existing NS alignment would either entail filling parts of the swamp – unlikely to be environmentally acceptable – or else bridging the swamp, which would be very expensive. It is likely that the Dismal Swamp issue alone would be sufficient to environmentally disqualify such an alternative. There are additional operational issues along the NS mainline at Portlock Yard which would also be bypassed by using the proposed "V Line" alignment.

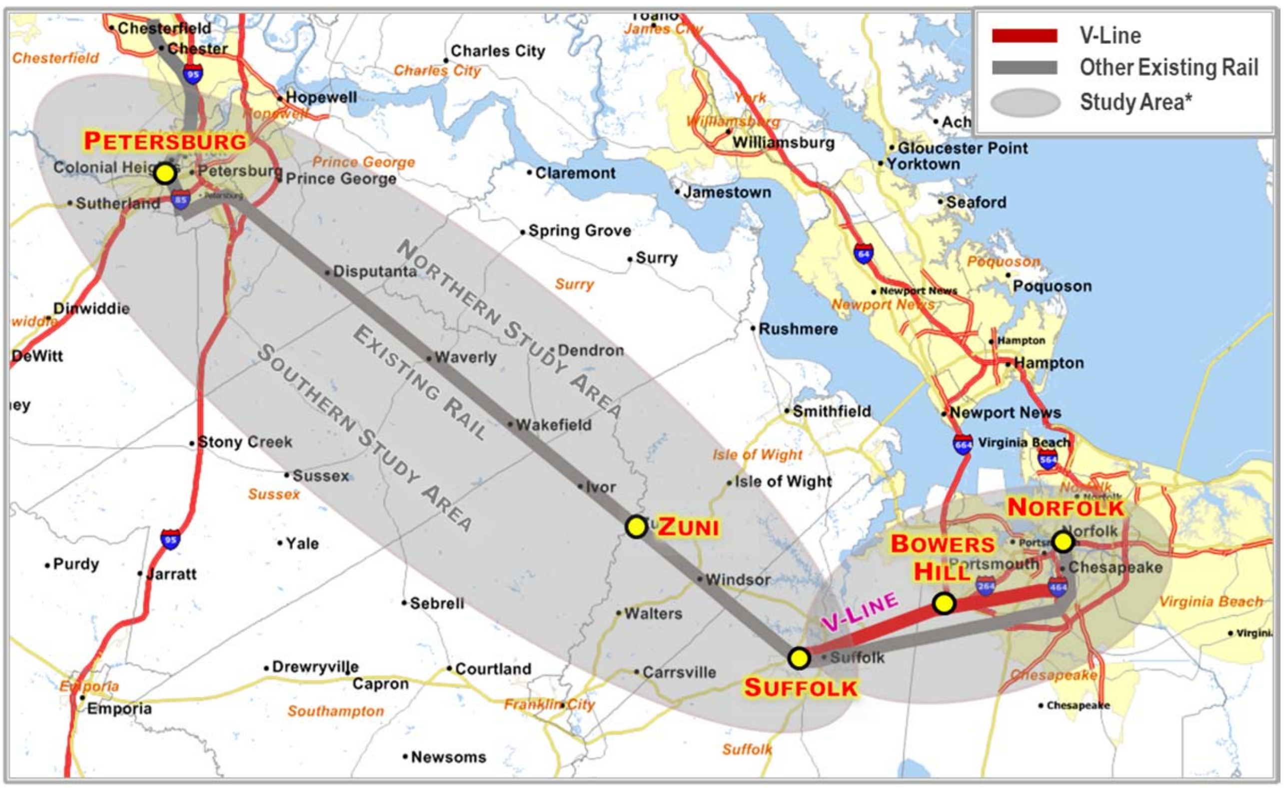
However, development of the "V Line" option is not without some challenges:

- At Algren on the west side of Suffolk, a new connection track is needed to link the Norfolk Southern mainline to the CSXT Portsmouth subdivision through Suffolk.
- From Algren through Suffolk, passenger trains would need to share tracks with CSXT double stack trains to a connection with the Commonwealth Railway, which provides access to the Portsmouth Marine Terminal at Craney Island. As already described, the right-of-way is highly restricted through downtown Suffolk, since the abandoned former Virginian right-of-way has been converted into a city street (Prentis Street) occupying the land that would be needed to develop a separated passenger alignment through this area.
- Beyond the Commonwealth Railway, the CSXT Portsmouth subdivision is lightly-used to its junction with the abandoned "V-Line" in the vicinity of the Hampton Roads Executive Airport.

- The tracks are in place, but the "V-Line" is out of service from the Hampton Roads Executive Airport to the Cavalier Industrial Park, just west of Cavalier Boulevard.
- From the Cavalier Industrial Park, crossing the Western Branch of the Elizabeth River on a lift bridge, to NS Main Line junction north of Portlock Yard (Seaboard Avenue and Richmond Streets in South Norfolk in Chesapeake) the "V-Line" is lightly used for industrial traffic.
- From the "V" Line junction into the Harbor Park train station (Seen in Photo 36), passenger trains must share right-of-way with the NS main line. This section includes a second major bridge crossing the Southern Branch of the Elizabeth River just south of the Harbor Park station. In this area, there is an out-of-service former Virginian Railroad bascule bridge, which is proposed to be rehabilitated and restored to service so as not to displace freight capacity of the existing NS main line.

These challenges will be shown in the following photos 32 through 36 covering Portsmouth, Chesapeake, and Norfolk following the V-line track from Norfolk to Suffolk (as shown in Exhibit 3-11). The location of these photos are shown in Exhibit 3-12.

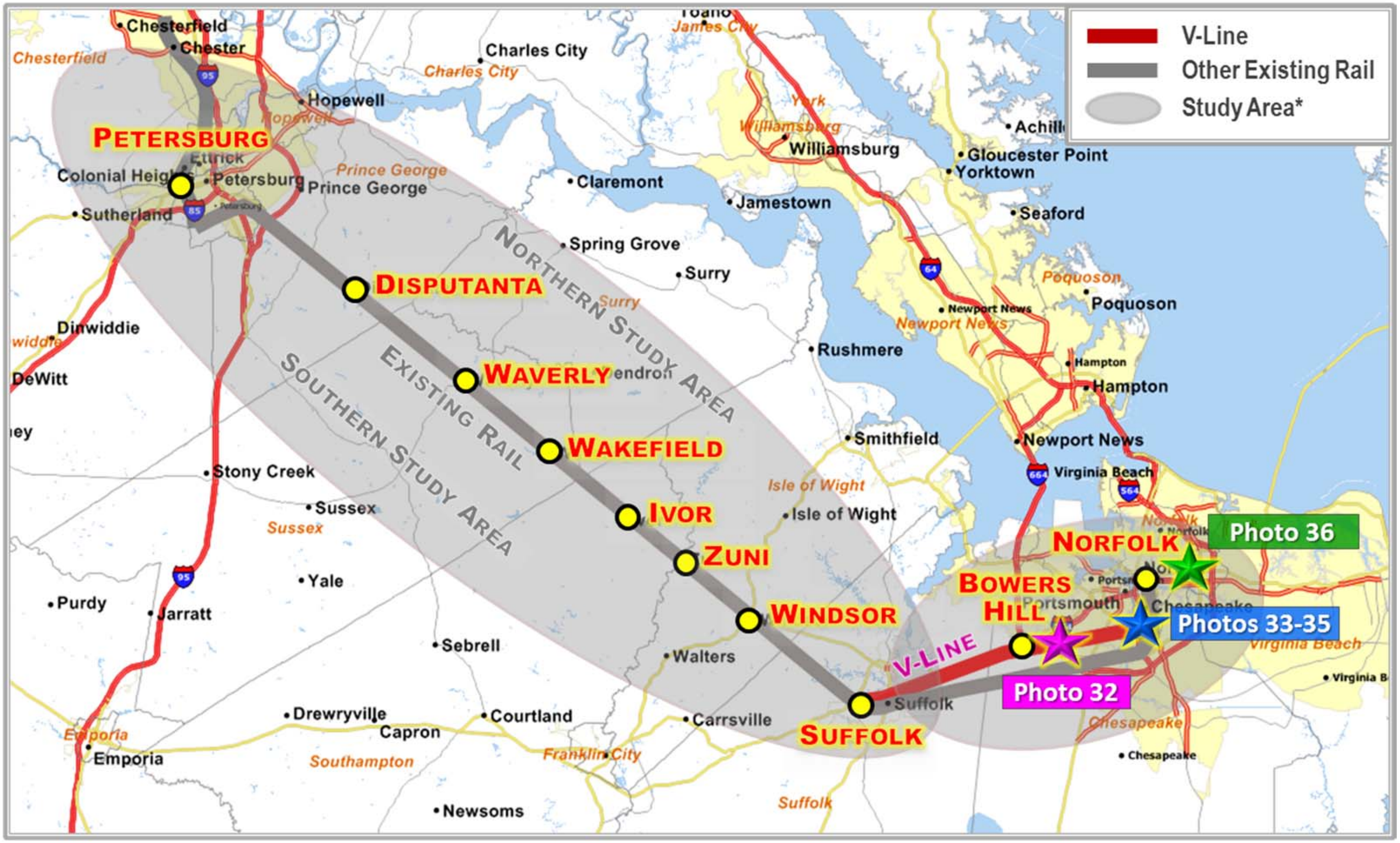
Exhibit 3-11: Existing V-line from Norfolk to Suffolk



*Alignment will not be determined until the Tier II Environmental Process is complete.

The following photos from 32 through 36 show abandoned tracks near I-64 and I-664, railroad crossings in Portsmouth, the humped railroad crossing at Chesapeake, tracks that requires roadwork and the improved Harbor Park station in Norfolk (See Exhibit 3-12 for location of these photos).

Exhibit 3-12: Photo Locations along Existing V-line from Norfolk to Suffolk



*Alignment will not be determined until the Tier II Environmental Process is complete.

Photo 32: Abandoned V-Line under the Bridge at Rotunda under I-664 and I-64.

Photo 33: Railroad crossing at Chapin Road in Portsmouth.

Photo 34: V-line joining the NS Main Line in South Norfolk, at the north end of Portlock Yard.

Photo 35: Humped Railroad Crossings at Park Avenue in Portsmouth.

Photo 36: Harbor Park Station in Norfolk.

3.5. INFRASTRUCTURE CAPITAL COSTS

In addition to the Engineering Assessment, a capital costing methodology was developed to identify infrastructure rolling stock (equipment) costs and land costs. Land costs are presented separately, as a placeholder for access to railroad rights-of-way and for procurement of additional privately owned property where required to construct new passenger rail infrastructure.

The Engineering Assessment for the Vision Plan is being conducted at a feasibility level of detail and accuracy. Exhibit 3-13 highlights the levels of accuracy associated with typical phases of project development and engineering design. A 30% level of accuracy is associated with the evaluation of project feasibility; while the level of accuracy of 10% is achieved during final design and production of construction documents. This phase of the study is only the first step in the project development process. As shown in Exhibit 3-13, the cost estimate is intended to be a mid-range projection with equal probability of the actual cost moving up or down.

Exhibit 3-13: Engineering Project Development Phases and Levels of Accuracy Development

Development Phases	Approximate Engineering Design Level*	Approximate Level of Accuracy**
Feasibility Study	0%	+/- 30% or worse
Project Definition/Advanced Planning	1-2%	+/- 25%
Conceptual Engineering	10%	+/- 20%
Preliminary Engineering	30%	+/- 15%
Pre-Final Engineering	65%	+/- 15%
Final Design/Construction Documents	100%	+/- 10% or better

*Percent of *Final Design*. **Percent of actual costs to construct.
Table prepared by Quandel Consultants, LLC.

The first step in the Engineering Assessment is to divide each corridor into segments. Route segments for existing railroad rights-of-way generally begin and end at major railroad control points or rail stations. For greenfield alignments, segments begin and end at stations or junction points. Typical corridors are divided into three to five route segments. Field inspections of the corridors have been conducted and reviewed at landscape level.

A systematic engineering planning process will be used to conduct the Engineering Assessment using the five basic costing elements:

- Guideway and Track Elements
- Structures – Approaches, Flyovers, Bridges and Tunnels
- Systems
- Crossings
- Stations and Maintenance Facilities

Three auxiliary costing elements have been defined in the chapter as follow:

- Right-of-Way and Land
- Vehicles
- Professional Services & Contingencies

The Engineering Assessment will be based on these eight costing elements. In addition to the field inspections and extensive work with GIS and railroad track charts, the assessment will include a thorough review of the alignment studies and estimate the costs.

3.5.1. INFRASTRUCTURE CAPITAL COSTS DEVELOPMENT

The infrastructure capital costs are summarized in this section of the chapter were similar to that presented in Preliminary Vision Plan and have been updated to 2012 dollars. The unit cost data base and corridor infrastructure costs are conceptual in nature and appropriate for a Vision Plan Feasibility Study. The costs will be further refined in future phases of work when the Alternatives Analysis for the Tier 1 and Tier 2 EIS work is undertaken.

The infrastructure capital unit costs used in the development of the preliminary capital cost estimates were developed from TEMS library of HSR unit costs. Peer panels, freight railroads and construction contractors have reviewed these costs. In addition, a summary validation was completed comparing the TEMS unit costs with unit costs used in regional rail studies around Virginia. Capital cost categories include:

- Land and right-of-way
- Sub-grade, structures and guideway
- Track
- Signals and communications
- Electrification
- Demolition
- Stations
- Maintenance and facilities
- Highway and railroad crossings
- Fencing and corridor protection

In addition to the engineering assessment, the capital costing methodology identifies rolling stock (equipment) costs and land costs. Land costs are presented separately, as a placeholder for access to railroad rights-of-way and for procurement of additional privately owned property where required to construct new passenger rail infrastructure.

Using the Engineering News Record Construction Cost Index (ENR CCI) Indices, unit costs used in this preliminary/initial portion of the Vision Plan study were adjusted for geographic region and annual escalation. Unit Prices will be adjusted to Regional Conditions and Escalate from 2009 to 2012. The following adjustment will be made:

- Unit Prices were based on the recent Rocky Mountain Rail Authority Business Plan for Denver region which was developed in 2009 dollars.
- From ENR CCI Analysis, the Denver to Hampton Roads adjustment is 97 percent, as the benchmark prices are slightly higher in the Denver area than they are in Hampton Roads.
- According to ENR CCI, National Cost Indices cost increases from 2009 to 2012 is the ratio of ENR CCI for 2012 divided by that of 2009[5] which is 1.085.

With the Regional Adjustment Factor of 0.97, and inflation of 1.085, the Escalation Factor from the Denver regional study of 2009 to Hampton Roads 2012 costs is the product of 0.97 * 1.085, which is 1.05.

The unit costs in the following section were estimated by applying this adjustment factor to the previous developed representative unit costs in previous TEMS work for the Midwest Regional Rail Authority high speed rail studies and for the Rocky Mountain Rail Authority High Speed Rail studies (as discussed earlier in Preliminary Vision Plan report).

[5] http://www.cahighspeedrail.ca.gov/assets/0/152/302/314/288d8ea6-bf10-4e14-80fc-fc92bd4ba48a.pdf and methodology based on Unit Price Regional & Escalation Analysis Rocky Mountain Rail Authority (RMRA), High Speed Rail Feasibility Study http://rockymountainrail.org/documents/RMRA_HSRBP_Appendix_F_03.2010.pdf

3.5.2. RAIL CAPITAL UNIT COSTS

The base set of unit costs addresses typical passenger rail infrastructure construction elements including: roadbed and trackwork, systems, facilities, structures, and grade crossings.

TRACKWORK AND LAND ACQUISITION

The FRA requires that passenger trains operating on the general railroad system comply with stringent crashworthiness standards. For the purposes of defining requirements necessary to proceed with the study and in order to develop planning level capital costs, it has been assumed that highway traffic and adjacent high speed trains will be separated by concrete barriers. On tangent highway and track segments, there exists a small probability that automotive vehicles will leave the highway. Thus, protection against highway traffic incursions into the high speed rail median would be provided using NCHRP Report 350 Level 5 highway concrete barrier walls. In curved median segments, where accidents are more likely, we have planned for NCHRP Level 6 barriers. It is anticipated that high speed rail systems will be separated from the freight rail corridors by at least 25 feet between track centers where practicable. Chain link fencing will be provided throughout the system in all corridors to prevent the intrusion of trespassers and animals. These planning assumptions may be subject to modification as a result of federal or state rule making.

Land acquisition costs for right-of-way owned and controlled by the railroad industry is always an issue when attempting to introduce new passenger rail service. Since its inception, Amtrak has had the statutory right to operate passenger trains over freight railroad tracks and rights-of-way. When using freight tracks, Amtrak is required to pay only avoidable costs for track maintenance along with some out-of-pocket costs for dispatching.[6]

Amtrak's payments do not include any access fee for the use of a railroad's tracks or its rights-of-way. Amtrak's federal statutory right-of-access has never required such a payment, and therefore, Amtrak avoids paying a fee or "rent" for occupying space on privately held land and facilities.

However, this study assumes a cost for access based on estimated across-the-fence land values would be included as part of the up-front capital expense, and would be used to purchase the rights to use the underlying railroad rights-of-way for the passenger service. It is assumed that railroads would receive this compensation in cases where the construction of a dedicated high speed passenger track is on their property. If new track cannot be constructed within the existing railroad rights-of-way, then this cost would fund the possible acquisition of adjacent property.

Elsewhere land will need to be purchased directly from land owners. Where highway rights-of-way are proposed, the study assumes that right-of-way or air rights access would be granted by appropriate authority at no cost to the rail system.

[6] However, these payments do not cover all of the freight railroads' incremental costs associated with dispatching Amtrak's passenger trains. Railroad costs increase due to delays caused by Amtrak's tightly scheduled trains. Track capacity constraints and bottlenecks create unreliable conditions where train delays often become unavoidable. While federal regulations give passenger trains dispatch priority, railroad dispatchers often encounter congestion where it becomes difficult to control traffic and adhere to Amtrak's timetables. In some cases, Amtrak will offer the railroads a payment to provide on-time passenger train performance. On heavily used line segments, however, these incentive payments only partially compensate a railroad for the costs of increased delay, and some railroads simply refuse to accept incentive payments. On lightly used lines, the economic rationale for making these payments is questionable since passenger trains cause very little delay on such tracks.

The outright purchase of land is not the only method whereby railroads could receive compensation for access to railroad rights-of-way. Commuter rail development provides examples of various types of payments for access rights. Some of these projects involved the purchase of the railroad rights-of-way while others provide up-front capital improvements in return for access to a railroad's tracks. The actual methods of payment remain to be determined during negotiation, and may depend on the importance of the track to the freight railroad as well as the level of capital to be invested by the passenger rail authority.

One area of possible concern is the freight railroads' ability to retain operating control over their rights-of-way. Whenever transit systems have paid full price to acquire a freight rail line, as on some commuter rail projects, the transit agencies have assumed operating control over the property. However, this study has assumed that the freight railroads would retain dispatching control over these rights-of-way. The railroads would have the right to use the increased capacity provided by the passenger system for its high speed freight services.

For budgetary purposes, this study assumes an over-the-fence methodology for appraising the maximum value of railroad rights-of-way. To estimate land values, two land uses alongside each corridor are identified:

- Rural (e.g., farmland)
- Urban (e.g., high density residential, commercial, and industrial areas)

The value of a 50-foot wide right-of-way was established for each land use and the total land cost of the railroad corridor was estimated.

A 100-foot right-of-way will be assumed for the greenfield, except where the alignment falls within an existing publicly-owned right-of-way, such as a highway or street alignment, no cost to the project for that particular right-of-way has been assumed. Where the geometric requirements take the alignment outside of the public right-of-way, impacted parcels will be evaluated and a square foot quantity calculated. A unit cost per acre was developed in conjunction with other studies.

Exhibit 3-14 shows the unit cost for track work and land acquisition in 2012 dollars by project element.

Item No.	Description	Unit	Unit Cost (Thousands of $2012)
1.1	HSR on Existing Roadbed (Single Track)	per mile	$1,246.11
1.2	HSR on Existing Roadbed (Double Track)	per mile	$2,492.42
1.3	HSR on New Roadbed & New Embankment (Single Track)	per mile	$1,872.29
1.4	HSR on New Roadbed & New Embankment (Double Track)	per mile	$3,355.65
1.5	HSR Double Track on 15' Retained Earth Fill	per mile	$17,724.11
1.6	Timber & Surface w/ 33% Tie replacement	per mile	$278.62
1.7	Timber & Surface w/ 66% Tie Replacement	per mile	$415.33
1.8	Relay Track w/ 136# CWR	per mile	$444.29
1.9	Freight Siding	per mile	$1,144.50
1.10	Passenger Siding	per mile	$1,726.77
1.11	NCHRP Class 6 Barrier (on curves)	lineal ft.	$1.38
1.12	NCHRP Class 5 Barrier (on tangent)	lineal ft.	$0.21
1.13	Fencing, 4 ft. Woven Wire (both sides)	per mile	$63.95
1.14	Fencing, 6 ft. Chain Link (both sides)	per mile	$191.97

1.15	Fencing, 10 ft. Chain Link (both sides)	per mile	$219.65
1.16	Decorative Fencing (both sides)	per mile	$494.45
1.17	Drainage Improvements (cross country)	per mile	$82.83
1.18	Drainage Improvements in Median or along highway	per mile	$662.56
1.19	Land Acquisition Urban and Resort (100' of ROW)	per mile	$410.35
1.20	Land Acquisition Rural (100' of ROW)	per mile	$136.82
1.21	#33 High Speed Turnout	each	$712.73
1.22	#24 High Speed Turnout	each	$564.67
1.23	#20 Turnout Timber	each	$155.59
1.24	#10 Turnout Timber	each	$86.55
1.25	#20 Turnout Concrete	each	$312.45
1.26	#10 Turnout Concrete	each	$148.06
1.27	#33 Crossover	each	$1,425.56
1.28	#20 Crossover	each	$625.76
1.29	Elevate & Surface Curves	per mile	$72.76
1.30	Curvature Reduction	per mile	$493.18
1.31	Elastic Fasteners	per mile	$102.88

3.5.3. STRUCTURES: APPROACHES, FLYOVERS, BRIDGES, AND TUNNELS

A complete inventory of bridges has been developed for each existing rail route from existing track charts. For estimating the cost of new bridges on either green field alignments or along existing rail beds, conceptual engineering plans will be used for a bridge to carry either single or double tracks over highways, streams, valleys, and rivers. Some bridges require rehabilitation on the abutments and superstructure. This type of work includes pointing of stone abutment walls, painting of bridges, and replacement of bearings. Many of the major bridge cost estimates will be estimated only as placeholders, which will be subject to more detailed engineering analysis in the future. Tunneling costs lie within the $20-73 thousand per linear foot range, where the higher cost was from the long undersea English Channel tunnel; but the estimates in Exhibit 3-15 were considered as benchmarks for the probable cost of tunnels and these costs will be used in this study. Exhibit 3-16 details the unit costs in 2012 dollars.

Exhibit 3-15: Unit Capital Costs, Structures in $2012

Item No.	Description (Bridges-under)	Unit	Unit Cost (Thousands of $2012)
2.1	Four Lane Urban Expressway (Rail over Highway)	each	$6,067.52
2.2	Four Lane Rural Expressway (Rail over Highway)	each	$5,051.03
2.3	Two Lane Highway (Rail over Highway)	each	$3,832.50
2.4	Rail (New Rail over Existing Rail)	each	$3,832.50
2.5	Minor river	each	$1,016.48
2.6	Major River	each	$10,162.30
2.7	Double Track High (50') Level Bridge	per LF	$15.27
2.8	Rehab for 110	per LF	$17.61
2.9	Convert open deck bridge to ballast deck (single track)	per LF	$5.83

2.10	Convert open deck bridge to ballast deck (double track)	per LF	$11.77
2.11	Single Track on Flyover/Elevated Structure	per LF	$5.30
2.12	Single Track on Approach Embankment w/ Retaining Wall	per LF	$3.71
2.13	Double Track on Flyover/Elevated Structure	per LF	$8.48
2.14	Double Track on Approach Embankment w/ Retaining Wall	per LF	$6.89
2.15	Ballasted Concrete Deck Replacement Bridge	per LF	$2.65
2.16	Land Bridges	per LF	$3.29
2.17	Four Lane Urban Expressway (Highway over Rail)	each	$3,675.64
2.18	Four Lane Rural Expressway (Highway over Rail)	each	$2,619.06
2.19	Two Lane Highway (Highway over Rail)	each	$2,388.06
2.20	Rail (Existing Rail over New Rail)	each	$7,667.55
2.21	Two Bore Long Tunnel	route ft.	$46.67
2.22	Single Bore Short Tunnel	lineal ft.	$26.52

3.5.4. SYSTEMS

The capital cost estimates for this study include costs to upgrade the train control and signal systems. Unit costs for system elements are shown in Exhibit 3-16. Under the 110-mph or higher speed scenarios, the signal improvements include the added costs for a vital Positive Train Control (PTC) signal system. The FRA "Cab signal rule" requires that wayside signals be displayed within the engine cab for any speeds of 80-mph or high. The PTC system would do this. However it should be noted that NS policy prohibits exceeding 79-mph on its tracks. For this study PTC would only need to be applied only to new dedicated tracks and not the existing NS freight tracks.

Most US railroads that allow or provide passenger and freight service operate under manual control with wayside signals. Centralized traffic control (CTC) signaling is provided on busy corridors including Amtrak's Northeast Corridor. FRA requires that passenger service exceeding 79-mph operate with cab signaling/automatic train protection or automatic train stop to provide protection against operator errors. In addition, FRA is currently sponsoring demonstration projects to develop a universal communications based train control system, known as positive train control or PTC. New high speed passenger service will include sophisticated signal systems to comply with FRA mandates and provide safe, reliable operations. Such signal systems include train borne components and wayside equipment such as track circuits, switch operators, and wayside detectors for protection against intrusion, high water, hot bearings and dragging equipment.

Modern signal systems rely on digital communication systems for data transmission using radio, fiber optic cables or a combination or the two. In addition, the communication system provides radio for operations, supervisory control and data acquisition for power systems, passenger station public address, etc. Wayside space must be provided for ducts and enclosures to house signal and communication components.

Electrified high speed rail options require traction power substations and distribution facilities. Electric utility is expected to provide substations, transmission equipment and connections to the utility network with such costs covered in the utilization charges. As such, it is assumed that the electric utility would amortize the costs for bringing power to the substations, so the costs of modifications to the utility's grid are not included in the electrification cost estimate. Typical requirements for electrification include substations at 25 mile intervals and distribution conductors. In the case of electrified rail systems, overhead catenary conductors provide power to the train pantograph and the rails serve as return conductors. The catenary conductors are supported by poles and cross arms spaced at roughly 100-150 foot intervals. The catenary system contact wire is generally located 17.5 to 23 feet above the top of the rail. Additional electrical clearance or high voltage insulation is required to overhead bridge structures.

Exhibit 3-16: Unit Capital Costs, Systems, in $2012

Item No.	Description	Unit	Unit Cost (Thousands of $2012)
3.1	Signals for Siding w/ High Speed Turnout	each	$1,591.23
3.2	Install CTC System (Single Track)	per mile	$229.62
3.3	Install CTC System (Double Track)	per mile	$376.52
3.4	Install PTC System	per mile	$181.36
3.5	Electric Lock for Industry Turnout	each	$129.29
3.6	Signals for Crossover	each	$878.39
3.7	Signals for Turnout	each	$501.98
3.8	Signals, Communications & Dispatch	per mile	$1,633.02
3.9	Electrification (Double Track)	per mile	$3,266.14
3.10	Electrification (Single Track)	per mile	$1,633.02

3.5.5. CROSSINGS

The treatment of grade crossings to accommodate 110-mph operations on existing rail is a major challenge to planning a high speed rail system. Highway/railroad crossing safety plays a critical role in future project development phases. A variety of devices were considered to improve safety including roadway geometric improvements, median barriers, barrier gates, traffic channelization devices, wayside horns, fencing and the potential closure of crossings. Greenfield routes were developed with grade separations at street and roadway crossings. Exhibit 3-17 details the unit costs for highway and railroad grade crossings.

Exhibit 3-17: Unit Capital Costs, Crossings, in $2012

Item No.	Description	Unit	Unit Cost (Thousands of $2012)
4.1	Private Closure	each	$104.15
4.2	Four Quadrant Gates w/ Trapped Vehicle Detector	each	$617.38
4.3	Four Quadrant Gates	each	$361.45
4.4	Convert Dual Gates to Quad Gates	each	$188.26
4.5	Conventional Gates single mainline track	each	$208.30
4.6	Conventional Gates double mainline track	each	$257.30
4.7	Convert Flashers Only to Dual Gate	each	$62.79
4.8	Single Gate with Median Barrier	each	$225.91
4.9	Convert Single Gate to Extended Arm	each	$18.77
4.10	Precast Panels without Roadway Improvements	each	$100.44
4.11	Precast Panels with Roadway Improvements	each	$188.26

3.5.6. STATION/MAINTENANCE FACILITIES

Passenger stations and parking facilities include platforms, escalators/elevators and other circulation elements, passenger ticketing and waiting facilities, lighting security, and station administration facilities.

The terminal stations may require four tracks for passenger boarding, train layover and light maintenance.

A maintenance facility with sufficient capacity to service the fleet is required. The facility must provide space and equipment to service the rolling stock and maintain the track structure and systems. Storage tracks can be expanded as the fleet grows. Sophisticated component repair may be subbed out to contract shops. It is anticipated that the maintenance facility for a non-electrified system will be less sophisticated than that of an electrified rail system. Exhibit 3-18 shows the unit costs for types of stations, terminals, and maintenance facilities.

Exhibit 3-18: Unit Capital Costs, Railroad Station/Maintenance Facilities, in $2012

Item No.	Description	Unit	Unit Cost (Thousands of $2012)
5.1	Full Service - New - Low Volume - 500 Surface Park	each	$5,303.03
5.2	Full Service - Renovated - Low Volume- 500 Surface Park	each	$4,242.42
5.3	Terminal - New - Low Volume - 500 Surface Park	each	$7,954.55
5.4	Terminal - Renovated - Low Volume - 500 Surface Park	each	$6,363.64
5.5	Full Service - New- High Volume - Dual Platform - 1000 Surface Park	each	$10,606.06
5.6	Terminal - New- High Volume - Dual Platform - 1000 Surface Park	each	$15,909.09
5.7	Heavy Maintenance Facility (non-electrified track)	each	$84,848.48
5.8	Heavy Maintenance Facility (electrified track)	each	$106,060.61
5.9	Layover Facility	lump sum	$10,606.06

3.5.7. OTHER COSTS

CONTINGENCY

Contingency costs will be added as an overall percentage of the total construction cost. Contingencies are an allowance added to the estimate of costs to account for items and conditions that cannot be realistically anticipated. The contingency is expected to be needed as the project develops. The contingency is estimated at 30 percent of the construction cost elements. This contingency included 15%+ for design contingency and 15%+ for construction contingency.

PROFESSIONAL SERVICES AND ENVIRONMENTAL

The project elements included in the Professional Services category are design engineering, program management, construction management and inspection, engineering during construction, and integrated testing and commissioning. For a project of this size, an overall program manager with several section designers is needed to provide conceptual engineering, preliminary engineering, environmental studies, geotechnical engineering, final engineering and engineering during construction. Field and construction management services and integrated testing services and commissioning of various project elements also are required. Professional services and other soft costs required to develop in this study have been estimated as a percentage of the estimated construction cost and are included in the overall cost estimates as a separate line item. These costs include, as a percentage of construction cost:

- Design engineering and related studies 10%
- Insurance and Bonding 2%
- Program Management 4%
- Construction management and inspection 6%
- Engineering services during construction 2%
- Integrated Testing and Commissioning 2%
- Erosion Control and Water Quality Mgt 2%

PLACEHOLDERS

The capital costs include allocation for special elements (placeholders) as conservative estimates for large and/or complex engineering projects that have not been estimated on the basis of unit costs and quantities. Placeholders provide lump sum budget approximations based on expert opinion rather than on an engineering estimate and are shown in the unit costs as lump sum items. Placeholders are used where detailed engineering requirements are not fully known. These costs will require special attention during the project development phase. The following list highlights some of the key placeholder costs that are assumed in this analysis:

- Costs for new stations in urban areas, such as for Bowers Hill Station
- Major tunnel improvements
- Rail capacity expansion
- Maintenance and layover facilities

3.5.8. CAPITAL COST SUMMARY

The capital cost for rail corridor infrastructure for the four Development Steps (See Chapter 1 Exhibit 1-1) of implementing high speed passenger rail for the Norfolk-Richmond corridor is summarized in the following Exhibit 3-19. These costs will be further developed as part of the following Phase of Analysis work for the Vision Plan.

Exhibit 3-19: Upgraded Capital Costs for the Norfolk-Richmond Corridor

HAMPTON ROADS PASSENGER RAIL INFRASTRUCTURE COST SUMMARY BY DEVELOPMENT STEP *$2012 ($millions)*				
STEP 1	**Construction Cost**	**Design and Construction Contingency**	**Professional Services and Environmental**	**TOTAL COST**
Norfolk – Petersburg Max Speed: 79 mph No. of Trains: 1-3* Infrastructure: Shared Track NS** Station: Staples Mill only/Norfolk	**$114.000**	**N/A**	**N/A**	**$114.000**
STEP 2				
Norfolk – Richmond Max Speed: 79-90 mph No. of Trains: 4-6 Infrastructure: Shared Track V Line** Station: Main Street/Bowers Hill	**$205.498**	**$61.649**	**$57.539**	**$324.686**
STEP 3				
Norfolk – Richmond Max Speed: 110 mph No. of Trains: 8-12 Infrastructure: Dedicated Track V Line Station: Main Street/Bowers Hill	**$1,017.237**	**$305.171**	**$284.826**	**$1,607.234**
STEP 4				
Norfolk – Richmond Max Speed: 150 mph No. of Trains: 12-16 Infrastructure: Dedicated Electric Track V Line Station: Main Street/Bowers Hill	**$1,817.418**	**$545.225**	**$508.877**	**$2,871.520**

Note: The development of costs for Step 3 and Step 4 are highly conceptual, see the unit costs in Exhibit C-2, page C-39 of "Hampton Roads High-Speed and Intercity Passenger Rail, Preliminary Vision Plan, Progress Report C – Preliminary Infrastructure Analysis", July 2012, TEMS, Inc. Development of much more detailed and accurate costs are anticipated in the next Phase of work.
* Two additional trains are planned in the near future by DRPT.
** Norfolk Southern (NS) does not permit passenger train maximum authorized speed in excess of 79 mph on any NS track. Where the V-line (former Virginian Railway) has existing freight services, maximum authorized speed for passenger trains will be 79 mph. Along the Algren – Kenyon portion of the V-line (over which NS freight rail service has been formally abandoned), passenger rail planners may consider speeds above 79 mph.

In the cost summary table, the capital costs for Step 1 and Step 2 are as reported by DRPT and Environmental documentation. Step 2 costs were inflated by 5% to express these costs as 2012 rather than 2010 dollars. The capital costs for Step 3 and Step 4 are developed using the upgraded unit cost data for the Norfolk-Richmond corridors[7].

[7] The development of costs for Steps 3 and 4 was highly conceptual, see the unit costs in Exhibit C-2, page C-39 of *Hampton Roads High-Speed and Intercity Passenger Rail, Preliminary Vision Plan, Progress Report C – Preliminary Infrastructure Analysis,* July 2010, TEMS, Inc.

4 TECHNOLOGY AND OPERATING COSTS DATABASE

This chapter is divided into five subsections: an introduction on the character of the High Speed operations; business models that have been used in different parts of the country, range of technologies that are typically used and also those of future potential; train performance typically obtained by a given technology and discussion on the operating unit costs

4.1. INTRODUCTION

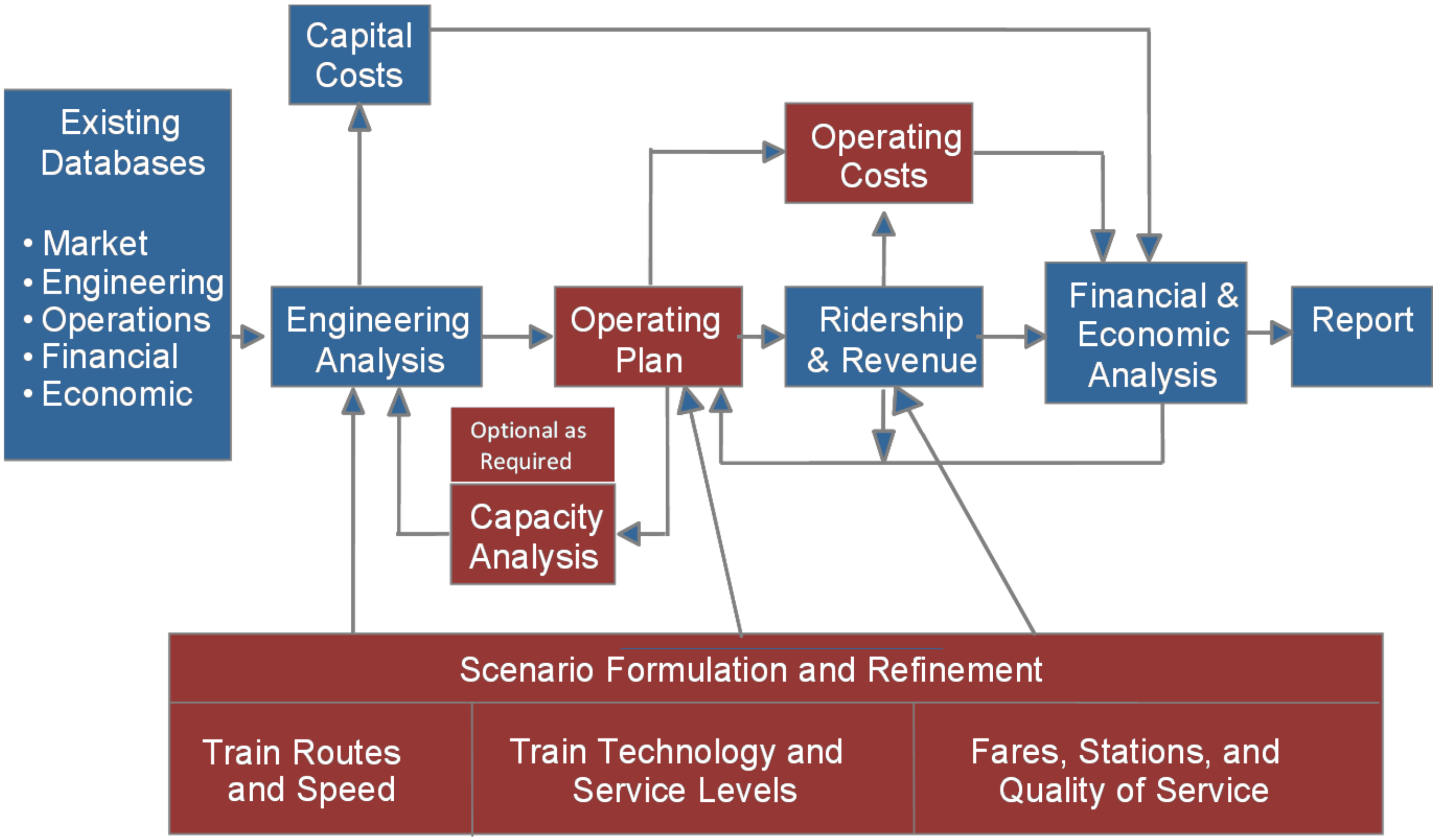
The key element for developing an operating plan for the generic routes is the technology selection from the range of alternative technologies available. In the case of the slower speed alternatives (79-110 mph), the most effective option is using existing railroad rights-of-way and where the volume of freight rail traffic is limited, to share tracks with freight traffic. As speeds and frequency of passenger rail service increase, the ability to share tracks with freight becomes more limited, although if wide enough the right-of-way may still be shared. For very high speeds the ability to even use existing railroad rights-of-way is lost. Of course, sharing track or using freight rail right-of-way may still occur (at lower speeds) in urban areas to gain access to downtown stations, but away from the urban area true high speed service is likely to require a greenfield route – since high speed rail operations need long stretches of straight track and very gentle curves to achieve high speed. Even sharing Interstate highway right-of-way may not be possible since they frequently have curves that are too tight for the faster trains. In general, faster systems have fewer stops. A compromise may be needed to ensure all key communities are served, but this results in a trade-off between end-to-end speed and connecting communities. Each station stop takes three to seven minutes (including deceleration, stop time and acceleration back to speed) so multiple stops soon dramatically increase end-to-end running times.

Given that reasonable high speed rail routes can be developed then the key issue is the technology to be used. In the earlier Chapter 3, the representative routes are discussed. This chapter focuses on the following issues for speeds greater than 90 mph:

- Generic technology categories,
- *LOCOMOTION™* equipment database that was collected for the generic trains, and
- Operating unit costs database.

As seen in Exhibit 4-1 of the interactive analysis process, train routes and speeds; technology and service levels; and fares; stations; and quality of service are all critical inputs in the operating plan process. *LOCOMOTION™* is the software used to calculate train travel times, train schedules for train alternatives, and to recommend train technology and rail system operating strategies. A key requirement for the analysis is to adjust the train size and frequency levels to appropriately match demand, providing enough capacity while still producing acceptable load factors, and respecting the financial constraints on the operation of the system. The results of the interactive analysis are then used to identify the system operating costs.

Exhibit 4-1: Interactive Analysis Process



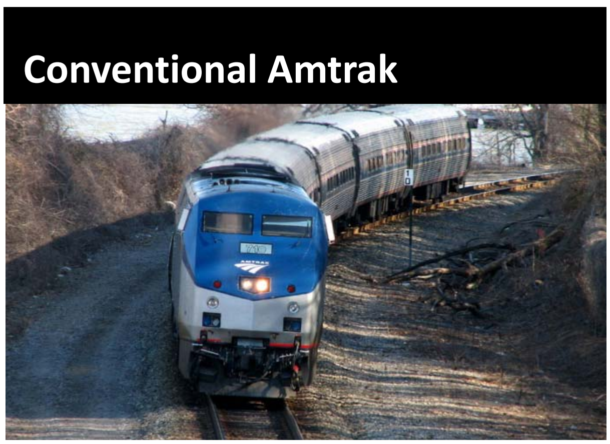
4.2. GENERIC TECHNOLOGY CATEGORIES

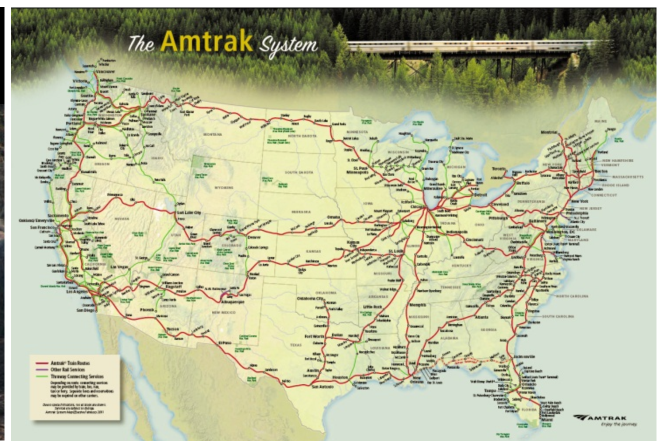
Conventional Rail – 79 mph or less: Conventional trains, as shown in Exhibit 4-2, can operate at up to 79 mph on existing freight tracks. 79 mph represents the highest speed at which trains can legally operate in the United States without having a supplementary cab signaling system on board the locomotive. The key characteristics of these trains are that they:

- Are designed for economical operation at conventional speeds
- Can be diesel or electric powered
- Are non-tilting for simplified maintenance

Conventional rail is used for example by Amtrak in corridors across the country outside the Northeast corridor.

Exhibit 4-2: Conventional Rail – Representative Trains and Corridor Service



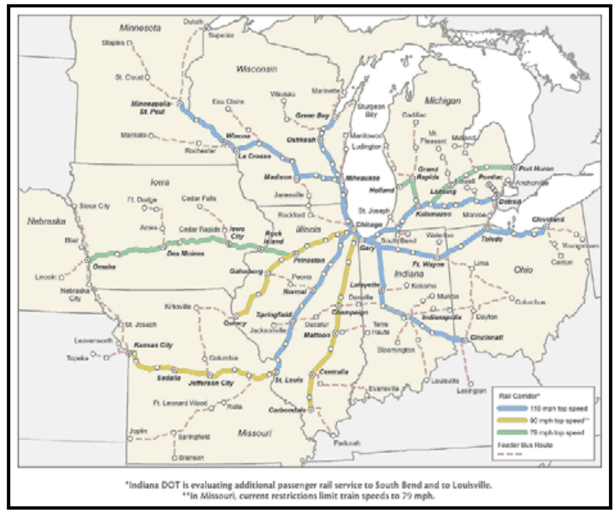


Higher Speed Rail - 110-130 mph: A 110 to 130-mph service can often be incrementally developed from an existing conventional rail system by improving track conditions, adding a supplementary Positive Train Control safety system, and improving grade crossing protection. Tilt capability, built into the equipment can be used to allow trains to go around curves faster, and has proven to be very effective for improving service on existing track, often enabling a 20-30 percent reduction in running times. Trains operating at 110 mph, such as those proposed for the Midwest, Ohio Hub and New York State systems (See Exhibits 4-3), have generally been found to be affordable, produce auto-competitive travel times, and are able to generate sufficient revenues to cover their operating costs. Higher speed trains:

- Are designed for operation above 110 mph on existing rail lines
- Can be diesel or electric powered
- Are usually tilting unless the track is very straight

In the United States, 110-mph service provides a low cost infrastructure option by using existing railroad rights-of-way, and quad-gating crossings, which are relatively low cost options.

Exhibit 4-3: High Speed Rail Shared Use (Diesel) – Representative Trains and Corridor Service



High Speed Rail - The costs of grade separation for 125 mph can easily double the capital cost of a project, as the number of public and private crossings can be as many as two per mile. This is why true high speed rail is typically twice the cost per mile of higher speed rail. Once full grade separation has been accomplished however, speeds can be pushed up to 150 mph or even higher by electrification and the use of Electric train systems. This will tend to improve further the economic return on capital investment.

Representative trains include the Amtrak Acela Electric locomotive hauled train as shown in Exhibit 4-4 below, while initially the Acela speed was limited to 150 mph, it was now being tested at speeds of 160 mph. Exhibit 4-5 shows the representative Greenfield high speed electric train. Tilting is not needed for the 220 mph electric train because it operates over a new right-of-way with minimal curvature.

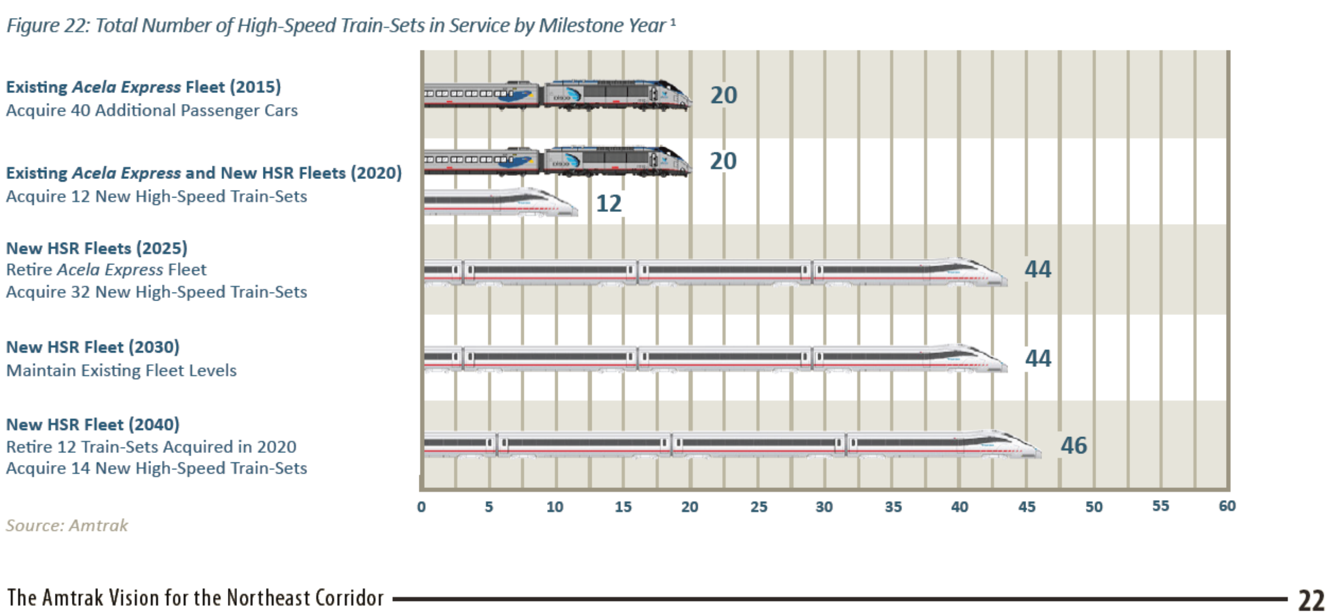
Exhibit 4-4: High Speed Rail Shared Use (Electric) – Representative Trains and Corridor Service

For very high speed train up to 220 mph a Greenfield alignment is needed to maximize the speeds. A greenfield allows mostly straight track and where necessary very gentle curves.

Exhibit 4-5: High Speed Rail Dedicated (Electric) – Representative Trains and Corridor Service

Amtrak has recently developed a Vision Plan for the Northeast Corridor for 220 mph true high speed rail. Their equipment strategy to achieve this change is shown in Exhibit 4-6. This shows that by 2015 additional 40 passengers cars will need to be added to the exiting 150 mph Acela express fleet, while in addition to this fleet 12 new 220 mph train sets will be purchased by 2020. By 2025 Amtrak is planning to expand its fleet by adding 32 new 220 mph train sets bringing the total fleet of 220 mph to 44 and by retiring the existing Acela express fleet. Amtrak has recently announced that it will not be purchasing any more Acela cars and will be moving directly to the next-generation of High Speed train equipment.

Exhibit 4-6: Amtrak NEC Equipment Strategy



4.3. TRAIN PERFORMANCE

In terms of assessing rail technology, there are two main criteria that need to be considered: type of propulsion and source of power:

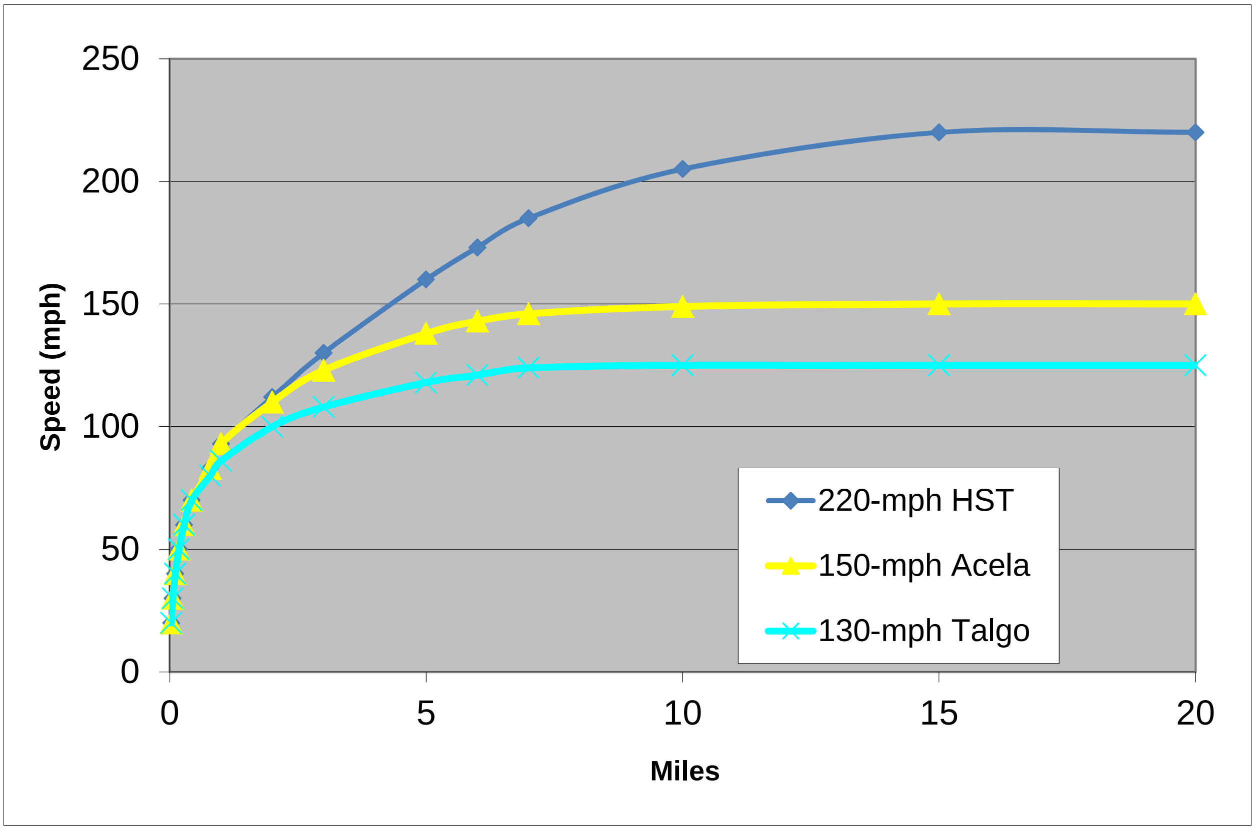
- **Type of Propulsion: Trains can be either locomotive-hauled or self-propelled.** Self-propelled equipment has each individual railcar powered whereas conventional coaches rely on a separate locomotive to provide the power.
- **Source of Power: Trains can be either diesel or electrically-powered.** Diesel or electric power can be used with either the locomotive hauled or self-propelled equipment options. (Turbine power has also been considered for high speed trains, but does not offer any clear advantage over diesel at this time.)

As a rule, diesel locomotives are heavier than electric locomotives, because of the weight of the engine and also of the fuel. Electric equipment also can be more powerful since it is not limited by the on-board generating capacity of the engine. Train performance curves for representative equipment types are shown in Exhibit 4-7. The curves reflect the acceleration capabilities of three rail technologies with speed 130 mph, 150 mph and 220 mph.

Purpose-built diesel higher-speed trains, such as the Talgo T21, can offer considerably improved performance over conventional diesel trains that are based on freight-derived designs. Conventional locomotive-hauled diesel trains have a practical top speed of about 100 mph, whereas purpose-built high speed diesel trains can achieve 125 mph to 135 mph and can accelerate much faster than a conventional diesel train. For speeds above 135 mph, electrified trains are needed. Some European diesel-powered 125-mph trains offer up to 500 seats, but if U.S. safety regulations were applied, the added vehicle weight (10-15 percent) would likely reduce the practical capacity of such trains down to 400-450 seats.

Up to its current top speed of 150 mph, Exhibit 4-7 shows that the Acela accelerates as fast as a TGV due to its very high power to weight ratio. This implies that the Acela could go even faster if it were given a straight enough track to run on. Acela's weight penalty however, expresses itself in terms of a higher operating cost and lower revenue generating capacity than a comparable TGV. However, this is not a serious problem in the special environment in which the Acela operates (i.e., limited capacity and a very high level of demand.

Exhibit 4-7: Comparative Train Acceleration Curves[1]



For the purpose of the Richmond – Hampton Roads Higher and High Speed Analysis, the following generic trains will be uses:

- **110 – 130 mph Talgo T21:** the technical characteristics are hauled (non-powered) axles equipped with independent wheels to prevent hunting movement and to reduce wheel-track interaction; Permanently steered axles by means of robust guiding bars that keep the wheels parallel to the track at all times; High-comfort tilting suspension, with natural car body tilting toward the interior of curves; Articulated couplings between adjacent cars with anti-overturning and anti-vertical hunting mechanisms; and maximum commercial speed of 140 mph[2].
- **150 mph Acela:** Acela express with standard gauge of 1,435 mm (4 ft 8 1/2 in) and maximum operating speed 150 mph (240 km/h)
- **220 mph AGV:** The trains that are certified to run 220 mph speed include Siemens Valero, Bombardier Zefiro, and Alstom AGV. Even Chinese HST are faster with speeds up to 240 mph. The trains are constructed from units comprising three cars, each with one transformer and two traction electronics packages located underneath the cars, and from single-car trailers. A 7-car unit has two 3-car modules separated by one trailer and seating for around 245, an 11-car unit

[1] Source: TEMS LOCOMOTION™ Equipment Database showing typical technology performance parameters, as developed and validated over the course of previous rail studies.
[2] http://www.talgo.com/pdf/TXXIen.pdf

has three 3-car modules with two trailer cars with seating for around 446. The maximum commercial speed is 360 km/h (220 mph)[3].

Exhibit 4-8 below summarizes the train characteristics.

Exhibit 4-8: Train Characteristics Table

Conventional	Higher-Speed	High Speed	
▪ 79 mph	▪ 110 mph	▪ 150 mph	▪ 220 mph
▪ Diesel	▪ Diesel	▪ Electric	▪ Electric
▪ Non-Tilting	▪ Tilting	▪ Tilting	▪ Non-Tilting
▪ Amtrak Regional NEC	▪ Acela Express	▪ Talgo T21	▪ AGV

4.4. TECHNOLOGY ANALYSIS

For the Hampton Roads Vision Plan the following train operations analysis is required. For each route option:

- Development of train running times
- Train timetable development
- Assessment of freight rail operations and their interactions with proposed timetables
- Computation of rolling stock requirements

The key tool used for development of pro-forma train schedules is the *LOCOMOTION™* Train Performance Calculator. *LOCOMOTION™* works in conjunction with a *TRACKMAN™* infrastructure database to estimate train speed given various types of track geometry, curves, gradients and station-stopping patterns. The *TRACKMAN™* database captures all the details of grades, curves, superelevation, speed limits and station locations along the line. *LOCOMOTION™* then calculates the train running time for each route segment and sums the running times to produce a timetable. *LOCOMOTION™* assumes a train will accelerate to a maximum possible speed and will only slow down for stations or speed restrictions due to curves, crossings, tunnels or civil speed restrictions such as grade crossings and sensitive urban areas.

The inputs for *LOCOMOTION™* consist of milepost-by-milepost data (as fine as 1/10th of a mile) defining gradient and curve conditions along the track. For this study, these data were derived from a condensed profile for existing rail alignments and the use of field inspection data along with satellite photography and GIS mapping to develop the geometry for new routes.

In addition, *LOCOMOTION™* includes a train technology database that defines the acceleration, top speed, and braking characteristics of each train technology type. The database includes many train types with varying performance characteristics, ranging from heavy freight trains all the way up through very high speed rail options.

Train timetables are determined from running times and are used to calculate rolling stock requirements. Train frequencies and the number of cars required per train are determined via an interactive process using the demand forecast *COMPASS™* model.

[3] http://en.wikipedia.org/wiki/Automotrice_%C3%A0_grande_vitesse

The results taken from *LOCOMOTION™* will be faster than the actual times, since they are based on optimized performance of trains under ideal conditions. While it is assumed that passenger trains will have dispatching priority over freight, practical schedules still need to allow 5-10 percent slack time in case of any kind of operating problem, including the possibility of freight or commuter train interference, depending on the degree of track sharing with freight. Slack time is included in the train timetables and in the input provided to the *COMPASS™* model.

4.5. OPERATING UNIT COSTS

This section describes the build-up of the unit operating costs that will be used in conjunction with the operating plans for assessing the total operating cost of each alternative that will be proposed. This study encompasses a wide variety of both technology and generic route options and list the unit operating costs.

In this chapter the character of the operating plan and equipment that optimizes each option will be described together with its unit operating costs. The costing framework that was originally developed for the Midwest Regional Rail System (MWRRS) was adapted for use in this study. Following the MWRRS methodology[4], nine specific cost areas have been identified. As shown in Exhibit 4-9, variable costs include equipment maintenance, energy and fuel, train and onboard (OBS) service crews, and insurance liability. Ridership influences marketing, and sales. Fixed costs include administrative costs, station costs, and track and right-of-way maintenance costs. Signals, communications and power supply are included in the track and right-of-way costs.

Exhibit 4-9: Operating Cost Categories and Primary Cost Drivers

Drivers		Cost Categories
Train Miles	→	Equipment Maintenance Energy and Fuel Train and Engine Crews Onboard Service Crews
Passenger Miles	→	Insurance Liability
Ridership and Revenue	→	Sales and Marketing
Fixed Cost	→	Service Administration Track and ROW Maintenance Station Costs

Operating costs can be categorized as variable or fixed. As described below, fixed costs include both Route and System overhead costs. Route costs can be clearly identified to specific train services but do not change much if fewer or additional trains were operated.

- Variable costs change with the volume of activity and are directly dependent on ridership, passenger miles or train miles. For each variable cost, a principal cost driver is identified and used

[4] Follow the links under "Midwest Regional Rail Initiative (MWRRI)" at http://www.dot.state.mn.us/planning/railplan/studies.html

to determine the total cost of that operating variable. An increase or decrease in any of these will directly drive operating costs higher or lower.

- Fixed costs are generally predetermined, but may be influenced by external factors, such as the volume of freight tonnage, or may include a relatively small component of activity-driven costs. As a rule, costs identified as fixed should remain stable across a broad range of service intensities. Within fixed costs are two sub-categories:
  - Route costs such as track maintenance, train control and station expense that, although fixed, can still be clearly identified at the route level.
  - Overhead or System costs such as headquarters management, call center, accounting, legal, and other corporate fixed costs that are shared across routes or even nationally. A portion of overhead cost (such as direct line supervision) may be directly identifiable but most of the cost is fixed. Accordingly, assignment of such costs becomes an allocation issue that raises equity concerns. These kinds of fixed costs are handled separately.

Operating costs have been developed based on the following premises:

- Based on results of recent studies, a variety of sources including suppliers, current operators' histories, testing programs and prior internal analysis from other passenger corridors were used to develop the cost data. However, as the rail service is implemented, actual costs will be subject to negotiation between the passenger rail authority and the contract rail operator(s).
- Freight railroads will maintain the track and right-of-way that they own, but ultimately, the actual cost of track maintenance will be resolved through negotiations with the railroads. For this study a track maintenance cost model will be used that reflects actual freight railroad cost data.
- Maintenance of train equipment will be contracted out to the equipment supplier.
- Train operating practices follow existing work rules for crew staffing and hours of service. Operating expenses for train operations, crews, management and supervision were developed through a bottoms-up staffing approach based on typical passenger rail organizational needs.

The MWRRS costing framework was developed in conjunction with nine states that comprised the MWRRS steering committee and with Amtrak. In addition, freight railroads, equipment manufacturers and others provided input to the development of the costs.

The costing framework has been validated with recent operating experience based on publicly available data from other sources, particularly the Midwest 403B Service trains Northern New England Passenger Rail Authority's (NNEPRA) Downeaster costs and data on Illinois operations that was provided by Amtrak. It has been brought to a $2012 costing basis and additional cost categories, such as for electrification, have been added into the model.

The original concept for the MWRRS was for development of a new service based on operating methods directly modeled after state-of-the-art European rail operating practice. Along with anticipated economies of scale, modern train technology could reduce operating costs when compared to existing Amtrak practice. In the original 2000 MWRRS Plan, European equipment costs were measured at 40 percent of Amtrak's costs. However, in the final MWRRS plan that was released in 2004, train-operating costs were significantly increased to a level that is more consistent with Amtrak's current cost structure. However, adopting an Amtrak cost structure for financial planning does not suggest that Amtrak would actually be selected for the corridor operation. Rather, this selection increases the flexibility for choosing an operator without excluding Amtrak, because multiple operators and vendors will be able to meet the broader performance parameters provided by this conservative approach.

This analysis uses 2012 constant dollars.

4.5.1 VARIABLE COSTS

These costs include those that directly depend on the number of train-miles operated. They include train equipment maintenance, train crew cost, fuel and energy, onboard service, and insurance costs.

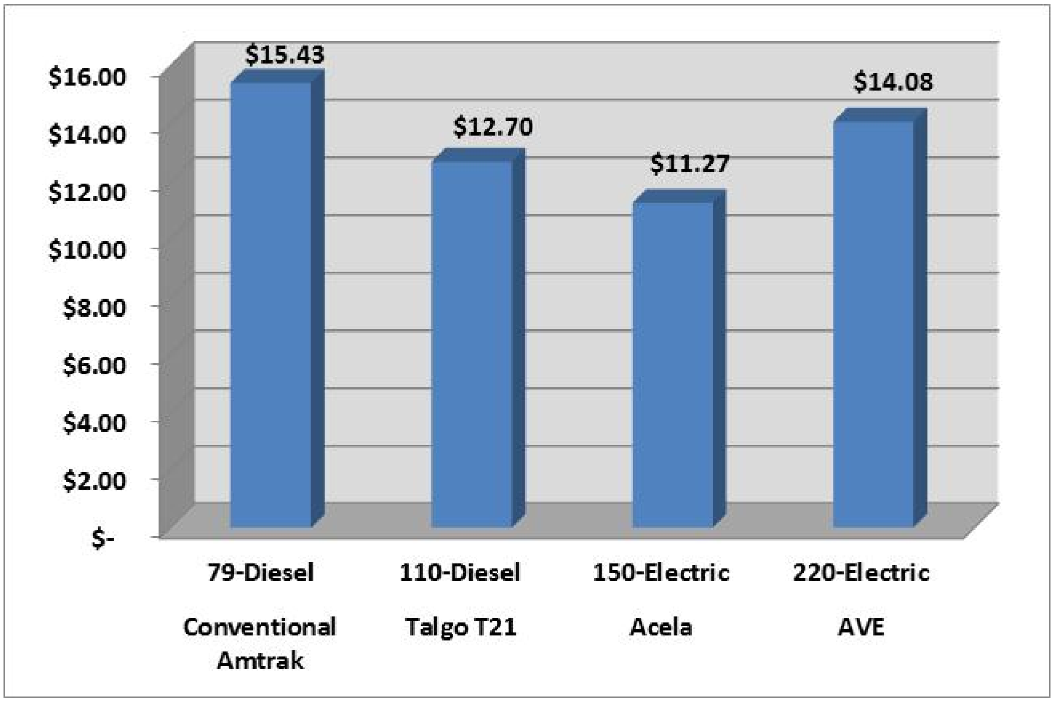
TRAIN EQUIPMENT MAINTENANCE

Equipment maintenance costs include all costs for spare parts, labor and materials needed to keep equipment safe and reliable. The costs include periodical overhauls in addition to running maintenance. It also assumes that facilities for servicing and maintaining equipment are designed specifically to accommodate the selected train technology. This arrangement supports more efficient and cost-effective maintenance practices. Acquiring a large fleet of trains with identical features and components, allows for substantial savings in parts inventory and other economies of scale. In particular, commonality of rolling stock and other equipment will standardize maintenance training, enhance efficiencies and foster broad expertise in train and system repair.

The MWRRS study developed a cost of $9.87 per train mile for a 300-seat train in $2002. This cost was increased to $12.34 per train mile in $2012. Available evidence suggests that the maintenance cost for a conventional electric train should be about 9 percent cheaper per equivalent seat-mile than that of a diesel train leading to a unit cost of $11.27 per mile for a 150-mph locomotive hauled electric train. However, high speed electric trains have a more than proportional increase in power: a typical 130-mph diesel train has about 18 kw/Seat; the 220-mph Alstom AGV has 24 kw/ Seat[5] while the 160-mph Acela is rated at 30 kw/Seat. However the Acela needs this much power due to the high weight of the steel coaches and low seating capacity of the train. As a result, the maintenance cost per mile for the 220-mph electric train benchmarked only slightly higher than that for the 130-mph diesel of equivalent capacity; a cost of $14.08 per mile was assumed for the 220-mph electric train. All equipment maintenance unit costs that will be used for the next phase of the study are summarized in Exhibit 4-10.

[5] See: http://en.wikipedia.org/wiki/Automotrice_%C3%A0_grande_vitesse

Exhibit 4-10: Equipment Maintenance Cost per Mile ($2012)



TRAIN AND ENGINE CREW COSTS

The train operating crew incurs crew costs. Following Amtrak staffing policies, the operating crew would consist of an engineer, a conductor and an assistant conductor and is subject to federal Hours of Service regulations. Costs for the crew include salary, fringe benefits, training, overtime and additional pay for split shifts and high mileage runs. An overtime allowance is included as well as scheduled time-off, unscheduled absences and time required for operating, safety and passenger handling training. Fringe benefits include health and welfare, FICA and pensions. The cost of employee injury claims under FELA is also treated as a fringe benefit for this analysis. The overall fringe benefit rate was calculated as 55 percent. In addition, an allowance was built in for spare/reserve crews on the extra board. Costing of train crews was based on Amtrak's 1999 labor agreement, adjusted for inflation to 2012.

Any intercity service needs the safety, fare collection and customer service functions performed by the on-board train crew. Regarding the train operator, it is equally possible to automate either a conventional rail system or a high speed rail, provided access to the right-of-way is equally controlled.

Crew costs depend upon the level of train crew utilization, which is largely influenced by the structure of crew bases and any prior agreements on staffing locations. Train frequency strongly influences the amount of held-away-from-home-terminal time, which occurs if train crews have to stay overnight in a hotel away from their home base. Since train schedules have continued to evolve throughout the lifetime of this study and a broad range of service frequencies and speeds have been evaluated, a parametric approach was needed to develop a system average per train mile rate for crew costs. Such an average rate necessarily involves some approximation, but to avoid having to reconfigure a detailed crew-staffing plan whenever the train schedules change, an average rate is necessary and appropriate for a planning-level study.

For this study, an intermediate value of $4.92 per train mile was selected for 110-mph scenarios. This is a moderate level of crew cost that includes the need for some away-from-home layover. 79-mph scenarios cost $6.59 per train-mile because of poor crew utilization in these low-frequency scenarios. With trains operating less frequently there is less opportunity to return crews to their home base on the same day, leading to more split shifts and overnight layovers. The 220-mph scenarios used $4.60 per train mile, reflecting operating efficiencies related both to higher speeds and more frequent trains, both of which tend to reduce the need for away-from-home layovers.

FUEL AND ENERGY

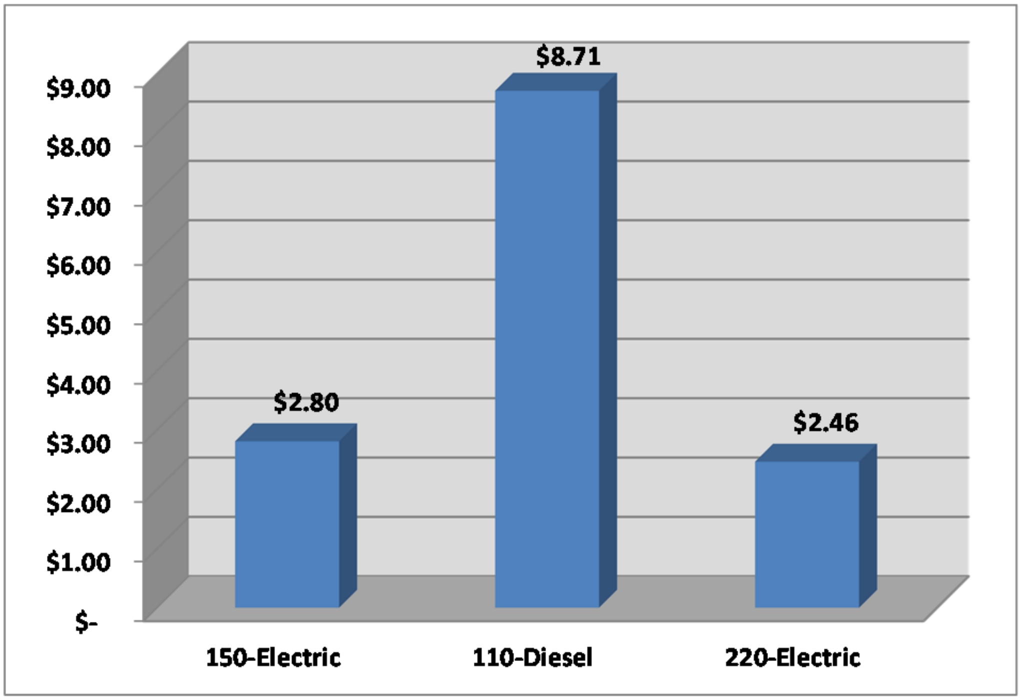
Both the ridership and operating cost models are based on fuel costs in $2012 and that will form the basis of the demand model calibration. The assumed diesel fuel cost on the operating side is consistent with the level of gasoline prices that were assumed for development of the demand forecasts.

A consumption rate of 2.42 gallons/mile was estimated for a 110-mph 300-seat train, based upon nominal usage rates of all three technologies considered in Phase 3 of the MWRRS Study. Assuming $3.60 a gallon for diesel fuel according to Energy Information Administration (EIA)[6], this translates into a cost of $8.71 per train mile, more than tripling (375%) the cost of diesel fuel as was prevalent at the time of the earlier MWRRS study. During the same time period Virginia electric power costs rose only by 46%.

However, electric traction has an advantage over diesel since it can be powered from any energy source, not just petroleum-based fuel. Even taking typical peaking demands into account, electric energy is typically less expensive than diesel fuel. However, there is a large regional variation in electricity prices and peak usage rate structures, for example, electric power has in the past been more expensive than diesel traction in the northeastern United States. However the rapid rise of petroleum costs over the past ten years has clearly tipped the cost advantage towards electrification. Virginia also enjoys lower average electricity rates than do other northeastern states[7]: in 2010, Virginia electric power for transportation averaged only 7.7¢ per kWH as compared to 11.9¢ per kWH in New Jersey.

[6] EIA diesel retail price in 2012 excluding the taxes http://www.eia.gov/petroleum/gasdiesel/
[7] See http://www.eia.gov/electricity/state/

Exhibit 4-11: Fuel and Energy Cost per Mile ($2012)



It should be noted that the actual price paid is largely driven by the peak hour surcharges that can more than double the railroad's electric energy bill. By employing power smoothing techniques such as onboard and wayside energy storage, the operator might reduce the level of fluctuation in its energy usage so it pays closer to the base average kilowatt-hour power generation charge. Given the high cost associated with electric power purchases, the issue of smoothing demand is an issue that should receive careful attention in the train equipment procurement, as well as in the design of the electric traction system itself, and the structure of peak usage charges should also be negotiated with the electric utilities to ensure that the operator can purchase the power it needs at the lowest possible cost.

The comparable cost for the 150-mph locomotive-hauled electric train was just $2.80 per train mile as compared to $8.71 for the diesel. Because it weighs less than the Acela, the 220-mph electric multiple unit is even more efficient at $2.46 per train mile (See Exhibit 4-11). All electric costs include the Peak Usage charge, which for electric rail systems is significant, usually doubling the overall electric cost.

ONBOARD SERVICES (OBS)

Onboard service (OBS) costs are those expenses for providing food service onboard the trains. OBS adds costs in three different areas: equipment, labor and cost of goods sold. Equipment capital and operating cost is built into the cost of the trains and is not attributed to food catering specifically. Small 200-seat trains cannot afford a dedicated dining or bistro car. Instead, an OBS employee or food service vendor would move through the train with a trolley cart, offering food and beverages for sale to the passengers.

The goal of OBS franchising should be to ensure a reasonable profit for the provider of on-board services, while maintaining a reasonable and affordable price structure for passengers. The key to attaining OBS profitability is selling enough products to recover the train mile related labor costs. If small 200-seat trains were used for start-up, given the assumed OBS cost structure, even with a trolley cart service the

OBS operator will be challenged to attain profitability. However, the expanded customer base on larger 300-seat trains can provide a slight positive operating margin for OBS service. 400-seat electric trains should provide a comfortable positive profit margin for the OBS operator.

Because the trolley cart has been shown to double OBS revenues, it can result in profitable OBS operations in situations where a bistro-only service would be hard-pressed to sell enough food to recover its costs. While only a limited menu can be offered from a cart, the ready availability of food and beverages at the customer's seat is a proven strategy for increasing sales. Many customers appreciate the convenience of a trolley cart service and are willing to purchase food items that are brought directly to them. While some customers prefer stretching their legs and walking to a bistro car, other customers will not bother to make the trip.

The cost of goods sold is estimated as 50 percent of OBS revenue, based on Amtrak's route profitability reports. Labor costs, including the cost of commissary support and OBS supervision, have been estimated at $2.56 per train mile for 110-mph service, declining to $1.78 per train mile because of better crew utilization in the 220-mph scenario (in $2012). This cost is generally consistent with Amtrak's level of wages and staffing approach for conventional bistro car services. However, this Business Plan recommends that an experienced food service vendor provide food services and use a trolley cart approach.

A key technical requirement for providing trolley service is to ensure the doors and vestibules between cars are designed to allow a cart to easily pass through. Since trolley service is a standard feature on most European railways, most European rolling stock is designed to accommodate the carts. Although convenient passageways often have not been provided on U.S. equipment, the ability to support trolley carts is an important equipment design requirement for the planned service.

INSURANCE COSTS

Liability costs were estimated at 1.3¢ per passenger-mile, the same rate that was assumed in the earlier MWRRS study brought to $2008. Federal Employees Liability Act (FELA) costs are not included in this category but are applied as an overhead to labor costs.

The Amtrak Reform and Accountability Act of 1997 (§161) provides for a limit of $200 million on passenger liability claims. Amtrak carries that level of excess liability insurance, which allows Amtrak to fully indemnify the freight railroads in the event of a rail accident. This insurance protection has been a key element in Amtrak's ability to secure freight railroad cooperation. In addition, freight railroads perceive that the full faith and credit of the United States Government is behind Amtrak, while this may not be true of other potential passenger operators. A recent General Accounting Office (GAO) review[8] has concluded that this $200 million liability cap applies to commuter railroads as well as to Amtrak. If the GAO's interpretation is correct, the liability cap may also apply to potential Colorado rail franchisees. If this liability limitation were in fact available to potential franchisees, it would be much easier for any operator to obtain insurance that could fully indemnify a freight railroad at a reasonable cost. It is recommended that the HRTPO seek qualified legal advice on this matter.

4.5.2 FIXED ROUTE COSTS

This cost category includes those costs that, while largely independent of the number of train-miles operated, can still be directly associated to the operation of specific routes. It includes such costs as track maintenance, which varies by train technology, and station operations.

[8] See: http://www.gao.gov/highlights/d04240high.pdf

TRACK AND RIGHT-OF-WAY COSTS

Currently, it is industry practice for passenger train operators providing service on freight-owned rights-of-way to pay for track access, dispatching and track maintenance. The rates for all of these activities will ultimately be based upon a determination of the appropriate costs that result from negotiations between the parties. The purpose here is to provide estimates based on the best available information; however, as the project moves forward, additional study and discussions with the railroads will be needed to further refine these costs. Both capital and operating costs will be estimated.

To accommodate passenger trains, the rail corridors would need a substantial increase in capacity. Once constructed, these improvements will need to be maintained to FRA standards required for reliable and safe operations. The costing basis assumed in this report is that of incremental or avoidable costs. Avoidable costs are those that are eliminated or saved if an activity is discontinued. The term incremental is used to reference the change in costs that results from a management action that increases volume, whereas avoidable defines the change in costs that results from a management action that reduces volume.

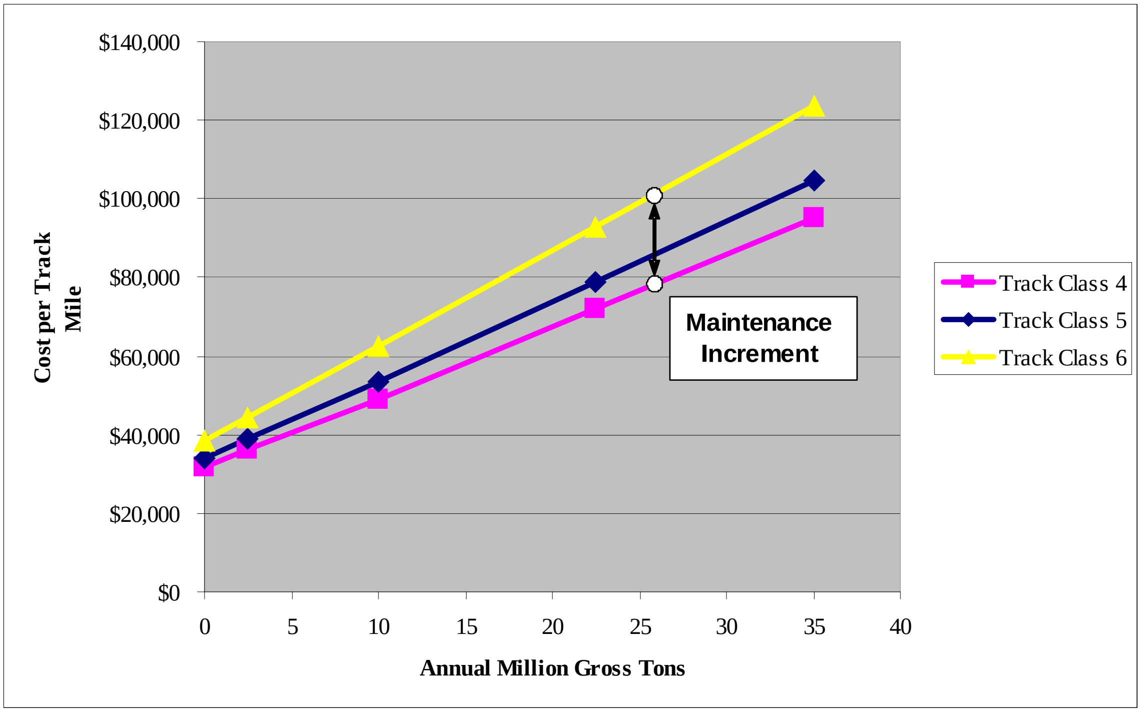
The following cost components are included within the Track and Right-of-Way category:

- **Track Maintenance Costs**. Costs for track maintenance are estimated based on Zeta-Tech's January 2004 draft technical monograph Estimating Maintenance Costs for Mixed High Speed Passenger and Freight Rail Corridors.[9] Zeta-Tech costs will be adjusted for inflation to $2012. However, Zeta-Tech's costs are conceptual and are still subject to negotiation with the freight railroads.
- **Dispatching Costs and Out-of-Pocket Reimbursement.** Passenger service must also reimburse a freight railroad's added costs for dispatching its line, providing employee efficiency tests and for performing other services on behalf of the passenger operator. These costs are included as an additive to Track and Right-of-Way Maintenance costs.
- **Costs for Access to Track and Right-of-Way**. Access fees, particularly train mile fees incurred as an operating expense, are specifically excluded from this calculation. Any such payments would have to be calculated and negotiated on a route-specific and railroad-specific basis. Such a calculation would have to consider the value of the infrastructure improvements made to the corridor for balancing up-front capital with ongoing operating payments.[10]

Exhibit 4-12 shows the conceptual relationship between track maintenance cost and total tonnage that was calibrated from the earlier Zeta-Tech study. It shows a strong relationship between tonnage, FRA track class (4 through 6, corresponding to a 79-mph to 110-mph track speed) and maintenance cost. At low tonnage, the cost differential for maintaining a higher track class is not very large, but as tonnage grows, so too does the added cost. For shared track, if freight needs only Class 4 track, the passenger service would have to pay the difference, called the "maintenance increment", which for a 25 MGT line as shown in Exhibit 4-12, would come to about $25,000 per mile per year. The required payment to reimburse a freight railroad for its added track cost would be less for lower freight tonnage, more for higher freight tonnage.

[9] Zeta-Tech, a subsidiary of Harsco (a supplier of track maintenance machinery) is a rail consulting firm who specializes in development of track maintenance strategies, costs and related engineering economics. See a summary of this report at http://onlinepubs.trb.org/onlinepubs/trnews/trnews255rpo.pdf. The full report is available upon request from the FRA.
[10] For 110-mph service, the level of infrastructure improvements to the corridor called for in this study should provide enough capacity to allow superior on-time performance for both freight and passenger operations

Exhibit 4-12: Zeta-Tech Track Maintenance Cost Function (in $2002)



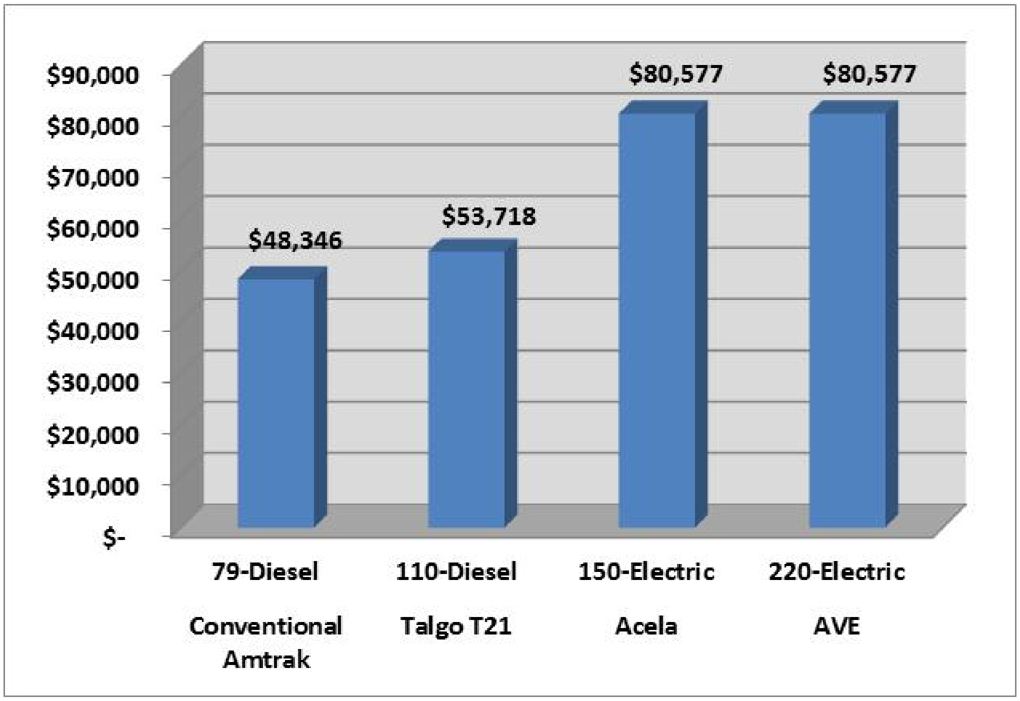
Please note that Exhibit 4-12 shows that the cost of shared track depends strongly on the level of freight tonnage, since the passenger trains are relatively lightweight and do not contribute much to the total tonnage, In fact, following the Zeta-Tech methodology, the "maintenance increment" is calculated based on freight tonnage only, since a flat rate of $1.56 per train mile as used in the Zeta- Tech report was already added to reflect the direct cost of added passenger tonnage regardless of track class. This cost, which was developed by Zeta-Tech's TrackShare® model, includes not only directly variable costs, but also an allocation of a freight railroad's fixed cost. Accordingly, it complies with the Surface Transportation Board's definition of "avoidable cost." An allowance of 39.5¢ per train-mile was added for freight railroad dispatching and out-of-pocket costs.

The same cost function shown in Exhibit 4-12 can also be used for costing dedicated passenger track. With dedicated track, the passenger system is assumed to cover the entire cost for maintaining its own track. (Freight would then have to reimburse the passenger operator on a car-mile basis for any damage it causes to the passenger track.) Because passenger train tonnage is very low however, it can be seen that the cost differential between Class 4, 5 and 6 track is very small. Adjusting Zeta-Tech's $2002 costs shown in Exhibit 4-13 up to $2012, the average annual cost per track-mile for maintaining dedicated Class 4 track is about $48,346; the cost for Class 6 track rises to $53,718. Adding $26,859 per track-mile for overhead electric catenary, the overall maintenance cost rises to about $80,577 per track mile per year. Reducing the axle loads as is a common design practice for 220 mph High Speed equipment helps keep guideway maintenance costs low. Early French experience[11] showed that the maintenance cost of a dedicated high speed track was actually lower (just 55%) of the cost of a conventional track with equivalent traffic. According to the French railways, the justification for such a difference was due basically to three causes: the uniformity of TGV rolling stock, the reduced axle loading (17 metric tons) and the strict quality conditions imposed during the construction of the line. Table 6 of this same report

[11] See Maintenance Costs of High-Speed Lines in Europe: State of the Art, Transportation Research Record, Railways 2008: http://trb.metapress.com/content/gg76453p458327qr/?genre=article&id=doi%3a10.3141%2f2043-02

showed that the mixture of traffic operated over a line influences track maintenance cost much more than does the top speed. As a result, considering the maintenance of a 220-mph dedicated track costs as equivalent to that of a Class 6 line shared with freight trains is, if anything, conservative.

Exhibit 4-13: Guideway Maintenance – Cost per Track Mile ($2012)



In addition to an operating component of track maintenance cost (which is shown in Exhibit 4-12) the track cost methodology also identifies a capital cost component. For track maintenance:

- Operating costs cover expenses needed to keep existing assets in service and include both surfacing and a regimen of facility inspections.
- Capital costs are those related to the physical replacement of the assets that wear out. They include expenditures such as for replacement of rail and ties, but these costs are not incurred until many years after construction. In addition, the regular maintenance of a smooth surface by reducing dynamic loads actually helps extend the life of the underlying rail and tie assets. Therefore, capital maintenance costs are gradually introduced using a table of ramp-up factors provided by Zeta-Tech (Exhibit 4-14). A normalized capital maintenance level is not reached until 20 years after completion of the rail upgrade program.

Exhibit 4-14: Capital Cost Ramp-Up Following Upgrade of a Rail Line

Year	% of Capital Maintenance	Year	% of Capital Maintenance
0	0%	11	50%
1	0%	12	50%
2	0%	13	50%
3	0%	14	50%
4	20%	15	75%
5	20%	16	75%
6	20%	17	75%
7	35%	18	75%
8	35%	19	75%
9	35%	20	100%
10	50%		

The next phase of the study when the alternatives area chosen, the Capital Cost Ramp up schedule will be used in the Benefit Cost Analysis and Financial Analysis will be assessed.

STATION OPERATIONS

A simplified fare structure, heavy reliance upon electronic ticketing and avoidance of a reservation system will minimize station personnel requirements. Station costs include personnel, ticket machines and station operating expenses.

- Staffed stations will be assumed at major stations.. All stations will be assumed open for two shifts. The cost for the staffed stations includes eight positions at each new location, costing $600,000 per year, as well as the cost of utilities, ticket machines, cleaning and basic facility maintenance.

- The cost for unstaffed stations covers the cost of utilities, ticket machines, cleaning and basic facility maintenance, costing $75,000 per year. (These costs are also included in the staffed station cost.) Volunteer personnel such as Traveler's Aid, if desired could staff these stations.

4.5.3 SYSTEM OVERHEAD COSTS

The category of System Overhead largely consists of Service Administration or management overheads, covering such needs as the corporate procurement, human resources, accounting, finance and information technology functions as well as call center administration. A stand-alone administrative organization appropriate for the operation of a corridor system was developed for the MWRRS and later refined for the Ohio Hub studies. This organizational structure, which was developed with Amtrak's input and had a fixed cost of $8.9 million plus $1.43 per train-mile (in $2002) for added staff requirements as the system grew. Inflated to $2012, this became $11.45 million plus $1.84 per train mile.

However, the Sales and Marketing category also has a substantial fixed cost component for advertising and call center expense, adding another $2.9 million per year fixed cost, plus variable call center expenses of 71¢ per rider, all in $2012.[12] Finally, credit card and travel agency commissions are all variable: 1.8 percent and 1 percent of revenue, respectively. Therefore, the overall financial model for a Stand-alone organization therefore has $13.29 million ($11.45 + $1.84 million) annually in fixed cost for administrative, sales and marketing expenses. In addition, the system operator was allowed a 10 percent markup on certain direct cost items as a contribution to operator profit.

[12] In the MWRRS cost model, call center costs were built up directly from ridership, assuming 40 percent of all riders call for information, and that the average information call will take 5 minutes for each round trip. Call center costs, therefore, are variable by rider and not by train-mile. Assuming some flexibility for assigning personnel to accommodate peaks in volume and a 20 percent staffing contingency, variable costs came to 57¢ per rider. These were inflated to 66¢ per rider in $2008.

5 ENVIRONMENTAL DATABASE

This chapter is divided into subsections; these discuss the purpose for developing the environmental database and definition of Service National Environmental Policy Act (NEPA), list of databases such as geographic boundaries, cultural resources, ecology, hazardous material sites, and air quality in the proposed environmental study area, and finally conclusion of the chapter on the mitigations.

5.1. PURPOSE AND DEFINITION

An initial overview of environmental assessment is considered as a critical element of the National Environmental Policy Act (NEPA) documentation for the development of High Speed passenger rail service from Petersburg/Richmond to Norfolk. According to High-Speed Intercity Passenger Rail Program (HSIPR), investments should be made in a three tiered passenger rail network.

- First being the *core express* services operating frequent trains at 125-250+mph trains,
- Second being *regional* service providing 90-125 mph service,
- Third being the *emerging* service of up to 90 mph service[1].

Under the HSIPR program guidance, Federal Railroad Administration (FRA) requires the environmental review process as required by the National Environmental Policy Act (NEPA) together with related laws and regulations, (including Section 106 of the National Historic Preservation Act and 49 U.S.C. 303, which protects public parks, recreation areas, wildlife and waterfowl refuges, and historic sites). The statutory requirement as stated in the *HSIPR NEPA Guidance*[2] is that "NEPA requires that appropriate environmental documentation be available to public officials and citizens before decisions are made and actions are taken. The available information should be relevant to the decision to be made at any particular stage of project development".

In terms of taking the first steps to develop a High Speed Rail System, FRA has defined the need for a Service NEPA as the essential first step. Service NEPA has been defined by the FRA as a landscape level of environmental review that defines from day one the most critical environmental issues before any substantial investments in the corridor are made.[3]

According to *HSIPR NEPA Guidance*, it has been stated that "Several different approaches are available to accomplish Service NEPA, including Tiered NEPA (Tier 1 environmental impact statement (EIS) or environmental assessment (EA) followed by Tier 2 EISs, EAs or categorical exclusion determinations (CE)) or non-Tiered NEPA (one EIS or EA covering both service issues and individual project components). A large expansive project would typically be addressed in a Tier 1 EIS process involving several rounds of environmental review, such as the EISs that FRA has prepared with the California High Speed Rail Authority for the state's proposed high speed rail project.

A corridor program of smaller scope with a narrower range of reasonable alternatives could be addressed though a Tier 2 type EIS, or possibly an EA, if appropriate. An EA would be appropriate only for a more limited corridor development program where no significant environmental impacts are anticipated. Regardless of whether a Tier 1 or Tier 2 EIS or an EA is used, to advance a rail corridor development program the document must address the broad service-level issues. The decision on the appropriate level

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[1] http://www.fra.dot.gov/rpd/downloads/HSIPR_Federal_Investment_Highlights_20120203.pdf
[2] Compliance With The National Environmental Policy Act In Implementing The High Speed Rail Intercity Passenger Rail Program, August 2009. http://www.fra.dot.gov
[3] This is discussed earlier in Chapter 1 of this report.

of documentation for a particular proposed action would be made by the FRA in consultation with the applicant."[2]

According to *HSIPR NEPA Table*[4], the steps required to complete Service NEPA are

- Planning and Project Development :completion of Service Development Plan (SDP),
- Engineering: Conceptual Engineering (CE) and supporting programmatic environmental analysis,
- Environmental Analysis: Service NEPA Landscape level data collection and impact analyses are required. Overall air and noise effects from train operations are considered.
- Public Involvement: Permitting agency involvement may be limited for Tier 1 documents. Permitting agencies should be informed of the preparation of the Service NEPA document. Public circulation of a Service NEPA document may be required prior an FRA decision. For Service EAs this may occur beyond application date and this may delay a selection decision.

For this study as it is a preliminary assessment, a Service NEPA would be appropriate. This is an environmental database document provided in preparation of Service NEPA Environmental Assessment for the Petersburg to Norfolk Corridor. This will define the requirements for further Environmental Analysis and recommends the need for Tier 1 or EA input.

5.2. LIST OF DATA COLLECTION AND MAPPING SOURCES

For the preliminary step of Service NEPA, the environmental study area from Petersburg to Norfolk was defined and landscape environmental data such as cultural resources, ecology, hazardous materials, air quality, noise and vibration, utilities were collected at a landscape level.

This chapter identifies the potential list of factors that impact on the community and environment to include transportation, air quality, noise and vibration, energy, land use, socioeconomic factors, community impacts, environmental justice, parklands, farmlands, aesthetics, utilities, contaminated sites, cultural resources, geologic resources, hydrologic and water resources, wetlands, and biological resources (habitats and species). Potential environmental constraints will be reported in the next phase of the study based on the proposed alternatives. A more detailed environmental analysis will be needed once preferred alternatives are assessed in the Tier 1/EA analysis. Exhibit 5-1 provides an overview of the list of data collection element that would be discussed in the following sections.

The following reports provided significant input to the development of this chapter:

- NEPA Guidance: Compliance with the National Environmental Policy Act in Implementing the High-Speed Intercity Passenger Rail Program.
- Service NEPA Environmental Assessment Chicago-Detroit/Pontiac Rail Corridor Improvements From Chicago, Illinois to Pontiac, Michigan by Michigan DOT.
- Route 460 Draft EIS Report.
- Richmond to Hampton Roads Passenger Rail Study, Tier I Environmental Impact Statement, Virginia DRPT.
- Passenger Rail Investment and Improvement Act of 2008 (PRIIA).

[4] Overview of HSIPR NEPA Requirements, August 2009.
http://www.fra.dot.gov/downloads/rrdev/hsipr_nepa_table_08132009Final.pdf

Exhibit 5-1: List of Elements and Data Sources

Data Element	Source
Geographic Boundaries: State, County, Census tract, Census Block Group, City, MPO, MSA, Congressional Districts, Community Facilities	US Census Bureau: 2009 TIGER/ Line Shapefiles and Virginia Department GIS
Cultural Resources: Parks, Wildlife Refuge, Heritage preserves, Archaeology resources, Historical resources, Federal lands, etc.	Virginia Department of Conservation and Recreation, United States Department of Agriculture Forest Service National Park Service U.S. Department of the Interior U.S. Fish and Wild life Service Natural Heritage Virginia Department of Forestry
Ecology: Wetlands, Hydric Soils, Streams, Waters of US, State waters, Federally protected species, State protected Species, Critical stream habitats, Migratory bird habitat, floodplain encroachment/impacts, coastal zone encroachments	Virginia Department of Game and Inland Fisheries
Hazardous Materials	Virginia Department of Environmental Quality
Air Quality	Environmental Protection Agency
OTHER	
Noise and Vibration,	*High-Speed Ground Transportation Noise and Vibration Impact Assessment*, U.S. Department of Transportation, Federal Railroad Administration, Washington, DC, December 1998 standards, and Richmond to Hampton Roads Passenger Rail Study, Tier I Environmental Impact Statement, Virginia DRPT.
Utilities,	Reviewing aerial photographs, mapping available from several internet sites and site specific photographs, and Richmond to Hampton Roads Passenger Rail Study, Tier I Environmental Impact Statement, Virginia DRPT.
Environmental Justice,	U.S. Census
Geology and Soil,	U.S. Geological Survey (USGS) maps
Transportation,	U.S. Census

Land Status, land Use, and Zoning,	U.S. Census
Socioeconomic Conditions, and	U.S. Census
Public Health and Safety: Railroads grade crossings, Pedestrians and Rail operations	Federal Highway Railroad (FRA) and Federal Highway Administration (FHWA)

5.3. RATIONALE FOR DEFINING THE ENVIRONMENTAL STUDY AREA

U.S. Census Data and 2009 TIGER lines and shapefiles provided information on the State, county, City, and MPO boundaries for the State of Virginia. The data from the MPO's as cited in Chapter 2 of Socioeconomic database section for the study area was used and the study area referred to as environmental study area. This information was taken as the base for preparing all the database maps[5]. The counties and independent cities considered in the environmental study area are Franklin City, Suffolk, Petersburg, Sussex, Courtland, Prince George, Colonial Heights, Hopewell, Surry, Isle of Wight, Chesapeake, Dinwiddie, Portsmouth, Norfolk, Virginia Beach, and parts of Chesterfield.

The Environmental Study Area (discussed in Chapter 3) considers the potential region or area within which potential rail alignments might lie, and for which environmental data must be collected. Exhibit 5-2 shows this environmental study area. Because of the possible difficulties of adding tracks to the existing rail alignments, it is proposed to develop potential northern and southern greenfield[6] options in the next phase of work. This follows the approach of the US-460 Highway study that similarly developed one option north, and one option south of the existing US-460 highway. Since this level of environmental assessment was considered adequate for locating a new highway corridor, it was thought that it should be adequate for locating the rail line as well, although the proposed next phase of work 2(B) may also develop additional options based on the feedback received through the public input process.

Even so, the process of conceptualizing potential greenfield options has already yielded useful insights for defining the study area. For example, while it was initially considered that the US-460 Study Area might be sufficient for the rail study, it has already been found that the most likely rail alignment possibilities lie beyond the US-460 Study Area boundaries. As a result, it has proven necessary to expand the study area for the environmental data collection to a larger region than was considered for the US-460 highway study. In particular:

- A Southern Option was considered that may use a portion of the abandoned "Virginian" rail right of way from Suffolk west to the vicinity of Walters, VA, where it would turn northwesterly on a new alignment to Petersburg. However, the Country Club of Petersburg and Richard Bland College were seen to both lie across the path of a direct rail alignment. This particular conflict could be eliminated by shifting the option farther south to Burgess. This shift necessitated expanding the environmental study area. It must be emphasized however, that this Southern routing has not been precisely located. The current analysis only suggests that it may be possible to avoid some

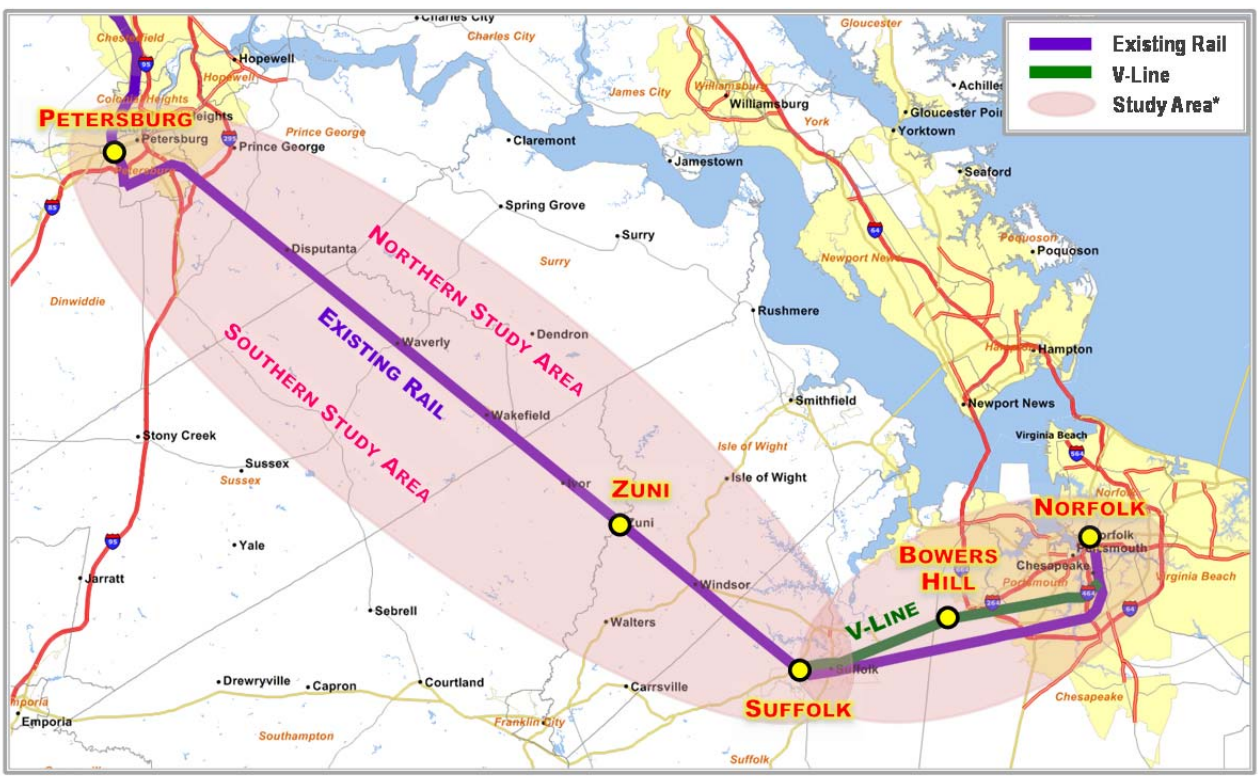
[5] Maps were created in ArcMap 10 and TransCAD.
[6] As discussed earlier in Chapter 3 a Greenfield is a brand-new proposed rail line where no rail line ever has existed. This contrasts with upgrades to an existing rail corridor, or the restoration of an abandoned rail corridor, since the locations of existing or abandoned alignments are known for sure. We have identified potential corridors for conceptual Greenfield options both north and south of the existing NS rail line, but have not located the alignments precisely.

obvious obstacles south of the existing rail alignment. It does not suggest any precise location for the alignment.

- A Northern Option was defined since most of the Norfolk ridership will be headed north towards Richmond and Washington D.C., a northerly alignment would tend to be shorter and more direct. A challenge to the development of any northerly option is how to get through the heavily built-up urban area around Petersburg. However a potential way to thread a north-south rail corridor between Petersburg and Hopewell could follow the I-295 highway corridor past Fort Lee. The Petersburg station would then be constructed on the eastern side of Petersburg in Fort Lee, which would also improve accessibility to the Hopewell area. From Suffolk to Zuni, a new rail alignment could parallel the existing rail line or an electric utility right of way. Beyond Zuni the proposed alignment could cross to the north side of the existing rail alignment and head towards Prince George, VA. The railroad would line up with I-295 and follow the highway past Fort Lee. From here it could either reconnect to the existing CSX rail line or follow a new greenfield alignment farther north as shown in Exhibit 5-2.

Going directly overland the southern option would target the Burgess Connection and the northern option would target I-295. As a result, it can be seen that the optional locations for these rail alignments must lie farther south and north of the existing US-460 highway than were envisioned by the Route 460 Draft EIS report. This necessitates expanding the study area beyond what the earlier highway study assessed. As a result of this preliminary work, it can be seen that the Study Team is well positioned to more precisely locate these alignments for the purpose of minimizing adverse environmental impacts, while still meeting the geometric requirements (primarily in regards to maximum curvature) that are needed for a high speed rail line.

Exhibit 5-2: Environmental Study Area* – Potential Rail Routes in the Route 460 Corridor



*Alignment will not be determined until the Tier II Environmental Process is complete.

The Environmental Data was gathered for the area shown in Exhibit 5-2. The scale of this area was determined by considering potential rail routes in the Route 460 corridor. This included potential greenfield routes to the north and south of existing NS rail route.

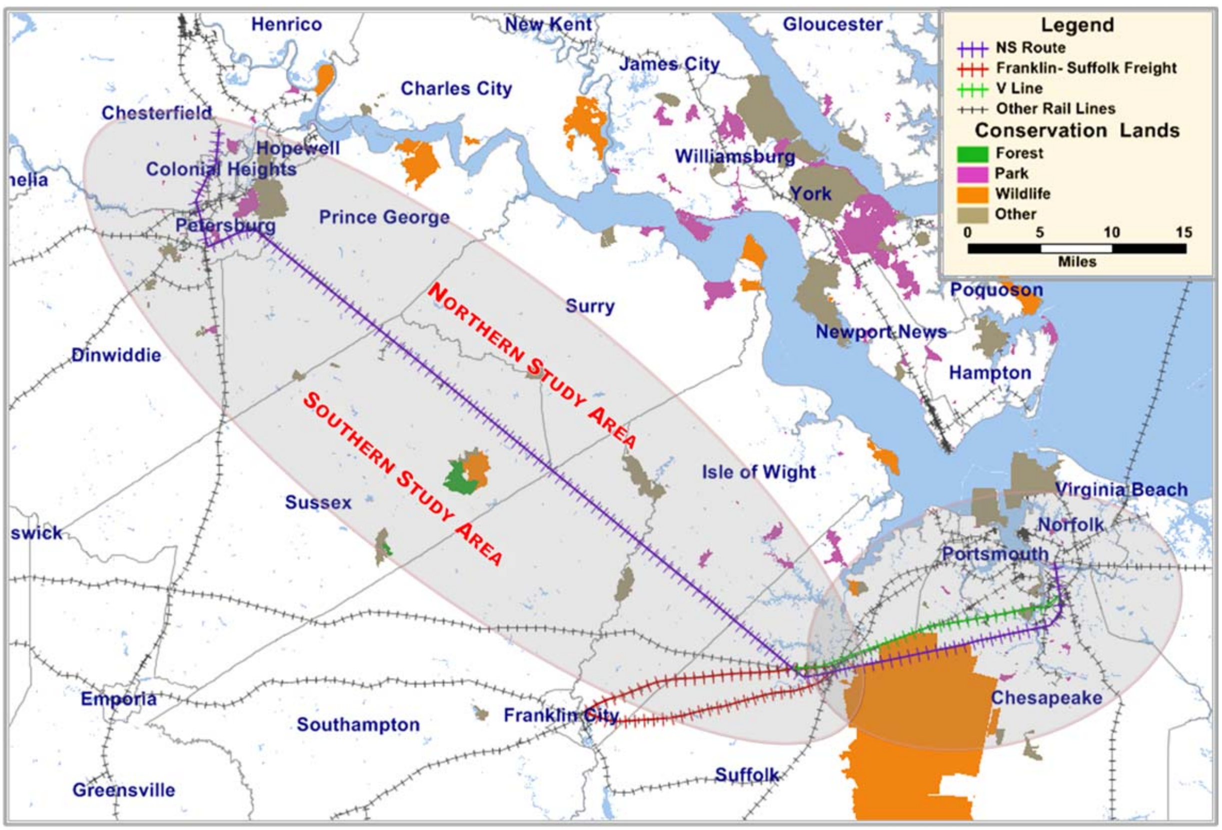
5.4. CULTURAL RESOURCES

Cultural resources include Parks, Wildlife Refuge, Heritage preserves, Archaeology resources, Historical resources, Federal lands, etc. Department of Virginia Conservation and Recreation (DCR) provide information on parks, wildlife refuge, heritage preserves, federal lands, etc. National Park Service (NPS) provides information on historic resources. In the next section conservation lands and historic resources for the environmental study area from Petersburg to Norfolk are discussed.

5.4.1. CONSERVATION LANDS

Department of Virginia Conservation and Recreation (DCR) provided the information that included state, federal, private, and locally managed lands and conservation easements. These Conservation lands in Virginia mainly were categorized info forest, parks, wildlife, and others. These are presented in Exhibit 5-3 focusing the environmental study area from Petersburg to Norfolk corridor.

Exhibit 5-3: DCR Conservation Lands in the Petersburg/Richmond to Norfolk Environmental Study Area*



*Alignment will not be determined until the Tier II Environmental Process is complete.

The forests include National and State forest; parks include national and state parks; wildlife includes refuge and management areas; and other conservation lands mainly include land holdings and area preserves. In the environmental study area from Petersburg to Norfolk corridor, the total acres of conservation land is approximately 544,784 acres, of which National Wildlife Refuge is 428,003 acres (approx.) (See Exhibit 5-4). In the next phase of the study, these conservation lands would be taken into consideration when choosing the alternatives.

Exhibit 5-4: DCR Conservation Lands Total Acres in the Petersburg to Norfolk Environmental Study Area[7]

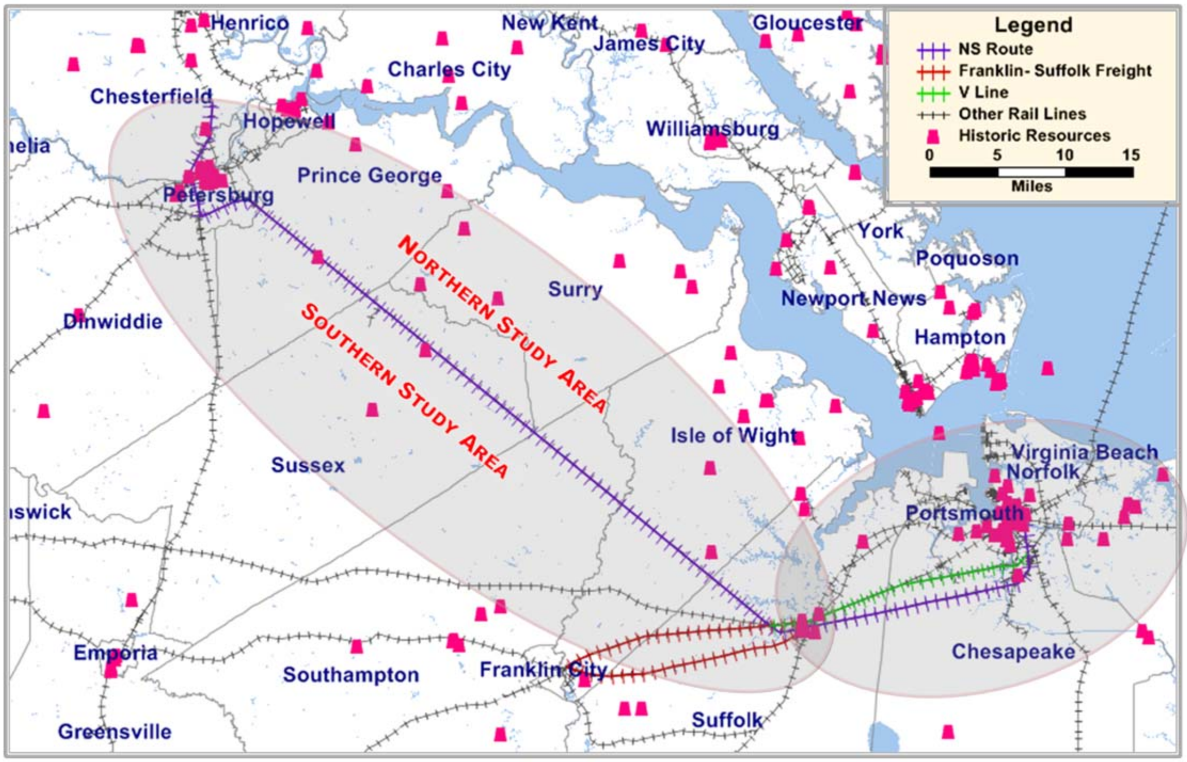
Main Category	Sub-Category	Acres (Approx.)
Forest		2,414
	State Forest	2,200
	State Forestry Center	214
Other		52,186
	Locality Land Holding	2,300
	Military Installation	21,264
	Non-Profit Fee Simple Holding	7,213
	State Natural Area Preserve	11,644
	TNC Land Holding	84
	TNC Preserve	9,681
Park		53,894
	Local Park	7,784
	National Park	46,110
Wildlife		436,290
	National Wildlife Refuge	428,003
	State Wildlife Management Area	8,286
Total		544,784

5.4.2. HISTORIC RESOURCES

National Park Service (NPS) U.S Department of the Interior[8] provides state-wise historic resources information. These include Church, Chapel, Monument, Schools, Cemetery etc. In the environmental study area as seen in Exhibit 5-5, churches (21), schools (6), historic buildings and houses (28) and theatres (3) are some of the major ones. Exhibit 5-6 shows the sample picture of the church at Walters, VA which falls within the environmental study area, but which can be avoided by any proposed alignment.

[7] This table was based the information provided in http://www.dcr.virginia.gov/
[8] http://nrhp.focus.nps.gov/natreg/docs/Download.html

Exhibit 5-5: Historic Resources in the Petersburg to Norfolk Environmental Study Area*



*Alignment will not be determined until the Tier II Environmental Process is complete.

Exhibit 5-6: Historic Resource – Church in Walters, VA within the Environmental Study Area

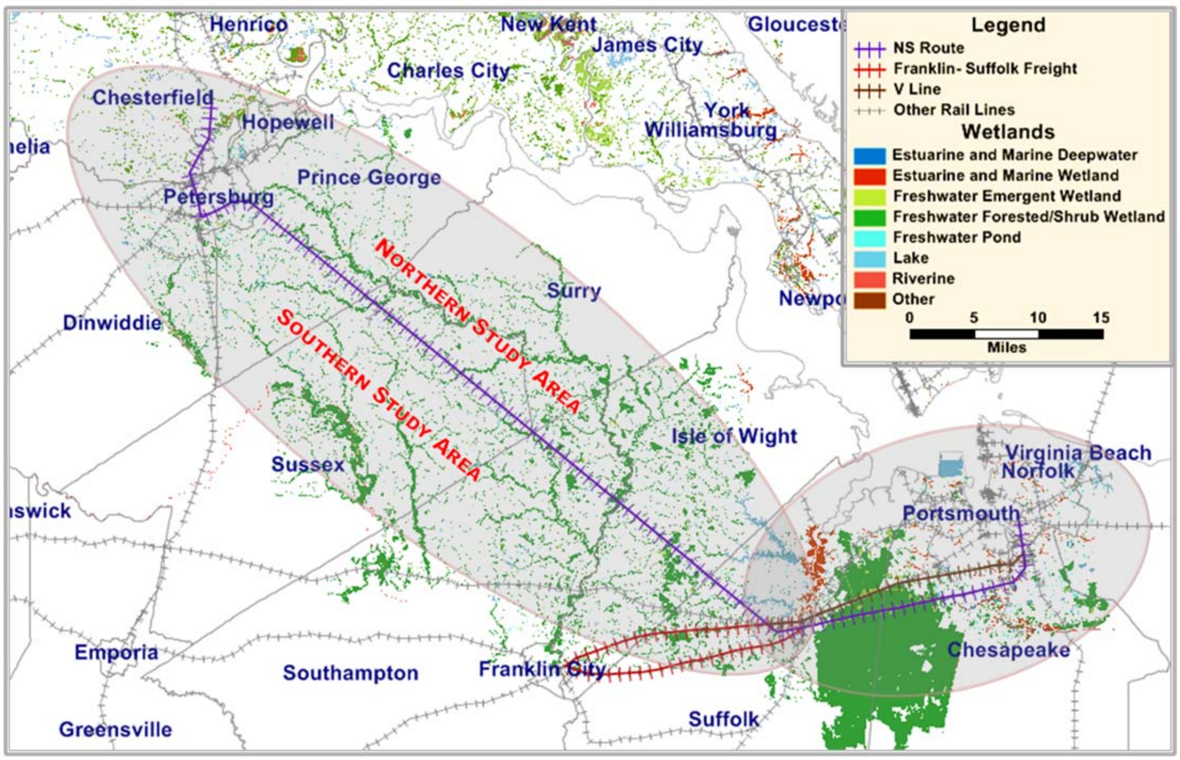
5.5. ECOLOGY

Wetlands, Hydric Soils, Streams, Waters of US, State waters, Federally protected species, State protected Species, Critical stream habitats, Migratory bird habitat, floodplain encroachment/impacts, and coastal zone encroachments come under ecology. These ecology systems were discussed in the next subsections.

5.5.1. WETLANDS

Department of Game and Inland Fisheries (DGIF)[9] provide information on Wildlife Management Areas (WMAs) and public fishing lakes. The goal of DGIF's Wildlife Management Area Program is to maintain and enhance habitats that support game and nongame wildlife while providing opportunities to hunt, fish, trap, and view wildlife. Other uses of WMAs may be allowed, as long as they do not interfere with these goals and uses. The data also includes information on Lakes, Creeks, Swamps, Reservoirs, Fish use areas, Inland navigable waters, Boating sites, and Bird Trails and Wildlife loops. Exhibit 5-7 identifies this information for the environmental study area from Petersburg to Norfolk[10].

Exhibit 5-7: Wetlands for the Petersburg to Norfolk Environmental Study Area



*Alignment will not be determined until the Tier II Environmental Process is complete.

Wetlands are mainly divided as follows:

- Estuarine and Marine Deepwater
- Estuarine and marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland

[9] http://www.dgif.virginia.gov/wildlife/
[10] Some of the wetlands such as Warwick Swamp and Tucker Swamp were also spotted by aerial source and field survey. In the next phase of work the alignment will be located to minimize the impact on these resources.

- Freshwater Pond
- Lake
- Riverine and
- Other wetlands

In the environmental study area, there are noticeable Freshwater forested/ shrub wetland especially between Suffolk and Norfolk. Some of the sample images of the wetlands are shown in Exhibit 5-8 and 5-9. Exhibit 5-8 shows a wetland along the existing tracks, and Exhibit 5-9 shows wetland along the abandoned "V" line corridor, just east of Suffolk, and north of the Great Dismal swamp.

Exhibit 5-8: Wetland along the Rail Track

Exhibit 5-9: Abandoned Rail Bridge on "V" Line

Exhibit 5-10: Bakers pond in Disputanta, VA

Exhibit 5-11: Bakers pond in Disputanta, VA

Exhibits 5-10 and 5-11 show lakes within the environmental study area. Exhibit 5-12 shows that majority of wetlands area for the environmental study area from Petersburg to Norfolk is due to Freshwater forested/shrub wetlands and from Exhibit 5-7 it can be seen that major portion of the area is between Suffolk and Norfolk. The next highest area being occupied by lakes (8,305 acres), followed by estuarine and marine wetlands, Freshwater Emergent Wetland and then by Freshwater Pond. These impacts however can be minimized by constructing bridge rather than fill, depending on the area of coverage.

In the next phase of the study for the proposed alternative wetlands should be in compliance with Executive Order 11990[11], Protection of Wetlands. If they are not compliant then coordination with the U.S. Army Corps of Engineers is required.

Exhibit 5-12: Wetland Total Area in the Environmental Study Area from Petersburg to Norfolk

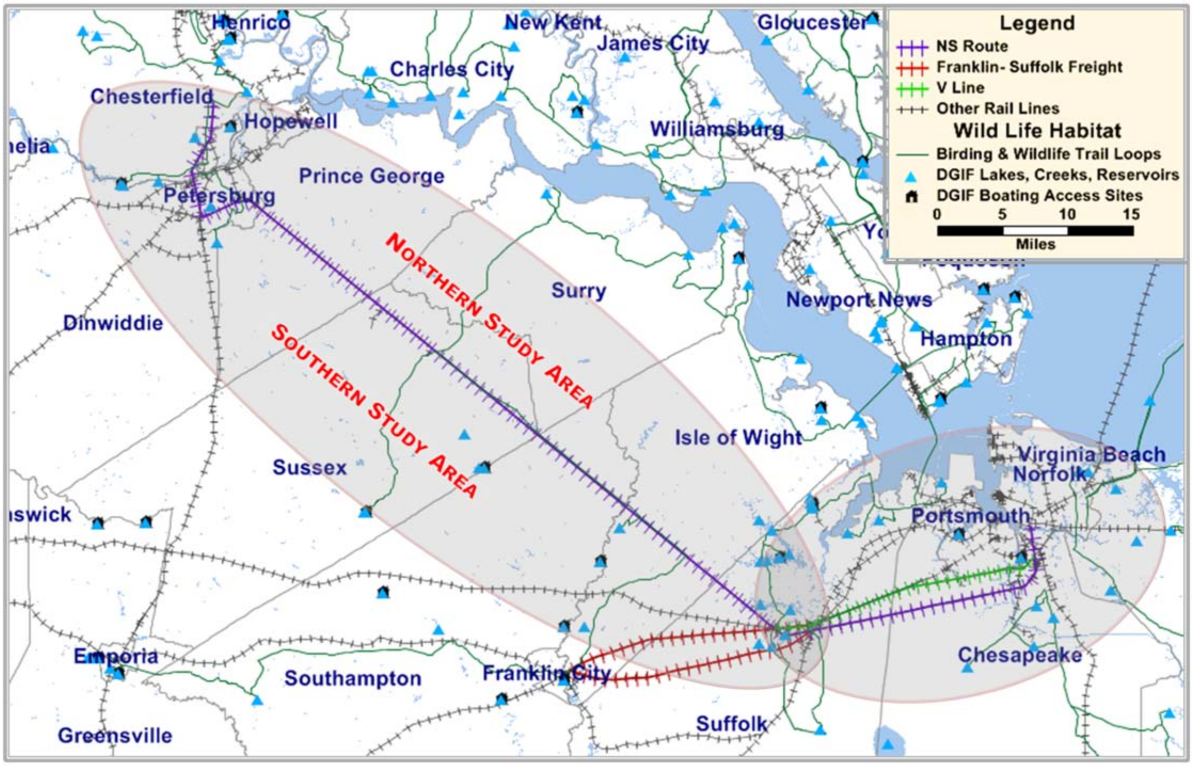
Wetland Types	Total Acres
Estuarine and Marine Deepwater	454.18
Estuarine and Marine Wetland	6,880.01
Freshwater Emergent Wetland	5,759.00
Freshwater Forested/Shrub Wetland	176,583.47
Freshwater Pond	5,752.56
Lake	8,305.55
Other	93.10
Riverine	1,507.56
TOTAL	**205,335.43**

[11] http://www.archives.gov/federal-register/codification/executive-order/11990.html

5.5.3. WIDE LIFE HABITAT

Virginia DGIF also provided information on Virginia hunting, fishing, bird trails and wild life loops, along with lakes, creeps, reservoirs and boating access sites. Exhibit 5-13 shows all these information for the environmental study area from Petersburg to Norfolk.

Exhibit 5-13: Wild Life Habitat in the Environmental Study Area* from Petersburg to Norfolk



*Alignment will not be determined until the Tier II Environmental Process is complete.

In the next phase of the study, the U.S. Fish and Wildlife Service should be contacted to determine whether any threatened or endangered species or habitat may be impacted by any of the proposed options.

5.6. HAZARDOUS MATERIALS

A database search was conducted using standard environmental record sources (see Exhibit 5-14). These databases contain the names and/or locations of reported hazardous waste sites, treatment, storage and disposal facilities, pollution and hazardous waste spills, including Leaking Underground Storage Tanks (LUSTs), and landfills in Virginia. The Hazardous Materials Technical Report describes more fully the approach and analysis methods used to determine identified hazardous material sites.[12] Any incident or facility identified within the search distance was reviewed to identify past activities that could potentially result in Recognized Environmental Conditions (RECs) at the subject property or within the search distance.

[12] http://www.virginiadot.org/projects/resources/TCP_Hazardous_Materials_Tech_Rpt_072704.pdf

Exhibit 5-14: Standard Environmental Record Sources[12, 13]

Source	Search Distance (miles)
Federal and State Equivalent – National Priorities List (NPL)	1.0
Federal and State Equivalent - Comprehensive Environmental Response, Compensation and Liability System (CERCLIS)	0.5
Federal and State Equivalent - Comprehensive Environmental Response, Compensation, and Liability System (CERCLIS), No Further Remedial Action Planned (NFRAP)	Subject and Adjoining Properties
Federal List of Treatment, Storage and Disposal (TSD) Facilities Subject to Corrective Action (CORRACTS) under the Resource Conservation and Recovery Act (RCRA)	1.0
Federal RCRA Non-CORRACTS	0.5
Federal RCRA Generators List	Subject and Adjoining Properties
Federal Emergency Response Notification System (ERNS) List	Subject Property Only
State Landfill and/or Solid Waste Disposal Site Lists	0.5
State Leaking Underground Storage Tanks (LUST) List	0.5
State Registered Underground and Aboveground Storage Tanks (USTs/ASTs) List	Subject and Adjoining Properties

At this stage of the project, superfund sites have been identified in the environmental study area from Petersburg to Norfolk corridor. Superfund is the name given to the environmental program established to address abandoned hazardous waste sites. It is also the name of the fund established by the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended (CERCLA statute, CERCLA overview). This law was enacted in the wake of the discovery of toxic waste dumps such as Love Canal and Times Beach in the 1970s. It allows the EPA to clean up such sites and to compel responsible parties to perform cleanups or reimburse the government for EPA-lead cleanups. For the environmental study area, Exhibit 5-15 and Exhibit 5-16 show the final NPL sites and proposed NPL sites with the site name, EPA ID, NPL status and address.[14, 15]

[13] Source: 460_DEIS_Section_4_5-6.pdf
[14] http://www.epa.gov/superfund/about.htm
[15] Virginia Department of Environmental Quality

Exhibit 5-15: Final National Priority List (NPL) sites from Petersburg to Norfolk Environmental Study Area.

Site Name	EPA ID	NPL Status	City	County	Zip
Abex Corp	VAD980551683	Final	Portsmouth	Portsmouth	23704
Atlantic Wood Industries	VAD990710410	Final	Portsmouth	Portsmouth	23704
C & R Battery	VAD049957913	Final	Richmond	Chesterfield	23234
Defense General Supply Center	VA3971520751	Final	Richmond	Chesterfield	23297
Former Nansemond Ordnance Depot	VAD123933426	Final	Suffolk	Suffolk	23434
Naval Amphibious Base	VA5170022482	Final	Norfolk	Virginia Beach	23521
Norfolk Naval Base	VA6170061463	Final	Norfolk	Norfolk	23511
Norfolk Naval Shipyard	VA1170024813	Final	Portsmouth	Portsmouth	23709
Rentokil, Inc.	VAD071040752	Final	Richmond	Henrico	23228
St Julien's Creek Annex (US Navy)	VA5170000181	Final	Chesapeake	Chesapeake	23702
Saunders Supply Co.	VAD003117389	Final	Chuckatuck	Suffolk	23432

Exhibit 5-16: Proposed National Priority List (NPL) sites - Petersburg to Norfolk Environmental Study Area

Site Name	EPA ID	NPL Status	City	County	Zip
Peck Iron and Metal	VAN000306115	Proposed	Portsmouth	Portsmouth	23704

At this stage of the study, 11 final NPL sites and 1 proposed NPL site were identified in the environmental study area corridor. In the next phase, based on this landscape level identification alternatives will be proposed.

5.7. AIR QUALITY

The Environmental Protection Agency (EPA) has set National Ambient Air Quality Standards (NAAQS) for six principal pollutants: Air Quality criteria are dependent on Carbon Monoxide (CO), Lead, Nitrogen Dioxide (NO_2), Ozone, Particle matter and Sulfur Dioxide (SO_2) – these are called "criteria" pollutants. Exhibit 5-17 shows the criteria for all the pollutants based on the NAAQS[16]. For the environmental study area from Petersburg to Norfolk, Ozone has been the only problem criteria pollutant. The 2008 8-hour Ozone classifications in 2008 are as follows:

- Extreme: Area with a design value of 0.175 ppm and above.
- Severe 17: Area with a design value of 0.119 up to but not including 0.175 ppm.
- Severe 15: Area with a design value of 0.113 up to but not including 0.119 ppm.
- Serious: Area with a design value of 0.100 up to but not including 0.113 ppm.
- Moderate: Area with a design value of 0.086 up to but not including 0.100 ppm.
- Marginal: Area with a design value of 0.076 up to but not including 0.086 ppm.

On April 30, 2004 (69 FR 23941), the environmental study area from Petersburg to Norfolk was designated as a marginal nonattainment for the 1997 ozone NAAQS, which was set at a level of 0.08 ppm

[16] http://www.epa.gov/air/criteria.html

or 84 ppb[17]. However, the area implemented a number of control measures that resulted in significant reductions in ozone, and the area qualified for attainment (maintenance) status in June 2007. On November 21, 2011, the DEQ Director submitted air quality designation recommendations for Virginia for the 2008 ozone National Ambient Air Quality Standard (NAAQS) to U.S. Environmental Protection Agency (EPA)[18]. In April 2012, the EPA concurred and designated this area as attaining the 2008 ozone NAAQS.

Exhibit 5-17: National Ambient Air Quality Standards (NAAQS) [19]

Pollutant [final rule cite]	Primary/ Secondary		Averaging Time	Level	Form
Carbon Monoxide	Primary		8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead	Primary and Secondary		Rolling 3 month average	0.15 μg/m³	Not to be exceeded
Nitrogen Dioxide	Primary		1-hour	100 ppb	98th percentile, averaged over 3 years
	Primary and secondary		Annual	53 ppb	Annual Mean
Ozone	Primary and Secondary		8-hour	0.075 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle Pollution	$PM_{2.5}$	Primary	Annual	12 μg/m³	Annual mean, averaged over 3 years
		Secondary	Annual	15 μg/m³	Annual mean, averaged over 3 years
		Primary and Secondary	24-hour	35 μg/m³	98th percentile, averaged over 3 years
	PM_{10}	Primary and Secondary	24-hour	150 μg/m³	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide	Primary		1-hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	Secondary		3-hour	0.5 ppm	Not to be exceeded more than once per year

As a result, the environmental study area has now been upgraded to an attainment area for all air pollutants.

[17] Page 3, *Ozone Advance Action Plan for the Richmond-Petersburg Area*, http://www.deq.virginia.gov/Portals/0/DEQ/Air/PublicNotices/Drafts/rppro.pdf

[18] See: http://www.deq.virginia.gov/Programs/Air/AirQualityPlanningEmissions/2008OzoneStandardDesignationRecommendations.aspx

[19] http://www.epa.gov/air/criteria.html

5.8. NOISE AND VIBRATION

Railroad activity and street level traffic, large truck traffic account for the majority of the noise and vibration impacts. The methodology used for measuring noise and vibration should be conducted in accordance with Federal Railroad Administration's (FRA) High-Speed Ground Transportation Noise and Vibration Impact Assessment guidelines[20], and Richmond Hampton Roads Passenger Rail Project Tier I Draft EIS report[21] . At this phase of study, only the methodology is identified. Typically, mitigations for noise and vibration are construction of noise fencing, elimination of horn noise associated with trains passing though the grade crossings, and prohibiting use of trucks on bridges.

5.9. UTILITIES

Selection of alternatives should take into consideration of utility lines. These utility lines are provided by reviewing aerial photographs, mapping available from several internet sites and site specific photographs[22]. Exhibit 5-18 shows a sample utility line in the environmental study area. Any utilities located in the right-of-way may need to be relocated. Another alternative is to run the tracks parallel to the utility line if the existing Right of Way is wide and straight enough.

Exhibit 5-18: Utility Line at Windsor, VA within Environmental Study Area from Petersburg to Norfolk

[20] High-Speed Ground Transportation Noise and Vibration Impact Assessment, U.S. Department of Transportation, Federal Railroad Administration, Washington, DC, December 1998 standards.
[21] Richmond Hampton Roads Passenger Rail Project Tier I Draft EIS report. Chapter 3 http://www.drpt.virginia.gov/projects/hamptonpassenger.aspx
[22] This information was based on the Richmond Hampton Roads Passenger Rail Project Tier I Draft EIS report. Chapter 3 http://www.drpt.virginia.gov/projects/hamptonpassenger.aspx

5.10. ENVIRONMENTAL JUSTICE

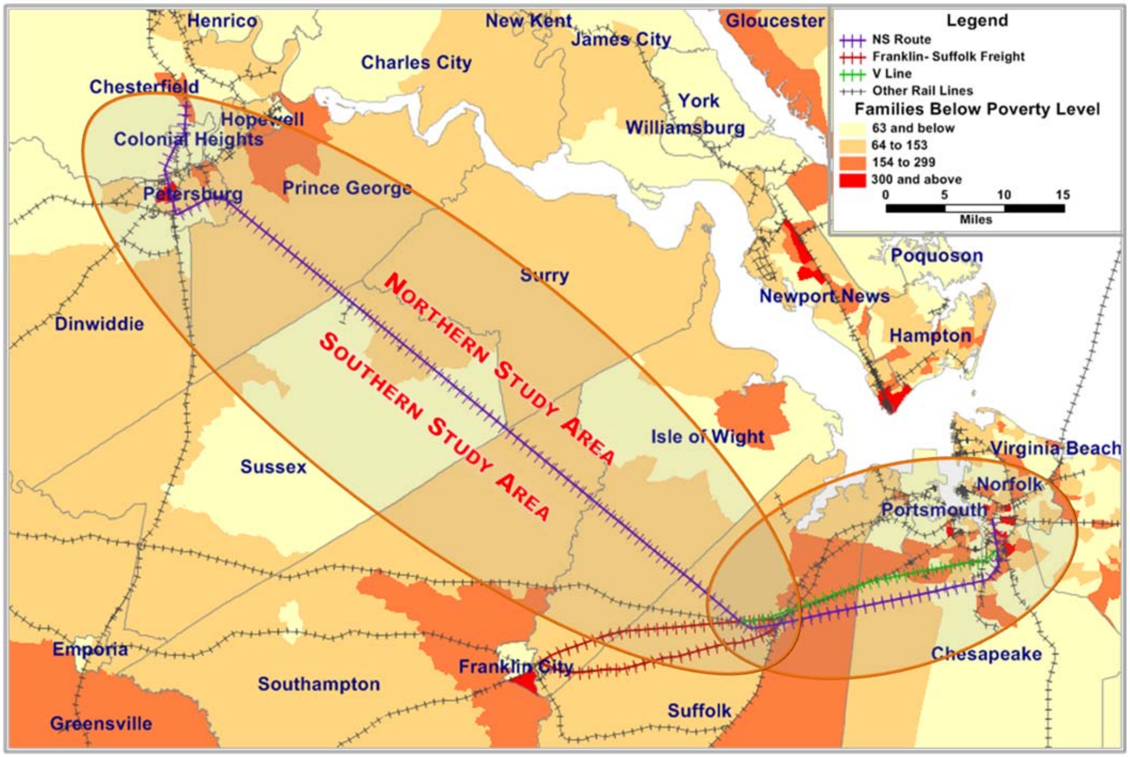
As Title VI of the Civil Rights Act and the Executive Order on Environmental Justice (EJ) (#12898) do not provide specific guidance to evaluate EJ issues within a region's transportation planning process. Thus, according to Delaware Valley Regional Planning Commission (DVRPC)'s 2001 EJ technical assessment[23], the following population groups need to be assessed, defined by the US Census Bureau:

- Non-Hispanic Minority
- Carless Households
- Households in Poverty
- Persons with a Physical Disability
- Female Head of Household with Child
- Elderly (over 75 years)
- Hispanic
- Limited English Proficiency

This data for all the population groups is provided by US Census Bureau. Exhibit 5-19 shows the families below the poverty level within the environmental study area. Most of the environmental study area has 64 to 153 families below poverty level; parts of Suffolk County, Portsmouth, Norfolk City and Prince George's County with levels in the range of 154 to 299 families and parts of Petersburg, Norfolk, Chesapeake and Portsmouth Cities with more than 300 families below poverty level. However, as seen in the Exhibit 5-19 within the environmental study area the EJ assessment population groups are very minimal from Petersburg to Suffolk. From Suffolk to Norfolk as the option follows existing rail alignment, it has minimal impact on the EJ population groups. This will be analyzed in detail in the next phase of the study along with proposed alternatives.

[23] http://www.dvrpc.org/webmaps/ej/

Exhibit 5-19: Families below Poverty Level for Petersburg to Norfolk Environmental Study Area*[24]



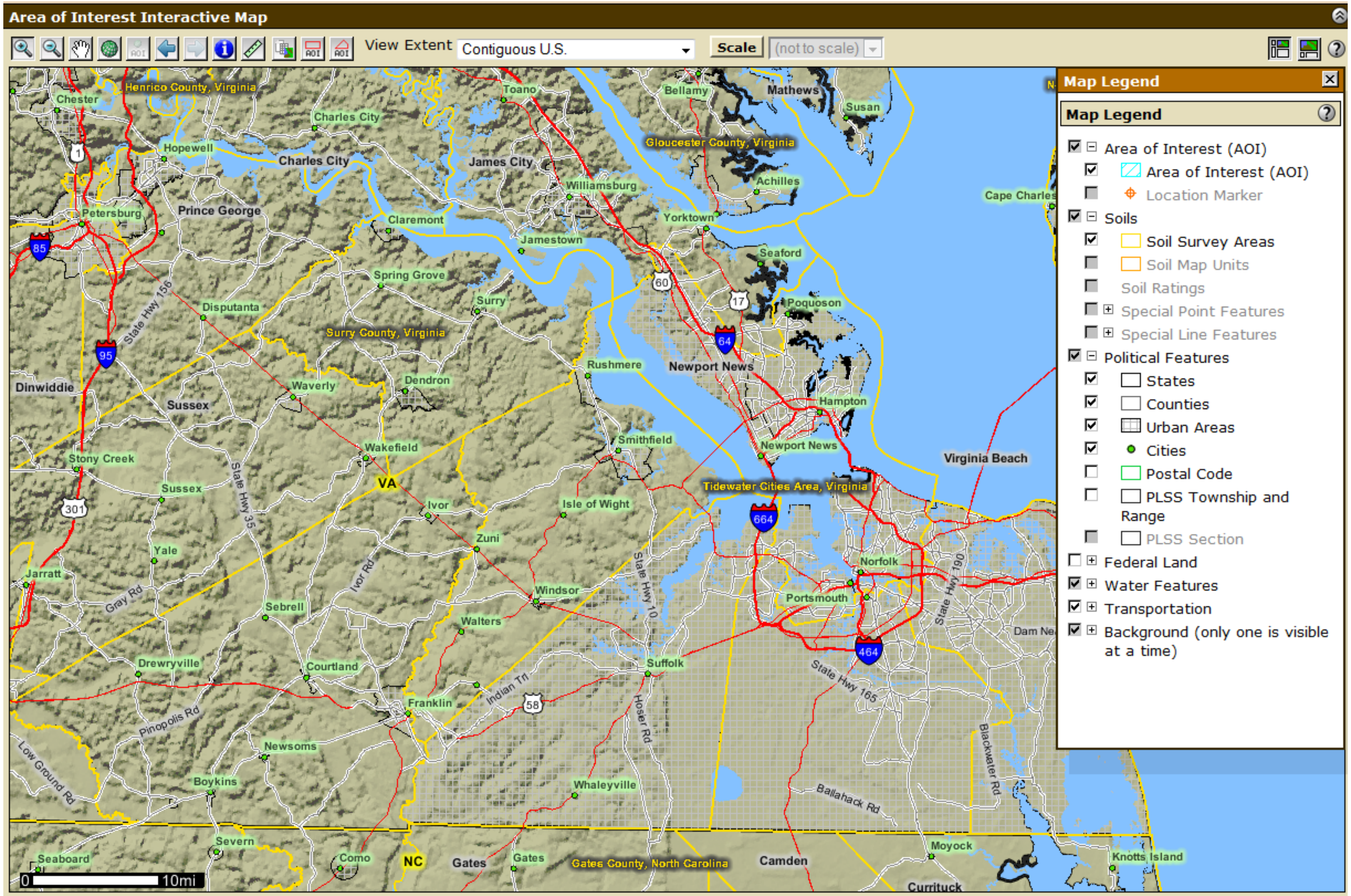
*Alignment will not be determined until the Tier II Environmental Process is complete.

5.11. GEOLOGY AND SOILS

The impact of dynamic loads of the trains on the soil may result in very intense compression cycles. For this reason type of soil and soil stability are very important factors. In order to provide a good foundation, thick layers of aggregate, and frequent and expensive maintenance may be required depending on the soil stability[25]. In order to determine the soil stability identification of the soil type is essential. This could affect the final alignment location. Soil data is available as prime farmland provided by the National Resource Conservation Service (NRCS) State Soil Geographic (STATSGO) Database and Soil Survey Geographic Database (SSURGO) (http://www.ncgc.nrcs.usda.gov/) soil data. Exhibit 5-20 shows the cities and counties which provide soil survey data.

[24] Data was based US Census data for the year 2000.
[25] http://www.haywardbaker.com/WhatWeDo/Applications/RRSubgradeStabilization/default.aspx; http://www.prestogeo.com/railroad_industry; http://www.tenaxus.com/en/geosynthetics/soil-stabilization/railroads-and-airport-runways.htm.

Exhibit 5-20: Interactive Soil Survey Area Within the Environmental Study Area[26]



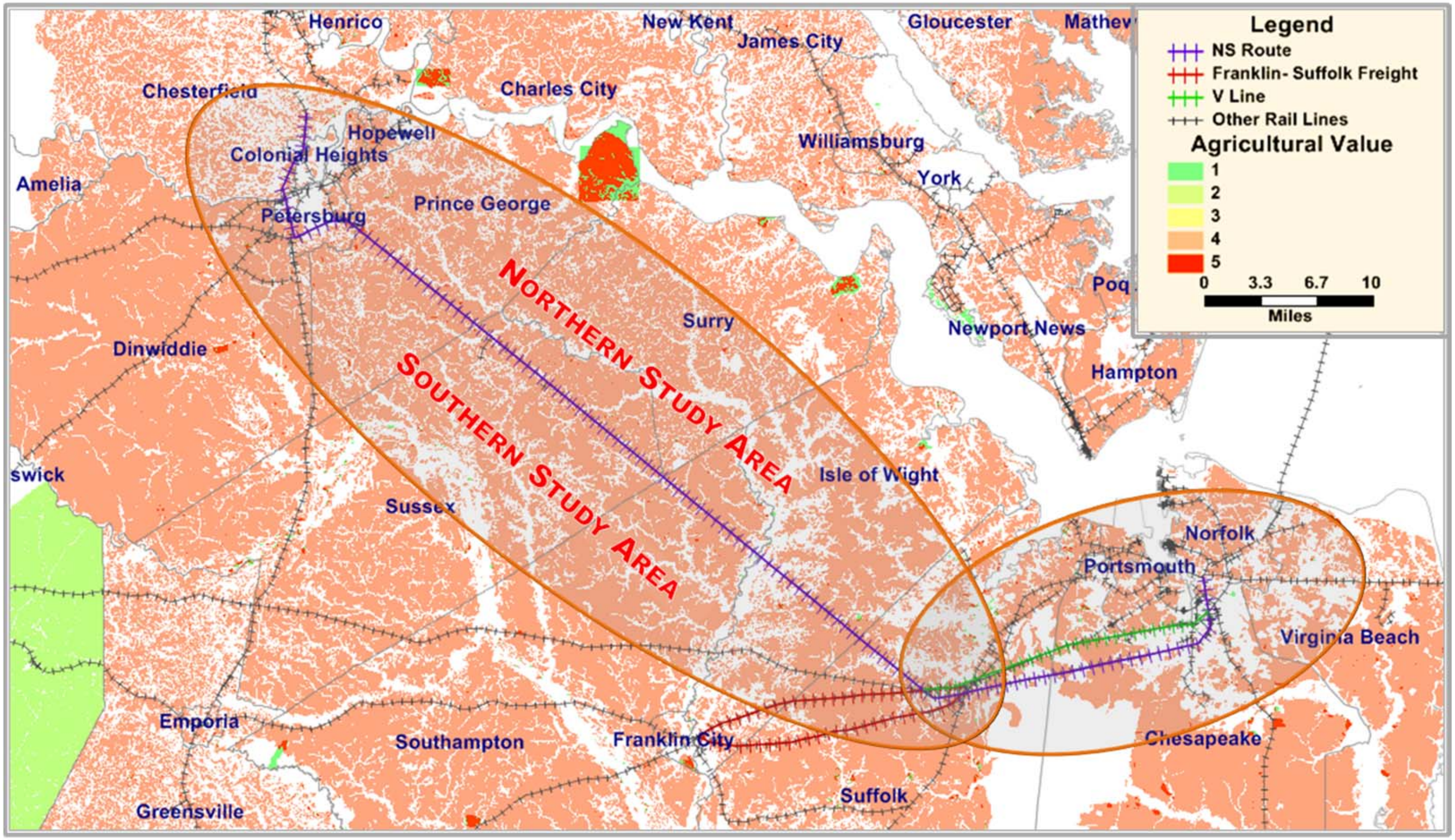
The soil data obtained by STATSGO data are available both in tabular and spatial form for each county and is expressed in proportion value ranges from 0.01 to 0.87 These values represent probability of finding prime farmland at a geographical location and are subdivided into 5 equal interval of classes with ranking as below[27].

Range[28]	Rank
0.8015686 – 1	5 (High)
0.6031372 – 0.8015686	4
0.4047058 – 0.6031372	3
0.2062745 – 0.4047058	2
0.0078431 – 0.2062745	1 (Low)

Exhibit 5-21 shows the agricultural ranking values within the environmental study ranging from a high of 5 to a low of 1. The ranking was based on the final prime farmland grid and final historic farm grids. It is seen that at this stage of data collection most of the environmental area fall in rank 4. For instance Virginias State soil[29] is Pamunkey soils formed in stream terrace sediments in the James River drainage basin of Virginia. This soil needs to be preserved as in recent years these soils produced yields of corn and wheat[30]. In the next stage of the study with the finalized alternatives, more detailed soil inspection is required, both for development of a detailed alignment option and for identification of farmland impacts.

[27] http://www.dcr.virginia.gov/natural_heritage/documents/AgriculturalModelTechReport.pdf
[28] According to Agricultural model Tech Report the final agricultural model describes that the ranges and ranking were based on prime farmland grid was weighted at 80%, the historic archaeological farms were weighted at 10% and the historic architectural farms were weighted at 10%.
[29] According to Natural Resources Conservation Service (NRCS) of US Department of Agriculture, A state soil is a soil that has special significance to a particular state. Each state in the United States has selected a state soil, twenty of which have been legislatively established. These "Official State Soils" share the same level of distinction as official state flowers and birds. Also, representative soils have been selected for Puerto Rico and the Virgin Islands. http://soils.usda.gov/gallery/state_soils/
[30] ftp://ftp-fc.sc.egov.usda.gov/NSSC/StateSoil_Profiles/va_soil.pdf

Exhibit 5-21: Agricultural Values within the Environmental Study Area*



*Alignment will not be determined until the Tier II Environmental Process is complete.

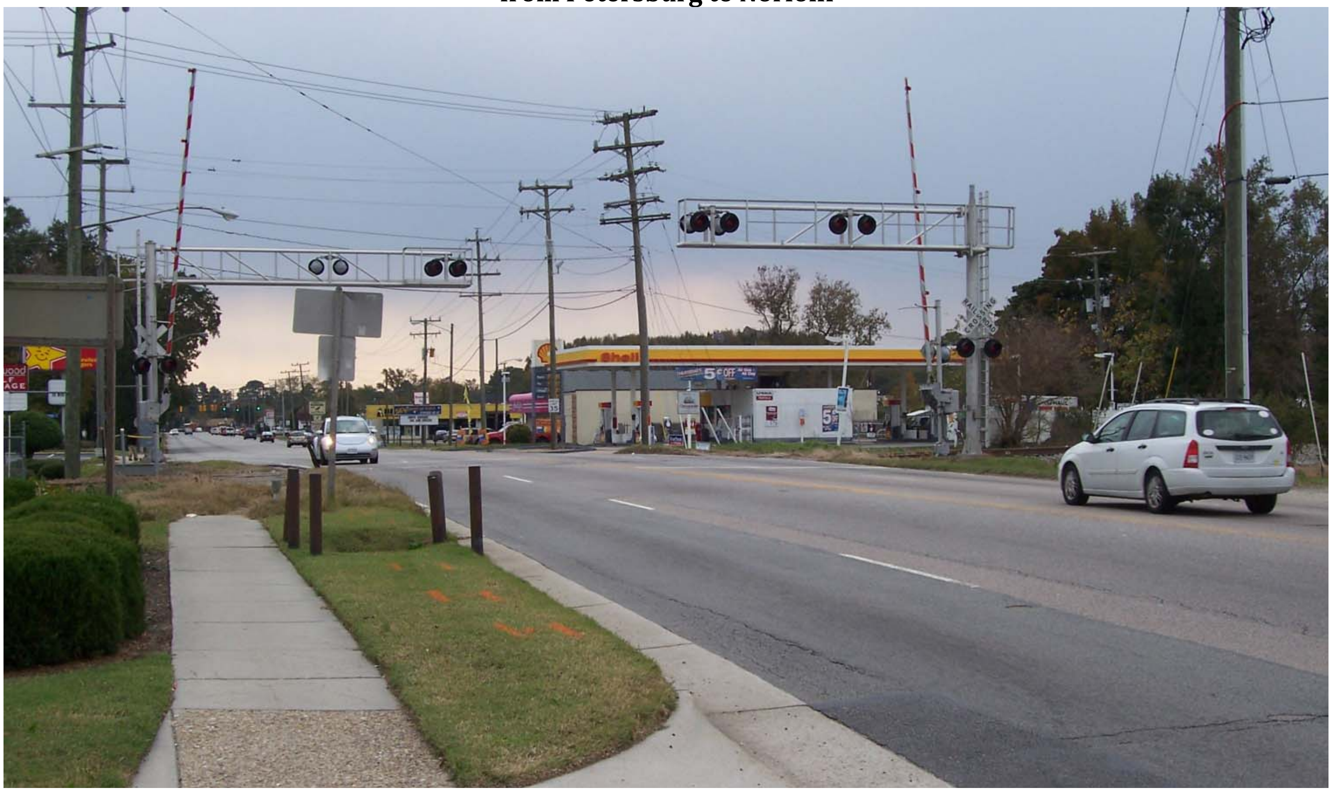
5.12. TRANSPORTATION; LAND STATUS, LAND USE AND ZONING; AND SOCIOECONOMIC CONDITIONS

- Transportation: The presence of interstates, highways or any major roadway must be identified for the proposed alternatives
- Land Status, Land Use, and Zoning: Right-of-ways for the proposed rail tracks must be within the taken into consideration as part the study.
- Socioeconomic Conditions: The hierarchical population density of the cities and counties for Petersburg to Norfolk environmental study area are Norfolk City, Portsmouth City, Colonial Heights City, Virginia Beach City, Petersburg City, Franklin City, Chesapeake City, Suffolk City, Prince George County, Isle of Wight County, Franklin County, Dinwiddie County, Sussex County, and Surry County, where Norfolk City being densely populated and Surry County being scarcely populated. Major resident city areas with major transportation hubs are very important in the identification of proposed alternatives

5.13. PUBLIC HEALTH AND SAFETY

Age of the bridge, water runoff, basal erosion, and accidents at rail road crossing are typical safety concerns that have to be taken into consideration for all the proposed alternatives. Railroad Crossing, Pedestrian safety and rail operations also are main factors contributing to the safety[31]. Exhibit 5-22 shows the rail crossing at Chesapeake, VA.

Exhibit 5-22: Rail Road Crossings at Chesapeake, VA within Environmental Study Area from Petersburg to Norfolk



[31] Based on Federal Highway Railroad (FRA, Federal Highway Administration (FHWA), and Richmond to Hampton Roads Passenger Rail Study, Tier I Environmental Impact Statement, Virginia DRPT.

5.14. CONCLUSION AND FURTHER ANALYSIS

- This chapter identifies the list the elements within the environmental study area from Petersburg to Norfolk. The highlights of the environmental data collection are as follows:
  - Conservations land identified within the environmental study area approximated to 544,784 acres that include 2,414 acres of forest area, 53,894 acres of federal, national and state park areas, 436,290 acres of wild life refuge and preserves area, and 52,186 acres of other conservation lands that include land holdings, military installation, and preserves.
  - 99 Historical resources were identified that include churches, buildings, houses, etc. within the environmental study area.
  - Wetlands identified within the environmental study area has approximately 205,335 acres that include 176,583 acres of freshwater forested/scrub wetlands, 8,305 acres of lakes, 6,880 acres of estuarine and marine wetlands, 5,759 of freshwater emergent wetlands, 5,752 acres of freshwater pond, 1,507 acres of riverine, 454 acres of estuarine and marine deepwater and 93 acres of other wetlands.
  - Wild life habitat within the environmental study area was identified capturing hunting, fishing, bird and wild life trial loops, boating access sites along with lakes, creeks, and reservoirs
  - Hazardous material superfund sites of 11 final NPL sites and 1 proposed NPL site were identified within the environmental study area.
  - Air quality within the environmental study area shows that the only pollutant that has recently been in the marginal levels was ozone. However in April 2012 the EPA designated the area as in compliance for ozone under the 2008 standards, so the study area is now in compliance status for all air pollutants.
  - Other human environmental elements that include noise and vibrations, utilities, environmental justice, geology and soils, transportation, land status, land use, and zoning, socioeconomic conditions, and public health and safety were all discussed in a landscape level and should be discussed in detail in the next phase of the study when choosing the alternatives.

These landscape level of data collection will help the next phase of the study in developing a Service NEPA for the high speed passenger rail study, once the route alignment options have been more carefully defined and optimized.

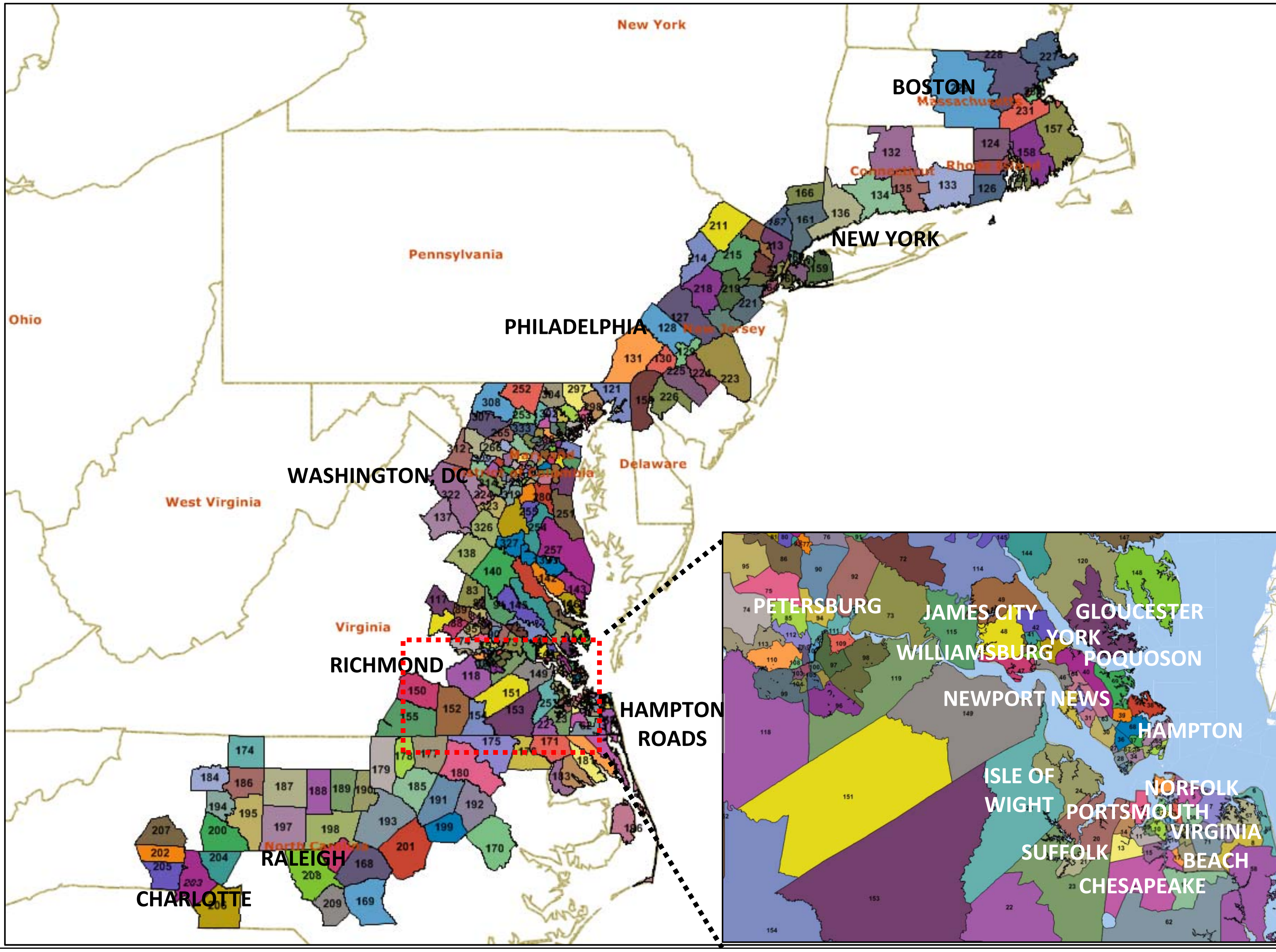
6 CONCLUSION

- The Phase 2A data collection has amassed four comprehensive databases:
  - Market Database
  - Technology Database
  - Engineering Database
  - Environmental Database
- The databases provide all the information needed to complete the HRTPO Vision Plan and if justified the Service Development Plan (SDP) required by USDOT FRA to support further high speed rail planning. The analysis sets out the evaluation of the higher and high speed options proposed by the HRTPO Board in its resolution of October 2009, Resolution 2009-05 for the Norfolk-Richmond corridor.
- The databases make extensive use of data provided by:
  - The U.S. Census Bureau, Bureau of Economic Analysis
  - MPO data from Hampton Roads Transportation Planning Organization, Richmond Regional Planning District Commission, Crater Planning District Commission, Metropolitan Washington Council of Governments, Baltimore Metropolitan Council
  - DRPT Tier 1 Environmental Impact Statement
  - Technology Data provided by Siemens Valero, Bombardier Zefiro, Alstrom AGV, Talgo T21
  - Engineering track data from Norfolk Southern and CSX track charts
  - VDOT Highway and Traffic Data
- The data has been assembled in TEMS *RightTrack™* Computer System which is specifically designed for passenger rail planning as specified by USDOT FRA in their guidance documents.
- In Phase 2B the processes discussed in Chapter 1 will use these databases:
  - for Ridership and Revenue analysis and forecast year projections
  - An Interactive Analysis to identify the optimum higher and high speed technology infrastructure and operating speeds given the character of the market; and
  - A Financial, Economic and Environmental analysis as specified by USDOT FRA guidance documents can be completed for any proposed alternatives.

This will provide HRTPO and DRPT the level of documentation needed for an Official Project Description (OPD), materials for presentations to the public, and institutional bodies (e.g., Chamber of Commerce). It would also provide information necessary for parties who may well be interested in participating in a Public Private Partnership (PPP) once the project has moved through Federal Environmental Process.

APPENDIX A – SOCIOECONOMIC PROJECTIONS BY ZONE FOR 2015, 2035 AND 2050

A.1. ZONE MAPS



A.2. ZONE DATA

Zone	State	County	Centroid Description
1	Virginia	City of Norfolk	Norfolk (Downtown)
2	Virginia	City of Norfolk	Lamberts Point - Colonial Place
3	Virginia	City of Norfolk	Fairmount Park - Lafayette Annex
4	Virginia	City of Norfolk	Glenwood Park
5	Virginia	City of Norfolk	Norfolk International Airport
6	Virginia	City of Virginia Beach	Virginia Beach
7	Virginia	City of Virginia Beach	Chinese Corner
8	Virginia	City of Virginia Beach	Oceana Naval Air Station
9	Virginia	City of Norfolk	Berkley - Campostella
10	Virginia	City of Portsmouth	Portsmouth
11	Virginia	City of Portsmouth	Victory Park
12	Virginia	City of Portsmouth	Arostead Forest - Craney Island
13	Virginia	City of Chesapeake	Bowers Hill
14	Virginia	City of Chesapeake	Boone
15	Virginia	City of Chesapeake	Loxley Gardens - Geneva Park
16	Virginia	City of Chesapeake	South Norfolk
17	Virginia	City of Chesapeake	1200 Battlefield Blvd N
18	Virginia	City of Chesapeake	910 Great Bridge Blvd
19	Virginia	City of Chesapeake	Chesapeake
20	Virginia	City of Suffolk	Bennett Corner
21	Virginia	City of Suffolk	Suffolk
22	Virginia	City of Suffolk	Holland
23	Virginia	City of Suffolk	Kings Fork
24	Virginia	Isle of Wight	Smithfield
25	Virginia	Isle of Wight	Zuni
26	Virginia	City of Newport News	Newport News (Downtown South)
27	Virginia	City of Newport News	Newport News Amtrak Station
28	Virginia	City of Newport News	Newport News (Downtown North)
29	Virginia	City of Newport News	Newport News (Reed)
30	Virginia	City of Newport News	Glendale - Beaconsville
31	Virginia	City of Newport News	Charles
32	Virginia	City of Newport News	Sunsan Constant Dr
33	Virginia	City of Newport News	2 Shore Park Dr
34	Virginia	City of Hampton	Hampton (West)
35	Virginia	City of Hampton	Hampton (Downtown)
36	Virginia	City of Hampton	Fox Corner
37	Virginia	City of Hampton	Chapel Village
38	Virginia	City of Poquoson	Poquoson
39	Virginia	York	Yorktown (Rt. 134 & Rt. 600)
40	Virginia	York	Yorktown (West)
41	Virginia	York	Greensprings-Plantation Heights
42	Virginia	York	Skimino
43	Virginia	York	Charleston Heights - York Terrace
44	Virginia	City of Williamsburg	Williamsburg
45	Virginia	City of Williamsburg	Williamsburg (Southeast - Forest Hill Park)
46	Virginia	James City	James Terrace - Grove
47	Virginia	James City	Jamestown - Hollybrook
48	Virginia	James City	Canterbury Hills - Jamestown Farms
49	Virginia	James City	Toano
50	Virginia	Gloucester	Gloucester
51	Virginia	City of Chesapeake	Grassfield - Chesapeake Regional Apt.
52	Virginia	City of Norfolk	Gent-Park Place
53	Virginia	City of Norfolk	Huntersville (Hunter's Village)
54	Virginia	City of Norfolk	Ocean View - Willoughby Beach

Zone	State	County	Centroid Description
55	Virginia	City of Norfolk	Sussex - Wards Corner
56	Virginia	City of Norfolk	Thomas Corner
57	Virginia	City of Virginia Beach	London Bridge
58	Virginia	City of Virginia Beach	Nimmo-Woodhouse Corner
59	Virginia	City of Portsmouth	Westhaven Park
60	Virginia	City of Chesapeake	Hawthorne Drive, Chesapeake
61	Virginia	City of Chesapeake	Shenandoah Pkwy
62	Virginia	City of Chesapeake	St. Brides
63	Virginia	City of Newport News	Deer Park - Harpersville
64	Virginia	City of Newport News	Newport News/Williamsburg International Airport
65	Virginia	City of Hampton	Hampton (East)
66	Virginia	City of Hampton	504 E Mercury Blvd
67	Virginia	City of Hampton	Greenwood Farms
68	Virginia	City of Hampton	Drummonds Corner
69	Virginia	York	Yorktown - Grafton
70	Virginia	City of Virginia Beach	Pecan Gardens
71	Virginia	City of Virginia Beach	Acredale
72	Virginia	New Kent	Woodhaven Shores - New Kent Co. Airport
73	Virginia	Charles City	Charles City
74	Virginia	Chesterfield	Swift Creek Resevoir
75	Virginia	Chesterfield	Chesterfield County Airport
76	Virginia	Henrico	East Highland Park
77	Virginia	City of Richmond	Church Hill
78	Virginia	City of Richmond	Ginter Park - Hotchkiss Field
79	Virginia	City of Richmond	Richmond (Downtown-West)
80	Virginia	City of Richmond	Richmond (The Fan District)
81	Virginia	City of Richmond	Richmond (West End)
82	Virginia	Hanover	Ashland
83	Virginia	Hanover	Goodallr-Farrington
84	Virginia	Henrico	Tuckahoe
85	Virginia	Chesterfield	Chester
86	Virginia	City of Richmond	Richmond (Southside)
87	Virginia	Henrico	Laurel
88	Virginia	Powhatan	Powhatan (Rt. 60 & Dorset Rd.)
89	Virginia	Goochland	Sabot
90	Virginia	Henrico	Richmond International Apt. (Sandston)
91	Virginia	Hanover	Mechanicsville (Henry Clay Heights)
92	Virginia	Henrico	Sandston (Rt. 156 & Rt. 33)
93	Virginia	City of Richmond	Richmond (Downtown-East)
94	Virginia	Chesterfield	Meadowville - Cameron Hills
95	Virginia	Chesterfield	Robious & Hylton Park
96	Virginia	Prince George	Ethridge Estates
97	Virginia	Prince George	Fort Lee
98	Virginia	Prince George	Rt. 106 & Rt. 156
99	Virginia	Dinwiddie	Petersburg (Dinwiddie County Airport - PTB)
100	Virginia	City of Petersburg	Petersburg (Blandford)
101	Virginia	City of Petersburg	Berkley Manor
102	Virginia	City of Petersburg	Petersburg (Downtown)
103	Virginia	City of Petersburg	Petersburg (Kennelworth)
104	Virginia	City of Petersburg	Camelot
105	Virginia	City of Petersburg	Petersburg (South)
106	Virginia	City of Colonial Heights	Colonial Heights
107	Virginia	City of Colonial Heights	Colonial Heights (East)
108	Virginia	Chesterfield	Ettrick (Amtrak Petersburg)
109	Virginia	City of Hopewell	Hopewell

Zone	State	County	Centroid Description
110	Virginia	Chesterfield	Matoaca
111	Virginia	Chesterfield	Screamersville
112	Virginia	Chesterfield	Pickadat Corner
113	Virginia	Chesterfield	Lake Chesdin Pkwy & Ivey Mill Rd.
114	Virginia	New Kent	New Kent
115	Virginia	Charles City	Sherwood Forest - Rustic
116	Virginia	Powhatan	Powhatan (Rt. 522 & Three Bridges Rd.)
117	Virginia	Goochland	Goochland
118	Virginia	Dinwiddie	Dinwiddie
119	Virginia	Prince George	Templeton
120	Virginia	Gloucester	Dutton
121	Maryland	Cecil	Elkton
122	Rhode Island	Bristol	Bristol
123	Rhode Island	Kent	Warwick
124	Rhode Island	Providence	Providence
125	Rhode Island	Newport	Newport
126	Rhode Island	Washington	Wakefield-Westerly
127	Pennsylvania	Bucks	Levittown
128	Pennsylvania	Montgomery	Norristown
129	Pennsylvania	Philadelphia	Philadelphia
130	Pennsylvania	Delaware	Springfield-Media
131	Pennsylvania	Chester	Downingtown-Exton
132	Connecticut	Hartford	Hartford-Glastonbury
133	Connecticut	New London	Norwich-New London
134	Connecticut	New Haven	New Haven
135	Connecticut	Middlesex	Middletown
136	Connecticut	Fairfield	Bridgeport
137	Virginia	Culpeper	Culpeper
138	Virginia	Spotsylvania/City of Fredericksburg	Fredericksburg
139	Virginia	Westmoreland	Hague
140	Virginia	Caroline	Bowling Green
141	Virginia	Essex	Tappahannock
142	Virginia	Richmond	Warsaw
143	Virginia	Northumberland	Heathsville
144	Virginia	King and Queen	Mattaponi
145	Virginia	King William	King William
146	Virginia	Lancaster	Irvington
147	Virginia	Middlesex	Topping-Deltaville
148	Virginia	Mathews	Foster
149	Virginia	Surry	Surry
150	Virginia	Lunenburg	Lunenburg
151	Virginia	Sussex	Waverly
152	Virginia	Brunswick	Lawrenceville
153	Virginia	Southampton/Franklin City	Franklin
154	Virginia	Greensville/City of Emporia	Emporia
155	Virginia	Mecklenburg	South Mill
156	Delaware	New Castle	Wilmington
157	Massachusetts	Plymouth	Plymouth-Kingston
158	Massachusetts	Bristol	Taunton
159	New York	Nassau	Hempstead
160	New York	Kings	Brooklyn
161	New York	Westchester	Yonkers-New Rochelle
162	New York	Bronx	Bronx
163	New York	New York	New York City
164	New York	Richmond	Staten Island
165	New York	Queens	Queens

Zone	State	County	Centroid Description
166	New York	Putnam	Carmel
167	New York	Rockland	Spring Valley
168	North Carolina	Harnett	Dunn
169	North Carolina	Cumberland	Fayetteville
170	North Carolina	Pitt	Greenville
171	North Carolina	Gates	Gatesville
172	North Carolina	Camden	Camden
173	North Carolina	Currituck	Currituck
174	North Carolina	Stokes	King
175	North Carolina	Northampton	Jackson
176	North Carolina	Hertford	Ahoskie
177	North Carolina	Warren	Warrenton
178	North Carolina	Vance	Henderson
179	North Carolina	Granville	Oxford
180	North Carolina	Halifax	Rosemary
181	North Carolina	Pasquotank	Elizabeth City
182	North Carolina	Perquimans	Hertford
183	North Carolina	Chowan	Edenton
184	North Carolina	Yadkin	Yadkinville
185	North Carolina	Franklin	Franklinton
186	North Carolina	Forsyth	Winston-Salem
187	North Carolina	Guilford	Greensboro
188	North Carolina	Alamance	Burlington
189	North Carolina	Orange	Chapel Hill
190	North Carolina	Durham	Durham
191	North Carolina	Nash	Rocky Mount
192	North Carolina	Edgecombe	Tarboro
193	North Carolina	Wake	Raleigh
194	North Carolina	Davie	Mocksville
195	North Carolina	Davidson	Lexington
196	North Carolina	Dare	Manteo
197	North Carolina	Randolph	Asheboro
198	North Carolina	Chatham	Siler City
199	North Carolina	Wilson	Wilson
200	North Carolina	Rowan	Salisbury
201	North Carolina	Johnston	Smithfield
202	North Carolina	Lincoln	Lincolnton
203	North Carolina	Mecklenburg	Charlotte
204	North Carolina	Cabarrus	Concord
205	North Carolina	Gaston	Gastonia
206	North Carolina	Union	Monroe
207	North Carolina	Catawba	Hickory
208	North Carolina	Moore	Southern Pines
209	North Carolina	Hoke	Raeford-Silver City
210	North Carolina	Lee	Sanford
211	New Jersey	Sussex	Sussex
212	New Jersey	Passaic	Paterson
213	New Jersey	Bergen	Paramus
214	New Jersey	Warren	Phillipsburg
215	New Jersey	Morris	Parsippany Troy Hills
216	New Jersey	Essex	Newark
217	New Jersey	Hudson	Jersey City-Hoboken
218	New Jersey	Hunterdon	Flemington
219	New Jersey	Somerset	Bridgewater-Somerville
220	New Jersey	Union	Elizabeth
221	New Jersey	Middlesex	New Brunswick

Zone	State	County	Centroid Description
222	New Jersey	Mercer	Trenton
223	New Jersey	Burlington	Willingboro
224	New Jersey	Camden	Camden
225	New Jersey	Gloucester	Woodbury
226	New Jersey	Salem	Penns Grove-Carneys Point
227	Massachusetts	Essex	Lawrence
228	Massachusetts	Middlesex	Cambridge - Burlington
229	Massachusetts	Worcester	Worcester
230	Massachusetts	Suffolk	Boston
231	Massachusetts	Norfolk	Quincy
232	Virginia	City of Alexandria	Alexandria (Old Town)
233	Virginia	Arlington	Metro-Ballston Station
234	Maryland	City of Baltimore	Downtown
235	Maryland	City of Baltimore	Johns Hospkins Hospital
236	Maryland	City of Baltimore	Brooklyn Manor
237	Maryland	City of Baltimore	South Baltimore - Locust Point
238	Maryland	City of Baltimore	Druid Hill Park - Mondawmin Mall
239	District of Columbia	City of Washington	The National Mall
240	District of Columbia	City of Washington	Capitol Hill - Union Station
241	District of Columbia	City of Washington	Washington Hospital Center
242	District of Columbia	City of Washington	Wesley Heights
243	District of Columbia	City of Washington	Brightwood
244	District of Columbia	City of Washington	Congress Heights
245	District of Columbia	City of Washington	Capital View
246	District of Columbia	City of Washington	Chevy Chase
247	District of Columbia	City of Washington	Downtown DC
248	District of Columbia	City of Washington	Logan Circle
249	Virginia	Arlington	Pentagon
250	Virginia	City of Alexandria	Landmark - Van Dorn
251	Maryland	Calvert	Prince Frederick
252	Maryland	Carroll	Westminster
253	Maryland	Carroll	Eldersburg
254	Maryland	Charles	Charlotte Hall (North) - Hughesville
255	Maryland	Charles	Waldorf
256	Maryland	Charles	Marbury-Pomonkey
257	Maryland	St. Mary's	Lexington Park
258	Maryland	Montgomery	Bethesda
259	Maryland	Montgomery	Silver Spring
260	Maryland	Montgomery	Wheaton
261	Maryland	Montgomery	Rockville
262	Maryland	Montgomery	Potomac
263	Maryland	Montgomery	Gaithersburg - Germantown
264	Maryland	Montgomery	Olney
265	Maryland	Montgomery	Damascus-Clarksburg
266	Maryland	Montgomery	Dawsonville
267	Maryland	Prince George's	Hyattsville (Chillum)
268	Maryland	Prince George's	College Park
269	Maryland	Prince George's	Hyattsville (Edmonston)
270	Maryland	Prince George's	Lanham (Landover Hills)
271	Maryland	Prince George's	Fairmount Heights
272	Maryland	Prince George's	Glenarden
273	Maryland	Prince George's	District Heights
274	Maryland	Prince George's	Marlow Heights
275	Maryland	Prince George's	Upper Marlboro
276	Maryland	Prince George's	Beltsville
277	Maryland	Prince George's	NASA Goddard Space Flight Center

Zone	State	County	Centroid Description
278	Maryland	Prince George's	Bowie
279	Maryland	Prince George's	Woodmore
280	Maryland	Prince George's	Cheltenham
281	Maryland	Prince George's	Fort Washington
282	Maryland	Anne Arundel	Severn
283	Maryland	Anne Arundel	Odenton
284	Maryland	Anne Arundel	Crofton
285	Maryland	Anne Arundel	Crownsville
286	Maryland	Anne Arundel	Davidsonville
287	Maryland	Anne Arundel	Galesville
288	Maryland	Anne Arundel	Riviera Beach
289	Maryland	Anne Arundel	Annapolis - Cape St. Clair
290	Maryland	Anne Arundel	Pasadena (Millersville)
291	Maryland	Anne Arundel	Linthicum Heights
292	Maryland	Anne Arundel	Glenmore
293	Maryland	Anne Arundel	Baltimore Washington International Airport
294	Maryland	Anne Arundel	Fort Meade-Patuxent Research Refuge
295	Maryland	Anne Arundel	Hanover
296	Maryland	Harford	Edgewood
297	Maryland	Harford	Bel Air
298	Maryland	Harford	Aberdeen
299	Maryland	Baltimore	Catonsville - Halethorpe
300	Maryland	Baltimore	Randallstown
301	Maryland	Baltimore	Reisterstown
302	Maryland	Baltimore	Brooklandville
303	Maryland	Baltimore	Towson
304	Maryland	Baltimore	Hereford
305	Maryland	Baltimore	Perry Hall
306	Maryland	Baltimore	Rosedale-Rossville
307	Maryland	Frederick	Frederick
308	Maryland	Frederick	Thurmont
309	Virginia	Loudoun	Sterling
310	Virginia	Loudoun	Ashburn South
311	Virginia	Loudoun	Leesburg
312	Virginia	Loudoun	Purcellville
313	Virginia	Fairfax/City of Fairfax/Falls Church	Herndon - Reston
314	Virginia	Fairfax/City of Fairfax/Falls Church	Centreville
315	Virginia	Fairfax/City of Fairfax/Falls Church	Fairfax
316	Virginia	Fairfax/City of Fairfax/Falls Church	Vienna
317	Virginia	Fairfax/City of Fairfax/Falls Church	Seven Corners
318	Virginia	Fairfax/City of Fairfax/Falls Church	Springfield
319	Virginia	Fairfax/City of Fairfax/Falls Church	Huntington
320	Virginia	Fairfax/City of Fairfax/Falls Church	McClean
321	Virginia	Fairfax/City of Fairfax/Falls Church	Great Falls
322	Virginia	Fauquier	Warrenton
323	Virginia	Prince William/Manassas/Manassas Park	Dale City
324	Virginia	Prince William/Manassas/Manassas Park	Manassas
325	Virginia	Prince William/Manassas/Manassas Park	Haymarket
326	Virginia	Stafford	Stafford
327	Virginia	King George	200-KGC01-King George
328	Maryland	Howard	Columbia
329	Maryland	Howard	Ellicott City
330	Maryland	Howard	Elkridge
331	Maryland	Howard	North Laurel-Savage
332	Maryland	Howard	Clarksville
333	Maryland	Howard	Cooksville

A.3. SOCIOECONOMIC PROJECTIONS BY ZONE

Zone	State	Population				Employment				PerCapita Income ($2012)			
		2010	2015	2035	2050	2010	2015	2035	2050	2010	2015	2035	2050
1	Virginia	10,966	11,562	14,291	16,228	31,928	33,058	37,989	41,558	37,876	39,635	46,670	51,950
2	Virginia	20,881	20,969	21,325	21,590	7,829	7,860	7,985	8,078	41,516	43,444	51,156	56,943
3	Virginia	19,804	19,873	20,152	20,359	2,778	2,808	2,931	3,023	33,509	35,065	41,290	45,961
4	Virginia	23,967	23,774	23,021	22,451	66,232	64,647	58,677	54,087	21,969	22,989	27,070	30,132
5	Virginia	43,310	43,442	43,972	44,369	11,373	11,492	11,983	12,347	32,842	34,367	40,467	45,045
6	Virginia	42,790	43,493	46,425	48,588	28,287	28,850	31,219	32,961	66,521	70,417	86,004	97,704
7	Virginia	77,310	78,635	84,164	88,239	57,127	57,883	61,008	63,320	43,863	46,432	56,709	64,424
8	Virginia	36,300	37,318	41,685	44,867	24,755	24,691	24,439	24,249	33,712	35,687	43,586	49,515
9	Virginia	7,714	7,734	7,817	7,879	6,659	6,378	5,369	4,578	18,913	19,791	23,304	25,941
10	Virginia	21,259	21,463	22,300	22,921	33,248	33,061	32,326	31,771	30,564	32,210	38,796	43,739
11	Virginia	34,361	34,808	36,655	38,021	9,775	9,521	8,568	7,834	35,143	37,036	44,608	50,291
12	Virginia	26,287	26,438	27,051	27,508	5,952	6,207	7,345	8,162	43,917	46,283	55,745	62,847
13	Virginia	11,848	13,079	19,425	23,716	6,662	7,129	9,351	10,904	35,100	37,291	46,055	52,635
14	Virginia	22,875	24,212	30,390	34,758	12,795	13,558	17,091	19,587	44,903	47,706	58,918	67,336
15	Virginia	20,149	20,737	23,268	25,110	6,636	6,724	7,087	7,356	38,726	41,143	50,813	58,072
16	Virginia	23,940	24,923	29,275	32,407	8,815	9,256	11,252	12,676	32,544	34,576	42,702	48,802
17	Virginia	8,246	8,699	10,772	12,244	10,555	11,028	13,139	14,652	32,544	34,576	42,702	48,802
18	Virginia	10,949	11,853	16,279	19,336	5,623	5,908	7,198	8,118	32,544	34,576	42,702	48,802
19	Virginia	50,727	54,322	71,434	83,387	13,592	15,320	24,722	30,941	45,959	48,828	60,304	68,919
20	Virginia	30,802	37,610	83,597	111,466	8,513	10,957	30,068	40,985	43,071	45,512	55,275	62,604
21	Virginia	27,926	30,440	42,971	51,562	18,224	19,703	26,923	31,915	30,039	31,741	38,550	43,662
22	Virginia	6,378	6,993	10,102	12,221	1,086	1,097	1,139	1,170	37,679	39,814	48,356	54,767
23	Virginia	19,766	23,668	48,651	64,122	6,091	7,945	22,997	31,465	36,417	38,481	46,736	52,932
24	Virginia	19,853	22,612	38,050	48,146	10,828	12,014	18,204	22,369	40,710	43,277	53,546	61,255
25	Virginia	15,446	17,304	27,256	33,882	4,519	5,434	11,361	15,015	40,710	43,277	53,546	61,255
26	Virginia	7,909	7,893	7,831	7,784	7,981	8,508	10,990	12,733	16,668	17,314	19,897	21,836
27	Virginia	4,544	4,530	4,474	4,432	3,234	3,175	2,952	2,782	36,345	37,753	43,386	47,614
28	Virginia	13,208	13,013	12,259	11,685	22,772	23,011	23,995	24,725	27,175	28,228	32,440	35,601
29	Virginia	11,693	11,774	12,104	12,350	1,427	1,425	1,418	1,413	25,178	26,154	30,056	32,985
30	Virginia	38,204	39,453	44,873	48,806	16,687	16,586	16,188	15,888	40,171	41,728	47,954	52,626
31	Virginia	19,310	19,771	21,723	23,153	2,240	2,406	3,201	3,755	31,123	32,329	37,152	40,772
32	Virginia	28,728	29,155	30,923	32,230	5,468	5,671	6,565	7,210	31,123	32,329	37,152	40,772
33	Virginia	5,373	5,321	5,116	4,961	11,440	10,860	8,819	7,205	31,123	32,329	37,152	40,772
34	Virginia	13,131	12,958	12,292	11,785	12,275	12,392	12,873	13,230	39,924	42,203	51,320	58,163
35	Virginia	11,986	11,989	12,001	12,011	6,641	6,726	7,075	7,334	33,149	35,042	42,612	48,294
36	Virginia	21,767	22,492	25,646	27,932	4,993	5,049	5,280	5,452	38,313	40,501	49,250	55,817
37	Virginia	10,289	10,577	11,810	12,708	11,828	12,019	12,818	13,407	34,529	36,500	44,385	50,304
38	Virginia	12,713	13,209	15,391	16,965	3,292	3,419	3,974	4,375	45,215	48,238	60,329	69,407
39	Virginia	20,784	21,605	25,229	27,841	2,666	2,801	3,414	3,850	33,292	35,518	44,421	51,105

Zone	State	Population				Employment				PerCapita Income ($2012)			
		2010	2015	2035	2050	2010	2015	2035	2050	2010	2015	2035	2050
40	Virginia	10,834	11,980	17,908	21,911	8,829	9,315	11,542	13,123	44,640	47,625	59,563	68,525
41	Virginia	1,089	1,356	3,258	4,385	3,978	4,119	4,732	5,175	43,406	46,308	57,916	66,631
42	Virginia	3,623	4,325	8,781	11,549	2,372	2,926	6,779	9,087	43,406	46,308	57,916	66,631
43	Virginia	7,435	7,994	10,677	12,544	5,919	6,630	10,434	12,967	51,056	54,469	68,123	78,374
44	Virginia	8,151	8,514	10,134	11,295	19,204	19,233	19,352	19,441	20,530	22,162	28,687	33,587
45	Virginia	7,047	7,750	11,337	13,772	5,767	6,449	10,080	12,503	38,917	42,009	54,379	63,667
46	Virginia	10,136	10,330	11,144	11,743	12,431	13,653	19,871	24,099	70,687	76,304	98,772	115,642
47	Virginia	14,248	14,579	15,981	17,008	3,833	3,917	4,275	4,537	60,291	64,144	79,555	91,124
48	Virginia	27,993	32,462	58,710	75,544	12,212	13,286	18,616	22,277	51,158	54,427	67,504	77,321
49	Virginia	13,889	17,131	39,649	53,142	3,460	4,400	11,502	15,615	42,366	45,073	55,903	64,032
50	Virginia	36,920	39,419	51,226	59,499	14,421	15,382	19,911	23,087	37,360	39,323	47,175	53,069
51	Virginia	15,235	17,223	28,128	35,318	2,818	3,838	13,196	18,206	41,110	43,676	53,942	61,648
52	Virginia	11,548	11,737	12,524	13,104	21,477	21,682	22,519	23,141	68,740	71,932	84,700	94,282
53	Virginia	10,393	10,440	10,628	10,769	3,584	3,598	3,656	3,699	21,924	22,942	27,014	30,070
54	Virginia	34,962	34,921	34,760	34,639	2,678	2,670	2,638	2,614	38,380	40,163	47,291	52,642
55	Virginia	19,604	19,684	20,007	20,247	6,864	6,873	6,911	6,940	44,061	46,107	54,291	60,433
56	Virginia	39,765	39,646	39,175	38,820	48,635	49,002	50,497	51,610	36,018	37,690	44,380	49,401
57	Virginia	68,333	68,362	68,480	68,569	40,241	41,765	48,458	53,289	53,463	56,594	69,121	78,524
58	Virginia	55,359	56,659	62,170	66,205	16,318	17,088	20,547	23,021	42,438	44,924	54,867	62,331
59	Virginia	13,720	13,450	12,421	11,633	8,439	8,136	7,029	6,167	36,710	38,688	46,597	52,534
60	Virginia	20,104	20,423	21,751	22,731	16,836	16,993	17,636	18,114	43,214	45,911	56,702	64,802
61	Virginia	28,797	31,888	47,946	58,771	32,706	34,328	41,662	46,894	43,214	45,911	56,702	64,802
62	Virginia	10,181	10,896	14,290	16,662	5,226	5,672	7,870	9,383	39,798	42,283	52,220	59,680
63	Virginia	16,904	17,987	23,060	26,627	23,061	24,310	30,018	34,072	33,704	35,009	40,233	44,153
64	Virginia	34,743	36,292	43,207	48,165	20,957	22,233	28,166	32,351	35,375	36,745	42,228	46,343
65	Virginia	37,701	37,164	35,089	33,509	7,402	7,361	7,197	7,074	39,499	41,754	50,774	57,545
66	Virginia	15,036	15,425	17,084	18,296	8,192	8,248	8,475	8,644	39,499	41,754	50,774	57,545
67	Virginia	7,673	7,576	7,202	6,917	1,738	1,730	1,698	1,674	36,106	38,167	46,412	52,601
68	Virginia	19,745	20,210	22,178	23,619	24,361	24,435	24,735	24,960	42,575	45,006	54,728	62,026
69	Virginia	21,120	21,951	25,611	28,249	9,168	9,525	11,097	12,230	56,028	59,773	74,757	86,005
70	Virginia	69,549	70,259	73,172	75,333	51,676	52,731	57,172	60,434	36,479	38,615	47,163	53,579
71	Virginia	89,481	90,768	96,107	100,052	21,667	21,729	21,980	22,168	41,315	43,735	53,416	60,682
72	Virginia	18,567	20,420	28,049	33,754	5,595	5,895	7,518	8,717	35,124	37,133	45,170	51,203
73	Virginia	7,276	7,351	7,732	8,011	2,492	2,717	4,076	5,091	32,581	35,010	44,728	52,025
74	Virginia	75,933	89,896	146,669	189,190	14,166	15,934	27,964	36,932	45,976	48,385	58,021	65,253
75	Virginia	85,752	101,519	165,633	213,652	30,310	34,092	59,833	79,020	31,414	33,060	39,643	44,585
76	Virginia	56,053	60,161	77,237	89,995	13,310	14,536	21,965	27,485	29,580	31,362	38,491	43,842
77	Virginia	25,800	25,543	24,799	24,217	2,643	2,624	2,774	2,886	22,973	24,229	29,255	33,027
78	Virginia	36,391	36,028	34,979	34,158	11,837	11,750	12,421	12,926	35,937	37,902	45,763	51,664
79	Virginia	3,430	3,396	3,297	3,220	31,839	31,605	33,412	34,770	39,512	41,673	50,316	56,804
80	Virginia	33,099	32,769	31,814	31,068	37,436	37,160	39,285	40,881	47,808	50,422	60,880	68,730
81	Virginia	16,204	16,042	15,575	15,209	8,812	8,747	9,247	9,623	87,798	92,600	111,806	126,222

Zone	State	Population				Employment				PerCapita Income ($2012)			
		2010	2015	2035	2050	2010	2015	2035	2050	2010	2015	2035	2050
82	Virginia	11,114	12,513	18,238	22,523	7,461	7,926	10,048	11,625	41,878	44,552	55,248	63,278
83	Virginia	18,691	21,043	30,671	37,877	2,234	2,373	3,008	3,480	42,043	44,728	55,466	63,528
84	Virginia	99,345	106,624	136,888	159,500	75,389	82,333	124,413	155,676	52,805	55,987	68,712	78,265
85	Virginia	40,605	48,071	78,431	101,169	21,323	23,984	42,093	55,591	37,707	39,683	47,585	53,517
86	Virginia	86,236	85,376	82,889	80,944	39,432	39,142	41,380	43,062	39,115	41,254	49,811	56,233
87	Virginia	111,527	119,699	153,674	179,059	94,891	103,632	156,598	195,947	44,335	47,007	57,691	65,712
88	Virginia	28,098	31,104	43,453	52,692	10,199	10,629	12,872	14,530	41,420	44,555	57,095	66,511
89	Virginia	21,765	25,047	38,438	48,464	19,558	21,633	35,365	45,585	61,598	67,403	90,621	108,059
90	Virginia	32,394	34,768	44,636	52,010	21,104	23,048	34,827	43,579	34,547	36,628	44,954	51,204
91	Virginia	70,156	78,983	115,121	142,167	49,158	52,222	66,206	76,599	45,017	47,892	59,390	68,022
92	Virginia	8,092	8,685	11,150	12,991	4,275	4,669	7,055	8,827	36,754	38,969	47,826	54,475
93	Virginia	2,999	2,969	2,882	2,815	37,012	36,739	38,840	40,418	56,037	59,102	71,360	80,561
94	Virginia	8,813	10,434	17,023	21,958	20,914	23,523	41,284	54,523	45,925	48,331	57,956	65,180
95	Virginia	106,056	125,557	204,852	264,241	79,782	89,738	157,491	207,997	48,680	51,231	61,433	69,090
96	Virginia	5,451	5,543	5,974	6,292	3,158	3,224	3,755	4,150	45,946	48,882	60,626	69,443
97	Virginia	10,916	11,101	11,964	12,601	7,501	7,660	8,919	9,860	25,140	26,747	33,173	37,997
98	Virginia	8,660	8,807	9,492	9,997	3,043	3,108	3,619	4,000	47,117	50,128	62,171	71,213
99	Virginia	10,871	10,985	11,560	11,981	5,968	6,079	6,765	7,273	32,404	34,533	43,048	49,441
100	Virginia	4,122	4,165	4,383	4,542	1,419	1,445	1,609	1,729	20,568	21,919	27,325	31,382
101	Virginia	1,847	1,867	1,964	2,036	1,492	1,520	1,691	1,818	34,571	36,843	45,928	52,748
102	Virginia	8,799	8,891	9,356	9,697	5,942	6,053	6,736	7,242	23,874	25,442	31,716	36,426
103	Virginia	9,438	9,537	10,036	10,401	1,807	1,841	2,048	2,202	26,912	28,680	35,753	41,062
104	Virginia	1,119	1,131	1,190	1,233	238	242	270	290	46,866	49,945	62,261	71,507
105	Virginia	9,690	9,791	10,304	10,679	4,366	4,447	4,949	5,321	41,122	43,824	54,630	62,743
106	Virginia	12,395	12,524	13,180	13,660	4,727	4,815	5,359	5,761	40,806	43,487	54,211	62,261
107	Virginia	4,640	4,688	4,934	5,114	5,106	5,201	5,788	6,223	55,810	59,477	74,144	85,154
108	Virginia	40,391	47,817	78,016	100,634	31,586	35,527	62,351	82,346	19,951	20,996	25,177	28,316
109	Virginia	22,514	22,896	24,676	25,990	17,493	17,861	20,799	22,992	31,103	33,090	41,041	47,009
110	Virginia	96,005	113,658	185,437	239,198	13,961	15,703	27,559	36,397	41,014	43,163	51,758	58,210
111	Virginia	57,809	68,439	111,661	144,033	82,269	92,534	162,399	214,479	51,048	53,722	64,420	72,451
112	Virginia	98,552	116,674	190,358	245,545	37,024	41,644	73,085	96,523	44,938	47,293	56,711	63,780
113	Virginia	24,402	28,889	47,134	60,799	1,657	1,863	3,270	4,319	47,554	50,046	60,012	67,493
114	Virginia	18,567	18,701	19,470	20,028	5,595	5,895	7,518	8,717	35,124	37,133	45,170	51,203
115	Virginia	7,276	7,329	7,630	7,848	2,492	2,717	4,076	5,091	32,581	35,010	44,728	52,025
116	Virginia	28,098	28,301	29,464	30,308	10,199	10,629	12,872	14,530	41,420	44,555	57,095	66,511
117	Virginia	21,765	21,922	22,823	23,477	19,558	21,633	35,365	45,585	61,598	67,403	90,621	108,059
118	Virginia	15,005	15,162	15,955	16,537	7,743	7,887	8,777	9,437	43,207	46,045	57,400	65,924
119	Virginia	10,802	10,986	11,839	12,470	3,022	3,085	3,593	3,972	40,517	43,106	53,462	61,237
120	Virginia	36,920	37,187	38,715	39,824	14,421	15,546	22,117	26,968	37,360	39,323	47,175	53,069
121	Maryland	101,209	109,926	145,887	172,775	39,888	41,970	54,480	63,870	38,508	40,920	50,569	57,812
122	Rhode Island	49,863	50,598	54,040	56,579	22,035	23,022	28,175	32,047	52,711	56,669	72,500	84,387
123	Rhode Island	166,069	175,256	214,020	242,942	94,671	99,577	123,759	141,963	44,738	47,619	59,142	67,792

Zone	State	Population				Employment				PerCapita Income ($2012)			
		2010	2015	2035	2050	2010	2015	2035	2050	2010	2015	2035	2050
124	Rhode Island	626,797	634,856	673,407	701,782	342,424	350,560	404,483	444,723	38,420	40,448	48,560	54,650
125	Rhode Island	82,847	82,899	83,892	84,567	53,629	55,135	64,850	72,089	50,259	54,042	69,175	80,538
126	Rhode Island	126,952	133,722	162,328	183,668	74,078	79,360	108,907	131,107	46,452	49,954	63,961	74,477
127	Pennsylvania	625,618	654,855	778,585	870,845	358,063	376,089	453,228	510,990	52,594	56,290	71,074	82,174
128	Pennsylvania	800,482	819,058	902,067	963,615	596,338	625,456	761,954	863,816	62,675	66,785	83,227	95,571
129	Pennsylvania	1,528,074	1,502,536	1,417,093	1,351,597	772,621	828,888	1,245,170	1,554,775	37,282	38,856	45,153	49,879
130	Pennsylvania	559,488	565,278	594,531	615,968	286,546	295,372	338,269	370,351	48,655	51,738	64,072	73,331
131	Pennsylvania	500,438	534,620	676,750	782,927	331,823	348,918	435,988	500,882	57,555	61,878	79,171	92,155
132	Connecticut	894,127	908,390	975,034	1,024,225	626,218	649,136	788,966	892,330	51,320	54,459	67,016	76,442
133	Connecticut	274,018	278,035	297,034	311,041	168,980	176,702	239,323	285,511	45,496	48,555	60,791	69,978
134	Connecticut	862,438	874,502	931,903	974,192	479,909	495,871	598,990	675,827	46,693	49,476	60,608	68,964
135	Connecticut	165,630	172,482	201,796	223,633	92,668	98,572	135,535	162,931	51,807	55,283	69,187	79,626
136	Connecticut	918,339	932,666	999,751	1,049,253	601,772	620,455	699,091	758,658	71,768	77,603	100,942	118,467
137	Virginia	46,842	47,180	49,119	50,527	21,247	23,127	33,010	40,406	34,610	36,671	44,915	51,104
138	Virginia	147,327	148,391	154,488	158,916	75,703	82,883	122,618	152,179	39,385	41,583	50,373	56,972
139	Virginia	17,455	17,581	18,303	18,828	6,062	6,505	8,236	9,528	35,483	37,903	47,585	54,854
140	Virginia	28,630	28,837	30,022	30,882	10,413	10,970	13,744	15,796	34,574	36,772	45,564	52,164
141	Virginia	11,178	11,259	11,721	12,057	5,442	5,739	6,424	6,947	32,598	34,724	43,226	49,608
142	Virginia	9,266	9,333	9,716	9,995	3,879	4,051	4,375	4,626	25,905	26,826	30,510	33,274
143	Virginia	12,354	12,443	12,955	13,326	4,457	4,732	5,811	6,614	40,413	43,273	54,715	63,305
144	Virginia	6,974	7,024	7,313	7,523	2,502	2,571	2,936	3,206	31,215	33,196	41,119	47,067
145	Virginia	15,990	16,106	16,767	17,248	5,004	5,111	5,568	5,905	37,613	39,826	48,678	55,322
146	Virginia	11,383	11,465	11,936	12,278	7,119	7,492	8,666	9,547	46,796	50,676	66,194	77,847
147	Virginia	10,977	11,056	11,511	11,841	5,079	5,369	6,559	7,444	39,552	42,339	53,489	61,860
148	Virginia	8,974	9,039	9,410	9,680	4,780	5,091	6,670	7,837	50,782	55,133	72,536	85,605
149	Virginia	7,061	7,112	7,404	7,616	3,161	3,305	3,989	4,495	34,130	36,560	46,279	53,576
150	Virginia	12,921	13,014	13,549	13,937	4,060	4,251	4,843	5,290	25,837	27,119	32,249	36,099
151	Virginia	12,068	12,155	12,655	13,017	4,442	4,455	4,803	5,054	28,290	29,835	36,016	40,655
152	Virginia	17,438	17,564	18,286	18,810	6,150	6,360	7,664	8,625	26,403	27,663	32,702	36,483
153	Virginia	27,201	27,398	28,523	29,341	11,636	12,032	14,172	15,766	31,434	33,641	42,471	49,101
154	Virginia	18,173	18,304	19,056	19,603	9,745	10,203	11,387	12,287	23,236	24,180	27,958	30,793
155	Virginia	32,710	32,946	34,300	35,283	16,312	17,048	19,959	22,152	29,977	31,781	38,995	44,411
156	Delaware	539,007	551,021	604,936	644,894	344,993	361,731	467,826	547,311	44,572	46,941	56,419	63,532
157	Massachusetts	495,731	526,657	656,543	753,503	255,421	270,321	338,500	389,836	49,066	52,777	67,620	78,764
158	Massachusetts	548,537	568,363	653,816	717,418	266,000	277,670	330,220	369,648	40,622	43,150	53,264	60,856
159	New York	1,341,033	1,357,507	1,437,563	1,496,421	811,476	837,327	969,885	1,069,662	65,615	69,769	86,385	98,859
160	New York	2,508,515	2,582,309	2,905,068	3,144,919	783,819	834,622	1,119,487	1,332,699	37,527	39,174	45,764	50,709
161	New York	950,283	966,825	1,043,150	1,099,554	567,842	586,189	687,137	762,966	73,159	78,324	98,983	114,494
162	New York	1,387,159	1,424,873	1,590,904	1,714,201	355,745	372,582	464,548	533,366	30,551	31,524	35,417	38,338
163	New York	1,587,481	1,597,779	1,655,502	1,697,394	2,757,409	2,893,376	3,588,296	4,109,691	111,386	120,857	158,742	187,191
164	New York	469,393	502,519	640,676	743,876	142,757	150,621	187,628	215,494	47,444	50,134	60,896	68,975
165	New York	2,233,895	2,273,222	2,454,420	2,588,346	747,603	788,470	965,657	1,099,107	40,285	41,305	45,387	48,450

Zone	State	Population				Employment				PerCapita Income ($2012)			
		2010	2015	2035	2050	2010	2015	2035	2050	2010	2015	2035	2050
166	New York	99,718	107,548	140,087	164,402	39,967	42,211	54,801	64,243	52,273	55,867	70,245	81,040
167	New York	312,520	323,749	372,151	408,176	152,597	156,495	177,045	192,552	52,030	55,434	69,049	79,270
168	North Carolina	115,789	126,563	171,069	204,347	41,382	44,997	66,370	82,284	28,537	30,555	38,627	44,687
169	North Carolina	320,169	333,275	388,840	430,258	206,591	214,966	274,969	319,444	42,523	45,403	56,922	65,571
170	North Carolina	168,752	186,817	261,280	316,975	89,288	95,589	148,151	187,102	32,001	34,073	42,359	48,580
171	North Carolina	12,192	12,626	14,514	15,919	2,571	2,615	3,043	3,356	26,105	27,473	32,946	37,053
172	North Carolina	10,005	11,017	15,125	18,201	3,800	4,076	5,148	5,942	35,414	37,926	47,973	55,517
173	North Carolina	23,652	26,153	36,291	43,883	8,949	9,668	13,399	16,170	38,239	40,930	51,692	59,773
174	North Carolina	47,364	50,019	61,189	69,525	12,691	13,115	16,257	18,588	28,919	30,581	37,228	42,217
175	North Carolina	22,051	21,989	21,914	21,841	7,274	7,541	9,716	11,321	28,541	30,746	39,567	46,189
176	North Carolina	24,620	24,411	23,993	23,649	11,622	11,849	14,327	16,166	27,093	28,660	34,929	39,635
177	North Carolina	20,944	21,673	24,794	27,117	5,080	5,087	5,823	6,362	24,047	25,533	31,478	35,940
178	North Carolina	45,376	46,229	50,038	52,860	18,226	19,183	23,309	26,410	28,785	30,392	36,820	41,644
179	North Carolina	60,059	63,369	77,236	87,586	24,959	26,016	32,729	37,733	27,588	29,316	36,227	41,415
180	North Carolina	54,548	55,149	58,015	60,123	22,552	23,107	28,182	31,922	28,819	30,677	38,107	43,685
181	North Carolina	40,714	42,755	51,370	57,796	22,130	23,212	28,305	32,071	27,915	29,367	35,174	39,534
182	North Carolina	13,490	14,177	17,074	19,234	3,760	3,895	4,527	4,998	29,068	31,121	39,331	45,496
183	North Carolina	14,763	14,981	16,067	16,865	7,115	7,218	8,466	9,390	33,122	35,543	45,226	52,496
184	North Carolina	38,398	39,780	45,734	50,167	13,921	14,522	18,393	21,271	29,959	31,681	38,570	43,741
185	North Carolina	60,835	66,747	91,147	109,393	21,850	23,790	34,521	42,649	29,071	31,169	39,560	45,860
186	North Carolina	351,383	370,466	450,844	510,817	221,720	233,742	316,389	377,704	37,059	39,003	46,781	52,619
187	North Carolina	489,670	502,040	556,826	597,482	328,919	342,702	420,003	477,565	36,748	38,832	47,167	53,423
188	North Carolina	151,532	158,568	188,424	210,683	76,986	81,088	104,358	121,815	30,720	32,313	38,687	43,470
189	North Carolina	134,200	149,910	214,534	262,878	80,735	85,419	126,657	157,071	46,713	50,321	64,752	75,589
190	North Carolina	268,411	293,660	397,940	475,913	231,320	252,979	397,205	504,514	37,964	40,326	49,773	56,865
191	North Carolina	95,851	100,771	121,441	136,866	50,514	53,549	69,192	80,864	34,640	36,743	45,155	51,470
192	North Carolina	56,552	57,020	59,362	61,075	24,542	25,083	28,605	31,228	27,103	28,657	34,873	39,538
193	North Carolina	906,788	1,018,784	1,479,078	1,823,458	563,347	615,708	912,087	1,133,244	41,440	44,195	55,215	63,489
194	North Carolina	41,331	44,313	56,735	66,015	15,454	16,434	22,745	27,447	35,231	37,632	47,238	54,449
195	North Carolina	162,873	171,221	206,478	232,777	70,570	74,960	98,519	116,171	32,068	33,999	41,725	47,524
196	North Carolina	34,016	35,718	42,905	48,266	27,431	30,007	41,701	50,398	37,747	40,610	52,062	60,661
197	North Carolina	141,896	146,259	165,265	179,396	59,924	61,292	67,955	72,924	28,723	30,119	35,701	39,892
198	North Carolina	63,803	71,262	101,944	124,898	36,207	39,636	62,562	79,656	45,804	49,585	64,711	76,068
199	North Carolina	81,374	83,500	92,743	99,612	45,134	47,201	54,025	59,172	33,044	35,017	42,909	48,833
200	North Carolina	138,344	144,957	172,668	193,348	53,475	55,942	65,347	72,416	29,816	31,430	37,887	42,734
201	North Carolina	169,674	190,502	276,110	340,158	68,920	75,804	112,351	139,573	32,731	34,973	43,941	50,673
202	North Carolina	78,390	84,539	110,015	129,056	25,247	26,776	34,725	40,658	33,029	35,007	42,920	48,859
203	North Carolina	923,141	1,020,777	1,423,399	1,724,517	692,866	757,342	1,169,797	1,476,672	43,882	46,945	59,198	68,397
204	North Carolina	178,558	204,471	310,942	390,611	89,733	95,794	134,775	163,711	33,926	36,247	45,529	52,497
205	North Carolina	206,196	215,749	255,819	285,717	92,717	95,525	113,637	127,162	33,922	36,131	44,965	51,596
206	North Carolina	202,201	229,338	340,927	424,416	74,229	81,020	122,089	152,794	34,184	36,418	45,355	52,064
207	North Carolina	154,344	161,576	191,902	214,531	94,384	97,094	110,425	120,355	32,504	34,218	41,074	46,220

Zone	State	Population				Employment				PerCapita Income ($2012)			
		2010	2015	2035	2050	2010	2015	2035	2050	2010	2015	2035	2050
208	North Carolina	88,567	94,877	121,106	140,704	43,447	47,405	69,869	86,649	38,216	41,151	52,889	61,703
209	North Carolina	47,506	51,987	70,494	84,333	13,516	14,404	20,006	24,200	30,972	33,076	41,492	47,810
210	North Carolina	57,898	61,959	78,849	91,468	32,198	34,287	43,074	49,673	32,193	34,079	41,621	47,282
211	New Jersey	149,198	159,416	202,078	233,942	61,764	63,664	73,856	81,561	49,207	52,634	66,340	76,631
212	New Jersey	501,606	505,312	525,371	539,973	227,251	232,264	252,346	267,539	42,228	44,309	52,634	58,883
213	New Jersey	906,184	910,844	938,885	959,117	594,073	618,843	717,906	793,004	65,486	70,101	88,563	102,424
214	New Jersey	108,671	114,208	137,612	155,069	46,944	48,780	56,381	62,112	44,183	46,812	57,326	65,219
215	New Jersey	492,681	508,311	576,275	626,813	374,280	388,674	450,696	497,595	69,811	75,513	98,323	115,452
216	New Jersey	784,099	780,928	776,196	771,957	454,381	457,911	480,559	497,842	50,791	54,109	67,383	77,348
217	New Jersey	634,979	641,170	672,597	695,607	304,723	315,056	383,367	434,468	44,926	47,640	58,496	66,646
218	New Jersey	128,354	136,836	172,293	198,772	76,296	79,557	99,377	114,306	67,053	72,679	95,182	112,080
219	New Jersey	324,078	342,286	418,903	476,078	220,044	233,590	309,520	366,817	69,886	75,439	97,651	114,329
220	New Jersey	537,475	540,820	559,794	573,550	289,347	299,552	343,147	376,228	50,448	53,231	64,362	72,718
221	New Jersey	810,747	847,167	1,002,080	1,117,546	490,313	511,675	598,488	664,312	48,256	51,047	62,213	70,595
222	New Jersey	366,933	378,684	429,744	467,716	265,682	272,421	324,398	363,288	52,496	55,964	69,836	80,250
223	New Jersey	449,119	465,595	536,372	589,064	263,113	276,908	353,727	411,059	47,391	50,582	63,346	72,929
224	New Jersey	513,601	521,290	557,639	584,442	256,809	261,978	290,796	312,409	42,720	45,138	54,809	62,069
225	New Jersey	288,557	307,907	388,424	448,569	125,089	129,707	152,900	170,218	41,337	43,673	53,019	60,035
226	New Jersey	65,996	67,593	74,699	79,970	28,552	28,659	29,953	30,900	39,704	41,691	49,637	55,601
227	Massachusetts	744,484	770,739	884,067	968,404	404,414	425,546	514,992	582,605	50,531	54,073	68,239	78,875
228	Massachusetts	1,505,720	1,520,012	1,592,107	1,644,889	1,069,454	1,137,380	1,438,656	1,665,527	60,765	65,424	84,062	98,056
229	Massachusetts	799,300	828,872	956,149	1,050,898	413,785	436,885	542,872	622,803	43,496	46,263	57,330	65,638
230	Massachusetts	722,731	729,339	762,923	787,492	688,860	704,991	814,393	896,161	52,856	56,676	71,955	83,426
231	Massachusetts	672,107	685,929	748,240	794,390	422,279	452,887	605,349	719,981	62,521	67,265	86,241	100,488
232	Virginia	57,871	59,313	65,323	70,192	53,286	51,420	64,102	70,130	91,158	97,619	123,463	142,866
233	Virginia	165,914	170,854	180,621	184,661	142,524	153,812	178,922	194,555	82,598	87,947	109,341	125,402
234	Maryland	48,988	50,010	58,832	66,860	143,533	145,724	148,172	152,002	44,722	46,822	55,219	61,521
235	Maryland	271,614	277,279	283,410	286,765	125,059	130,874	145,924	161,856	41,605	43,558	51,370	57,233
236	Maryland	12,180	12,434	12,504	12,448	9,011	9,045	9,247	9,413	32,011	33,513	39,524	44,034
237	Maryland	9,209	9,401	9,805	10,099	7,796	7,743	7,705	7,628	66,084	69,186	81,593	90,906
238	Maryland	278,569	284,379	293,547	299,795	101,133	102,308	104,586	107,186	37,158	38,902	45,879	51,115
239	District of Columbia	13,260	15,762	22,678	27,347	94,993	98,841	115,592	128,163	75,074	80,632	102,866	119,559
240	District of Columbia	79,888	87,211	118,665	139,640	131,966	145,364	184,782	211,418	60,768	65,268	83,264	96,777
241	District of Columbia	70,801	79,304	101,590	116,703	54,996	56,978	70,939	81,779	47,616	51,141	65,243	75,831
242	District of Columbia	78,641	80,503	87,347	93,738	60,901	61,670	64,446	67,415	144,424	155,117	197,888	230,003
243	District of Columbia	47,798	49,004	54,018	57,831	21,203	21,203	23,120	24,738	54,260	58,277	74,346	86,411
244	District of Columbia	84,564	86,759	103,592	114,716	27,620	29,313	55,889	74,898	34,388	36,934	47,118	54,765
245	District of Columbia	56,593	59,999	71,498	80,082	10,721	14,416	20,979	25,734	36,835	39,562	50,471	58,662
246	District of Columbia	18,931	19,071	20,211	21,622	2,889	2,889	2,918	2,987	132,553	142,367	181,623	211,097
247	District of Columbia	27,351	28,010	32,557	35,673	373,214	375,414	384,617	397,803	112,205	120,513	153,743	178,693
248	District of Columbia	127,085	133,344	146,702	157,938	46,966	47,658	52,399	56,342	71,054	76,315	97,358	113,158
249	Virginia	43,377	45,912	54,197	59,123	68,010	79,427	94,207	103,890	69,902	74,429	92,534	106,127

Zone	State	Population				Employment				PerCapita Income ($2012)			
		2010	2015	2035	2050	2010	2015	2035	2050	2010	2015	2035	2050
250	Virginia	83,023	85,156	96,157	104,701	64,910	68,235	107,888	133,090	66,048	70,729	89,454	103,513
251	Maryland	88,912	93,516	103,668	110,154	33,019	38,552	45,120	49,930	46,157	48,872	59,976	68,261
252	Maryland	108,772	114,604	134,881	149,468	59,173	60,923	64,083	66,470	47,942	50,838	61,951	70,610
253	Maryland	58,475	60,665	66,944	71,216	23,056	23,758	25,035	25,996	37,374	39,850	49,122	56,347
254	Maryland	21,502	23,741	29,796	33,611	4,610	5,609	6,915	7,963	47,144	50,499	65,648	76,917
255	Maryland	97,366	109,634	152,169	181,704	44,903	49,665	58,022	64,453	41,953	44,491	53,732	60,727
256	Maryland	28,235	29,966	36,576	41,433	10,494	10,714	12,526	13,849	46,278	50,331	68,786	82,556
257	Maryland	105,749	118,596	163,205	197,063	63,205	68,425	78,910	86,772	43,448	46,243	57,914	66,575
258	Maryland	120,220	133,992	139,998	142,575	141,128	150,173	164,867	174,415	111,365	119,048	160,117	189,437
259	Maryland	85,895	96,337	97,154	97,933	54,949	56,368	61,686	65,210	37,442	39,358	48,723	55,360
260	Maryland	150,357	154,665	162,076	165,107	66,122	73,457	78,596	82,496	62,333	63,412	70,185	74,809
261	Maryland	116,339	127,655	173,806	200,941	158,493	167,513	215,728	247,522	156,325	164,621	209,534	240,554
262	Maryland	73,250	74,084	75,970	77,760	45,273	49,510	53,957	57,434	124,910	132,700	162,409	184,496
263	Maryland	210,235	218,093	274,727	311,542	137,879	150,836	250,545	318,691	18,339	19,373	23,267	26,027
264	Maryland	141,167	141,398	143,510	143,645	30,386	32,561	35,750	37,888	48,462	51,395	61,285	68,500
265	Maryland	42,375	53,743	70,291	76,786	9,550	11,524	29,455	40,635	22,218	24,049	32,565	38,766
266	Maryland	35,600	35,561	35,900	36,063	3,873	3,892	3,913	3,927	28,837	31,644	41,925	49,641
267	Maryland	74,842	74,781	76,464	77,997	24,397	24,957	28,337	31,646	36,481	37,720	42,635	46,319
268	Maryland	70,643	74,276	84,856	91,416	45,433	47,878	60,039	68,945	16,930	17,515	21,088	23,572
269	Maryland	27,115	27,127	29,553	30,682	17,156	17,494	20,349	21,991	16,154	16,714	18,823	20,428
270	Maryland	41,697	41,349	44,196	45,420	25,443	25,868	34,905	41,880	40,658	42,279	48,895	53,824
271	Maryland	23,330	23,141	24,030	24,487	12,505	12,393	14,060	15,848	32,246	33,247	37,122	40,086
272	Maryland	31,880	32,533	33,880	34,661	11,120	11,338	13,375	15,458	15,060	15,565	17,520	19,001
273	Maryland	48,583	48,436	48,811	48,896	24,872	25,198	28,477	30,746	39,413	40,932	46,974	51,491
274	Maryland	85,048	85,009	88,494	90,329	33,350	33,844	38,832	44,242	58,360	60,298	67,895	73,627
275	Maryland	57,182	62,211	83,750	97,672	22,486	24,950	44,032	58,278	52,504	54,748	63,413	69,709
276	Maryland	86,088	88,549	93,093	96,318	75,281	79,161	122,416	153,239	76,988	79,971	91,077	99,158
277	Maryland	32,534	32,882	33,603	34,093	25,757	24,957	27,699	29,199	25,767	26,766	30,777	33,576
278	Maryland	58,765	59,628	61,798	63,371	20,747	22,174	29,679	34,008	55,514	57,718	65,837	71,619
279	Maryland	57,229	57,864	62,402	64,830	19,437	20,563	24,900	30,383	32,672	34,352	40,759	45,295
280	Maryland	53,774	56,726	64,909	69,838	28,776	31,110	35,477	39,361	24,523	25,630	29,647	32,511
281	Maryland	116,509	127,396	147,022	159,356	37,545	40,728	47,635	54,659	27,586	28,828	33,749	37,226
282	Maryland	41,488	42,252	44,834	46,119	9,174	9,781	11,996	13,198	37,327	40,513	53,099	63,096
283	Maryland	27,090	28,055	31,106	32,813	11,770	14,217	25,057	31,111	44,078	47,325	63,181	74,540
284	Maryland	44,562	47,716	49,345	50,107	8,293	8,384	8,693	8,859	50,927	53,721	65,931	75,618
285	Maryland	19,741	20,114	21,022	21,423	28,906	30,154	32,255	33,469	170,699	181,404	213,845	241,420
286	Maryland	13,184	13,213	13,447	13,546	7,365	7,440	7,802	7,992	64,341	68,519	85,428	97,520
287	Maryland	61,327	61,727	64,082	65,287	14,741	15,204	16,728	17,586	99,944	106,483	134,303	156,896
288	Maryland	68,193	70,278	75,519	78,209	15,691	16,155	20,669	23,194	38,671	41,586	54,202	63,576
289	Maryland	86,950	87,899	91,857	93,882	63,722	65,925	69,015	70,746	51,048	53,938	66,702	76,018
290	Maryland	65,492	66,405	69,274	70,561	23,172	23,706	25,293	26,164	50,007	52,982	64,928	73,791
291	Maryland	26,326	27,719	29,300	30,123	27,046	28,506	35,277	39,164	35,811	39,109	53,409	64,014

Zone	State	Population				Employment				PerCapita Income ($2012)			
		2010	2015	2035	2050	2010	2015	2035	2050	2010	2015	2035	2050
292	Maryland	46,696	46,987	49,014	50,016	31,737	32,656	36,439	38,503	33,101	35,001	42,447	47,898
293	Maryland	927	928	960	979	6,113	6,778	8,617	9,673	36,318	38,313	44,062	48,673
294	Maryland	25,121	25,646	27,831	29,075	63,698	78,462	115,104	137,313	35,196	40,768	59,617	72,684
295	Maryland	12,144	13,906	18,846	21,329	46,395	51,722	69,375	79,529	22,677	28,497	50,767	66,041
296	Maryland	81,007	86,325	92,385	100,934	28,142	30,354	36,047	43,572	44,219	46,089	59,852	67,836
297	Maryland	100,774	106,392	108,911	115,942	42,171	43,889	50,377	57,931	50,599	51,797	64,351	72,075
298	Maryland	63,409	68,602	80,665	91,200	45,327	52,623	60,688	71,722	44,335	46,869	65,932	76,328
299	Maryland	109,803	111,014	115,196	119,375	88,063	90,537	95,954	102,160	29,004	30,574	37,275	41,710
300	Maryland	116,816	119,268	123,437	129,728	60,621	61,434	64,796	69,324	58,158	63,814	85,374	99,295
301	Maryland	72,648	76,607	79,423	86,931	49,513	53,265	60,307	70,333	40,487	43,457	52,544	59,036
302	Maryland	58,992	59,734	61,703	65,144	21,571	21,948	23,073	24,249	68,288	74,250	93,376	106,250
303	Maryland	153,494	156,328	161,862	167,912	160,198	163,461	171,833	180,485	71,262	75,589	91,228	101,948
304	Maryland	31,784	32,371	33,859	35,950	13,904	14,125	14,907	15,821	25,010	27,089	33,700	38,161
305	Maryland	65,372	67,220	70,080	75,164	18,379	18,760	19,813	20,920	46,957	50,565	61,721	69,347
306	Maryland	197,054	201,286	208,641	217,553	96,041	103,370	109,498	119,175	40,429	42,992	54,124	61,440
307	Maryland	164,901	181,135	264,942	336,361	115,134	121,920	137,333	148,781	52,105	55,461	68,837	78,957
308	Maryland	69,287	74,568	93,050	106,986	14,050	15,468	17,910	19,714	31,663	33,818	42,177	48,513
309	Virginia	151,325	159,139	180,871	193,274	101,463	118,139	163,412	195,236	46,242	47,744	54,021	58,645
310	Virginia	60,223	79,802	141,605	170,931	46,688	57,809	101,226	130,592	78,641	84,816	108,120	125,864
311	Virginia	70,078	75,895	108,427	125,875	24,532	29,784	50,961	65,016	48,496	52,624	66,151	76,750
312	Virginia	33,679	37,450	60,649	74,614	7,047	8,572	13,823	17,498	47,680	49,243	54,286	58,196
313	Virginia	189,809	200,245	232,211	254,752	172,549	185,838	229,644	256,170	86,820	94,421	126,369	149,230
314	Virginia	157,681	166,507	209,038	237,067	109,195	117,405	147,081	167,454	81,687	88,726	119,051	141,563
315	Virginia	147,778	150,421	156,387	163,482	75,420	79,164	90,720	99,149	44,569	48,203	64,550	76,573
316	Virginia	93,242	101,796	112,218	121,675	111,322	117,175	132,078	143,164	79,293	86,071	113,124	132,993
317	Virginia	108,607	111,933	123,161	132,546	73,903	78,436	87,215	91,759	18,845	20,068	25,115	28,736
318	Virginia	146,532	150,478	164,204	176,834	65,154	77,000	84,644	91,286	36,945	39,006	47,736	54,395
319	Virginia	195,652	206,884	239,081	262,754	106,345	117,265	136,065	150,510	70,112	73,290	86,448	95,764
320	Virginia	64,753	69,712	82,577	92,710	124,189	133,266	167,978	193,185	147,167	165,334	222,618	266,289
321	Virginia	16,999	17,189	17,910	19,545	3,840	3,974	4,389	4,656	41,399	45,059	57,061	66,108
322	Virginia	65,384	75,317	132,765	182,001	37,019	41,322	64,694	82,434	51,454	55,280	70,368	81,718
323	Virginia	235,769	256,840	307,505	339,886	85,058	93,216	127,397	154,530	37,625	39,719	47,891	54,047
324	Virginia	136,267	144,669	177,802	199,629	64,774	70,030	90,643	106,692	47,736	50,189	59,433	66,431
325	Virginia	87,043	97,999	130,392	151,401	37,672	52,291	103,184	143,912	51,969	55,800	73,272	86,235
326	Virginia	129,772	152,250	232,111	293,361	47,148	53,616	76,703	94,038	40,657	42,844	51,511	58,025
327	Virginia	23,668	26,251	39,843	50,354	16,061	20,229	31,693	40,504	39,296	41,086	48,246	53,620
328	Maryland	101,087	101,128	99,811	99,359	81,811	85,808	101,231	111,968	58,497	61,396	73,889	83,311
329	Maryland	61,281	62,453	64,898	65,413	32,024	32,405	37,336	40,383	60,889	65,121	79,084	90,028
330	Maryland	40,169	44,993	50,922	52,997	21,741	26,337	39,196	48,302	53,751	58,189	76,381	90,207
331	Maryland	37,917	40,059	50,202	55,631	30,923	36,361	46,173	52,789	47,191	49,812	59,862	67,066
332	Maryland	18,065	21,143	24,206	25,791	14,743	17,070	18,400	19,443	87,332	96,134	133,201	161,590
333	Maryland	29,954	32,851	38,452	41,236	9,317	10,502	14,359	16,928	103,866	112,491	140,675	162,425

APPENDIX B – STATED PREFERENCE SURVEY FORMS

Exhibit B-1: Survey Form for Auto Users with VOT questions

Virginia Travel Survey

This survey is part of a transportation study conducted by Hampton Roads Transportation Planning Organization (HRTPO) aimed to understand and improve the travel needs of Virginia residents and workers. Please complete and return this form to our survey staff.

*For the following questions below, recall a RECENT INTERCITY **AUTO** TRIP of **40 miles or more** that you made anywhere in Virginia or Virginia to Washington DC.*

1. *For the 40 miles or more INTERCITY AUTO trip, what is your*

STARTING POINT (City) ______________________ (State/Zip code) ________

DESTINATION (City) ______________________ (State/Zip code) __________

PRIMARY RESIDENCE (City) __________________ (State/Zip code) ________

2. *How often do you make the same trip you indicated in Questions #1?* *Enter number and circle week, month or year.*

__________ times per **WEEK/MONTH/YEAR.**

3. *What is the primary purpose of your trip today?* *Check only one*

O Commuting to/from work O Business Travel O Site Seeing

O Travel to/from school O Shopping

O Other _______________

If Business travel, who is paying for your trip?

O Self O Employer O Other__________

4. *What is your current employment status?* *Check all that apply*

O Employed Full/Part-time O Student O Not-Employed

O Military Personnel O Veteran O Retired O Other ________

5. *What is the combined annual income of everyone in your household?* *Check only one*

O Less than $25,000 O $25,000 – $49,999

O $50,000 - $99,999 O $100,000 or more

How much do you value your time while driving?

TRAVEL TIME is the total time you actually spend driving to your trip Destination; &
COST of your trip is the total cost you incur for travel including gas, parking, etc.

For each question below, check (✓) only ONE circle that best indicates your degree of preference for the time and cost alternatives given.

Option A	**Imagine your** **<u>TRAVEL TIME</u> is <u>3 hr</u> and** **<u>COST</u> of your trip is $32** for the Similar "Trip" & Same "Purpose" as Questions #1, 3

(Refer to **<u>Option A</u>** for answering Questions 6 to 10)

6. Would you spend $33 or **$1 more** if the TRAVEL TIME were **20 min less**?
Check only one
O Yes O Probably O Not Sure O Probably Not O No

7. Would you spend $39 or **$7 more** if the TRAVEL TIME were **40 min less**?
Check only one
O Yes O Probably O Not Sure O Probably Not O No

8. Would you spend $49 or **$17 more** if the TRAVEL TIME were **1 hr less**?
Check only one
O Yes O Probably O Not Sure O Probably Not O No

9. Would you spend $59 or **$27 more** if the TRAVEL TIME were **1hr 10 min less**? *Check only one*
O Yes O Probably O Not Sure O Probably Not O No

10. Would you spend $72 or **$40 more** if the TRAVEL TIME were **1 hr 20 min less**? *Check only one*
O Yes O Probably O Not Sure O Probably Not O No

Thank You for Your Time and Cooperation!

Exhibit B-2: Survey Form for Transit Users with VOT and VOF Questions

Virginia Travel Survey

This survey is part of a transportation study conducted by Hampton Roads Transportation Planning Organization (HRTPO) aimed to understand and improve the travel needs of Virginia residents and workers. Please complete and return this form to our survey staff.

1. *Where are you going today?*

STARTING POINT (City) __________________ (State/ZIP)________

DESTINATION (City) __________________ (State/ZIP)________

RESIDENCE (City) __________________ (State/ZIP)________

2. *What is the primary purpose of your trip today?* *Check only one*

O Commuting to/from work O Business Trip

O Site Seeing O Travel to/from school

O Shopping O Other ______

If Business travel, who is paying for the trip?

O Self O Employer O Other ________

3. *How often do you make this trip?*

Enter number and circle week, month or year.

______ times per WEEK / MONTH / YEAR

4. *What is your employment status?* *Check only one*

O Employed Full/Part-time O Student

O Not-Employed O Military Personnel

O Veteran O Retired

O Other ______

5. *What is the combined annual income of everyone in your household?* *Check only one*

O Less than $25,000 O $25,000 – $49,999

O $50,000 - $99,999 O $100,000 or more

How much do you value your time when traveling and waiting for the train?

Travel time is the TOTAL TIME you spend traveling on the train;
Wait Time is the time between departures or how long you have to wait for the next train;
COST of your trip is one-way train fare.

For each question below, check (✓) only ONE circle that best indicates your degree of preference for the time and cost alternatives given.

Option A	**Imagine your <u>TRAVEL TIME</u> is <u>2 hr 30 min</u> and <u>COST</u> of your trip is $35** for the Similar "Trip" & Same "Purpose" as Questions #1, 2

(Refer to <u>Option A</u> for answering Questions 6 to 10)

6. Would you spend $37 or **$2 more** if the TRAVEL TIME were **30 min less**? *Check only one*

O Yes O Probably O Not Sure O Probably Not O No

7. Would you spend $42 or **$7 more** if the TRAVEL TIME were **45 min less**? *Check only one*

O Yes O Probably O Not Sure O Probably Not O No

8. Would you spend $51 or **$16 more** if the TRAVEL TIME were **1 hr less**? *Check only one*

O Yes O Probably O Not Sure O Probably Not O No

9. Would you spend $66 or **$31 more** if the TRAVEL TIME were **1hr 26 min less**? *Check only one*

O Yes O Probably O Not Sure O Probably Not O No

10. Would you spend $82 or **$47 more** if the TRAVEL TIME were **1 hr 40 min less**? *Check only one*

O Yes O Probably O Not Sure O Probably Not O No

Option B	**Imagine your <u>WAIT TIME</u> is <u>2 hrs</u> and the <u>COST</u> of your trip is $35** for the Similar "Trip" & Same "Purpose" as Questions #1, 2

(Refer to <u>Option B</u> for answering Questions 11 to 15)

11. Would you spend $36 or **$1 more** if the WAIT TIME were **30 min less**? *Check only one*

O Yes O Probably O Not Sure O Probably Not O No

12. Would you spend $41 or **$6 more** if the WAIT TIME were **45 min less**? *Check only one*

O Yes O Probably O Not Sure O Probably Not O No

13. Would you spend $49 or **$14 more** if the WAIT TIME were **1 hr less**? *Check only one*

O Yes O Probably O Not Sure O Probably Not O No

14. Would you spend $60 or **$25 more** if the WAIT TIME were **1 hr 15 min less**? *Check only one*

O Yes O Probably O Not Sure O Probably Not O No

15. Would you spend $74 or **$39 more** if the WAIT TIME were **1 hr 30 min less**? *Check only one*

O Yes O Probably O Not Sure O Probably Not O No

Thank You for Your Time and Cooperation!

Exhibit B-3: Survey Form for Transit Users with VOA Questions

Virginia Travel Survey

This survey is part of a transportation study conducted by Hampton Roads Transportation Planning Organization (HRTPO) aimed to understand and improve the travel needs of Virginia residents and workers. Please complete and return this form to our survey staff.

1. *Where are you traveling today? Please indicate your:*

STARTING POINT (City) ______________________ (State/Zipcode) _______

DESTINATION (City) ________________________ (State/Zipcode) _______

PRIMARY RESIDENCE (City) __________________ (State/Zipcode) _______

2. How often do you make the same trip you indicated in Questions #1? *Enter number and circle week, month or year.*

___________ times per WEEK/MONTH/YEAR.

3. What is the primary purpose of your trip today? *Check only one*

O Commuting to/from work O Business Travel O Site Seeing

O Travel to/from school O Shopping O Other _________

If Business travel, who is paying for your trip?

O Self O Employer O Other_________

4. How did you travel to this airport? *Check only one*

O Drove my own car O Dropped off O By Walk O Taxi/cab

O Public Transit O Other ________

If public transit, how did you travel to Public Transit? Check only one

O Drove my own car O Dropped off O By Walk O Other________

5. What is your current employment status? *Check all that apply*

O Employed Full/Part-time O Student O Not-Employed

O Military Personal O Veteran O Retired O Other ________

6. What is the combined annual income of everyone in your household? *Check only one*

O Less than $25,000 O $25,000 – $49,999

O $50,000 - $99,999 O $100,000 or more

How much do you value your time when traveling to the airport?

TRAVEL TIME is the total time spent traveling to the airport & **COST** includes gas, parking, and/or fares for public transit, etc.

For each question below, check (✓) only ONE circle that best indicates your degree of preference for the time and cost alternatives given.

Option A	**Imagine your** **TRAVEL TIME to the station is 36 mins** **&** **COST of your trip is $34** for the Similar "Trip" & Same "Purpose" as Questions #1, 3

(Refer to **Option A** for answering Questions 6 to 10)

6. Would you spend $35 or **$1 more** if the TRAVEL TIME were **10 min less**? *Check only one*

O Yes O Probably O Not Sure O Probably Not O No

7. Would you spend $38 or **$4 more** if the TRAVEL TIME were **15 min less**? *Check only one*

O Yes O Probably O Not Sure O Probably Not O No

8. Would you spend $42 or **$8 more** if the TRAVEL TIME were **20 min less**? *Check only one*

O Yes O Probably O Not Sure O Probably Not O No

9. Would you spend $49 or **$15 more** if the TRAVEL TIME were **26 min less**? *Check only one*

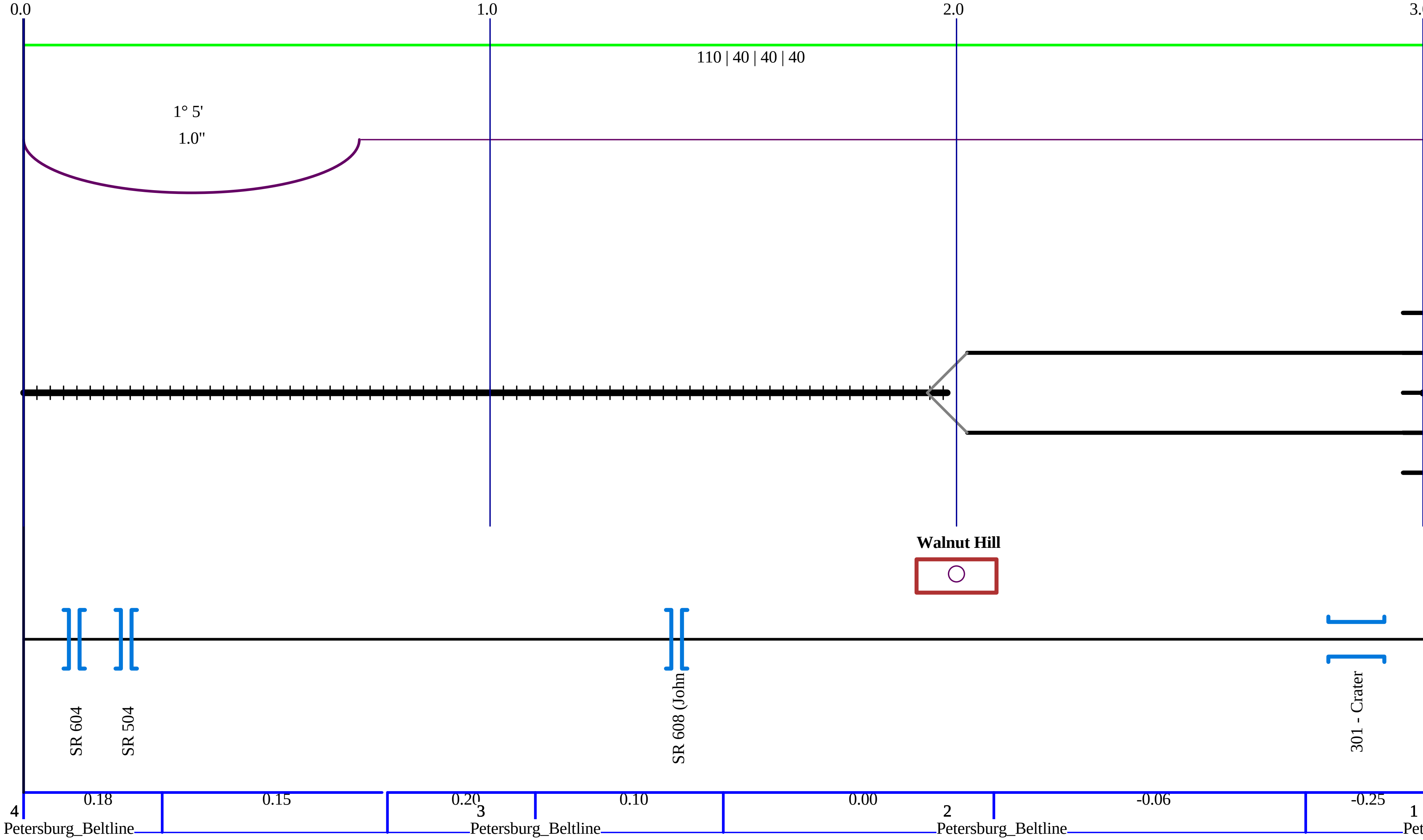
O Yes O Probably O Not Sure O Probably Not O No

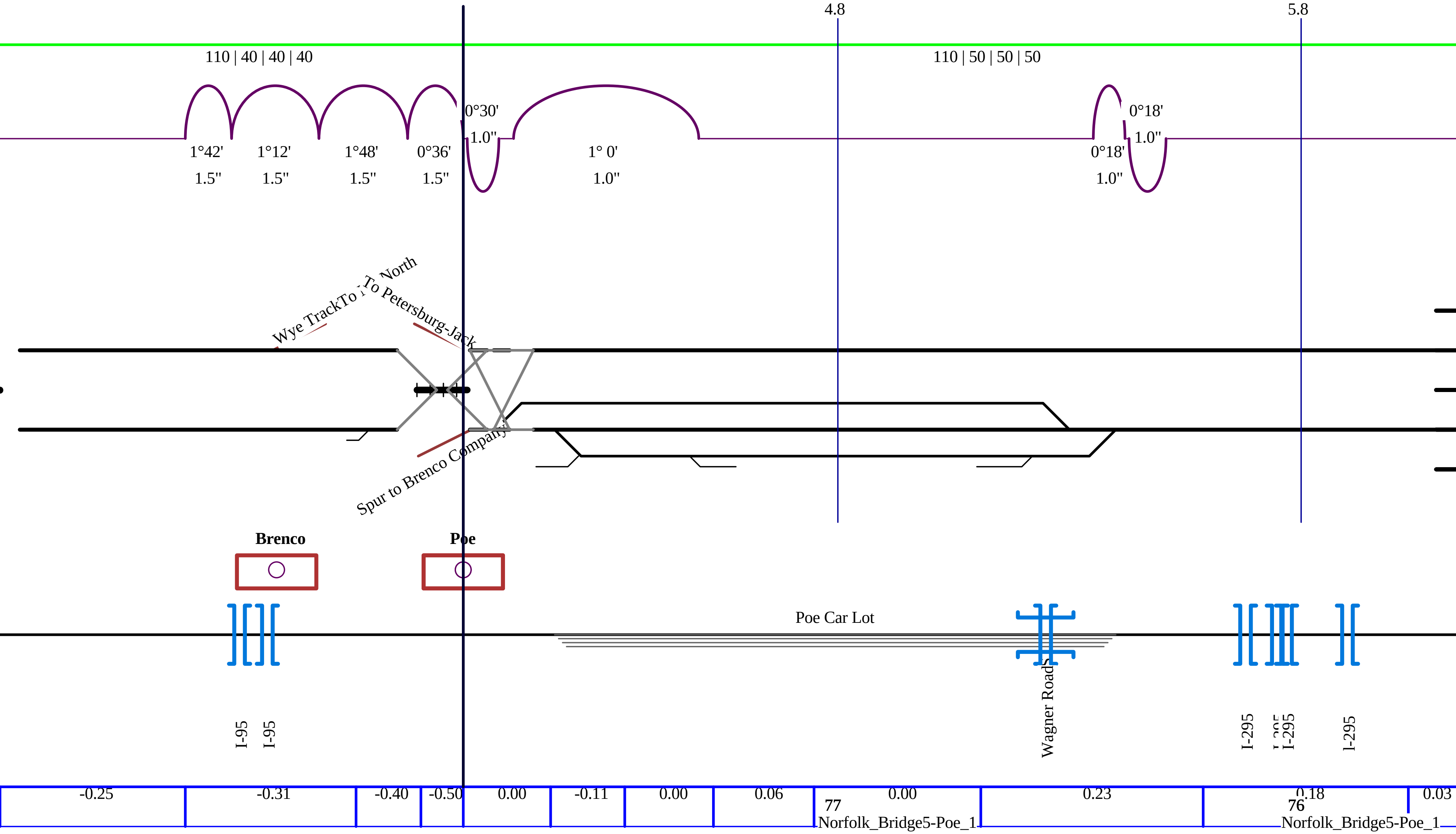
10. Would you spend $57 or **$23 more** if the TRAVEL TIME were **30 min less**? *Check only one*

O Yes O Probably O Not Sure O Probably Not O No

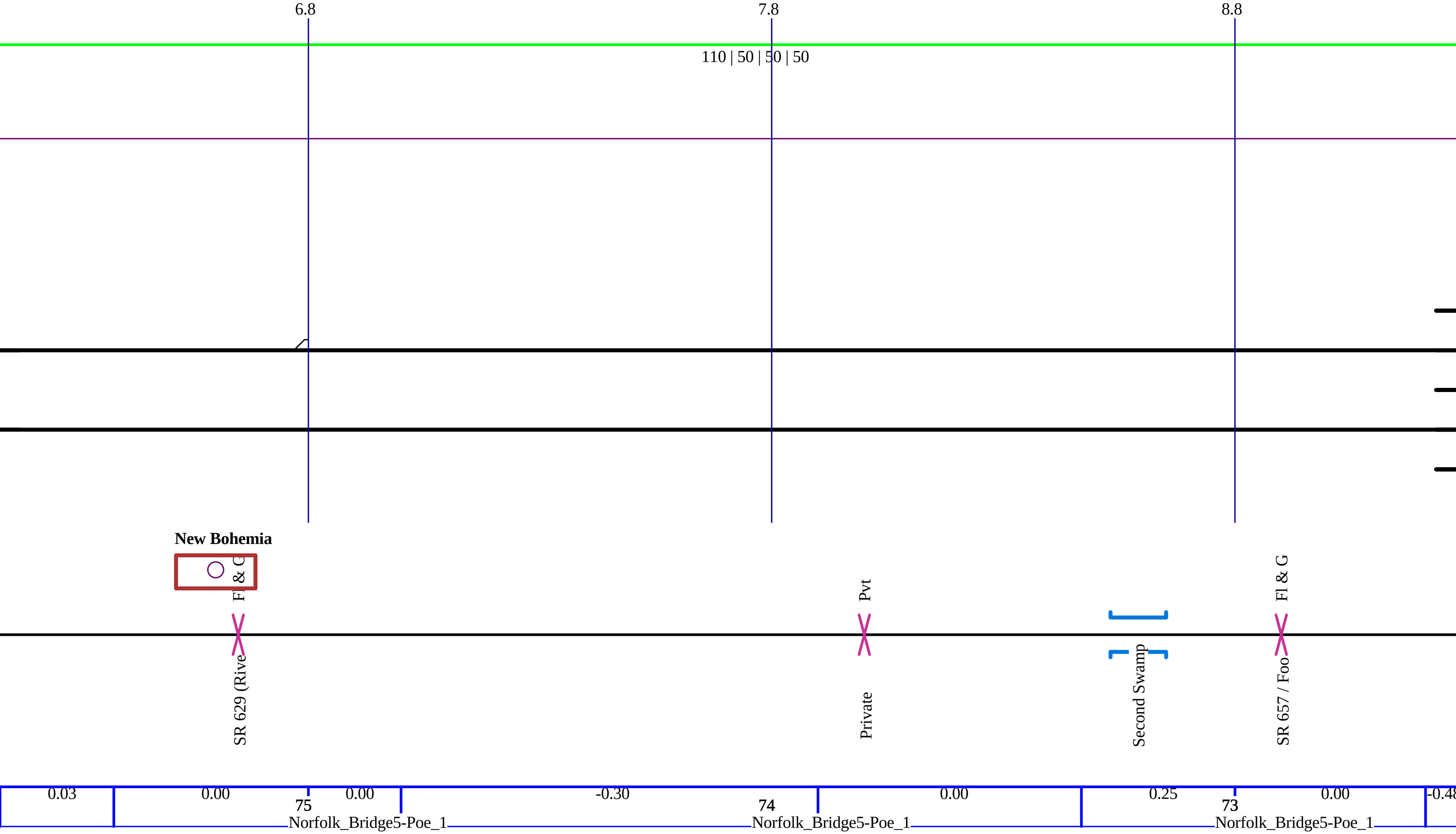
Thank You for Your Time and Cooperation!

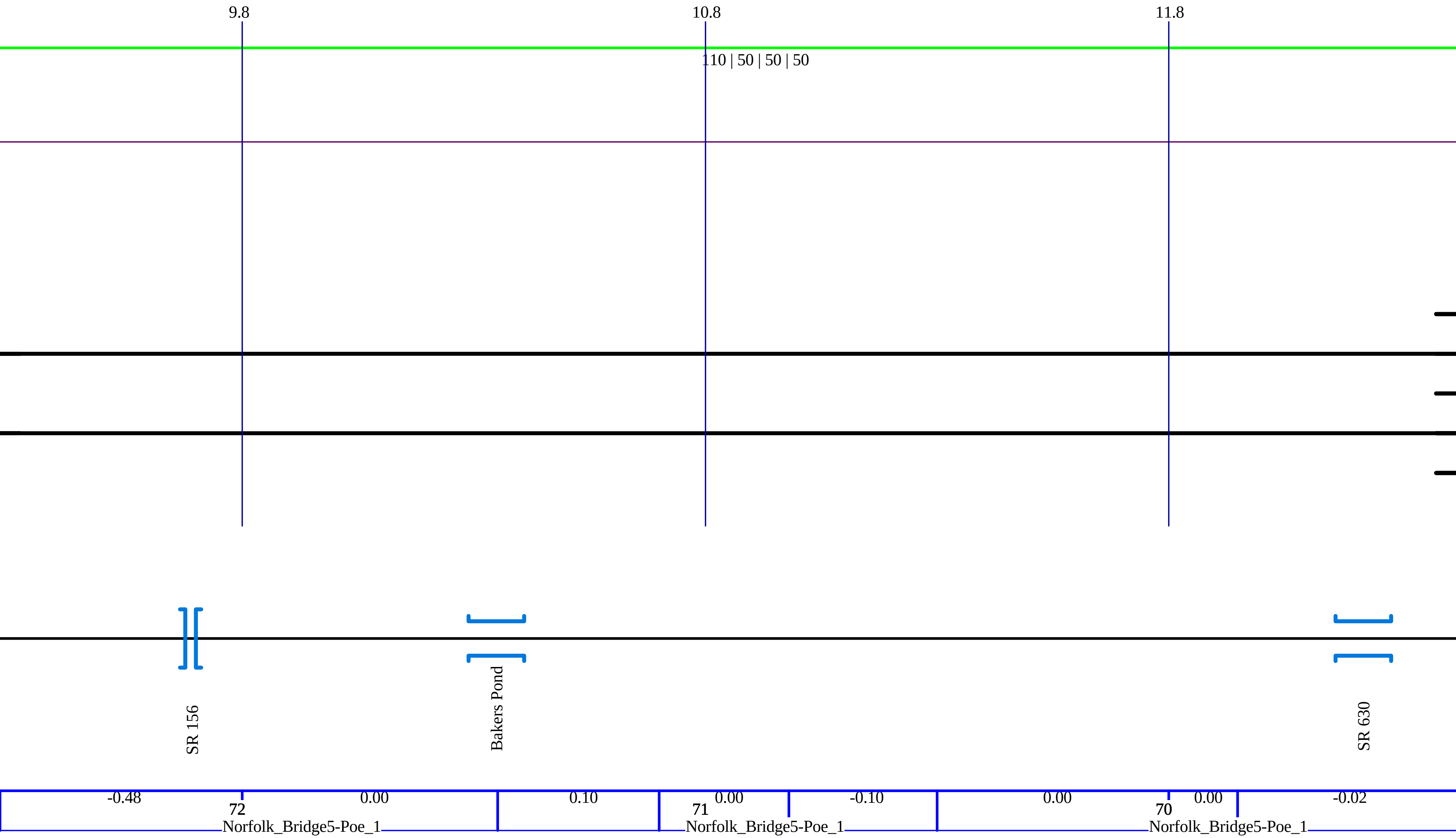
APPENDIX C – TRACKMAN™ FILES FOR NORFOLK SOUTHERN ALIGNMENT

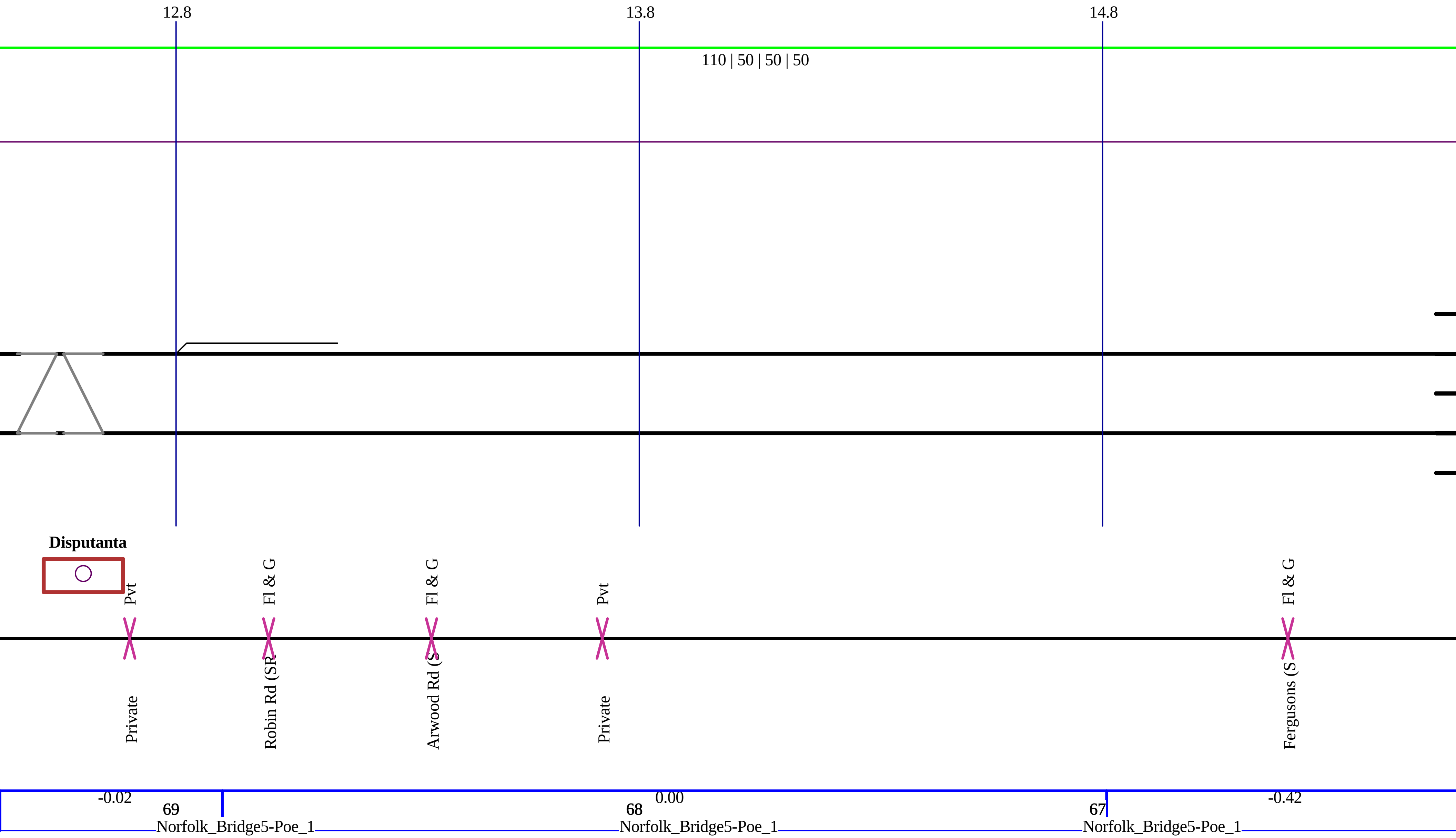

0.0
1.0
2.0
3.
110 | 40 | 40 | 40
1° 5'
1.0"
Walnut Hill
SR 604
SR 504
SR 608 (John
301 - Crater
0.18
0.15
0.20
0.10
0.00
-0.06
-0.25
4
3
2
1
Petersburg_Beltline
Petersburg_Beltline
Petersburg_Beltline
Pet



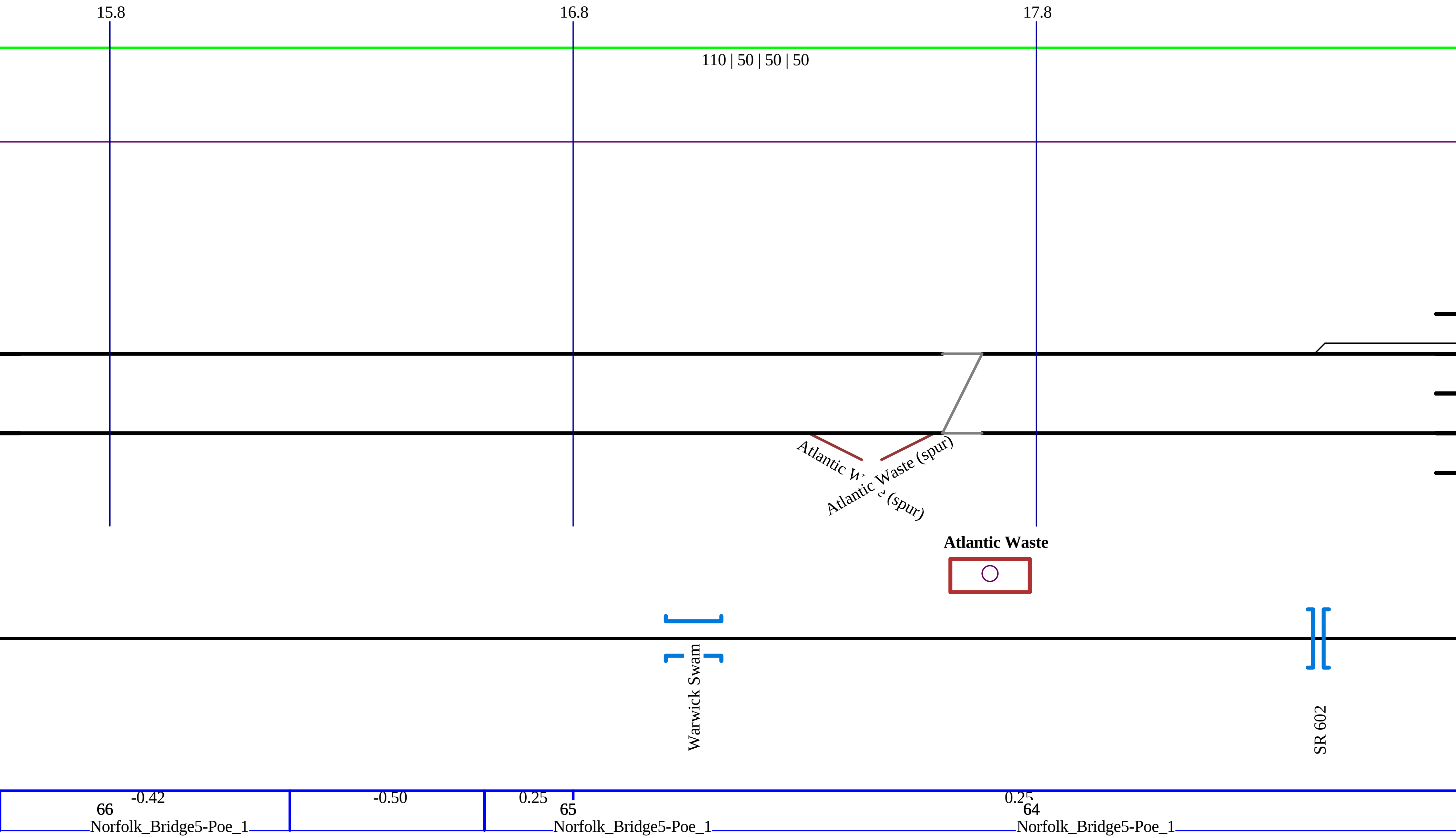
4.8
5.8
110 | 40 | 40 | 40
110 | 50 | 50 | 50
0°30'
1.0"
0°18'
1.0"
1°42'
1.5"
1°12'
1.5"
1°48'
1.5"
0°36'
1.5"
1° 0'
1.0"
0°18'
1.0"
Wye Track To : To North
To Petersburg-Jack
Spur to Brenco Company
Brenco
Poe
Poe Car Lot
I-95
I-95
Wagner Road
I-295
I-295
I-295
-0.25
-0.31
-0.40
-0.50
0.00
-0.11
0.00
0.06
0.00
0.23
0.18
0.03
77
Norfolk_Bridge5-Poe_1
76
Norfolk_Bridge5-Poe_1


6.8
7.8
8.8
110 | 50 | 50 | 50
New Bohemia
Fl & G
SR 629 (Rive
Pvt
Private
Second Swamp
Fl & G
SR 657 / Foo
0.03
0.00
0.00
-0.30
0.00
0.25
0.00
-0.48
75
74
73
Norfolk_Bridge5-Poe_1
Norfolk_Bridge5-Poe_1
Norfolk_Bridge5-Poe_1


9.8
10.8
11.8
110 | 50 | 50 | 50
SR 156
Bakers Pond
SR 630
-0.48
0.00
0.10
0.00
-0.10
0.00
0.00
-0.02
72
71
70
Norfolk_Bridge5-Poe_1
Norfolk_Bridge5-Poe_1
Norfolk_Bridge5-Poe_1



12.8
13.8
14.8
110 | 50 | 50 | 50
Disputanta
Pvt
Private
Fl & G
Robin Rd (SR
Fl & G
Arwood Rd (S
Pvt
Private
Fl & G
Fergusons (S
-0.02
69
Norfolk_Bridge5-Poe_1
0.00
68
Norfolk_Bridge5-Poe_1
67
-0.42
Norfolk_Bridge5-Poe_1



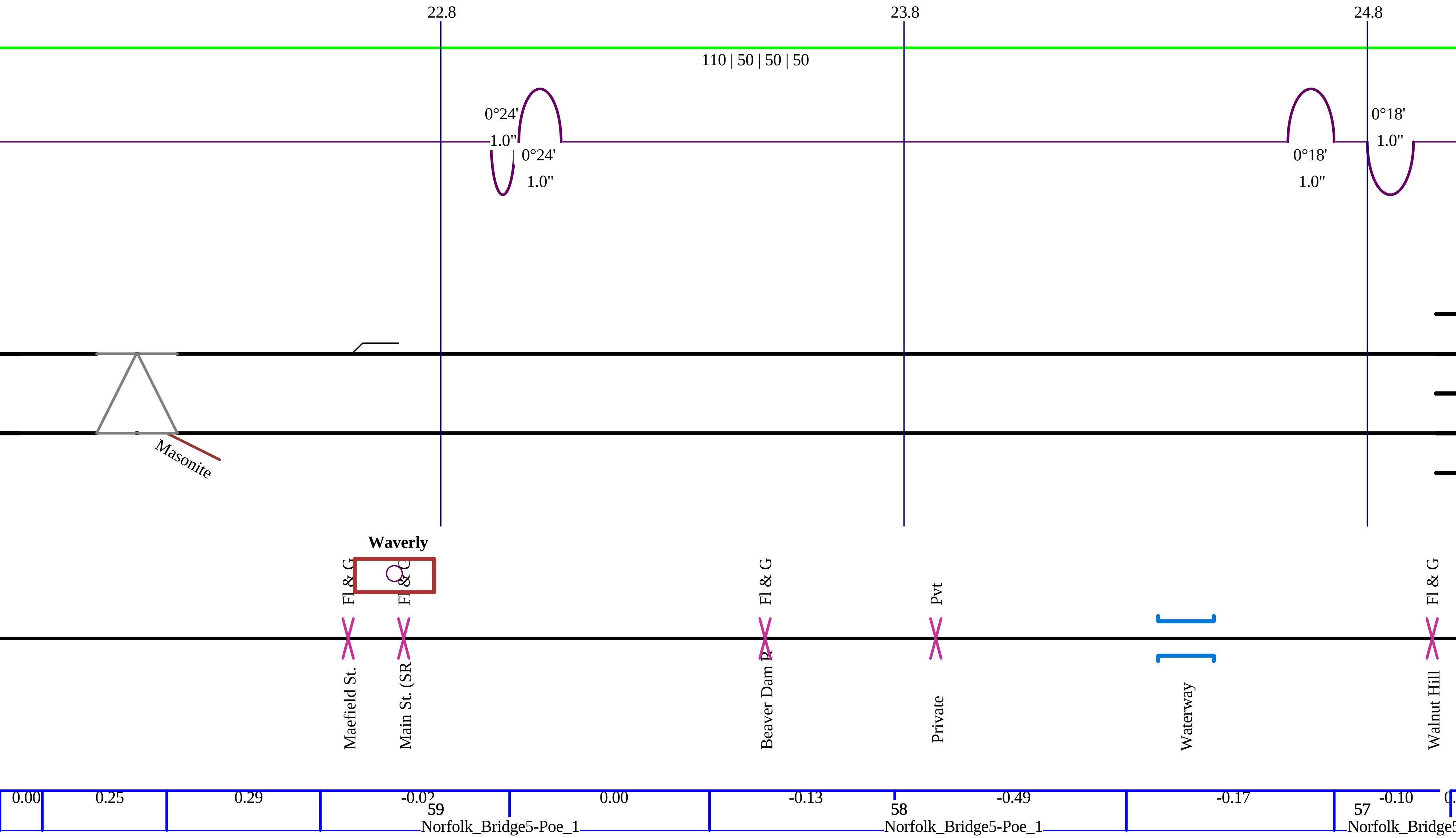
15.8
16.8
17.8
110 | 50 | 50 | 50
Atlantic Waste (spur)
Atlantic Waste
Warwick Swam
SR 602
-0.42
66
Norfolk_Bridge5-Poe_1
-0.50
0.25
65
Norfolk_Bridge5-Poe_1
0.25
64
Norfolk_Bridge5-Poe_1

18.8 19.8 20.8 21.8

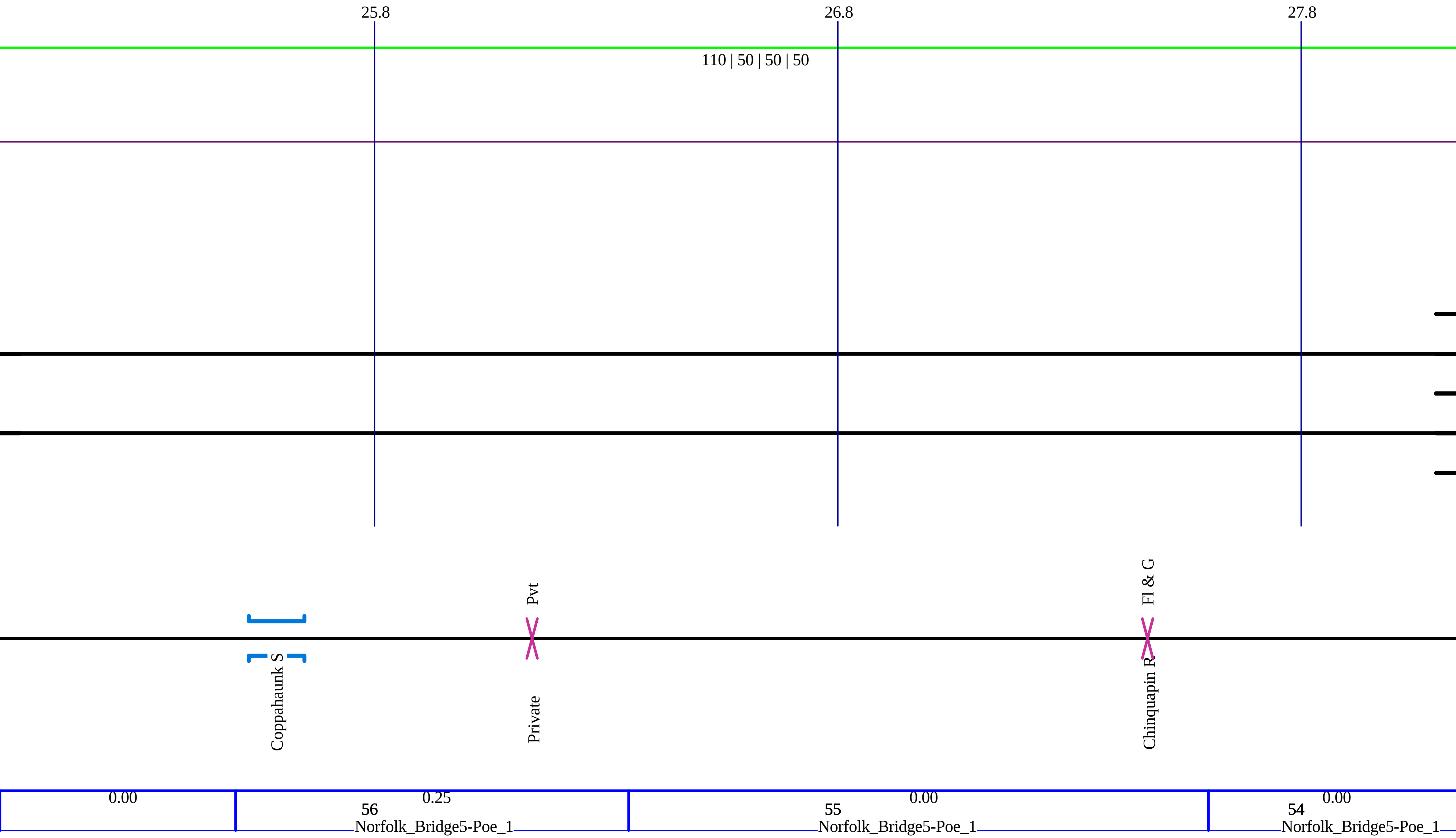
110 | 50 | 50 | 50

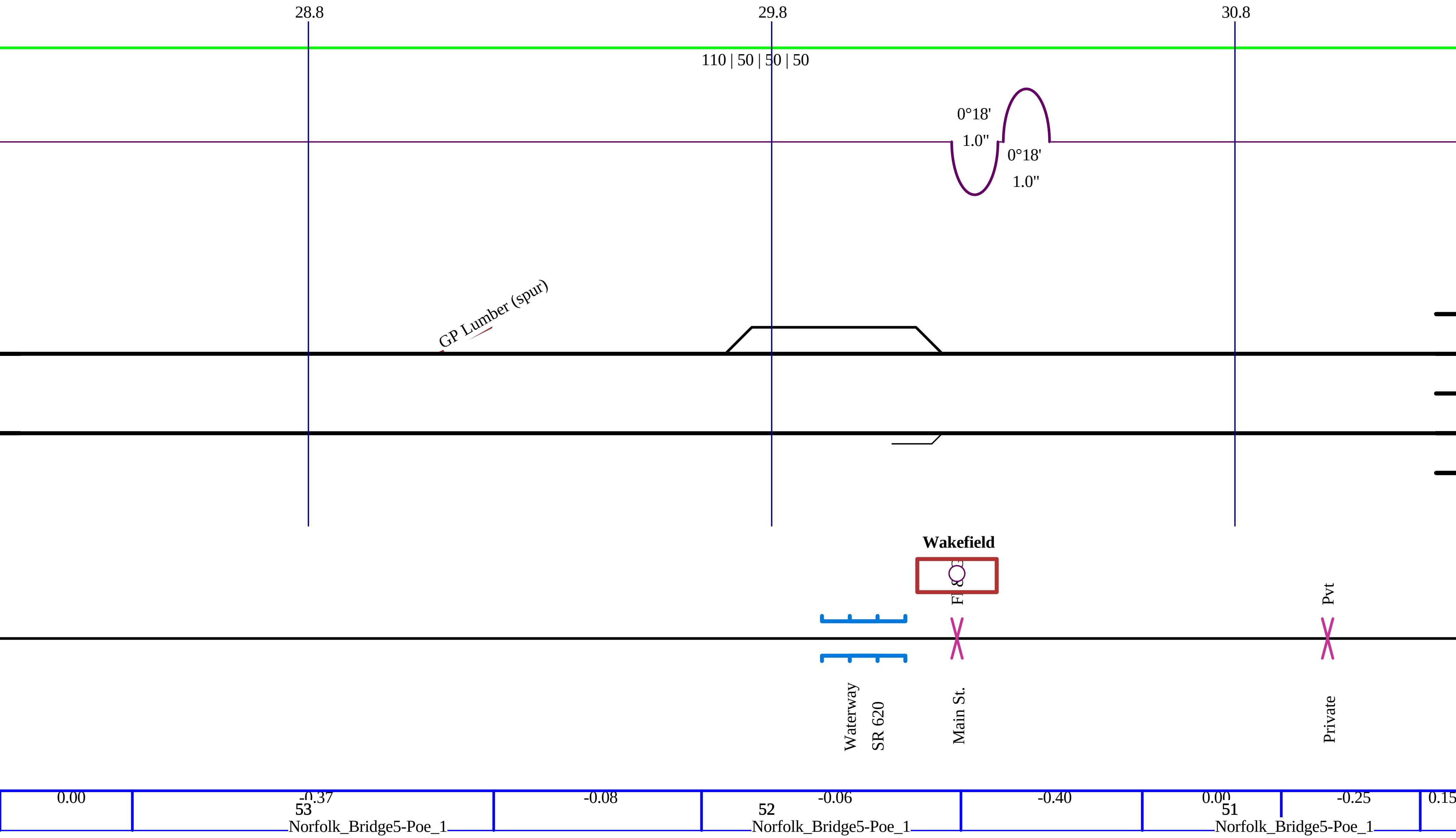
0.25 0.00 0.13 0.00 -0.26 -0.47 0.00 0.07 0.00 -0.08 0.00 0.0

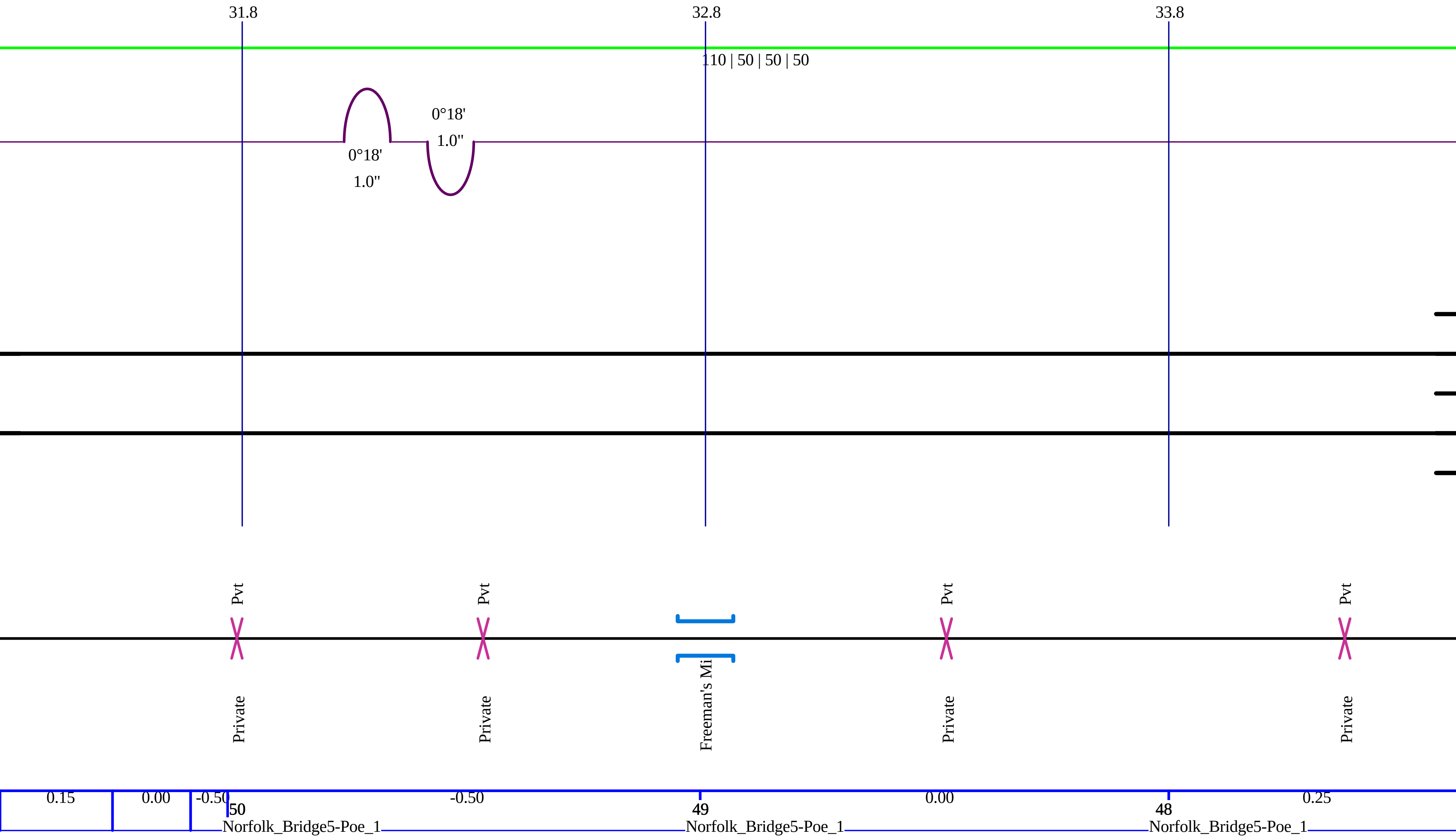
63 Norfolk_Bridge5-Poe_1
62 Norfolk_Bridge5-Poe_1
61 Norfolk_Bridge5-Poe_1
60 Norfol

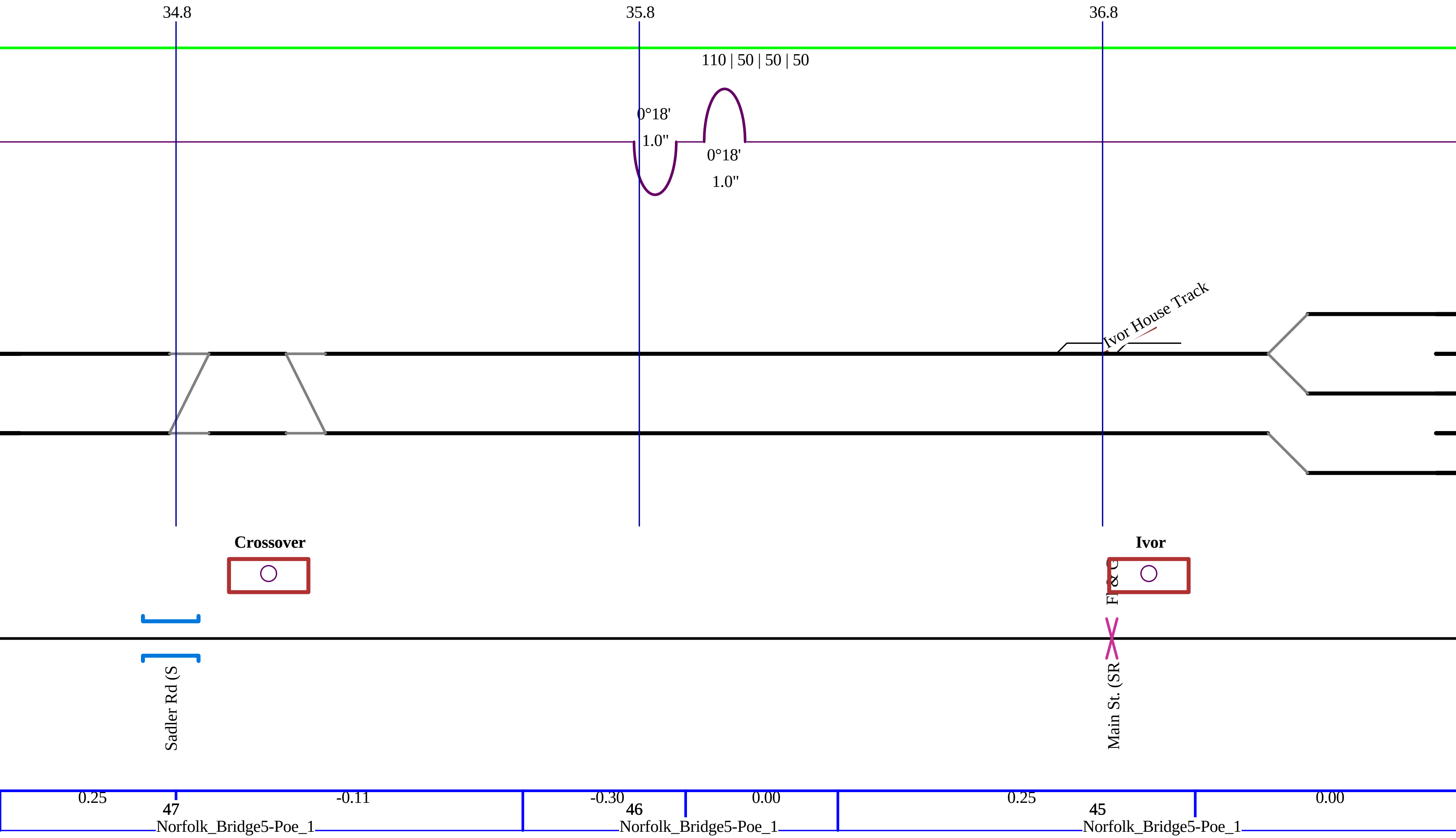


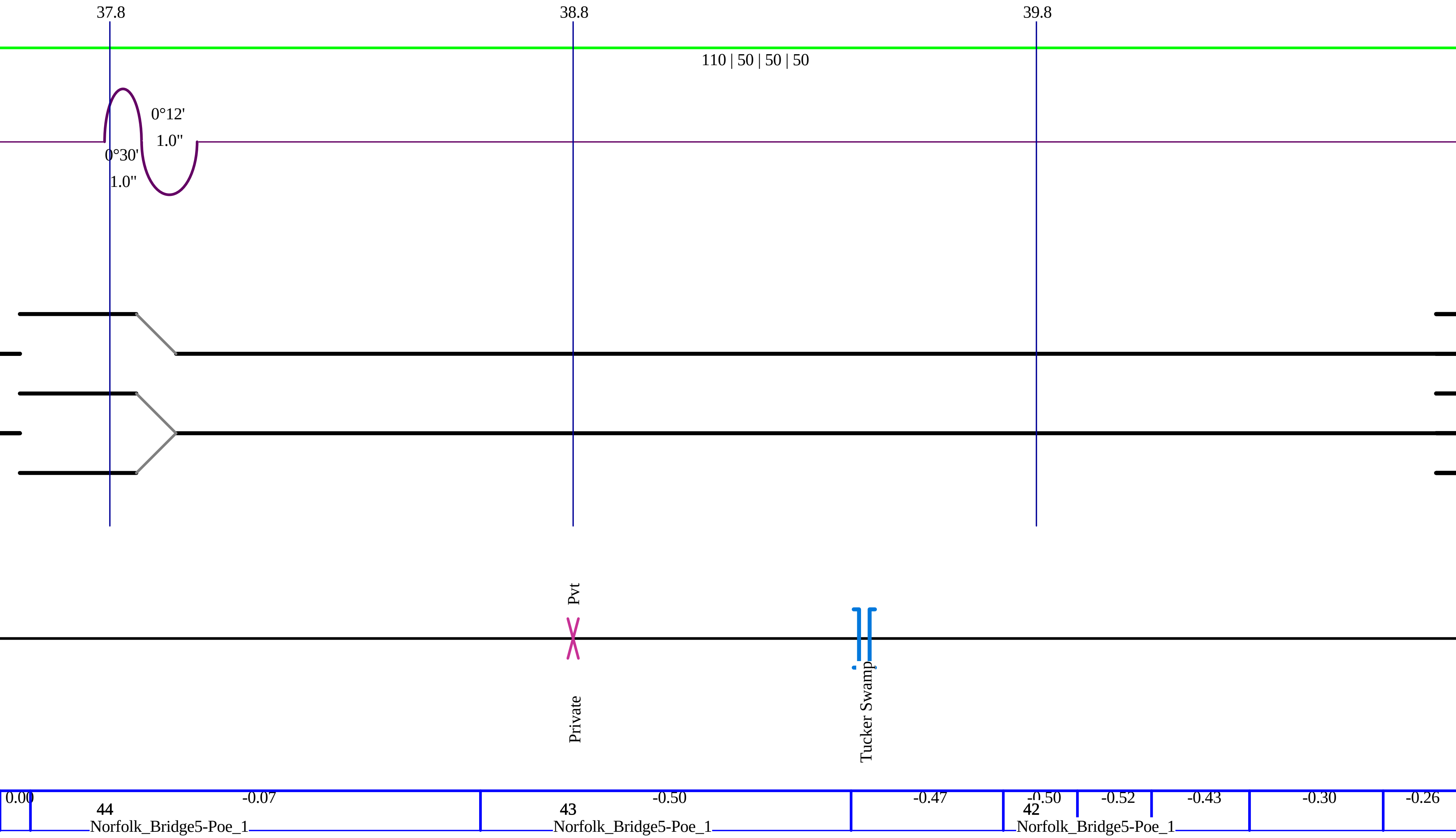
22.8
23.8
24.8
110 | 50 | 50 | 50
0°24'
1.0"
0°24'
1.0"
0°18'
1.0"
0°18'
1.0"
Masonite
Waverly
Fl & G
Fl & G
Fl & G
Pvt
Fl & G
Maefield St.
Main St. (SR
Beaver Dam R
Private
Waterway
Walnut Hill
0.00
0.25
0.29
-0.02
0.00
-0.13
-0.49
-0.17
-0.10
59
Norfolk_Bridge5-Poe_1
58
Norfolk_Bridge5-Poe_1
57
Norfolk_Bridge5


25.8
26.8
27.8
110 | 50 | 50 | 50
Pvt
Fl & G
Coppahaunk S
Private
Chinquapin R
0.00
0.25
0.00
0.00
56
55
54
Norfolk_Bridge5-Poe_1
Norfolk_Bridge5-Poe_1
Norfolk_Bridge5-Poe_1

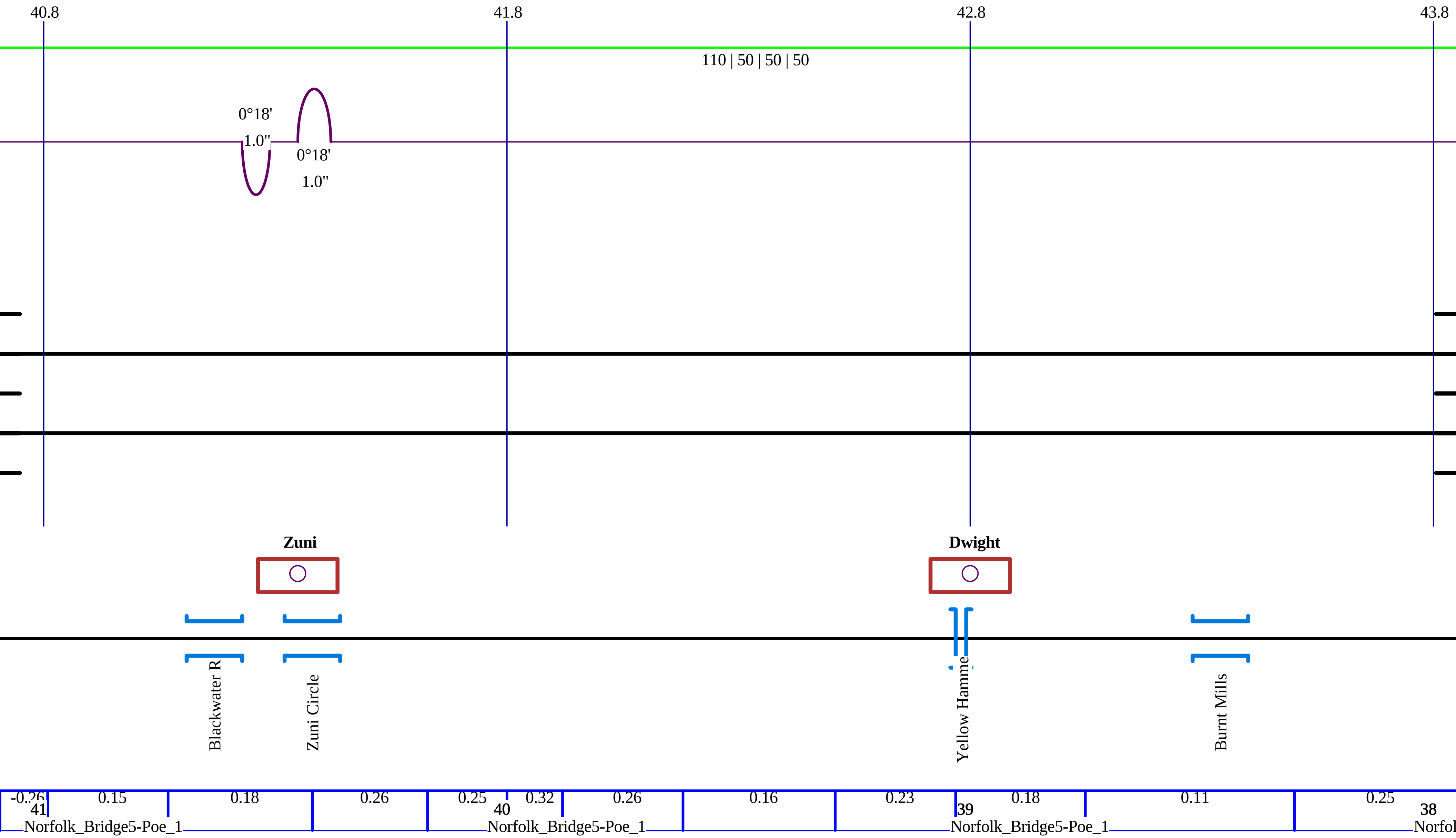

28.8
29.8
30.8
110 | 50 | 50 | 50
0°18'
1.0"
0°18'
1.0"
GP Lumber (spur)
Wakefield
Pvt
Waterway
SR 620
Main St.
Private
0.00
-0.37
53
Norfolk_Bridge5-Poe_1
-0.08
-0.06
52
Norfolk_Bridge5-Poe_1
-0.40
0.00
51
Norfolk_Bridge5-Poe_1
-0.25
0.15

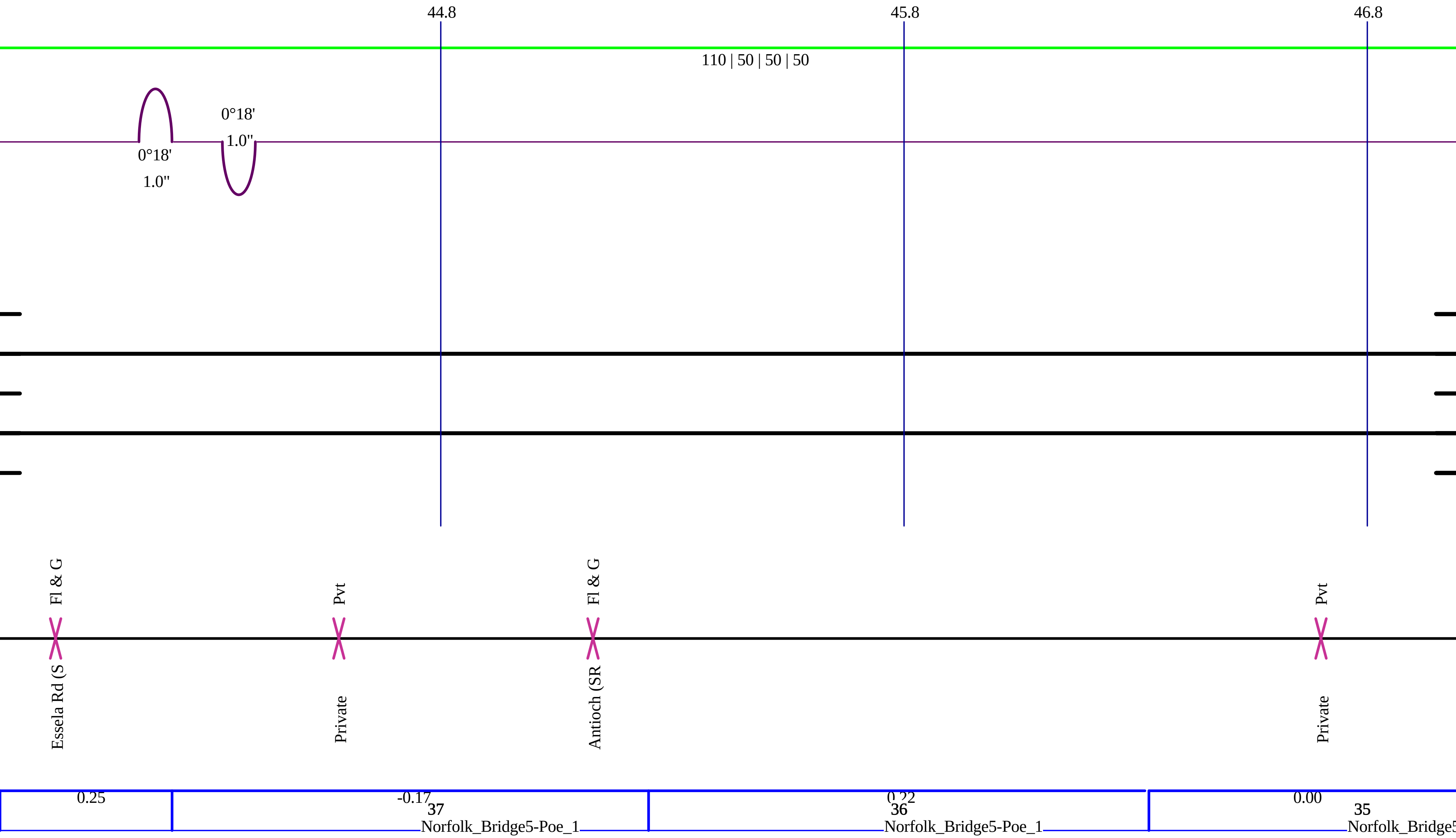

31.8
32.8
33.8
110 | 50 | 50 | 50
0°18'
1.0"
0°18'
1.0"
Pvt
Private
Pvt
Private
Freeman's Mi
Pvt
Private
Pvt
Private
0.15
0.00
-0.50
50
-0.50
49
0.00
48
0.25
Norfolk_Bridge5-Poe_1
Norfolk_Bridge5-Poe_1
Norfolk_Bridge5-Poe_1

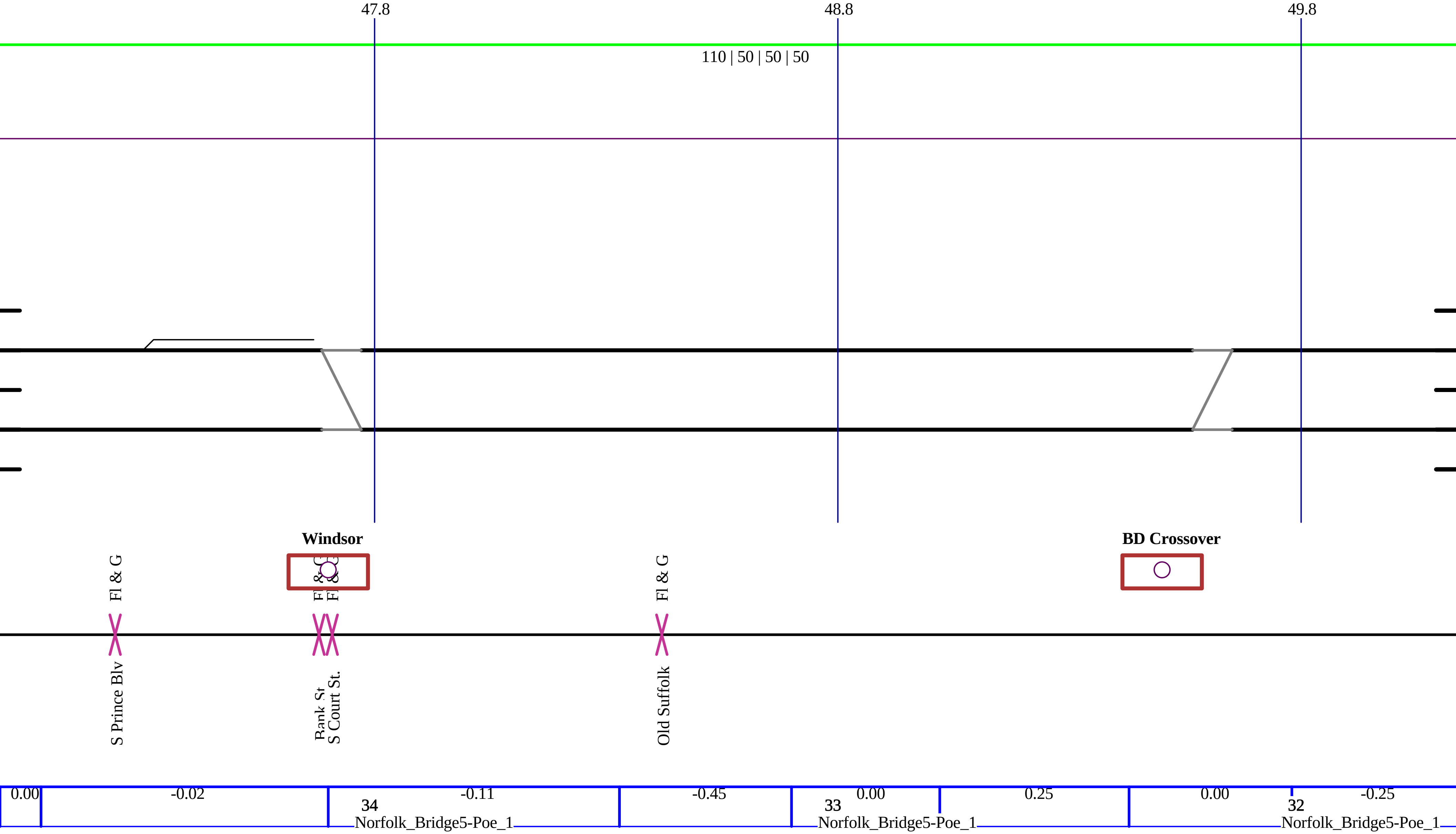

34.8
35.8
36.8
110 | 50 | 50 | 50
0°18'
1.0"
0°18'
1.0"
Ivor House Track
Crossover
Ivor
Sadler Rd (S
Main St. (SR
0.25
-0.11
-0.30
0.00
0.25
0.00
47
46
45
Norfolk_Bridge5-Poe_1
Norfolk_Bridge5-Poe_1
Norfolk_Bridge5-Poe_1

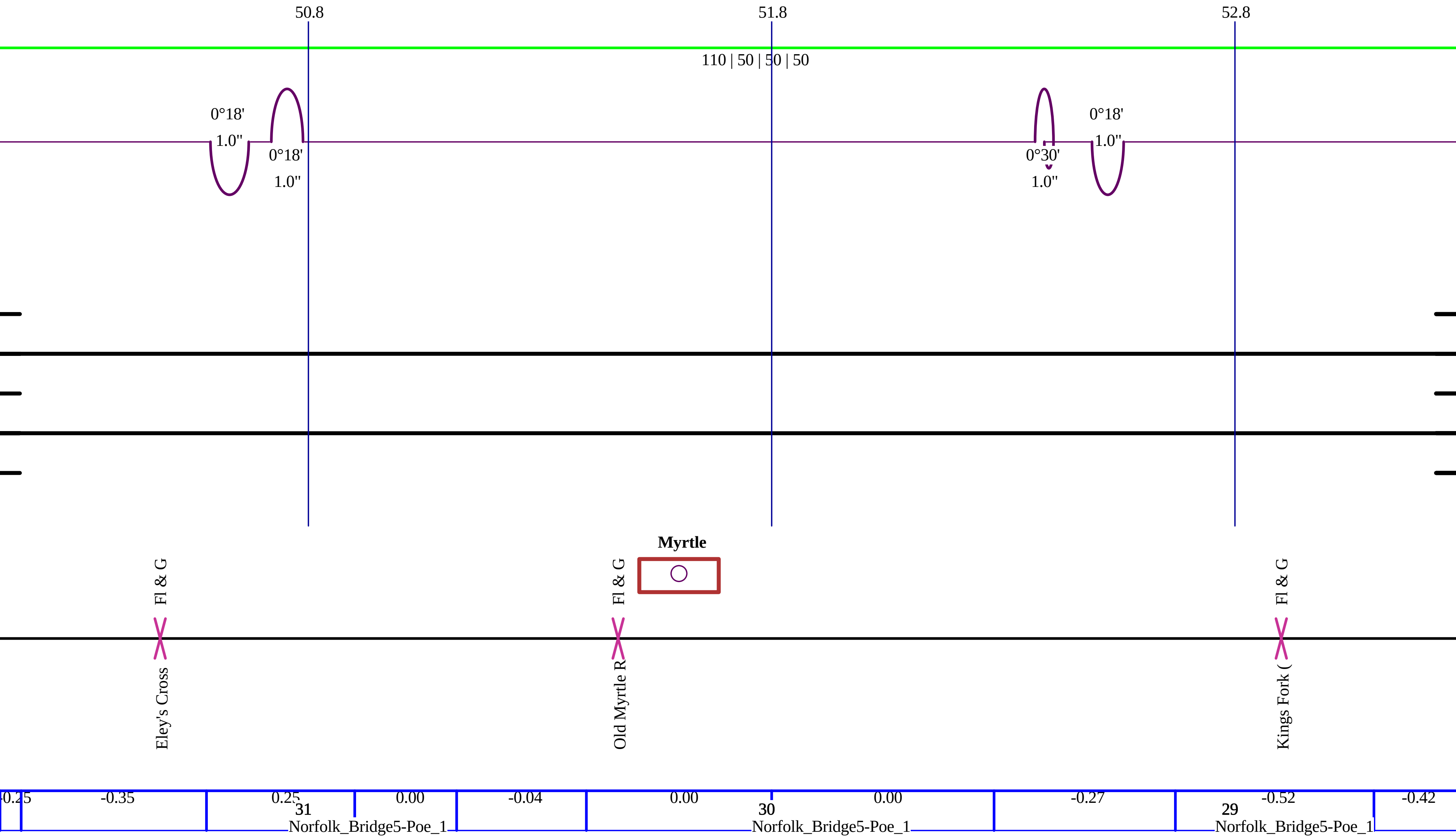


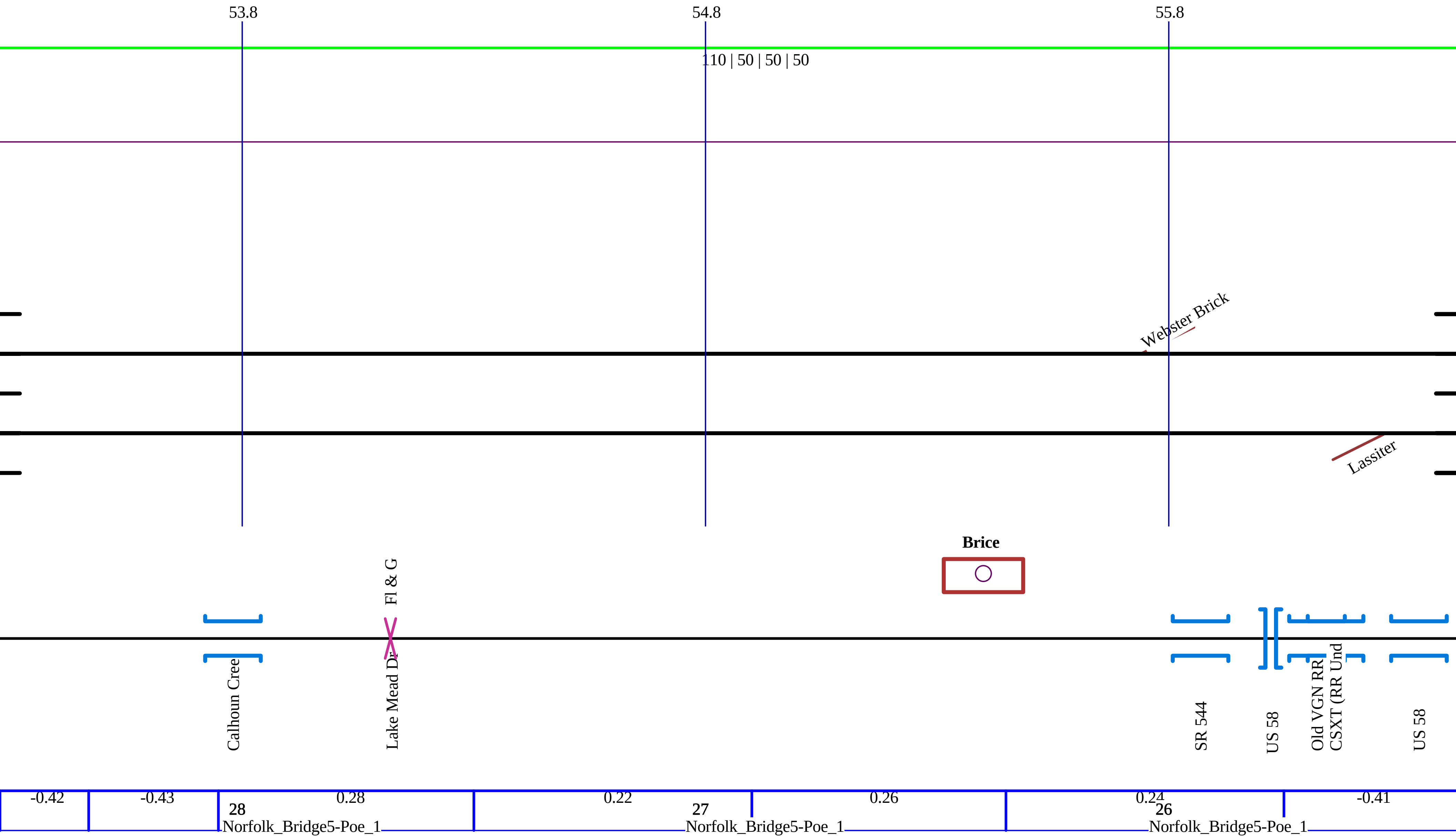
37.8
38.8
39.8
110 | 50 | 50 | 50
0°12'
1.0"
0°30'
1.0"
Pvt
Private
Tucker Swamp
0.00
-0.07
-0.50
-0.47
-0.50
-0.52
-0.43
-0.30
-0.26
44
43
42
Norfolk_Bridge5-Poe_1
Norfolk_Bridge5-Poe_1
Norfolk_Bridge5-Poe_1


40.8
41.8
42.8
43.8
110 | 50 | 50 | 50
0°18'
1.0"
0°18'
1.0"
Zuni
Dwight
Blackwater R
Zuni Circle
Yellow Hamme
Burnt Mills
-0.26
0.15
0.18
0.26
0.25
0.32
0.26
0.16
0.23
0.18
0.11
0.25
41
40
39
38
Norfolk_Bridge5-Poe_1
Norfolk_Bridge5-Poe_1
Norfolk_Bridge5-Poe_1
Norfol

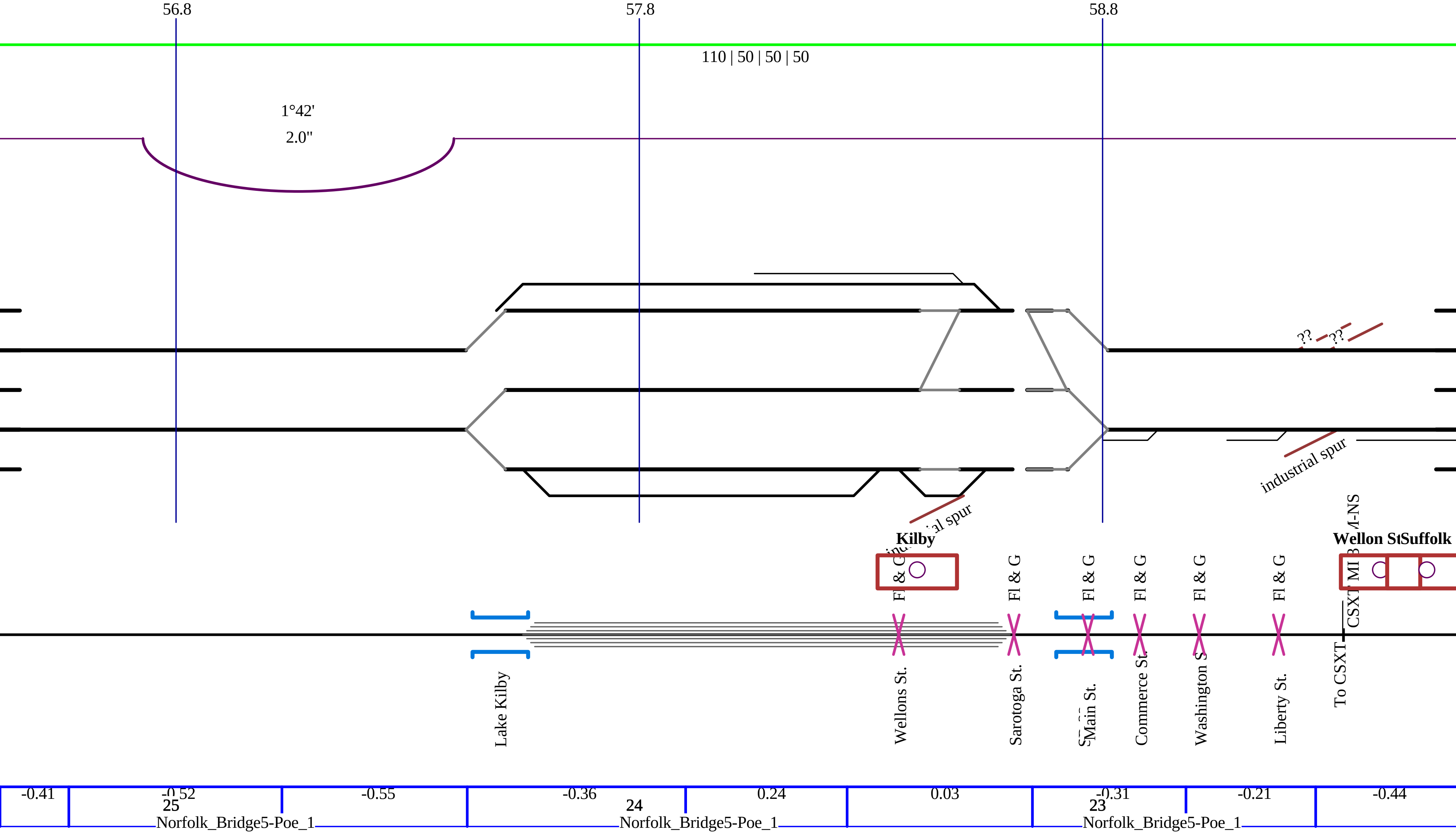

44.8
45.8
46.8
110 | 50 | 50 | 50
0°18'
1.0"
0°18'
1.0"
Fl & G
Essela Rd (S
Pvt
Private
Fl & G
Antioch (SR
Pvt
Private
0.25
-0.17
37
Norfolk_Bridge5-Poe_1
0.22
36
Norfolk_Bridge5-Poe_1
0.00
35

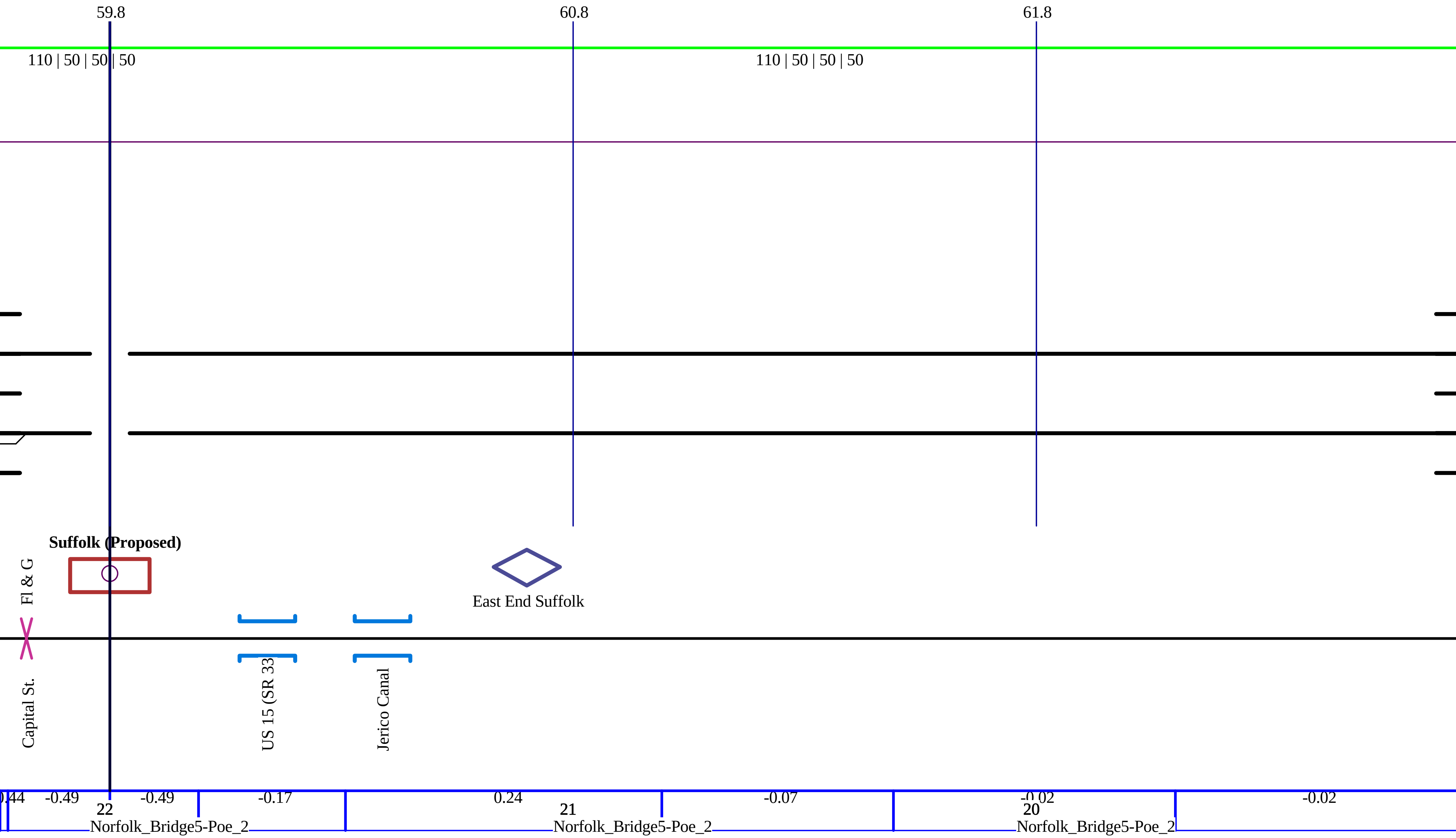

47.8
48.8
49.8
110 | 50 | 50 | 50
Windsor
BD Crossover
Fl & G
Fl & G
S Prince Blv
S Court St.
Old Suffolk
0.00
-0.02
-0.11
-0.45
0.00
0.25
0.00
-0.25
34
Norfolk_Bridge5-Poe_1
33
Norfolk_Bridge5-Poe_1
32
Norfolk_Bridge5-Poe_1

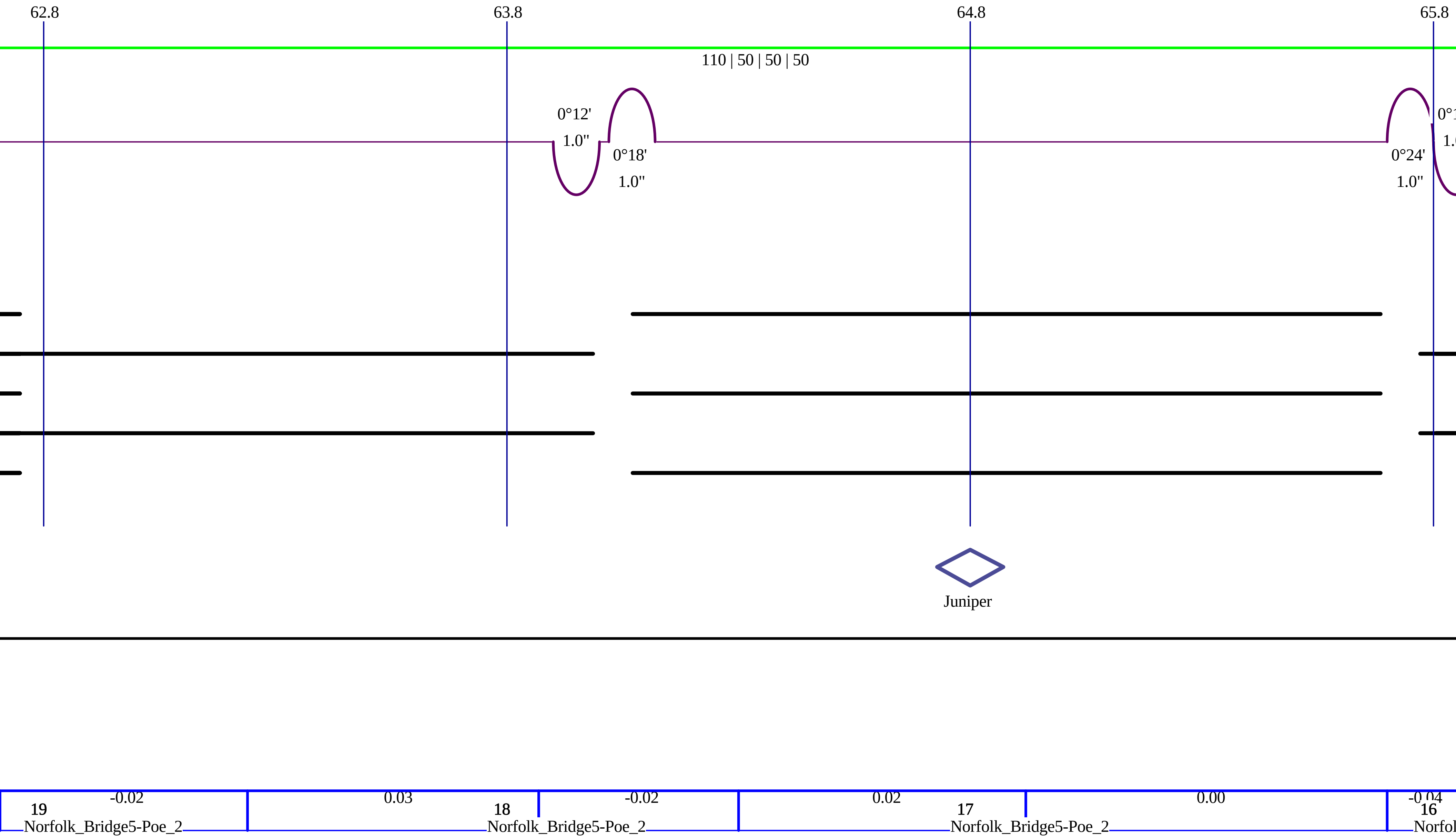

50.8
51.8
52.8
110 | 50 | 50 | 50
0°18'
1.0"
0°18'
1.0"
0°30'
1.0"
0°18'
1.0"
Myrtle
Fl & G
Eley's Cross
Fl & G
Old Myrtle R
Fl & G
Kings Fork (
-0.25
-0.35
0.25
0.00
-0.04
0.00
0.00
-0.27
-0.52
-0.42
31
Norfolk_Bridge5-Poe_1
30
Norfolk_Bridge5-Poe_1
29
Norfolk_Bridge5-Poe_1

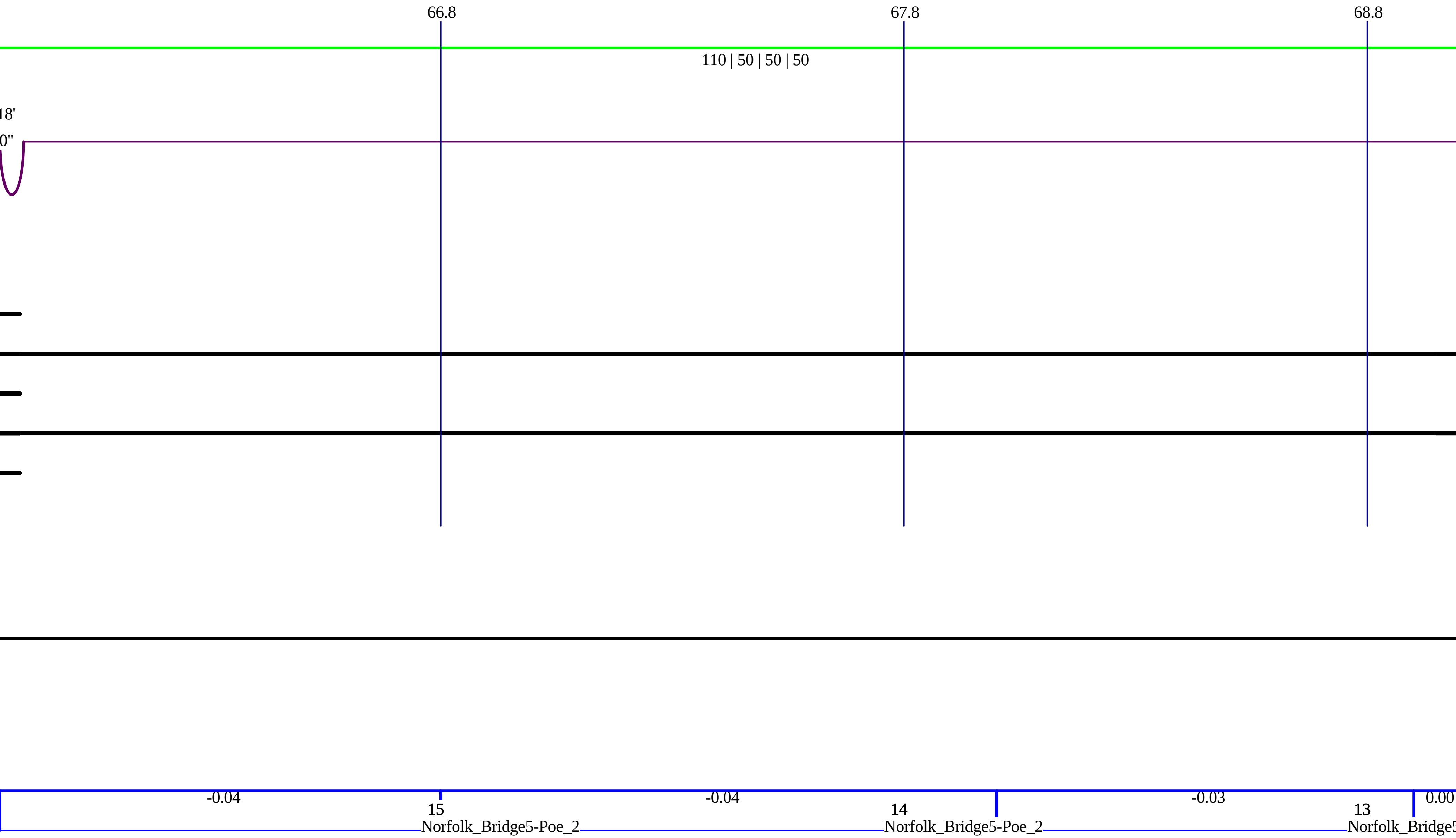


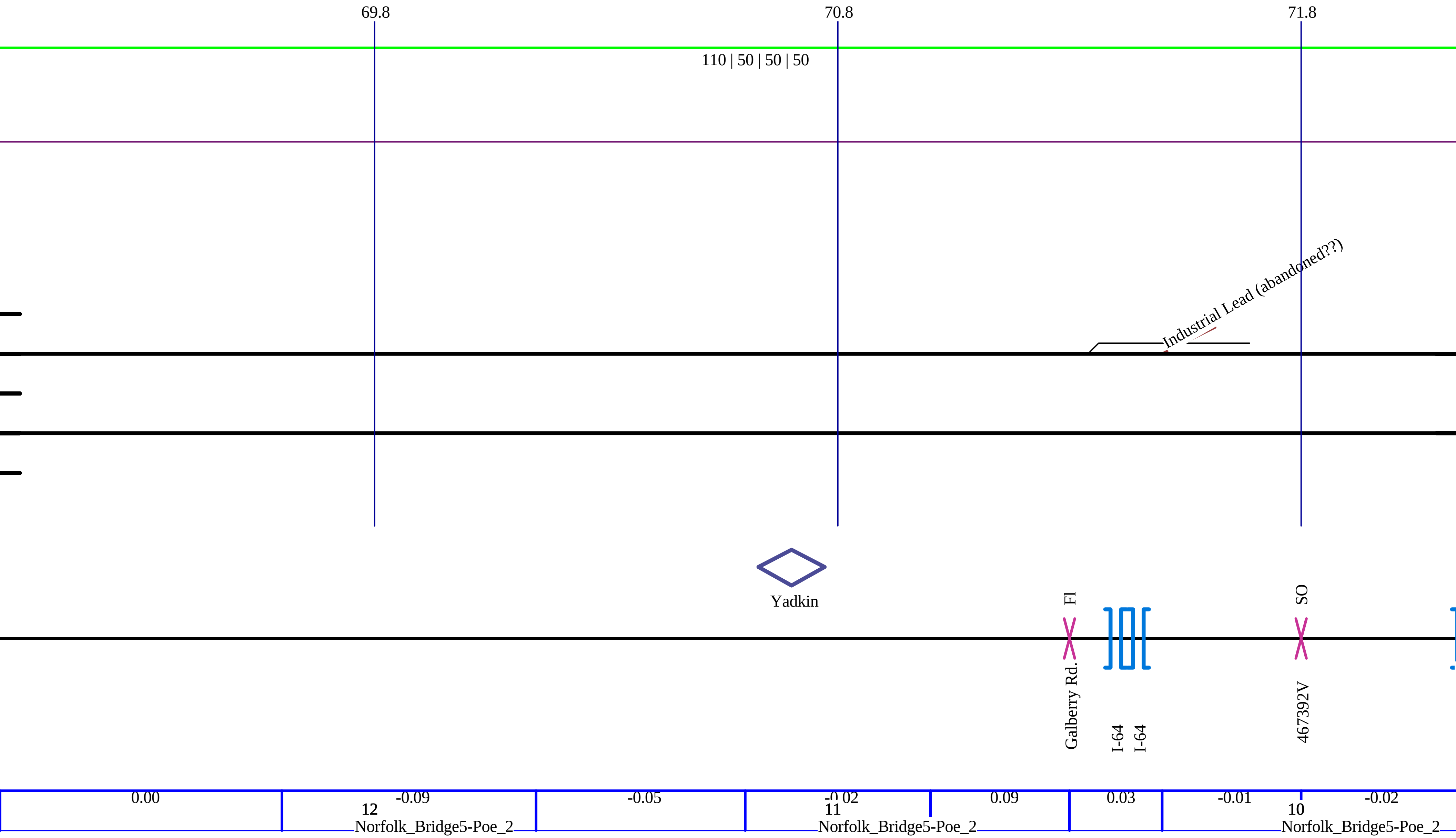
53.8
54.8
55.8
110 | 50 | 50 | 50
Webster Brick
Lassiter
Brice
Fl & G
Calhoun Cree
Lake Mead Dr
SR 544
US 58
Old VGN RR
CSXT (RR Und
US 58
-0.42
-0.43
0.28
0.22
0.26
0.24
-0.41
28
27
26
Norfolk_Bridge5-Poe_1
Norfolk_Bridge5-Poe_1
Norfolk_Bridge5-Poe_1

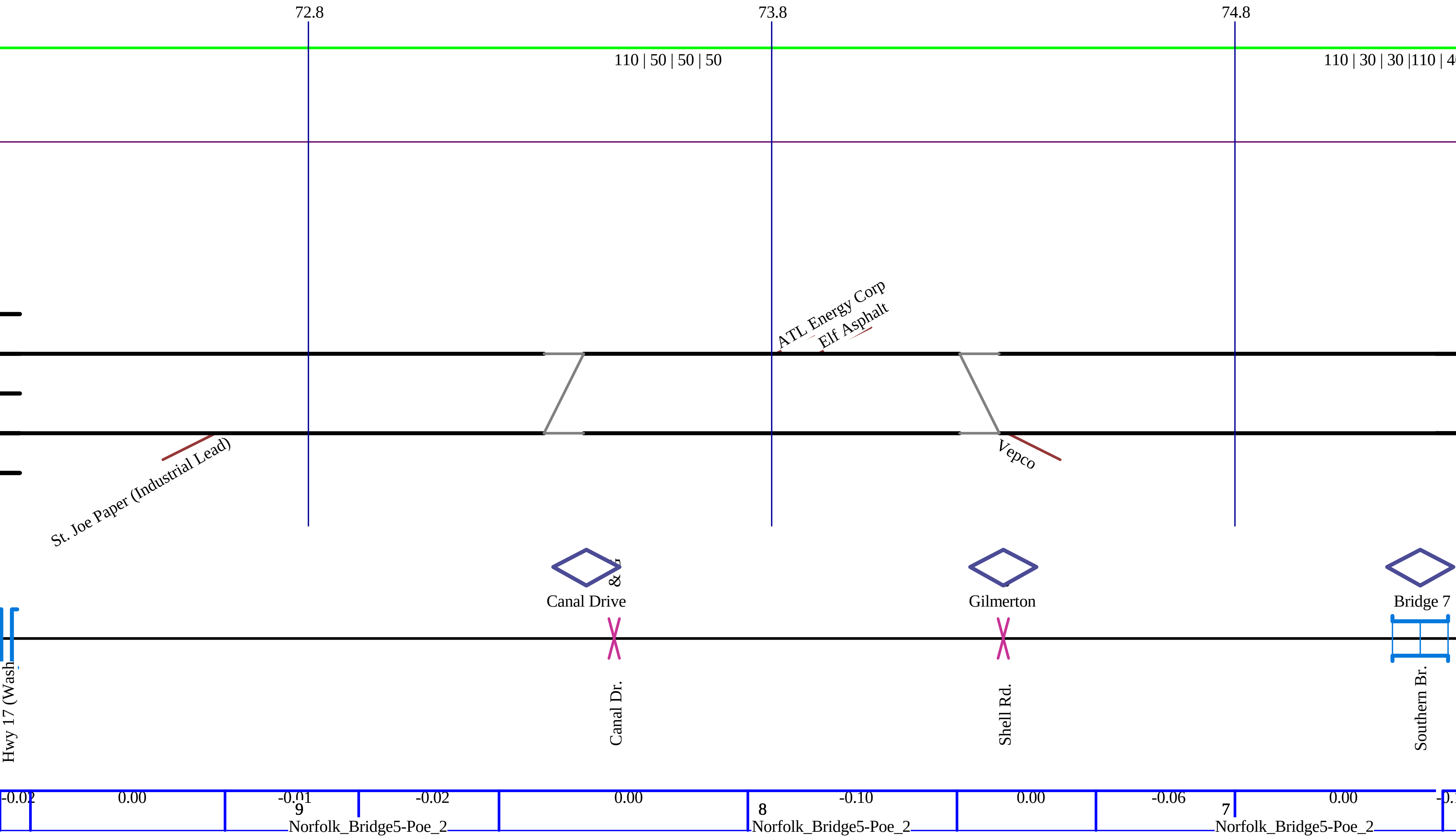

56.8
57.8
58.8
110 | 50 | 50 | 50
1°42'
2.0"
industrial spur
??
??
Kilby
Wellon St
Suffolk
Fl & G
Fl & G
Fl & G
Fl & G
Fl & G
Fl & G
Lake Kilby
Wellons St.
Sarotoga St.
Main St.
Commerce St.
Washington S
Liberty St.
To CSXT
-0.41
-0.52
-0.55
-0.36
0.24
0.03
-0.31
-0.21
-0.44
25
24
23
Norfolk_Bridge5-Poe_1
Norfolk_Bridge5-Poe_1
Norfolk_Bridge5-Poe_1

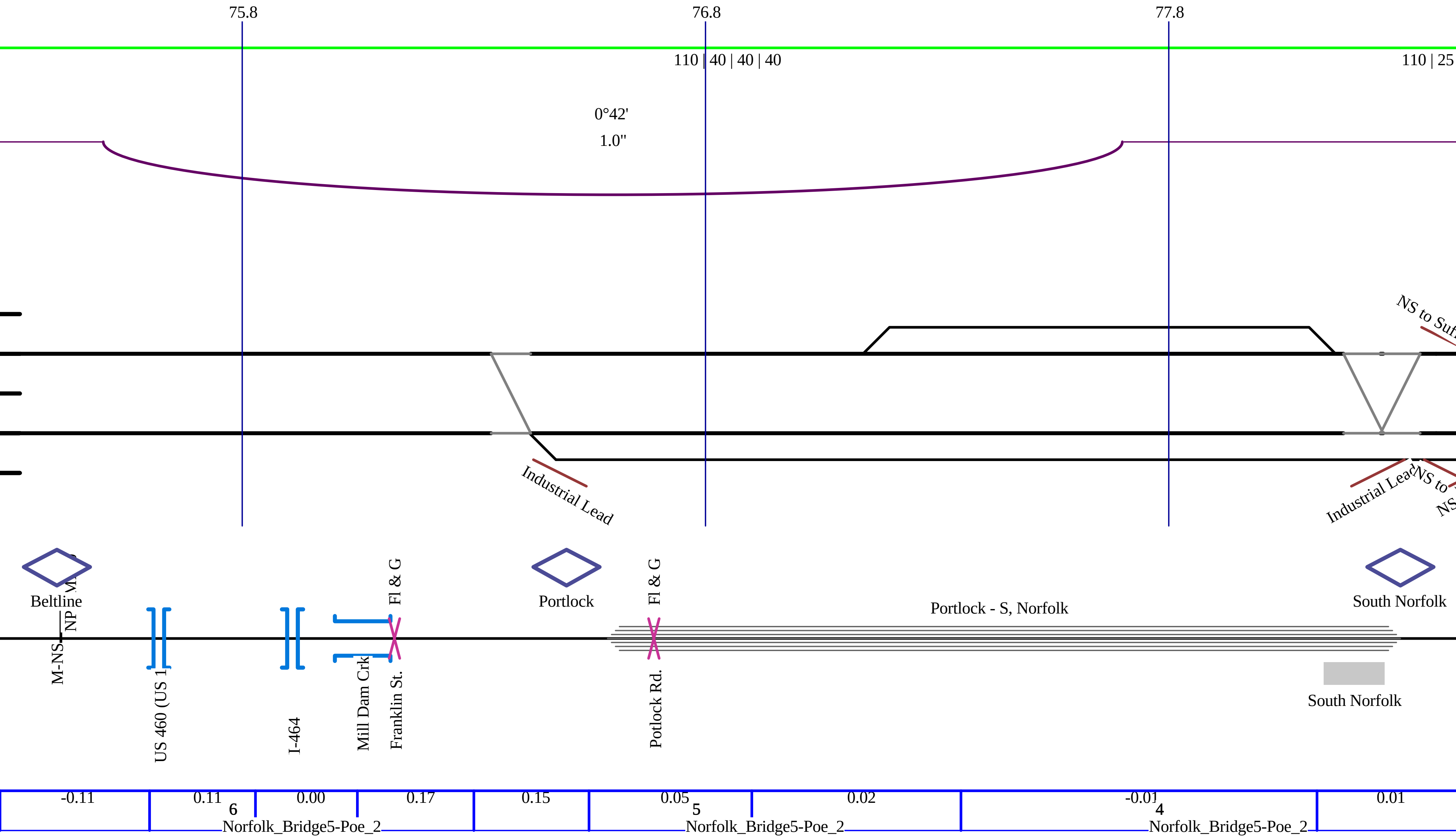

59.8
60.8
61.8
110 | 50 | 50 | 50
110 | 50 | 50 | 50
Suffolk (Proposed)
Fl & G
East End Suffolk
Capital St.
US 15 (SR 33
Jerico Canal
-0.49
-0.49
-0.17
0.24
-0.07
-0.02
22
21
20
Norfolk_Bridge5-Poe_2
Norfolk_Bridge5-Poe_2
Norfolk_Bridge5-Poe_2

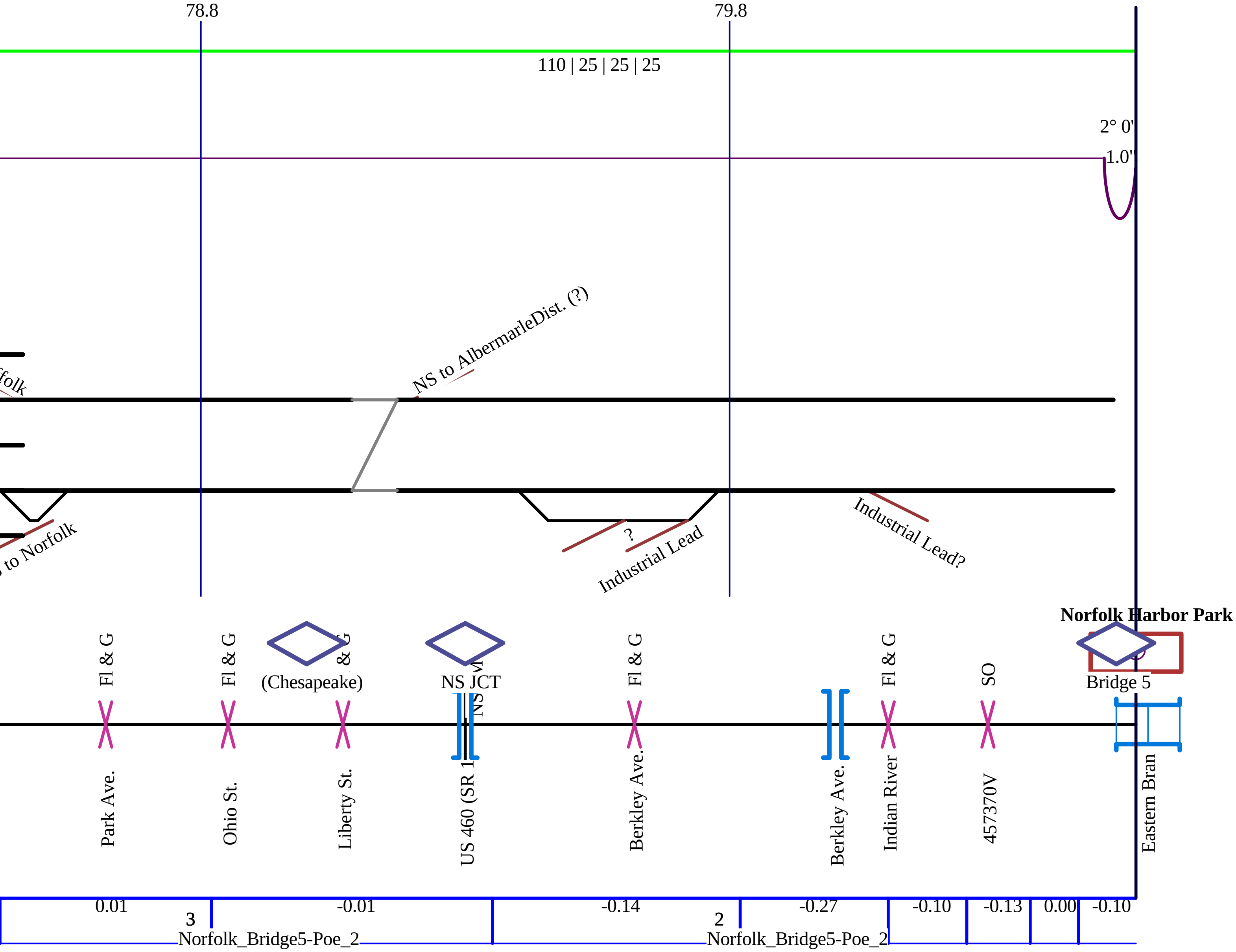

62.8
63.8
64.8
65.8
110 | 50 | 50 | 50
0°12'
1.0"
0°18'
1.0"
0°24'
1.0"
Juniper
-0.02
0.03
-0.02
0.02
0.00
19
Norfolk_Bridge5-Poe_2
18
Norfolk_Bridge5-Poe_2
17
Norfolk_Bridge5-Poe_2
16


66.8
67.8
68.8
110 | 50 | 50 | 50
18'
0"
-0.04
-0.04
-0.03
0.00
15
14
13
Norfolk_Bridge5-Poe_2
Norfolk_Bridge5-Poe_2
Norfolk_Bridge5


69.8
70.8
71.8
110 | 50 | 50 | 50
Industrial Lead (abandoned??)
Yadkin
Fl
Galberry Rd.
I-64
I-64
SO
467392V
0.00
-0.09
-0.05
-0.02
0.09
0.03
-0.01
-0.02
12
Norfolk_Bridge5-Poe_2
11
Norfolk_Bridge5-Poe_2
10
Norfolk_Bridge5-Poe_2


72.8
73.8
74.8
110 | 50 | 50 | 50
110 | 30 | 30 |110 | 4
ATL Energy Corp
Elf Asphalt
St. Joe Paper (Industrial Lead)
Vepco
Canal Drive
Gilmerton
Bridge 7
Hwy 17 (Wash
Canal Dr.
Shell Rd.
Southern Br.
-0.02
0.00
-0.01
-0.02
0.00
-0.10
0.00
-0.06
0.00
9
8
7
Norfolk_Bridge5-Poe_2
Norfolk_Bridge5-Poe_2
Norfolk_Bridge5-Poe_2


75.8
76.8
77.8
110 | 40 | 40 | 40
110 | 25
0°42'
1.0"
NS to Suf
Industrial Lead
Industrial Lead
NS to
NS
Beltline
Portlock
South Norfolk
Fl & G
Fl & G
Portlock - S, Norfolk
M-NS
NP
US 460 (US 1
I-464
Mill Dam Crk
Franklin St.
Potlock Rd.
South Norfolk
-0.11
0.11
0.00
0.17
0.15
0.05
0.02
-0.01
0.01
6
5
4
Norfolk_Bridge5-Poe_2
Norfolk_Bridge5-Poe_2
Norfolk_Bridge5-Poe_2


78.8
79.8
110 | 25 | 25 | 25
2° 0'
1.0"
NS to AlbermarleDist. (?)
to Norfolk
?
Industrial Lead
Industrial Lead?
Norfolk Harbor Park
Fl & G
Fl & G
(Chesapeake)
NS JCT
Fl & G
Fl & G
SO
Bridge 5
Park Ave.
Ohio St.
Liberty St.
US 460 (SR 1
Berkley Ave.
Berkley Ave.
Indian River
457370V
Eastern Bran
0.01
3
Norfolk_Bridge5-Poe_2
-0.01
-0.14
2
Norfolk_Bridge5-Poe_2
-0.27
-0.10
-0.13
0.00
-0.10