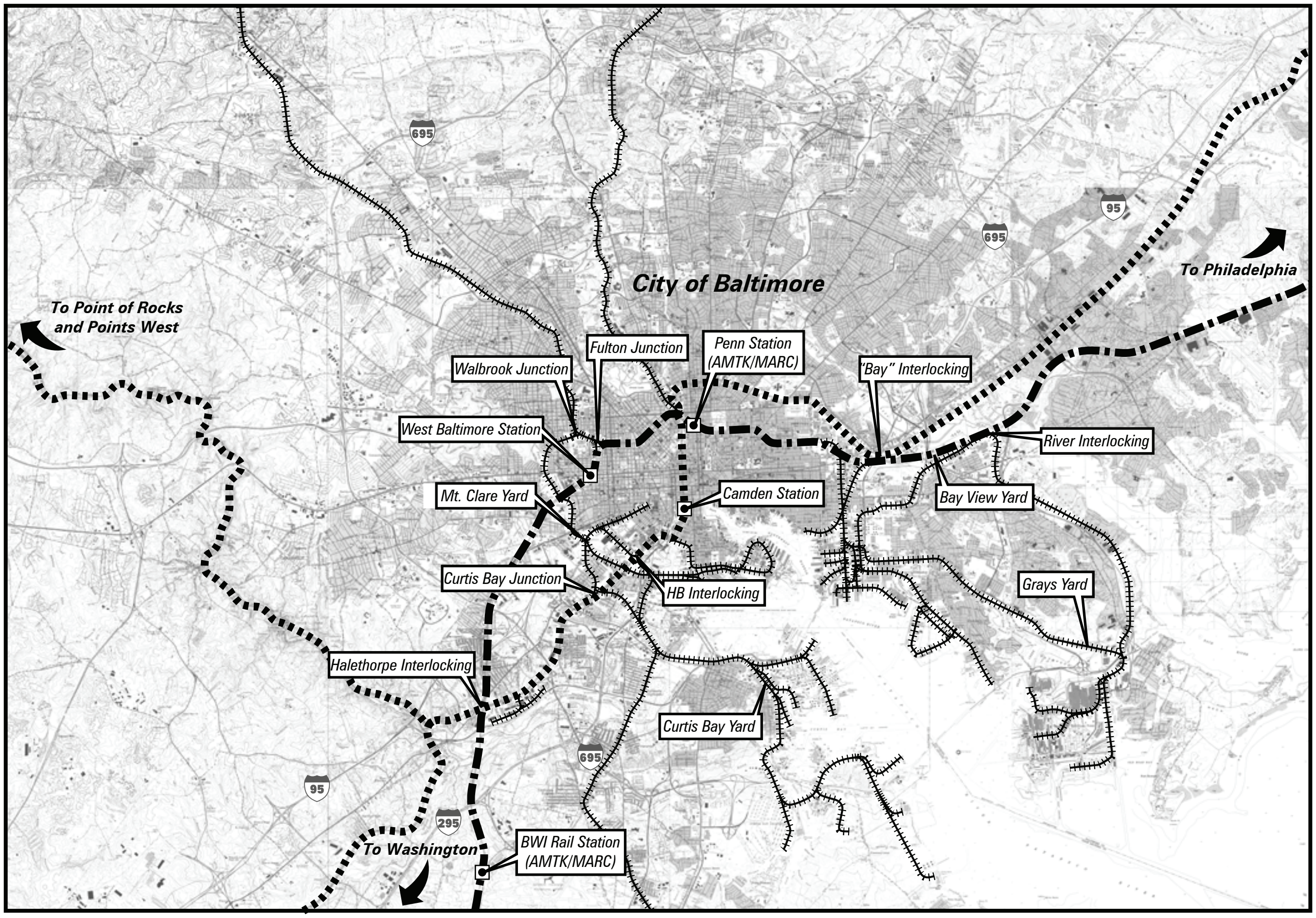
BALTIMORE'S RAILROAD NETWORK:
ANALYSIS AND RECOMMENDATIONS



U.S. Department of Transportation
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BALTIMORE'S RAILROAD NETWORK:

ANALYSIS AND RECOMMENDATIONS

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EXECUTIVE SUMMARY

A fire resulting from a derailment in the Howard Street Tunnel on July 18, 2001 essentially suspended commercial activity in downtown Baltimore for nearly a week and forced rail traffic to detour as far west as Cleveland, Ohio. As a result of this event, in November 2001, Congress requested "a comprehensive study to assess problems in the freight and passenger rail infrastructure in the vicinity of Baltimore, Maryland." [1] The original project budget was $3.0 million; however, because of a budget shortfall, only $1.0 million was made available. Although a reduction in scope precluded completion of the original study design, the report, *Baltimore's Railroad Network: Challenges and Alternatives*, was submitted to Congress on November 4, 2005. Then, as a part of the SAFETEA-LU Act, additional funds were provided to complete the study. The State of Maryland also became a financial participant, the final funding split for the study was an 80 percent share by Federal Railroad Administration (FRA) and 20 percent share by Maryland Transit Administration. It is the purpose of this Report to build on what was accomplished in the November 4, 2005 Report to Congress and complete the originally budgeted study work plan.

It is important to note that this Report is a feasibility study, the NEPA process is not preempted by this effort, and no agreements have been made by any of the stakeholders. Further, the selection of alternatives documented herein is not binding upon any of the participating stakeholders.

SECTION 1 – INTRODUCTION

SCOPE

The Report focuses on the principal elements of Baltimore's network of passenger and freight rail lines extending from Perryville, northeast of Baltimore on the Susquehanna River – the junction of Amtrak' s Northeast Corridor (NEC) with the Norfolk Southern (NS) principal route from Harrisburg and points west – to Halethorpe, southeast of Baltimore, where the CSX Transportation (CSXT) and Amtrak lines from Washington cross.

Although convoluted and antiquated, Baltimore's railroads have strategic importance far beyond the confines of their immediate region. Originating and terminating rail freight traffic in the Baltimore region remains significant, largely due to the Port of Baltimore – which brings in about $1.5 billion annually in business revenues. With respect to intercity passenger service, one-fifth of Amtrak's passenger-trips and one-third of its ticket revenues depend on travel over Baltimore's railways.[2]

PLAN OF THE REPORT

This Report has been divided into two phases: Phase One (Sections 2-12) and Phase Two (Sections 13-16).

Phase One traces the development, current condition, and utilization levels of Baltimore's rail network (Sections 2-4) and characterizes the dissonance between the network as it has evolved and the demands have been placed upon it. Sections 5-12 examine the potential for restructuring actions that could raise passenger and freight railway capabilities in the Baltimore region to a new level. A number of passenger and freight alternative routes through Baltimore were developed and evaluated. At the conclusion of Phase One, the alternatives were circulated to stakeholders and a selection was made of one freight and one passenger alternative to study further in Phase Two.

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1 U. S. House of Representatives, Report 107-308, Making Appropriations for the Department of Transportation and Related Agencies for the Fiscal Year Ending September 30, 2002, and for Other Purposes, November 30, 2001, p. 100.

2 Also worthy of note, but primarily of regional significance: rail commuter service in the Baltimore-Washington urban complex has shown marked growth since the 1970s under the sponsorship of the Maryland Department of Transportation.

Phase Two activities further refined the engineering and cost aspects of the two selected alternatives, the Great Circle Passenger Tunnel and the Belt-Modified Freight Alternative (Sections 13-15). Section 16 concludes the report by identifying various additional issues that need to be addressed before the projects can be implemented.

In addition, a *Graphics Supplement* has been developed that provides route-of-line drawings and profiles for the six alternatives that survived the initial screening process in Phase One, and more detailed drawings and profiles for the two alternatives studied further in Phase Two.

PHASE ONE

SECTION 2 – EXISTING INFRASTRUCTURE

Baltimore's railway network includes many important component main lines, yards, branches, and support facilities, and a variety of traffic flows originating within the region. The main traffic lane at issue, however, is one that is southwest-northeast across the region.

The Pennsylvania Railroad (PRR) and Baltimore and Ohio Railroad (B&O) designed and built their respective routes as multipurpose facilities, for both freight and passenger service. As a result, these two facilities increasingly fall short of what the traffic would necessitate. Examples of this mismatch between facilities and functions include grades and curves, capacities, and clearances. In the latter case, neither route can accommodate modern, high-capacity freight car types as double-stack container and tri-level auto carrier cars (Plate H 20′ 2″clearance).[3]

Although this study was precipitated by the July 18, 2001 fire, there are no structural issues associated with the 1.6 mile-long Howard Street Tunnel. A new replacement freight tunnel's economic benefits would accrue from the Plate H clearance and congestion relief on the only rail freight route in the I-95 corridor.

SECTION 3 – TRAFFIC LEVELS

As **Table ES-1** indicates, the demand for train movements of all types is expected to increase by 40 percent northeast of Baltimore and 37 percent southwest of Baltimore from 2008 levels to 2050 levels. By mid-century, a heightened pressure for transport would place a huge incremental load on an antiquated rail network that would, if left unchanged,[4] continue to detract from the speedy, efficient, and economic movement of passengers and goods along the East Coast.

SECTION 4 – NO-BUILD SCENARIO

Absent of a replacement for the CSXT Howard Street and Amtrak's B&P Tunnels, the railroads will be left with their existing routes through Baltimore. **Table ES-2** presents the simulation results of the No-Build Scenario. Because of the schedule priority given to passenger trains, there is minimal impact to this service in 2050. However, it becomes apparent that the freight capacity of the Baltimore network is insufficient to handle the expected freight volumes forecasted for 2050.

Concerning the B&P Tunnel, there is no realistic No-Build Scenario. The physical condition of the tunnel requires that it be rebuilt or replaced within the next 10-20 years. Rebuilding would contradict the fundamentals of engineering economy. The tunnel's basic geometry was substandard when it was completed and is irremediable by any reasonable amount of rehabilitation. Also, the reconstruction would

[3] Washington's Virginia Avenue Tunnel constitutes a similar clearance constraint and would need to be addressed as part of a solution to the limitations on East Coast rail freight traffic.

[4] This statement assumes that the physical facilities can survive for another half-century – an assumption for which no conclusive engineering backup presently exists. As explained later in this report, the design life for new tunnels is 120 years.

be inefficient because it must be undertaken while keeping only one track in service, so its cost would surpass that of constructing a new tunnel.

Table ES-1. Existing and Projected Rail Traffic on Main Lines in the Baltimore Region

Existing Service – 2008 Daily Train Movements (Total Both Directions, Round Trip = 2 Movements)	Via CSXT Main Line		Via NEC Main Line		Total Both Routes	
	Aikin – Baltimore	Baltimore – Washington (Freight via Howard Street Tunnel)	Perryville – Baltimore	Baltimore – Washington (via B&P Tunnel)	Northeast of Baltimore	Southwest of Baltimore
Total Passenger	0	18	105	139	105	157
Freight	22	33	9	4	31	37
Grand Total Operations	**22**	**51**	**114**	**143**	**136**	**194**
Projected Service – 2050 Daily Train Movements (Total Both Directions, Round Trip = 2 Movements)	**Via CSXT Main Line**		**Via NEC Main Line**		**Total Both Routes**	
	Aikin – Baltimore	**Baltimore – Washington**	**Perryville – Baltimore**	**Baltimore – Washington**	**Northeast of Baltimore**	**Southwest of Baltimore**
Total Passenger	0	36	124	160	124	196
Freight	38	56	27	13	65	69
Grand Total Operations	**38**	**92**	**151**	**173**	**189**	**265**
Projected Percentage Growth 2008 – 2050	**Via CSXT Main Line**		**Via NEC Main Line**		**Total Both Routes**	
	Aikin – Baltimore	**Baltimore – Washington**	**Perryville – Baltimore**	**Baltimore – Washington**	**Northeast of Baltimore**	**Southwest of Baltimore**
Total Passenger	No Service	100%	18%	15%	18%	25%
Freight	73%	70%	200%	225%	110%	86%
Grand Total Operations	**73%**	**80%**	**32%**	**21%**	**40%**	**37%**

SECTION 5 – STUDY OBJECTIVES, STANDARDS, AND METHODS

After synthesizing the objectives of the analysis, the study team developed specific standards for developing and evaluating alternatives.

STUDY OBJECTIVES

The principal study objectives were as follows:

1. Remove all through-freight service from the Howard Street Tunnel.
2. Provide tri-level auto carrier clearance (Plate H – 20′2″) routes through Baltimore for both NS and CSXT freight trains.
3. Provide grades for freight trains that are less than those now encountered – preferably much less.
4. Provide a replacement for the B&P Tunnel.
5. Provide capacity to support traffic levels for freight, intercity passenger, and commuter services based on reasonable projections for the year 2050.

STANDARDS FOR ALTERNATIVES

Section 5 contains a very detailed exposition of the standards. Highlights include:

- **Grades**. For freight, a one-percent maximum (0.8-percent desirable maximum) would be established.

Table ES-2. Year 2050 No-Build Scenario Average Delay Minutes per Passenger and Freight Train

Simulation Alternative		No-Build
Passenger		Existing B&P Tunnel
Service	Dir.	Late/Train
ACELA	N	0:00:48
	S	0:01:06
Regional	N	0:00:36
	S	0:00:19
Long Distance	N	0:00:59
	S	–
MARC	–	0:00:57
Freight		
NS	N	0:00:00
	S	0:04:24
NS Bypass (via Hagerstown, MD)	N	3:16:44
	S	3:16:44
CSXT (via Howard Street Tunnel)	N	0:19:39
	S	0:31:51

- **Curves**. Curvature needs to be reduced so that both services can achieve their maximum design speeds over as much trackage as possible.
- **Maximum Design Speeds**. The facilities should be designed to support maximum speeds of 50 mph for freight trains. Maximum passenger speeds should be in the range of 125-150 mph.[5]
- **Clearances**. Plate H (20′ 2″, allowing for double-stack container and tri-level auto rack cars) would be established for freight service.

SECTION 6 – CONCEPTUAL FRAMEWORK FOR THE ALTERNATIVES

Since the primary flow of traffic across the Baltimore region is southwest to northeast and vice versa, all alternative approaches would fall into one of four concentric sectors – Far North, Near North, Central, and Harbor – as depicted in **Figure ES-1.**

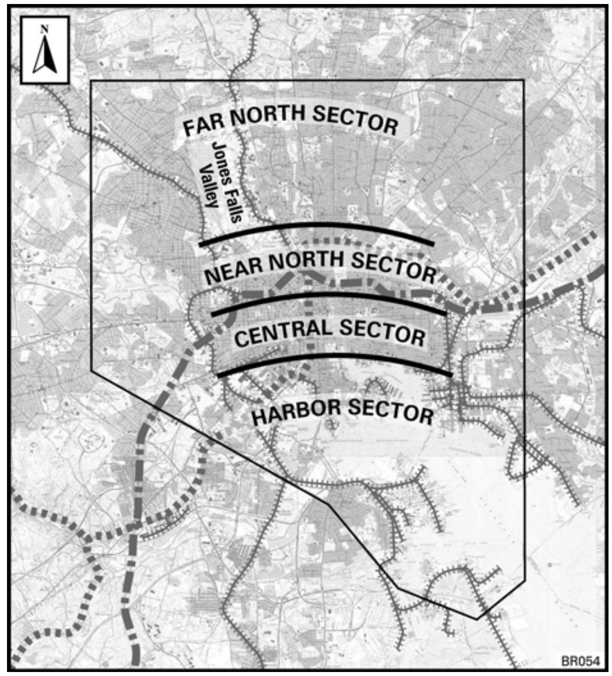

Figure ES-1. The Sectors

SECTION 7 – PASSENGER ALTERNATIVES

An option investigated was to rebuild the B&P Tunnel. Recent evaluations have concluded that the B&P Tunnel needs to be replaced within the next 10-20 years as it is increasingly difficult and expensive to maintain. Current conditions include: drainage through the tunnel's walls, leakage from existing utility lines, poor drainage of the tunnel's invert, and insufficient clearance. Reconstruction challenges include: safety of operating passenger and freight trains while under reconstruction, integrity of tunnel structure, unforeseen underground conditions, and potential damage to existing facilities. Also, it would be necessary to take one track out of service during the reconstruction period of over one year. Thus, the Amtrak NEC would be reduced to one track with the consequential cancelation of certain trains, delays to other trains, reduced service levels, and a major overall inconvenience to NEC patrons. Further, the B&P Tunnel upgrading cost as suggested by the *Mid-Atlantic Rail Operations Study* ($1 billion) exceeds the estimate within this report of $773 million for a new passenger tunnel.

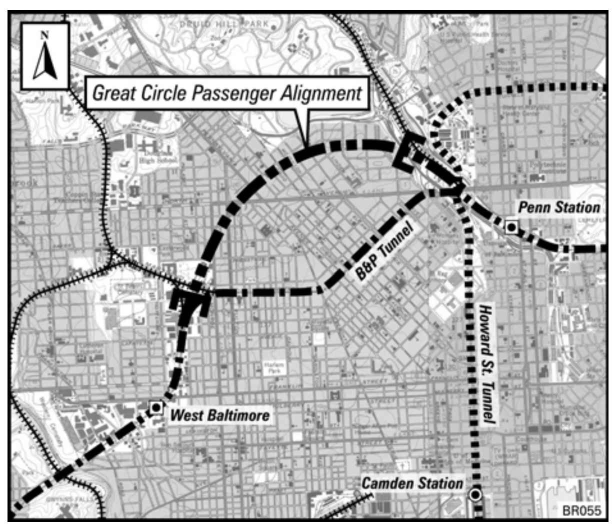

Figure ES-2. Great Circle Passenger Tunnel Alignment

NEAR NORTH SECTOR – GREAT CIRCLE PASSENGER TUNNEL

Of the alternatives examined in the Near North Sector, a Great Circle Passenger Tunnel (GCPT) exhibited the most promise (**Figure ES-2**). With

[5] The cost-effectiveness of expanding the NEC mileage subject to a 150-mph top speed limit has yet to be determined. Use of this theoretical 150-mph top speed in this report does not imply FRA endorsement of such an expansion, which would require FRA's Office of Safety approval.

portals not far removed from those of the B&P Tunnel, the GCPT would follow a large arc north of the existing alignment. Implementation of a GCPT would imply continued use of the existing Penn Station, in Baltimore, for both Amtrak intercity and MARC Penn Line commuter service. This option was carried forward for further analysis.

CENTRAL SECTOR – ROUTE 40 ALTERNATIVE

A hypothetical alignment for a Route 40 Alternative would be along the Franklin/Mulberry-Orleans Street corridor through the center of the city. Although a Route 40 alignment would promise optimal performance and a more central station location, it would present three major difficulties: (1) the high costs and potential environmental consequences of a tunnel beneath Baltimore's core, (2) the implications for Penn Line commuters from points north, and (3) the potential community impacts on the Franklin-Mulberry corridor. For all of these reasons, the study team did not consider this alternative further.

HARBOR SECTOR – LOCUST POINT PASSENGER ALTERNATIVE

The study team also developed a hypothetical passenger route between Locust Point and Canton. Like the Central Sector route, the Locust Point Alternative would present notable challenges. For example:

- It would involve a new, fixed bridge across the Middle Branch;
- The study team was unable to locate an obvious site for a new main passenger station that would be as accessible from downtown, for pedestrians and others, as the existing Penn Station;
- Crossing the Canton area would be constrained by numerous railroad, highway, and industrial facilities; and
- An underwater passenger tunnel would be far more costly than a land-based alternative.

Therefore, the study team did not carry the Locust Point Alternative forward for further analysis.

CENTRAL SECTOR – SPORTS COMPLEX ALTERNATIVE

The Sports Complex Alternative was developed to re-evaluate the feasibility of Central Sector service. The alternative's west end would diverge from the Amtrak main line and go into a tunnel leading to an underground station located between the Oriole's Park at Camden Yards baseball stadium and the M&T Bank football stadium. From there, it would go to Canton and connect with the Amtrak main line in the vicinity of Bay View. The Sports Complex route shares the same fundamental disadvantages as the Route 40 Alternative; however, these might be offset somewhat by its proximity to the Inner Harbor.

SECTION 8 – FREIGHT ALTERNATIVES

NEAR NORTH SECTOR – GREAT CIRCLE FREIGHT TUNNEL

The study team developed two land-based tunnel alternatives, both of which would employ a Great Circle Freight Tunnel (GCFT) similar in concept to the GCPT.

- In the **Belt Freight Alternative**, the GCFT route would cross the Jones Falls Valley and then link with the CSXT Belt Line and proceed eastward to a junction at Bay View.
- The **Belt-Modified Freight Alternative** is a variation on the **Belt Freight Alternative.** The Belt-Modified Alternative has more advantageous tunneling conditions.
- In the **Penn Freight Alternative**, the GCFT route would link up with the NEC just northwest of Penn Station and employ upgraded freight-only trackage through the station area and a renewed Union Tunnel.

Figure ES-3 depicts the GCFT and the route alternatives described above.

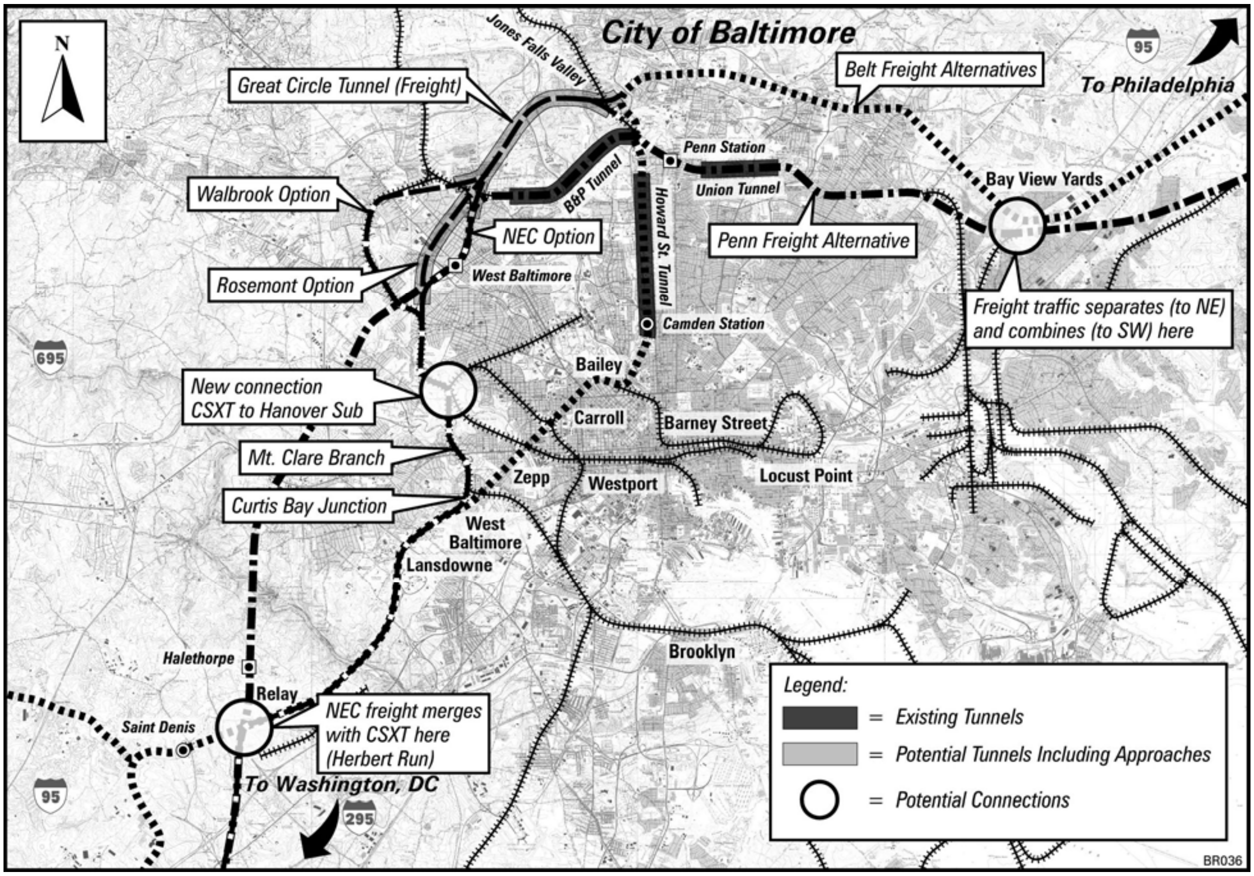

Figure ES-3. Belt-Modified and Penn Freight Alternatives

FREIGHT TUNNELS UNDER BALTIMORE HARBOR

The study team considered a number of potential portal sites on each side of Baltimore Harbor and all of the possible tunnels between these two sets of portals (**Figure ES-4**).

HARBOR SECTOR – CANTON FREIGHT ALTERNATIVE

Because of the apparent directness of a Locust Point–Canton route, an alternative was engineered to meet study gradient requirements; however, the criteria requiring major redesign of the CSXT, NS, and NEC facilities at Bay View and maintaining a 50-mph freight speed were downgraded. Having substantially met the modified screening criteria, the Canton Freight Alternative remained under consideration.

HARBOR SECTOR – SPARROWS POINT FREIGHT ALTERNATIVE

The route for the Sparrows Point Alternative would begin at Curtis Bay Junction and use the Curtis Bay Branch and Marley Neck Industrial Track to the Marley Neck area, a tunnel between a Marley Neck Portal and Sparrows Point, and then the NS Sparrows Point Industrial Track to Bay View.

In summary, the four freight alternatives that passed the initial screening were:

- Near North Sector – Belt-Modified
- Near North Sector – Penn
- Harbor Sector – Canton
- Harbor Sector – Sparrows Point

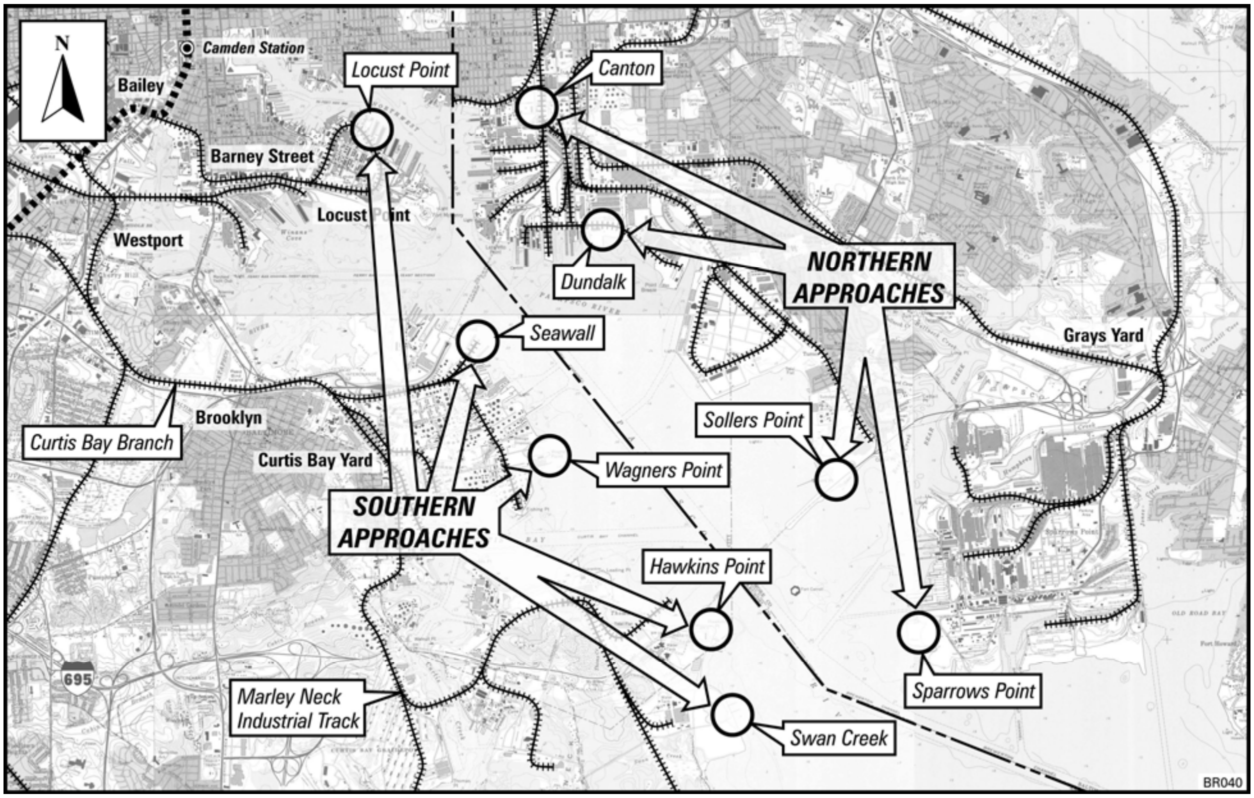

Figure ES-4. Portals Examined in the Study

SECTION 9 – RAILROAD OPERATIONS

Forecasted increases in train numbers and additional NS service in the NEC would dramatically impact the viability of operations though Baltimore. In order to evaluate the alternatives for replacing the railroad tunnels in Baltimore, the same assumptions regarding forecasted train volumes and operational patterns were used to test each alternative.

OPERATIONAL COMPARISON – PASSENGER

There are three passenger tunnel alternatives – the No-Build Scenario retains the existing tunnels and passenger and freight operations, while the GCPT and Sports Complex Alternatives involve new tunnel configurations and separation of passenger and freight services. The complete simulation for each case involved pairing a passenger tunnel alternative with a freight tunnel alternative.

Table ES-3 shows an overall summary of the simulation results in terms of total delay minutes and average delay minutes per passenger train and freight train. Passenger delay times were based on operating 179 trains per day for each alternative except the Sports Complex Alternative, which operated 195 trains to account for additional non-revenue movements to and from the new Martin service facility.

All alternatives exhibit similar passenger service performance characteristics. It is noted that the existing tunnel exhibits the best performance; however, this statement applies to existing train schedules and not 2050 levels of traffic as do all of the other alternatives.

OPERATIONAL COMPARISON – FREIGHT

Each freight tunnel alternative was simulated using the same forecasted year 2050 timetable and line-up of CSXT and NS freight trains. All alternatives were simulated with a base count of 92 daily freight trains, which were in addition to the passenger trains.

Table ES-3. Year 2050 Total Delay Minutes and Average Delay Minutes per Train – Passenger and Freight Service

	Total Delay	Delay/ Train	Total Delay	Delay/ Train	Total Delay	Delay/ Train	Total Delay	Delay/ Train	Total Delay	Delay/ Train	Total Delay	Delay/ Train
Passenger Tunnel	Existing B&P Tunnel		Great Circle Passenger		Great Circle Passenger		Great Circle Passenger		Great Circle Passenger		Sports Complex Passenger	
Passenger Delays	2:28:04	0:00:49	3:10:58	0:01:07	2:36:33	0:00:53	2:49:45	0:00:57	3:26:27	0:01:09	3:36:51	0:01:07
Freight Tunnel	Existing Howard Street		Belt-Modified		Penn		Sparrows Point		Canton		Belt-Modified	
Freight Delays	57:05:41	0:39:50	20:35:46	0:14:22	23:49:57	0:16:38	30:18:58	0:21:09	24:54:08	0:17:22	20:20:15	0:14:11
TOTAL DELAYS	**59:33:45**		**23:46:44**		**26:26:30**		**33:08:43**		**28:20:35**		**23:57:06**	

All of the freight tunnels reduce average freight train delay compared to the No-Build Scenario. The Belt-Modified/Sports Complex combination performs the best, with an average delay per freight train of 0:14:11, and the GCPT/Belt-Modified combination performs second, with 0:14:22 delay per train.

Table ES-4 shows the distances and running times for each freight alternative through the length of the study area (from the JD Tower to the Susquehanna River). The time differentials are compared with the No-Build Scenario.

Table ES-4. Freight Tunnel Distances and Running Times

FREIGHT LINE	JD HYATTSVILLE TO NORTH OF SUSQUEHANNA RIVER			
	MILES	DIFFERENCE (MILES)	RUNNING TIME	DIFFERENCE (TIME)
No-Build	72.4		1:37:14	
Belt-Modified	71.9	-0.5	1:35:33	-0:01:41
Penn	72.6	0.2	1:36:06	-0:01:08
Canton	72.7	0.3	1:36:50	-0:00:24
Sparrows Point	80.3	7.9	1:41:08	0:03:54

SECTION 10 – ENVIRONMENTAL/LAND OWNERSHIP CONSIDERATIONS

An environmental review was performed for four freight and two passenger route alternatives that have been developed at the conceptual design level in this study.

The reviews assessed the potential for environmental impacts within one-quarter mile on each side of the conceptual alignments and above or below subsurface or elevated alignments. Seven aspects of environmental effects were considered that had the most potential to identify measureable differences among alternatives and to aid in developing recommendations for further study.

In terms of environmental considerations, all six of the alternatives have the potential to be implemented with appropriate mitigation or minimization of the identified potential effects and avoidance of some potential impacts through further alternative definition and design refinements.

SECTION 11 – VIRGINIA AVENUE TUNNEL

A major objective for the Baltimore freight network is to improve tunnel clearances to Plate H standards. Closely associated with the latter objective is the need to improve the CSXT's Virginia Avenue Tunnel in Washington, DC, for double-track and improvement to Plate H standards. The tunnel was built in 1872 and is 3,788 feet long.

The feasibility investigation led to the development of an initial strategy of building a new single-track tunnel and routing traffic through the new tunnel, then improving the existing tunnel. Initial estimates of construction costs ranged between $158.8 and $164.5 million.

SECTION 12 – INITIAL ASSESSMENTS AND PATHS FOR ANALYSIS

PRELIMINARY COST MEASURES

Figure ES-5 summarizes the preliminary cost estimates for the remaining alternatives.

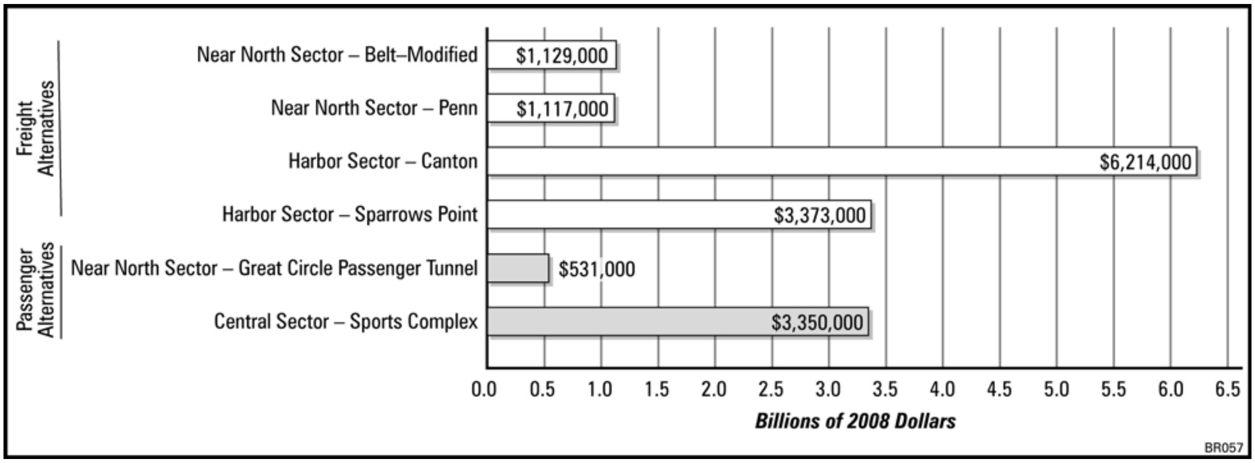

Figure ES-5. Preliminary Cost for Alternatives

These preliminary estimates include contingencies of between 30 and 40 percent (with the higher figure applying to tunneling costs) and add-on fees of 58 percent to cover design, construction management, environmental mitigation, property costs, burden, and project management.

BENEFIT-COST ANALYSIS

Table ES-5 summarizes the estimated costs for each of the alternatives and the estimated savings in terms of roadway costs and shipper cost savings.

Based on the roadway cost savings alone, all of the Great Circle (freight and passenger) alternatives would provide a benefit-cost ratio greater than 1.0 (indicating that the benefits outweigh the costs). The Sparrows Point Freight Alternative would provide benefit-cost ratios of just over 1.0.

INITIAL ASSESSMENTS

- Baltimore's railway network is antiquated, underdeveloped, and wholly essential to the Nation's transportation system; Congress recognized this factor by requesting this analysis. For example, the B&P Tunnel was completed eight years after the Civil War ended.
- The physical infrastructure of freight and passenger service differs so greatly as to justify separate freight and passenger facilities.
- Further incremental repairs to existing facilities can only moderate safety risks and prolong operations, but will not address any of the inherent physical decay and geometric problems that plague the rail routes through Baltimore.

- With respect to passenger alternatives, only the Near North Alternative utilizing the existing Penn Station appears to provide a cost-effective long-term solution to the challenges posed by the existing B&P Tunnel.[6]
- With respect to freight alternatives, both the Near North Sector and Harbor Sector appear to offer possibilities for alternative freight routes.

Table ES-5. Summary of Benefits and Costs (unless noted, all costs are in billions)

	FORECAST RANGE	BELT-MODIFIED FREIGHT	PENN FREIGHT	CANTON FREIGHT	SPARROWS POINT FREIGHT	GREAT CIRCLE PASSENGER	SPORTS COMPLEX PASSENGER
Total Estimated Cost		$1.129	$1.117	$6.214	$3.373	$0.531	$3.350
Total Amortized Cost [1]		$3.152	$3.118	$17.347	$9.416	$1.482	$9.352
Roadway Cost Savings [2]	Lower	$9.499				$1.919	
	Upper	$10.528				$1.919	
Benefit-Cost Ratio (based on Roadway Cost Savings) [3]	Lower	3.01	3.05	0.55	1.01	1.29	0.21
	Upper	3.34	3.38	0.61	1.12	1.29	0.21
Shipper Cost Savings [4]	Lower	$91.215					
	Upper	$101.071					
Total Savings [5]	Lower	$100.714				$1.919	
	Upper	$111.599				$1.919	
Benefit-Cost Ratio (based on Total Savings) [6]	Lower	31.96	32.30	5.81	10.70	1.29	0.21
	Upper	35.41	35.79	6.43	11.85	1.29	0.21
Total Fuel Savings (billions of gallons) [7]	Lower	15.956					
	Upper	17.680					

Notes:
[1] -- Total of annualized costs from 2007 to 2050 assuming 6 percent interest rate.
[2] -- Total of annualized savings from 2007 to 2050 for roadway construction and maintenance costs.
[3] -- Ratio of Benefits (as measured by Roadway Cost Savings) to Total Amortized Costs.
[4] -- Total of annualized savings from 2007 to 2050 for shippers using rail rather than truck.
[5] -- Sum of shipper cost savings and roadway cost savings (2007 to 2050).
[6] -- Ratio of Benefits (as measured by Total Cost Savings) to Total Amortized Cost.
[7] -- Total of annualized fuel savings from 2007 to 2050 based on shipping goods on rail versus truck.

POSSIBLE NEXT STEPS

- **Refinement of alternatives analyzed in Phase One**. The Scope of Work for Phase Two of this study calls for a more detailed analysis of the two promising routes identified in Phase One. The selection of the two alternatives was made by the Federal Railroad Administration (FRA) in cooperation with the State of Maryland, the City of Baltimore, railroads, and other stakeholders.
- **Operations and facility analyses.** For each alternative under consideration, operational studies would be necessary to further verify the improvement to train operations.
- **Further engineering analyses.** Further development of reasonable and feasible Baltimore tunnel alternatives would necessarily require ever more detailed engineering work on such topics as:
  - Geology/underground utilities;
  - Confirmation of right-of-way/property lines;

[6] Regarding cost-effectiveness: analyses by others imply that the cost of a Great Circle Passenger Tunnel could conceivably be less than that of rebuilding the existing B&P Tunnel. (See Section 7, "Upgrade the B&P Tunnel.") Any such inference would, of course, require detailed substantiation in the course of additional investigations.

- Successive levels of design;
- Construction staging; and
- Refinement of construction cost estimates.

- **Institutional arrangements.** To successfully implement the Baltimore rail line restructuring would require well-designed institutional structures and relationships. For example, cost sharing would be an issue of profound importance. The creation or adaptation of such institutions and the resolution of cost and operational issues before any construction begins are of utmost importance.
- **Environmental documentation.** Engineering and operational analyses like those described above would help to support the important task of preparing all necessary environmental documentation for a restructuring of Baltimore's railway network.

PHASE TWO

SECTION 13 – FURTHER ENGINEERING AND ANALYSIS REFINEMENTS FOR THE TWO SELECTED ALTERNATIVES

Phase One (the previous 12 sections) presented the project's background and history and identified and characterized more than eight passenger and 20 freight tunnel alternatives for the Baltimore rail network. Various data and comparison tables were given to the various stakeholders (including FRA, MDOT, Amtrak, CSX, NS, MARC, City of Baltimore, Port of Baltimore, and others) for evaluation to determine which alternatives should be studied further in Phase Two, the selection being limited to one passenger and one freight alternative.

MDOT coordinated the document for evaluation to the various parties and reported the following selected alternatives:

- The Great Circle Passenger Tunnel Alternative
- The Belt-Modified Freight Alternative

In Phase Two, additional engineering and analysis refinements have taken place regarding each selected alternative.

SECTION 14 – GREAT CIRCLE PASSENGER TUNNEL ALTERNATIVE

The new GCPT is basically an improved replacement in kind for the B&P Tunnel; however, the GCPT has improved curvature compared to the B&P Tunnel (see **Figure ES-6**). The maximum benefit of the more favorable curvature is not fully realized, however, because of the need to slow down for the Baltimore Penn Station stop. The GCPT time savings is 1 - 1½ minutes.

The GCPT was designed to accomplish several objectives:

- Replace deteriorating infrastructure;
- Increase capacity to handle forecasted growth in trains;
- Reduce the running times of passenger trains through Baltimore;
- Improve reliability of service by eliminating bottlenecks; and
- Provide a tunnel structure that meets all current Fire, Life, and Safety Standards (National Fire Protection Association [NFPA] – 130).

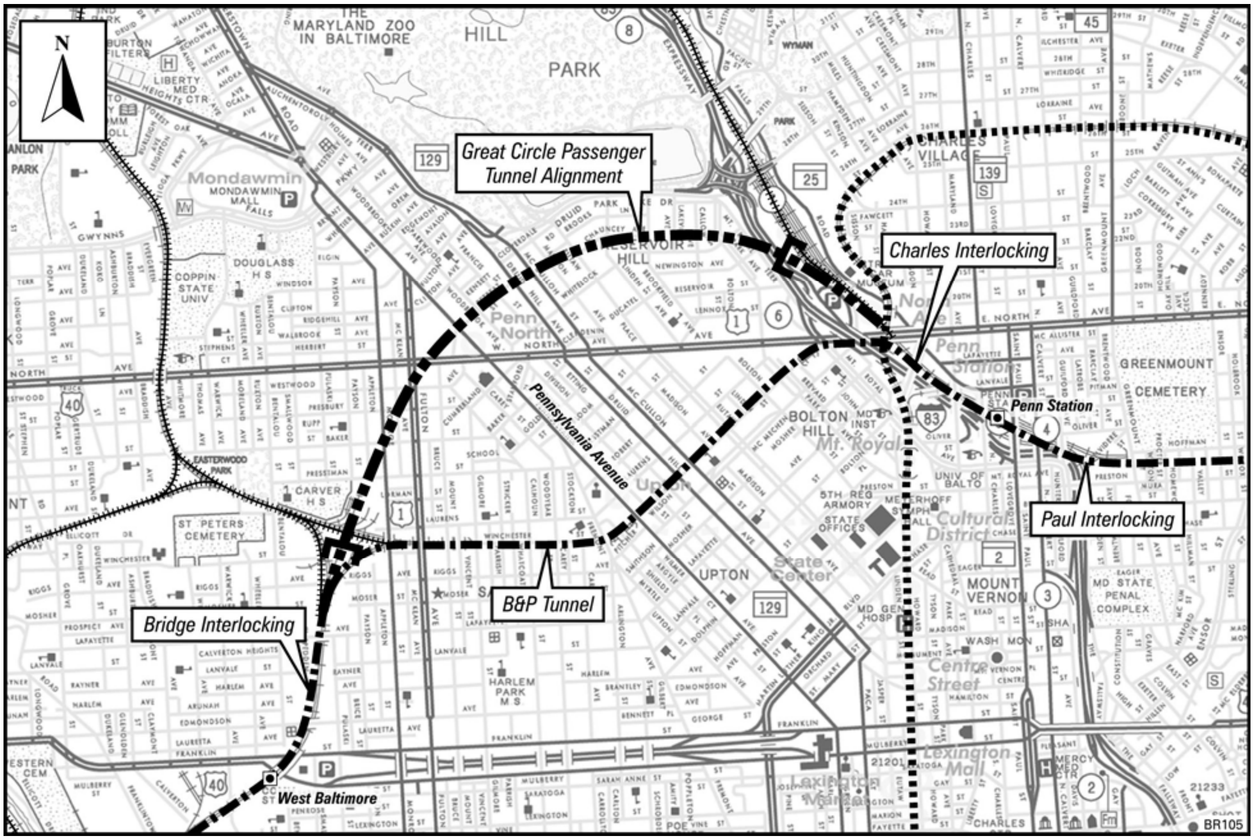

Figure ES-6. General Configuration of the Great Circle Passenger Tunnel

Rail Line Capacity Analysis. During Phase Two, additional rail line capacity simulations were performed to further test the main line capacity of the GCPT. Railroad network capacity and overall train performance was determined by simulating operations for 2050 and measuring the resultant train delay.

IMPROVEMENTS ELSEWHERE ON THE MAIN LINE CORRIDOR

In order to isolate the ability of the GCPT to handle the 2050 traffic levels, it was necessary to postulate certain other capacity improvements that would be in place elsewhere on the NEC that would allow the rest of the network to handle the forecasted volumes.

The number of MARC trains between Baltimore and Washington, DC is forecasted (by MARC) to increase from the current (2010) 52 trains/weekday (26 each way, including through trains to Perryville and two empty positioning moves) to 96 weekday trains. This is a most significant increase in passenger operations and places the greatest stress on the two-track passenger tunnel capacity. While Amtrak's projected increase from 2010 is 22 more trains, MARC proposes to operate 50 more trains south of Baltimore—hence **the absolute requirement for the 4th main track from West Baltimore to Landover and three tracks into Washington. In addition, a minimum of three tracks are needed between Edgewood and the Susquehanna River.**

Table ES-6 indicates overall train performance for the assumed train schedules and track configuration.

REFINED ROUTE ENGINEERING

<u>Tie-in at East Portal of GCPT.</u> The tie-in at the east end portal would consist of connecting the new track going to the GCPT with the existing track to Penn Station.

<u>Tie-in at West Portal of GCPT.</u> The portal at the west end of the tunnel is north of the B&P Tunnel portal, and as such, the two tracks from the GCPT would tie directly into the tracks from the B&P Tunnel.

ENVIRONMENTAL ASPECTS

The vast majority of this project involves tunnel boring through hard rock. The tunnel roof is at least 40 feet below the surface for about 80 percent of its length and about 140 feet below the surface at its deepest location. Surface construction activities would be limited to the approach tracks to the tunnels.

GCPT West Portal. The approach track alignment to the west portal would bisect a construction aggregate operation in a cut as the profile lowers into the portal. It is probable that aggregate operation would be closed or relocated.

GCPT East Portal. A new alignment would be needed from the east portal of the tunnel to Charles Interlocking, a distance of about 1,000 feet. Turnouts for a reconfigured Charles Interlocking would be placed in this area. All construction is in a corridor having existing railroad trackage; therefore, a new land use is not introduced at this location.

Table ES-6. Overall Train Schedule Performance for the Year 2050

SOUTHBOUND	TRAINS	LATE TRAINS	LATE MINUTES	AVERAGE LATENESS
Acela	19	2	3:07	1:33
Regional	23	5	19:04	3:48
SE HSR	5	1	0:59	0:59
Long Distance	5	–	–	–
Delmarva	1	–	–	–
All Amtrak	**53**	**8**	**23:10**	**2:53**
NORTHBOUND	**TRAINS**	**LATE TRAINS**	**LATE MINUTES**	**AVERAGE LATENESS**
Acela	19	4	14:40	3:40
Regional	23	5	3:36	0:43
SE HSR	5	3	17:47	5:55
Long Distance	5	–	–	–
Delmarva	1	–	–	–
All Amtrak	**53**	**12**	**12:03**	**1:00**

TUNNEL CONSTRUCTION

Engineering indicates that approximately 10,400 linear feet of tunnel is required and the selected configuration must accommodate two tracks. The two basic options for the tunnel segment are: (1) twin, single-track tunnels or (2) a single, double-track tunnel (refer to **Figure ES-7**). Cross sections for both options are sized to accommodate Plate H clearance. Even though the tunnel/s would be primarily for passenger service, cross sections have been sized for Plate H clearance to enable high dimension freight service in the future. Both cross section options would have to meet the NFPA 130 Guidelines. Substantial supplementary facilities would be needed to satisfy the NFPA 130 emergency egress requirements.

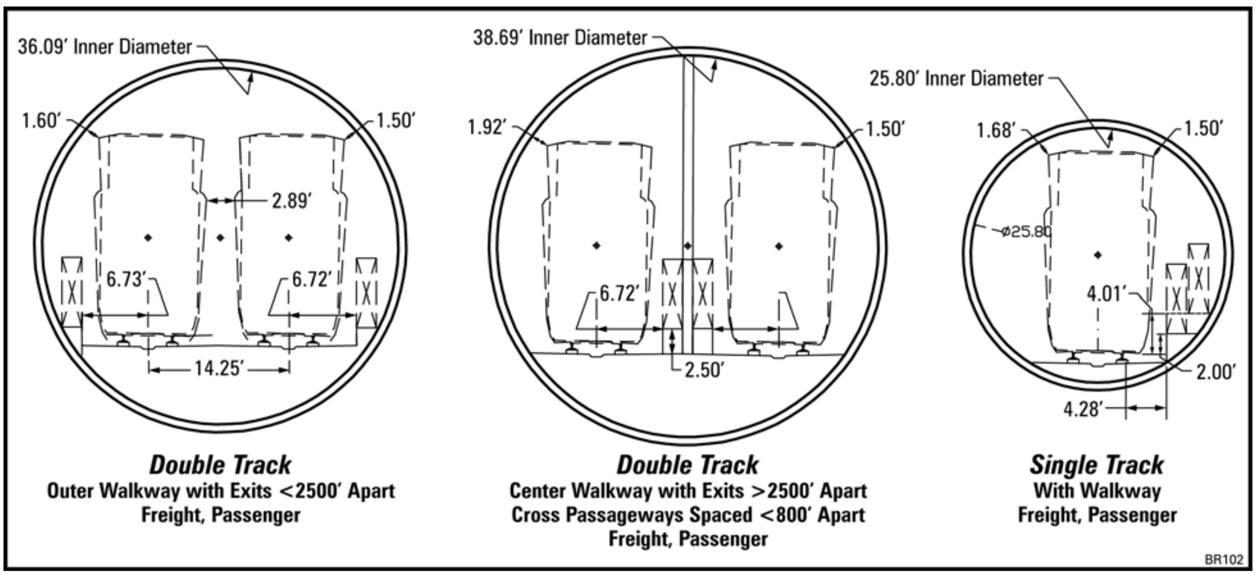

Figure ES-7. Passenger Tunnel Cross Section Options

The first cross section option considers two single-track tunnels. The second cross section option considers a single bore, double-track tunnel. A double-track tunnel with no center wall between its tracks would require surface exit shafts spaced no more than 2,500 feet apart. A double-track tunnel with a fire-rated center wall separating its tracks would require either surface exit shafts spaced no more than 2,500 feet apart or 1 ½ hour fire-rated doors in the center wall (acting as cross passages) no more than 800 feet apart.

The electrification system (catenary) can be accommodated in all tunnel section options.

GEOLOGY /CONSTRUCTION METHODS

Cut-and-cover structures are anticipated at both portals where ground cover is insufficient to support mined construction. Adjacent to each portal structure are transition zones comprised of fill, sand and gravel, and residual soil, through which a tunnel may be driven by any one of a variety of methods. The vast majority of the tunnel is in hard rock.

The length of the passenger tunnel alignment lends itself to Tunnel Boring Machine (TBM) construction.

TUNNEL CROSS SECTION COST COMPARISON

Table ES-7 presents a cost comparison of the various alternative cross sections considered herein. The cost comparison between the various passenger tunnel concepts does not identify a clear economic favorite at this level of analysis.

Table ES-7. Tunnel Cross Section Cost Comparison (in millions)

	GREAT CIRCLE PASSENGER TUNNEL		
	TWIN, SINGLE-TRACK WITH X-PASSAGES	DOUBLE-TRACK WITHOUT WALL, WITH SHAFTS	DOUBLE-TRACK WITH WALL AND DOORS
Total Bid Costs	$460.3	$452.9	$455.7

PROPERTY REQUIREMENTS

Property impacts were considered for a width of 50 feet on either side from the center line of the GCPT, and the depth considered varied between 40-170 feet from the surface to the top of the tunnel case. **Table ES-8** indicates the estimated number of impacted parcels.

Table ES-8. Estimated Impacted Land Parcels

SECTION	# OF PARCELS	RESIDENCE	RESIDENCE (MULTI)	INDUSTRIAL	COMMERCIAL	PUBLIC
Total*	159	124	28	4	2	1

*Minimum width impact considered was 100 feet.

PRELIMINARY PROGRAM OF PROJECTS

The Northeast Corridor has been and continues to be the subject of various operational studies and planning by Amtrak, MDOT/MARC, and other agencies. These reports have a common theme: the corridor needs significant capital improvements in order to maintain and grow passenger and freight movement capabilities.

SEQUENCE OF PRELIMINARY PROJECTS TO MEET 2050 GOALS

It is noted that the Northeast Corridor segment between Washington Union Station and Perryville, a distance of approximately 75 miles, presently has only two continuous through tracks. Triple-track exists in three sections, totaling approximately 38 miles, and four tracks occur in two sections, totaling approximately 20 miles or just 27 % of the segment. A four-track configuration is generally considered necessary to enable combined high density commuter and high-speed rail (HSR) operations: the outer two tracks for the slower trains (usually commuter) and the inner two tracks for HSR.

As a matter of note, a two-track tunnel is able to accommodate the 2050 traffic levels because the transiting speed through the tunnel of the Amtrak and MARC trains is relatively uniform - in the 30-50 mph speed range. South of the tunnel, Amtrak operates at a much higher average speed than MARC; this performance necessitates overtaking movements and the additional trackage to accomplish those moves.

As noted in the MARC *Growth and Investment Plan*, by 2020, an additional track is added between New Carrollton and West Baltimore, resulting in quadruple track in that segment. The construction of the new GCPT is included in the 2020 configuration. The construction of the tunnel can proceed independently of the other Northeast Corridor track improvements; however, a ten-year time frame from the present is reasonable considering the need to arrange for financing, complete the environmental process, and to procure long-lead construction items.

PROJECT COSTS

Table ES-9 presents the construction and associated costs for the GCPT route through Baltimore.

Table ES-9. Project Costs (in millions)

CONSTRUCTION ITEM	CONSTRUCTION COST	COMPONENT COST
Tunnel (Single Bore, Double-Track)		
Portal Structures	$50.6	
Soft Ground Tunnel	$202.5	
Rock Tunnel	$207.2	
Subtotal	**$460.3**	**$460.3**
Track / Civil		
Earthwork	$2.0	
Track, Interlockings	$32.5	
Subtotal	**$34.5**	**$34.5**
Structures	$30.7	
Signals	$7.5	
Property / Right of Way	$15.0	
Subtotal	**$53.2**	**$53.2**
Design Cost at 8%		$43.8
Construction Management Cost at 5%		$26.7
Contingency at 25%		$154.6
Total Estimated Cost		**$773.1**

CONSTRUCTION/PHASING SCHEDULE

Construction of the tunnel is the critical path duration in the overall project. Initial estimates indicate that the tunnel construction duration would be about two to three years, depending on the tunnel cross section selected (i.e., single bore with two tracks or two single-track tunnels). Construction of the approach track network would be based on the tunnel construction duration.

SECTION 15 – GREAT CIRCLE FREIGHT TUNNEL – BELT-MODIFIED ALTERNATIVE

DISCUSSIONS WITH STAKEHOLDERS

During this phase of the project, additional discussions and meetings were conducted with the stakeholders. The insights gained from the site visits, comments, and personnel interviews have been incorporated, to the extent possible, into the track layouts and the train operation strategy supporting those layouts. **Figure ES-8** provides a general configuration of the Belt-Modified freight tunnel alignment.

Important issues were raised during the course of stakeholder conversations. NS noted that it has made significant investments in the current route via Manassas Junction, VA – Hagerstown, MD – Harrisburg, PA and did not express interest in the new Baltimore freight tunnel through route. Likewise, CSXT expressed satisfaction with their current route through the Howard Street Tunnel and did not convey interest in the new freight tunnel route. Both railroads expressed major concerns for the high capital costs and the institutional issues involved.

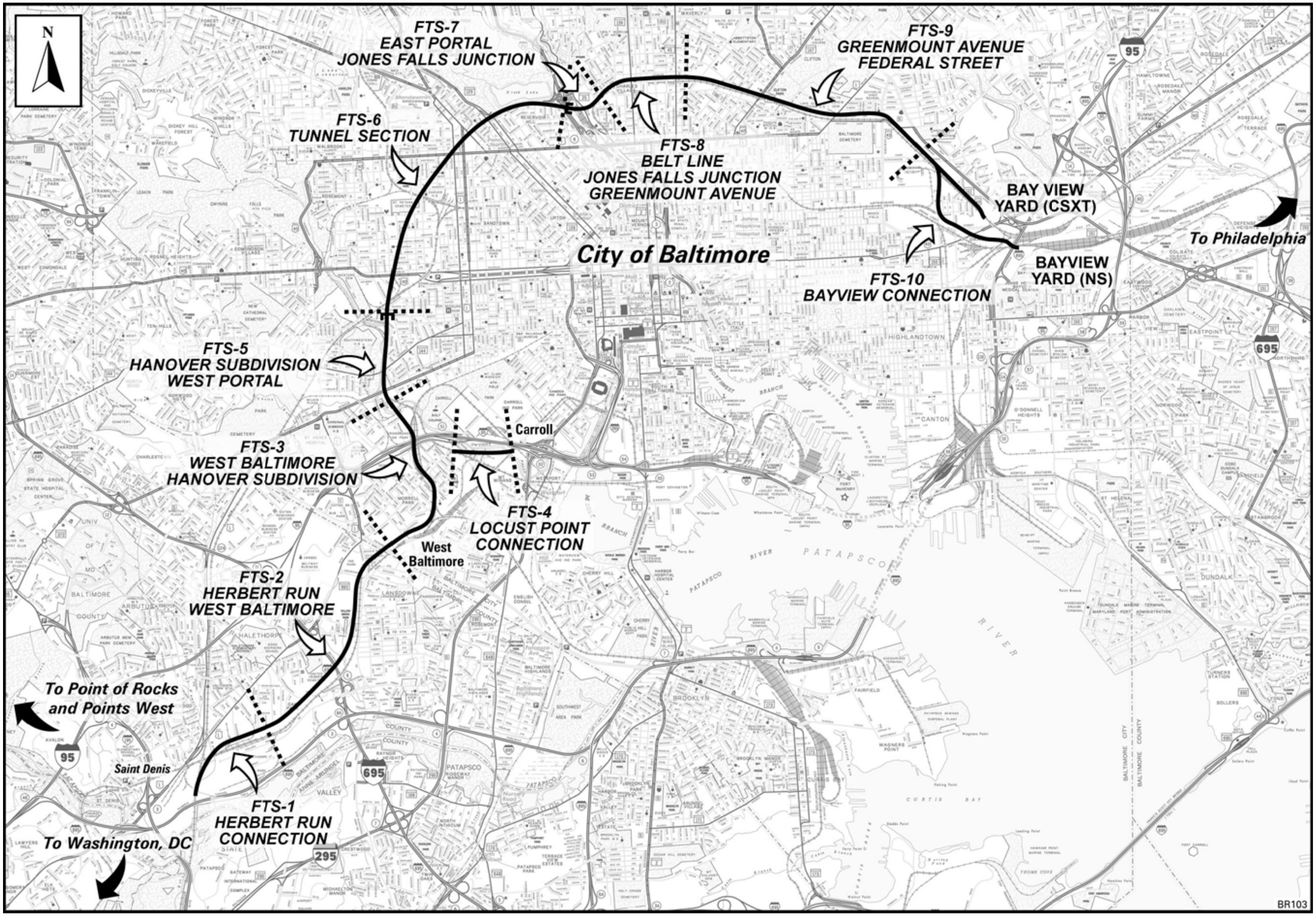

Figure ES-8. General Configuration of Belt-Modified Route

Nonetheless, both railroads continued to cooperate with the engineering aspects of the project during Phase Two on the condition that their participation would not be interpreted as a commitment to the project.

PROCEDURES TO CONTROL RAIL CONGESTION

To test the performance of the new freight tunnel, CSXT and NS freight service, along with MARC Camden commuter service, were simulated. A number of features have been incorporated into the track layouts simulated to provide routing flexibility and to prevent rail congestion on the network, principally a double-track, bi-directionally signaled through main line on the complete Belt-Modified route.

MARC CAMDEN LINE

MARC's 2050 Camden Line service is projected to operate 28 trains per day, 14 trains in each direction. Morning and evening peak periods would have 30-minute headways. This is an increase from the 2010 level of service of 18 weekday trains, 9 in each direction.

NORFOLK SOUTHERN FREIGHT IN THE NEC

The 2050 forecast for NS freight on the NEC is for 12 freight trains to operate through the new freight tunnel. The new freight tunnel route saves about three hours runtime and 111 miles as compared to the existing route via Manassas Junction-Hagerstown-Harrisburg to North New Jersey and Philadelphia markets.

CSXT FREIGHT

CSXT continues to be the dominant freight operator in the Baltimore area. CSXT's major capacity constraint through Baltimore is the 6.7-mile Howard Street Tunnel-Clifton Park segment of single track connecting its north-south operations.

FREIGHT TUNNEL

Freight traffic is forecasted to increase significantly by the year 2050 (see **Table ES-10**).

In addition to the new freight tunnel's construction, significant improvements would be required on both the north and south ends of the tunnel.

Table ES-10. CSXT and NS Freight Train Projections 2010 – 2050

	TUNNEL TRAINS	2010	2020	2030	2050
North Side Tunnel	CSXT	22	26	31	42
	NS	0	6	10	12
	Through Tunnel	22	32	41	54
South Side Tunnel	Curtis Bay, Locust Point	12	13	16	16
	Total through Halethorpe	**34**	**45**	**57**	**70**

SIMULATION

The 2050 freight traffic levels were used to test how the new freight tunnel and approaches would handle the forecasted numbers of trains. The tunnel itself was not a capacity problem. Running times in the tunnel vary with freight train sizes and horsepower/ton assignments, but typically, five minutes southbound and five minutes and 45 seconds northbound are required to clear the head end of the tunnel—the difference explained by the ascending grade northbound through the tunnel.

The simulations indicate the largest freight train delays occur north of Baltimore where operating the forecasted numbers of trains over a 12-mile single-track section creates delays. MARC commuter operations create delays at Carroll and points south of Saint Denis—Jessup, Savage, Ammendale, Greenbelt—as freight and passenger trains compete for track space. Delays at Saint Denis northbound are freight trains waiting to enter the Mt. Winans Yard tracks, and southbound are trains queuing into the

Metropolitan Subdivision. Delays at the tunnel portals are modest—one train (of 54 through the tunnel) is held for seven minutes clear of the North Portal, while trains ahead of it clear the Bay View Connection Interlocking and CSXT Bay View Yard. The longest train delays occurred at Van Bibber (a siding located north of Baltimore) where six freight trains were delayed for an average of 27.62 minutes.

While NS was included within the study to determine the capacity and overall construction impacts of a new joint freight route tunnel operation, benefits would also accrue if CSXT was the only user of the new freight tunnel.

DESCRIPTION OF ROUTE AND CONSTRUCTION FEATURES

BACKGROUND

The total route length of the Belt-Modified freight route is approximately 15 miles. To facilitate discussion, the route has been divided into 10 segments, designated Freight Tunnel Segment 1 through 10 (FTS-1 to FTS-10). The geographical limits of these sections are depicted on Figure ES-8.

FTS-1, HERBERT RUN CONNECTION

A two-track connection is envisioned. It would diverge from the NEC and would pass under the CSXT Baltimore Terminal Subdivision main tracks in a new overhead structure. The CSXT tracks in this area also accommodate MARC Camden Line commuter service.

FTS-2, HERBERT RUN CONNECTION – WEST BALTIMORE

From the junction of the Herbert Run Connection, the track configuration would have four or five tracks to West Baltimore Interlocking. As requested by CSXT, three 10,000-foot holding tracks have been provided adjacent to the main line.

FTS-3, WEST BALTIMORE – HANOVER SUBDIVISION

At West Baltimore, the alignment continues on the Baltimore Terminal Subdivision, following tracks along the north side of Mt. Winans Yard to Curtis Bay Junction, then following the Mt. Clare Branch for a short distance. At the north end of the yard, the alignment would turn to the northwest, away from the existing alignment, and cut into a bluff on the west side of the yard and would begin to descend to meet the CSXT Hanover Subdivision.

FTS-4, LOCUST POINT CONNECTION, CARROLL INTERLOCKING – HANOVER SUBDIVISION

A connection has been developed linking the Baltimore Terminal Subdivision main line to the Hanover Subdivision. It would begin at Carroll Interlocking, turn to the northwest, and roughly parallel Gwynns Falls waterway until it merges into the Hanover Subdivision.

FTS-5, HANNOVER SUBDIVISION AND WEST PORTAL

The existing Hanover Subdivision alignment would be used for a short distance between the connection from Mt. Clare Yard and the tunnel portal.

FTS-6, TUNNEL SECTION

The tunnel would be almost three miles long and curve in an arc northeasterly from its western portal to its eastern portal. For most of its length, the tunnel will be deep enough to be bored. As presently envisioned, the tunnel configuration would be a single bore with two tracks; the tunnel would have an outside diameter of approximately 39 feet 6 inches.

FTS-7, EAST PORTAL – JONES FALLS JUNCTION

The east portal would be situated in the wall/slope below the Jones Falls Expressway, just south of the 28th Street Bridge, at the approximate elevation of the existing NS Bulk Intermodal Transfer Yard. The alignment would cross the NS yard while curving to the left and cross a new bridge. The NS yard operations must be moved to another location. In project meetings, NS has indicated an interest in moving from the existing facility.

FTS-8, THE BELT LINE, JONES FALLS JUNCTION – GREENMOUNT AVENUE

East of the Jones Falls Junction, the existing CSXT Belt Line alignment would be used to Greenmount Avenue.

The current configuration of this route is inadequate for Plate H clearance. As a consequence, the line would have to be extensively rebuilt. There are seven tunnel-like structures of arched masonry construction that would have to be replaced.

FTS-9, BELT LINE, GREENMOUNT AVENUE – BAYVIEW

To the east of Greenmount Avenue, the land use becomes commercial and remains so, for the most part, as far as Bay View. The line follows the existing CSXT Belt Line to Bay View.

FTS-10, BAYVIEW CONNECTION

The connection alignment would diverge from the Belt Line near Federal Street and turn to the south, parallel a set of transmission lines, then continue on the north side of the Amtrak tracks.

The connection track alignment would then cut into an embankment that supports the CSXT Sparrows Point Branch and lead tracks. In the same location, the Amtrak alignment would be depressed and realigned to reduce curvature. From the NS overcrossing, the connection alignment would descend to connect with the northernmost tracks of Bayview Yard.

The connecting track would be somewhat difficult to construct as it would be on a fill about 4,000 feet long that is generally 10-30 feet high. It would also require a 30-foot depression of the Amtrak four-track main line. Although the most realistic route, neither Amtrak nor MTA are satisfied with the layout of the connecting track as presented herein and further discussions would be required regarding this issue.

TUNNEL CONSTRUCTION

The freight tunnel would be approximately 15,400 feet long. Potential cross sections for the tunnel segment are: twin, single-track tunnels and a single bore, double-track tunnel. **Figure ES-9** presents typical cross sections for the two tunnel options.

A single-track freight tunnel, of the two tunnel options, would require an inside diameter (ID) of about 26 feet 0 inches and a lining 15 inches thick. This results in an outside diameter (OD) of about 28 feet 6 inches, which has a cross sectional area of 638 square feet. The double-track freight tunnel would require an ID of about 36 feet 4 inches and a lining 19 inches thick. This double-track tunnel has an OD of about 39 feet 6 inches with a cross sectional area of 1,225 square feet.

GEOLOGY/CONSTRUCTION METHODS

The tunnel profile transitions from at-grade sections at both ends of the tunnel, where the tunnel penetrates existing slopes, and descends to a completely underground alignment. Cut-and-cover structures are anticipated at both portals where there are transition zones comprised of fill, sand, and gravel. The vast majority of the tunnel is in hard rock. The length of the freight tunnel alignment lends itself to Tunnel Boring Machine (TBM) construction.

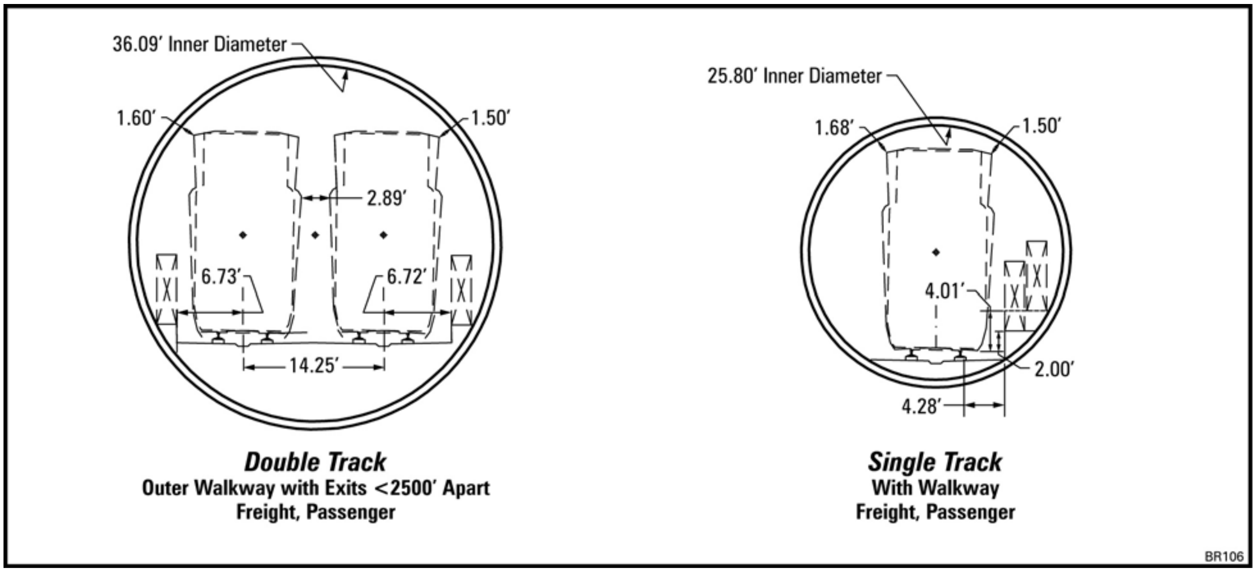

Figure ES-9. Freight Tunnel Cross Section Options

TUNNEL CROSS SECTION COST COMPARISON

Table ES-11 presents a cost comparison of the two tunnel cross sections considered herein. The table indicates that the double-track single bore tunnel is the least expensive option.

Table ES-11. Tunnel Cross Section Cost Comparison (in millions)

	BELT-MODIFIED FREIGHT	
	TWIN, SINGLE-TRACK	SINGLE BORE, DOUBLE-TRACK
Total Bid Costs	$564.5	$530.0

PROPERTY REQUIREMENTS

Property impacts were considered for a width of 50 feet on either side from the center line of the freight tunnel, and the depth considered varied between 40-140 feet from the surface to the top of the tunnel case. **Table ES-12** indicates the estimated number of impacted parcels.

Table ES-12. Estimated Impacted Land Parcels

SECTION	# OF PARCELS	RESIDENCE	RESIDENCE (MULTI)	INDUSTRIAL	COMMERCIAL	PUBLIC
Total*	331	269	25	18	11	8

* Minimum width impact considered was 100 feet.

ENVIRONMENTAL ASPECTS

The Belt-Modified tunnel route, in conjunction with the Virginia Avenue Tunnel in Washington, DC, would be the last components of a high-dimension railroad freight route that would serve the I-95 corridor from Florida to Philadelphia. This project would have a ***multi-state impact***. This added capability would make rail transportation more efficient and competitive with the resultant benefits of diverting freight from trucks and the subsequent reduction in fuel consumption, pollution, and wear and tear on the highway network. Considering overall traffic growth projections for the next 50 years, this could be considered a project of ***national significance.***

The vast majority of the project uses existing in-service railroad routes; therefore, environmental effects are minimal compared to a project involving a comparable length of new right-of-way. There are, however, some potential impacts that are noteworthy from an environmental stand point. Principal effects include multiple crossings of Gwynns Falls waterway, construction or modification of 12 highway bridges, a crossing of the Jones Falls, the relocation of the NS Bulk Terminal, and crossings of wetlands.

SEQUENCE OF PRELIMINARY PROJECTS TO MEET 2050 GOALS

It is probable that the construction of the new freight tunnel would begin during the 2015 - 2020 time period. This scheduling takes onto consideration the need to develop a financing plan, complete environmental documentation, negotiate institutional issues (tunnel ownership, dispatching control, liability, NS shared use of CSXT tracks, etc.), and procure long-lead construction items. The timing of the new freight tunnel is flexible, however, and dependent upon financing, traffic demand influences, and the generally perceived importance of removing the CSXT tracks from the Howard Street Tunnel.

PROJECT COSTS

Table ES-13 presents the construction and associated costs for the Belt-Modified route through Baltimore.

Table ES-13. Project Costs (in millions)

CONSTRUCTION ITEM	CONSTRUCTION COST	COMPONENT COST
Tunnel (Single Bore, Double-Track)		
Subtotal	**$530.0**	**$530.0**
Track / Civil		
Subtotal	**$91.2**	**$91.2**
Other		
Structures	$156.0	
Signals	$20.0	
Property / Right of Way	$19.1	
Subtotal	**$195.1**	**$195.1**
Design Cost at 8%		$65.3
Construction Management Cost at 5%		$39.8
Contingency at 25%		$230.2
Total Estimated Cost		**$1,151.6**

CONSTRUCTION/PHASING SCHEDULE

Boring the tunnel is the longest single construction activity within the overall project. Initial estimates indicate that the tunnel construction duration would be about 2.0 to 2.5 years, not including engineering and the NEPA process. Construction of the approach tracks and structures would be based on that duration.

SECTION 16 – CONCLUSIONS AND PROJECT IMPLEMENTATION ISSUES

The principal goal of this study effort was to develop the alignment and cost of construction for a freight and passenger route through the Baltimore region. The goal of this study has been achieved, and the resultant conclusions are presented herewith.

1. Baltimore's railway network is so antiquated and underdeveloped, and so important to the nation's transportation system, as to fully justify the Congressional request for this analysis.
2. Both the passenger and freight alternatives have beneficial multi-state impacts by diverting traffic off the I-95 Corridor with the resultant reduction in energy use, air pollution, highway wear and tear, and congestion.
3. Further incremental repairs to existing facilities, other than for purposes of safety and operational continuity, will not address any of the inherent geometric problems that plague the transit of Baltimore by rail.
4. Baltimore City, with its heavy existing development, pre-existing facilities, and difficult topography, presents severe engineering challenges to the design of new tunnel crossings, whether for freight or passenger service.
5. If and when the concerned parties wish to progress a restructuring of the railway network in the Baltimore region, significant further analytical work will be unavoidable—and essential to assure that any possible future investment is wisely and optimally spent.

6. As detailed throughout this report, the Great Circle Passenger Tunnel (construction cost, $773.1 million) and the Belt-Modified Freight (construction cost, $1.152 billion) Alternative were selected by the stakeholders for the additional engineering and analysis that was undertaken in Phase Two.

Implementation Issues. Before these two projects can proceed to construction, there are institutional issues that need to be resolved. Issues common to both projects include those relating to the follow-on environmental process, regional funding (because both projects produce out-of-state benefits), and ownership of facilities. An issue for the new passenger tunnel involves the additional funding needed to complete the project above the $60 million authorized in the *Passenger Rail Investment and Improvement Act of 2008*.

Issues for the freight tunnel include relocation of the NS Bulk Terminal Yard and the operation and control of the joint use segment. In addition, Amtrak has a concern regarding what they see as a fundamental issue with the operation of Plate H equipment under catenary. It is felt that to do so would require that the trolley wire be so high that it may have an adverse impact on pantograph/trolley wire interface at very high speeds. This issue needs further study. Finally, there is interdependence between the Baltimore, MD and the Washington, DC rail networks with regard to development of a north-south high-dimension freight route. Such a route would not only require clearance improvements to the Baltimore network but also the Virginia Avenue Tunnel in Washington, DC.

1 – INTRODUCTION

1.1 BACKGROUND

Physical constraints in Baltimore, Maryland, have been major obstacles to north-south rail service since the first railroad was built there in 1829. Before there was through service, rail cars were transferred between different lines by being hauled along Pratt and Howard Streets. In 1873, the city built the Union Tunnel to connect the Northern Central Railroad to the waterfront terminals in Canton. By 1875, the Pennsylvania Railroad (PRR) built the B&P Tunnels to connect its subsidiary lines north and south of the city. Together they formed a through route between the north and south. In 1895, the Baltimore and Ohio Railroad (B&O) extended its line to Philadelphia by constructing a cut-and-cover tunnel under Howard Street and a belt line around the north side of the city. The line passed over the B&P Tunnel of the PRR and through several short tunnels in North Baltimore.

A fire resulting from a derailment in the Howard Street Tunnel on July 18, 2001 essentially suspended commercial activity in downtown Baltimore for nearly a week and forced rail freight traffic to detour as far west as Cleveland, Ohio. Because of the restrictive clearances, the B&P Tunnel could not be used as a detour route.

1.2 COMMITTEE REPORT DIRECTION

In November 2001, after the railway infrastructure of Baltimore had attracted public attention due to the catastrophic fire in CSX Transportation's (CSXT) tunnel under Howard Street, Congress made the following request:

> *Baltimore, Maryland Freight and Passenger Infrastructure Study.* The conference agreement includes $750,000 to conduct a comprehensive study to assess problems in the freight and passenger rail infrastructure in the vicinity of Baltimore, Maryland. The Federal Railroad Administration (FRA) shall carry out this study in cooperation with the State of Maryland, Amtrak, CSX Corporation, and Norfolk Southern Corporation, as outlined in the Senate bill (Sec. 351). The Administrator of FRA shall submit a report, including recommendations, on the results of the study to the House and Senate Appropriations Committees not later than 24 months after the date of enactment of this Act.[1]
>
> *[Section 351 of the Senate bill reads as follows:]* SEC. 351. (a) Of the funds appropriated by title I for 16 the Federal Railroad Administration under the heading "Railroad Research and Development," up to $750,000 may be expended to pay 25 percent of the total cost of a comprehensive study to assess existing problems in the freight and passenger rail infrastructure in the vicinity of Baltimore, Maryland, that the Secretary of Transportation shall carry out through the Federal Railroad Administration in cooperation with, and with a total amount of equal funding contributed by, Norfolk Southern Corporation, CSX Corporation, and the State of Maryland.
>
> (b)(1) The study shall include an analysis of the condition, track, and clearance limitations and efficiency of the existing tunnels, bridges, and other railroad facilities owned or operated by CSX Corporation, Amtrak, and Norfolk Southern Corporation in the Baltimore area.

[1] U. S. House of Representatives, Report 107-308, Making Appropriations for the Department of Transportation and Related Agencies for the Fiscal Year Ending September 30, 2002, and for Other Purposes, November 30, 2001, p. 100.

(2) The study shall examine the benefits and costs of various alternatives for reducing congestion and improving safety and efficiency in the operations on the rail infrastructure in the vicinity of Baltimore, including such alternatives for improving operations as shared usage of track, and such alternatives for improving the rail infrastructure as possible improvements to existing tunnels, bridges, and other railroad facilities, or construction of new facilities.

(c) Not later than one year after the date of the enactment of this Act, the Secretary shall submit a report on the results of the study to Congress. The report shall include recommendations on the matters described in subsection (b)(2).

It is important to note that this report is a feasibility study, the NEPA process is not preempted by this effort, and no agreements have been made by any of the stakeholders. Further, the selection of alternatives documented herein is not binding upon any of the participating stakeholders.

1.3 FUNDING SOURCES AND LIMITATIONS

The Congressional directive envisioned a $3,000,000 study of an urban railway network that is America's oldest[2] and arguably one of its most important and complex. That amount was appropriate to the task; thus, the FRA, with a $750,000 appropriation in hand, initiated the study on a scale commensurate with the Congressional directive. While the State of Maryland—despite the budgetary constraints afflicting all State governments in Fiscal Year 2002—provided a welcomed $250,000 (one third of its Congressionally-foreseen share), the two major freight railroads, CSX Transportation (CSXT) and Norfolk Southern (NS), made no financial contribution.[3] Thus, a study that was planned and begun on an assumed $3,000,000 budget ended up $2,000,000 short.[4]

In consultation with the State of Maryland, the FRA revised the study plan during the course of the project to recognize the unforeseen shortfall in funding. Although the reduction in scope precluded completion of the original study design, the report *Baltimore's Railroad Network: Challenges and Alternatives* was submitted to Congress on November 4, 2005, and summarized results to that date.

Congress, as part of the SAFETEA-LU Act, has provided the additional funds to complete the report. The State of Maryland also became a financial participant, the final funding split for the study was an 80 percent share by Federal Railroad Administration (FRA) and 20 percent share by Maryland Transit Administration. It is the purpose of this Report to build on what was accomplished in the previous Report to Congress and complete the originally budgeted study work plan.

1.4 CONTRACTOR

The engineering work underlying this report was performed for the FRA and the State of Maryland by the Parsons Transportation Group.

1.5 RAILROAD PARTICIPATION

Amtrak, CSXT, and NS provided certain types of non-proprietary data and met with members of the study team on an as-needed basis. However, CSXT and NS noted that participation in the study was not intended to be a commitment to any level of financial involvement in the project. The smaller, local switching railroads (Canton and Patapsco & Back Rivers) were consulted regarding their operational

[2] The Baltimore & Ohio Railroad, a predecessor of CSXT, laid its first stone in 1827.
[3] Owing to Amtrak's particularly precarious financial situation at the time of the 2002 appropriation process, the Congress elected not to seek Amtrak's funding participation even though it would be a major beneficiary of certain improvements covered by the study.
[4] I.e., with a total funding of $1,000,000—$750,000 from FRA and $250,000 from Maryland.

needs. However, at this early stage, the large and small railroads were not asked to review the study concepts; their intensive involvement would, of course, be necessary in any future stages of development.

1.6 GEOGRAPHIC SCOPE OF STUDY

The study focused on the principal elements of Baltimore's network of passenger and freight rail lines, extending from Perryville, northeast of Baltimore on the Susquehanna River—the junction of Amtrak's Northeast Corridor (NEC) with NS's principal route from Harrisburg and points west—to Halethorpe, southeast of Baltimore, where the CSXT and Amtrak lines from Washington cross.[5] A more detailed definition of the study area appears in Section 2.

1.7 PLAN OF REPORT

The study plan for the remaining work effort in the Report is divided into two phases. Phase One builds on the Report to Congress - 2005 previously completed and studies in more detail the recommended alternatives from that report. In addition, one new passenger-only alternative serving Baltimore's inner harbor area is addressed. At its conclusion, the Phase One report was circulated for comments. During the comment period, a maximum of two alternatives were to be selected for further study; this additional study effort was then undertaken in Phase Two.

The organization of the Report generally follows that of the earlier Report to Congress. As applicable, the previous writing has been used herein and updated when necessary.

Phase One of the Report provides the current condition and utilization levels of Baltimore's rail network. Section 2 describes the current rail infrastructure, with its geometric failings and operational drawbacks. With today's energy and economic conditions, passenger and freight operations have expanded in recent years and promise to show even more growth by mid-century (Section 3). Section 4 considers the ramifications if Baltimore's rail network is not improved over the next 50 years. Thus, Phase One underlines the dissonance between the network as it has developed and the demands have been placed upon it, a tension that constitutes the fundamental motivation for the study.

The Report also demonstrates the potential for restructuring actions that would raise passenger and freight railway capabilities in the Baltimore region to a new level. Comparing the deficiencies in Baltimore with standard practices in the railroad industry, Section 5 presents a set of objectives and standards that would appropriately guide the creation and evaluation of alternative Baltimore solutions, as well as the methodology adopted in this study. It becomes clear that the goals for passenger and freight service, respectively, cannot be met—given the design limitations established by geography, existing development, and railway operations—with a single mixed-use tunnel facility. Thus, Section 6 presents the guiding concept for developing restructuring alternatives, while Sections 7 and 8 explore the passenger and freight options, respectively. The differences in train performance and rail line capacity between the various alternatives are explored in Section 9 while Section 10 considers the potential effects of the various alternatives upon the environment and land ownership issues. The CSXT clearance envelope between Washington, D.C. and Baltimore is examined in Section 11, including the potential for double-tracking the Virginia Avenue Tunnel in Washington, D.C. Section 12 provides very preliminary performance and cost estimates for illustrative alternatives, summarizes the study results, and identifies some avenues for further research that might provide decision-makers with deeper insights on the choices, costs, and benefits implicit in the restructuring of Baltimore's railway network.

[5] The crossing is grade separated with no connection ever having existed between the two lines.

At the conclusion of Phase One activities, the alternatives were circulated to stakeholders and a selection was made of one freight and one passenger alternative to study further in Phase Two.

Phase Two of the Report further refines and discusses the engineering, cost, scheduling, and environmental aspects of the two selected alternatives, the Great Circle Passenger Tunnel and the Belt-Modified Freight Alternative (Sections 13-15). Section 16 concludes the report by identifying various additional issues that need to be addressed before the projects can be implemented.

In addition, a *Graphics Supplement* has been developed that provides route-of-line drawings and profiles for the six alternatives that survived the initial screening process in Phase One and more detailed drawings and profiles for the two alternatives studied further in Phase Two.

PHASE ONE

2 – EXISTING INFRASTRUCTURE

The prior section explained how Baltimore's challenging railway plant came to be; the present section examines existing infrastructure in some detail. Emphasis falls on the CSXT and NEC main lines; however, the storage and classification yards, branch lines, trackage serving industries, and the Port of Baltimore also require intensive scrutiny in any further development of restructuring options.

The geometrically substandard railroads of the Baltimore region can neither assure reliable operations, expeditiously move their critical burden of passenger traffic, nor accommodate many state-of-the-art, high-capacity freight cars. These manifest failings provide the background for an analysis of potential improvements.

2.1 LIMITS OF THE STUDY AREA

This report primarily examines the railroads in the region between Martin,[1] to the northeast of Baltimore City, and Halethorpe (in the vicinity of Amtrak's BWI Thurgood Marshall Airport Rail Station [BWI Rail Station]), where the CSXT tracks cross over Amtrak's Northeast Corridor (NEC) (see **Figure 2-1**).

The major railroads in the study area are Amtrak, CSXT, and NS.[2] Two short-line railroads, the Canton Railroad and the Patapsco & Back Rivers Railroad (P&BR), serve portions of the east Baltimore industrial area. Although the layout of trackage must be complex to reach the Port and industries, the main lines essentially consist of two parallel routes, those of Amtrak and CSXT, both serving the same NEC metropolitan areas. The principal yards, stations, and junctions in the study area are shown in **Figure 2-2**.

Baltimore — important as it is — cannot undergo scrutiny entirely in isolation. For instance, improvements in Baltimore that are necessary to attain more generous freight car clearances along the NEC traffic lanes would be of limited value if the clearance limitations in Washington's Virginia Avenue Tunnel were left unaddressed. For reasons such as this, the study team not only considered an extended region from the Susquehanna River through the District of Columbia but it was also mindful of the larger-scale traffic flows across the nation that depend on a smoothly functioning network in Baltimore (**Figure 2-3)**. In particular, the development of a high-dimension north-south east coast route generally paralleling I-95 is dependent upon Baltimore and Washington, DC tunnel improvements.

2.2 OWNERSHIP AND CONTROL

As noted earlier, the owners of the railroad main lines in the study area are Amtrak and CSXT. NS owns only freight support facilities — yards, branch lines, industrial tracks, and appurtenances. Two short-line railroads, the Canton Railroad and the Patapsco & Back Rivers Railroad, serve portions of the east Baltimore industrial area.

A summary of current track ownership and operating control appears in **Table 2-1**.

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[1] CSXT and NS freight yards are located at Bay View, about 8 miles southwest of Martin.

[2] Although NS owns no main line tracks in the immediate area, it accesses Baltimore on trackage rights and owns important yard and industrial facilities.

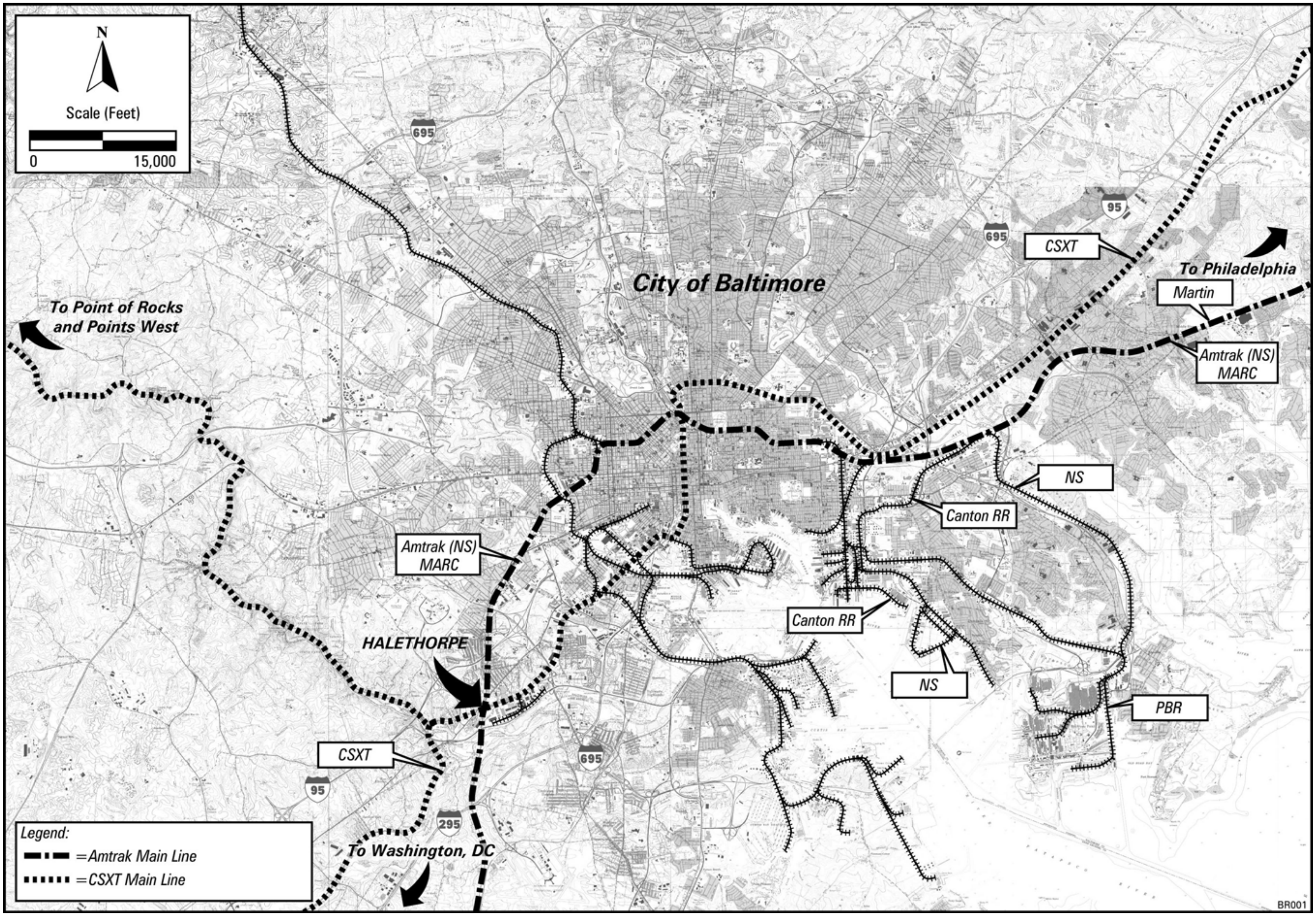

Figure 2-1. The Study Area

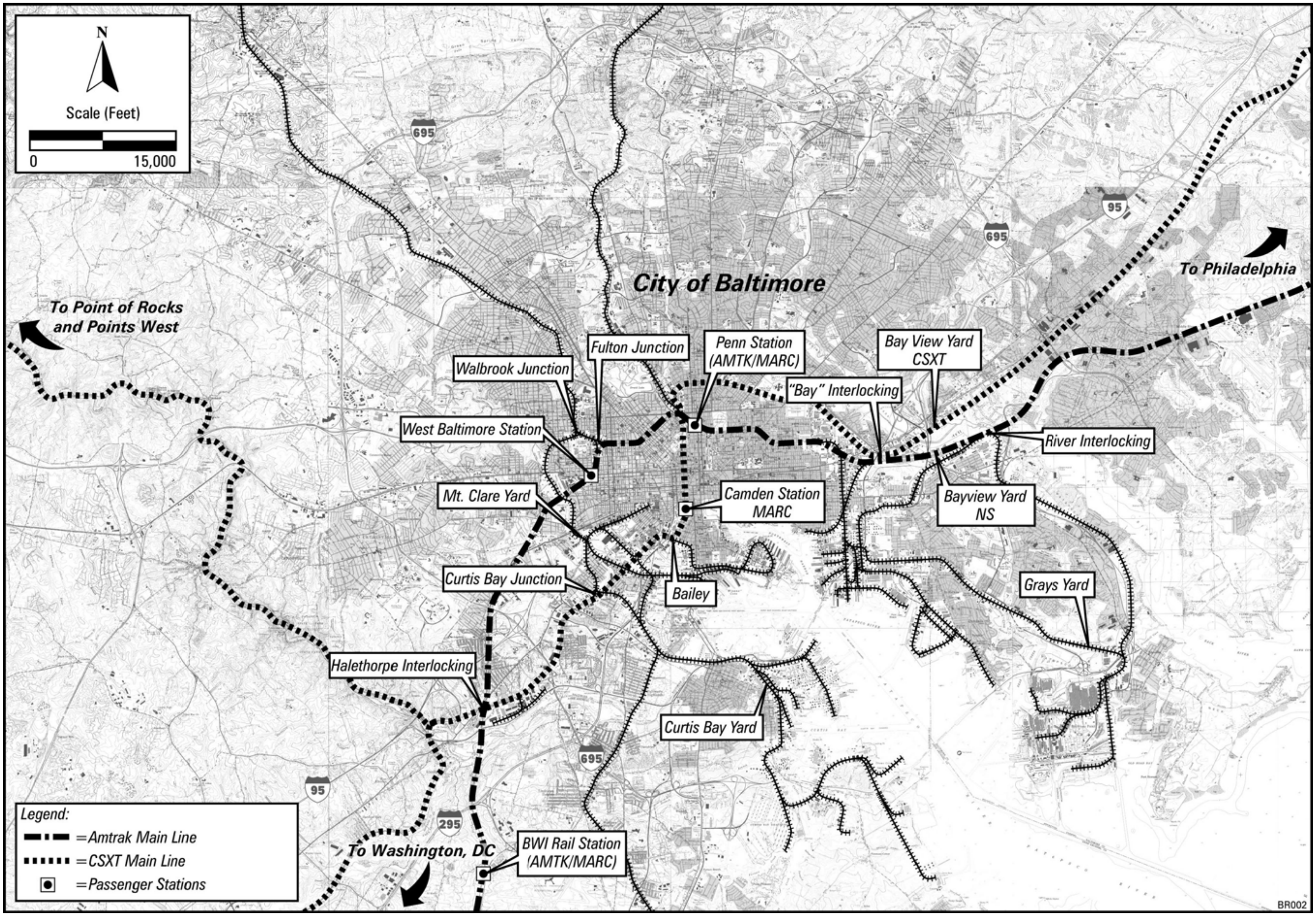

Figure 2-2. Principal Yards, Stations, and Junctions

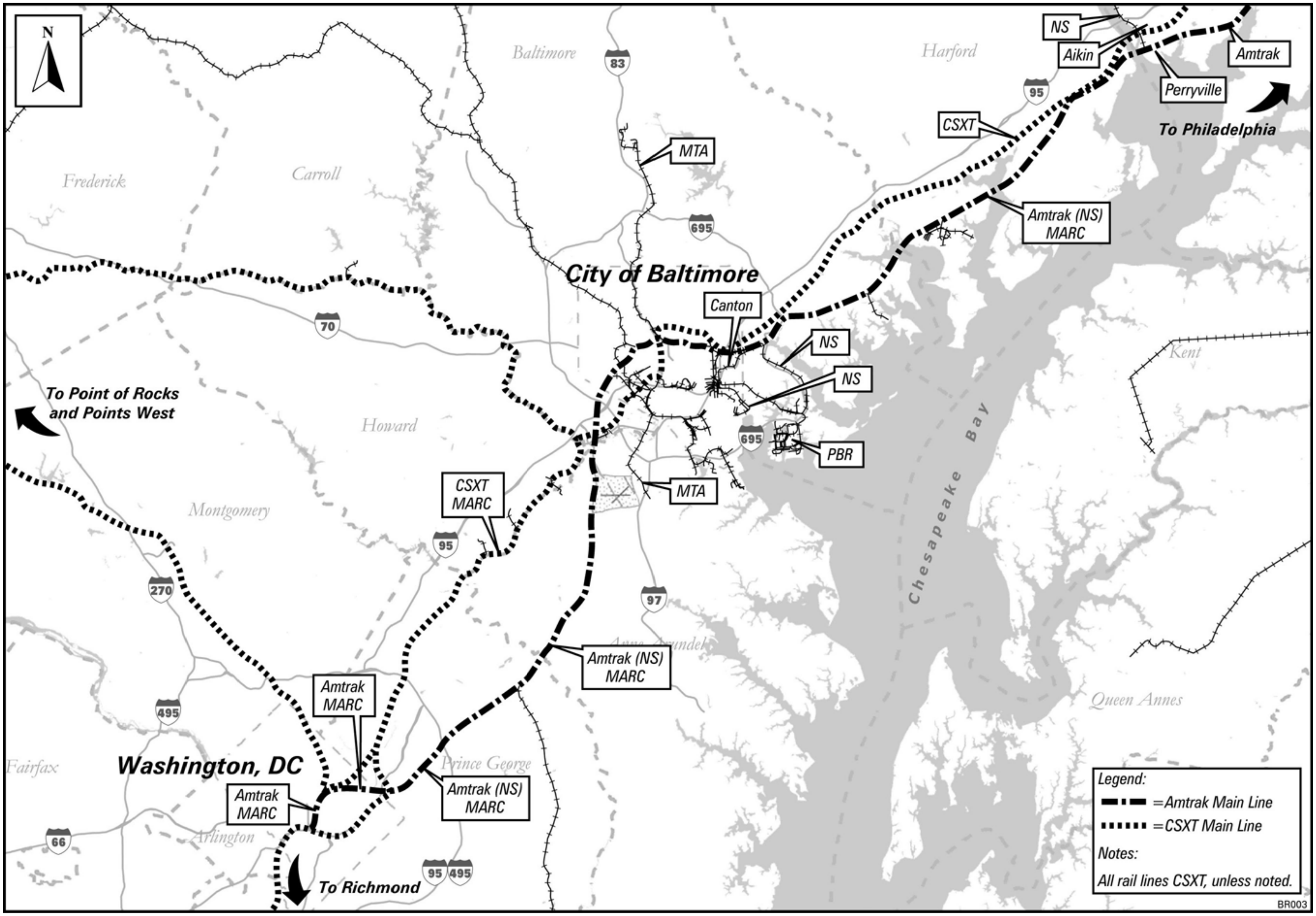

Figure 2-3. Extended Study Region

Table 2-1. Track Ownership and Operating Control of Main, Branch, and Short Lines in the Study Area

	LOCATIONS	MILEPOST[1] BETWEEN-	MILEPOST[1] AND-	OWNER	SUBDIVISION	ROUTE-MILES	DISPATCHED FROM
CSXT MAIN LINES	East Aikin (Perryville) – Bay View	BAK 54.5	BAK 89.6	CSXT	Philadelphia	35.1	Halethorpe, MD
	Bay View – HB Tower	BAK 89.6	BAK 96.0	CSXT	Baltimore Terminal	3.4	Halethorpe, MD
	HB Tower – Halethorpe	BAA 0.4	BAA 5.8	CSXT	Baltimore Terminal	5.4	Halethorpe, MD
	Halethorpe – JD	BAA 5.8	BAA 33.6	CSXT	Capital	27.8	Halethorpe, MD
	Old Main Line: Halethorpe – East Avalon	BAC 5.9	BAC 7.9	CSXT	Old Main Line	2	Halethorpe, MD
CSXT BRANCHES	***Sparrows Point Industrial Track:*** Bay View Yard – Grays Yard	0	6	CSXT	Baltimore Terminal	6	Yardmaster, Penn-Mary
	Passenger Terminal Lead Track: Camden Station – HB or Carroll	BAA 0.0	BAA 0.7	CSXT	Baltimore Terminal	0.7	Halethorpe, MD
	Locust Point Branch: Barney Street – Bailey	BAM 0.0	BAA 0.7	CSXT	Baltimore Terminal	0.8	Halethorpe, MD
	Mt. Clare Branch: Carroll – Curtis Bay Junction	BAN 0.0	BAN 2.2	CSXT	Baltimore Terminal	2.2	Halethorpe, MD
	Curtis Bay Branch: Brooklyn – Curtis Bay Junction	BAO 0.0	BAO 3.3	CSXT	Baltimore Terminal	3.3	Halethorpe, MD
	Marley Neck Industrial Track: South End Curtis Bay Yard – Curtis Creek[2]	BBR 0.0	BBR 6.2	CSXT	Baltimore Terminal	6.2	n/a
	Former Western Maryland Main Line: Westport – Walbrook Junction	BRN 0.5	BAS 3.8	CSXT	Baltimore Terminal and Hanover	4.3	Halethorpe, MD
AMTRAK NEC MAIN LINE	***The Northeast Corridor:*** Perryville – BWI Rail Station	59.4	106.3	Amtrak	Main Line-Philadelphia to Washington (PW)	56.9	Philadelphia, PA
NS BRANCHES	***Sparrows Point Industrial Track:*** Bayview Yard – Grays Yard			NS		5.6	Yardmaster Bay View
	Bear Creek Running Track: Canton Junction – Dundalk			NS		5.4	Yardmaster Bay View
SHORT LINES	***Canton Railroad:*** East Baltimore					6	n/a
	Patapsco and Back Rivers Railroad: Sparrows Point						n/a

[1] Several numbering systems are in use in the study area; these reflect the subdivision organization of CSXT and the ownership of the rail segments in question by CSXT, Amtrak, and two short-line railroads.
[2] CSXT Employees Timetable indicates Industrial Track is 8 miles long.

2.3 TRACKAGE AND TRACK CONDITIONS BY SEGMENT

This report assumes, on the basis of limited observations in the course of the study, that all segments of trackage have been maintained to a level of repair that meets or exceeds the FRA safety standards for the reported speed classifications.[3]

2.3.1 CSXT MAIN LINE

AIKIN – BAY VIEW

This segment (**Figure 2-4**), a portion of the Philadelphia Subdivision of the CSXT main line, is primarily single-tracked with sidings. The sidings include the 10,000-foot Aikin siding (east of the Susquehanna River Bridge) and the 10,450-foot Van siding. The Subdivision is double-tracked between Rossville (BAK

[3] No conclusions regarding the safety of the infrastructure should be drawn from this assumption, which is for planning purposes only.

84.4) and Bay View (BAK 89.6).[4] The maximum freight train speed is 50 mph east of Bay View. A CSXT freight yard is located at Bay View; however, operations there are declining and local supervision may be transferred to other Baltimore CSXT locations.

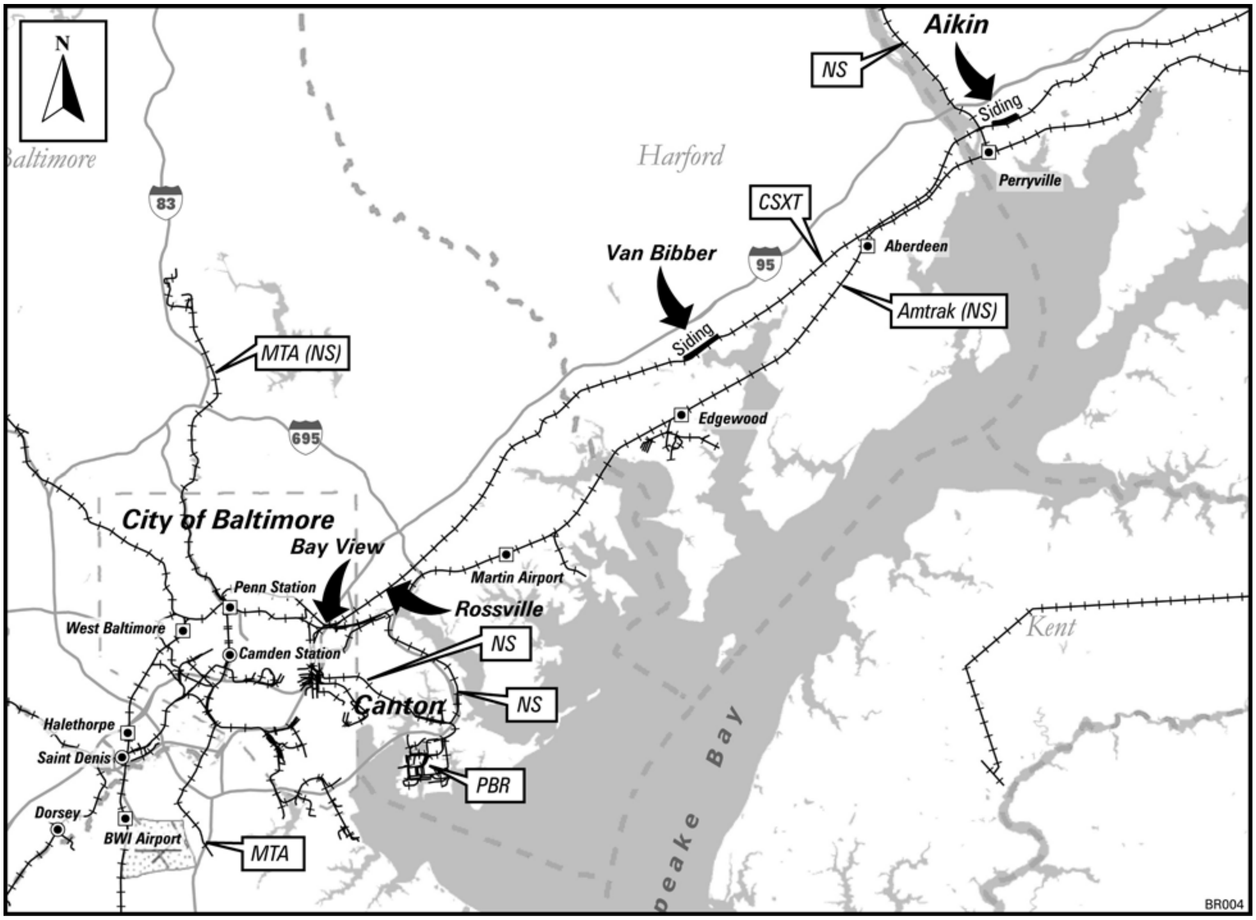

Figure 2-4. Aikin to Bay View (CSXT Main Line)

BAY VIEW – HB TOWER

This segment, a portion of the Baltimore Terminal Subdivision of the CSXT main line, is primarily single-tracked with one 4,600-foot siding that is located at the north end of the Howard Street Tunnel (**Figure 2-5**). A 4,600-foot main line siding is considered short by today's railroad practices. The Subdivision is double-tracked between Bay View (BAK 89.6) and Clifton Park (BAK 91.5). The segment of the line between Clifton Park and HB Tower includes eight short tunnels and the Howard Street Tunnel. The Howard Street Tunnel is 1.6 miles long and has a gradient of 0.8 percent rising from the south portal to the north portal. The tunnel

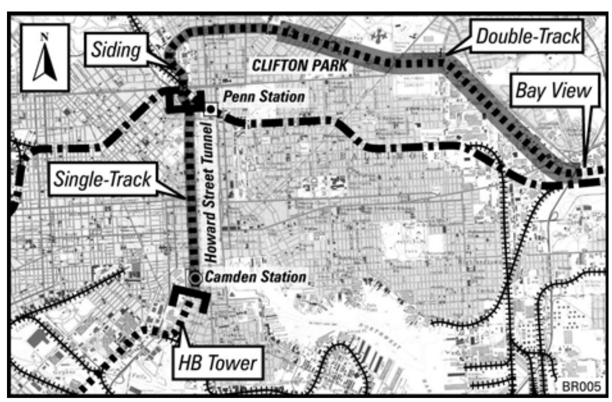

Figure 2-5. Bay View to HB Tower (CSXT Main Line)

[4] The entire B&O line between Baltimore and Philadelphia was, however, double-tracked at its inception. Herbert Harwood, op. cit., p. 43.

is structurally sound and CSXT is satisfied operating through the tunnel in its current condition. However, the Howard Street Tunnel does not have high dimension Plate H clearance (20′ 2″)

The rail line is single-tracked through the tunnels for clearance purposes. Passenger trains no longer operate over the line. The maximum freight train speed is 35 mph between Bay View and HB Tower.

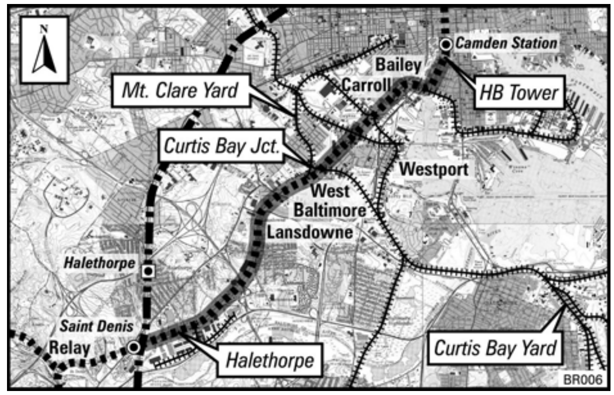

Figure 2-6. HB Tower to Halethorpe (CSXT Main Line)

HB TOWER – HALETHORPE

This line is a segment of the CSXT main line between Baltimore and Washington (**Figure 2-6**). MARC commuter trains originate on the passenger lead tracks at Camden Station and operate to Washington Union Station. The track configuration allows commuter train operations to merge with the main line either at HB (BAA 0.4) or Carroll (BAA 1.5). The Baltimore Terminal Subdivision is presently:

- Double-tracked for freight service between Bailey (BAA 0.7) and Carroll (BAA 1.5); a third track is provided exclusively for passenger train access to and from Camden Station;
- Double-tracked to West Baltimore (BAA 3.2), where the tracks to Curtis Bay Junction, the Curtis Bay Branch, and the Mt. Clare Branch become parallel to the main line tracks;
- Triple-tracked to Lansdowne (BAA 3.8); and
- Quadruple-tracked to Halethorpe (BAA 5.8).

West of Halethorpe (BAA 5.8), the CSXT mainline becomes the Capital Subdivision. The Old Main Line Subdivision to Cumberland and points west diverges from the Capital Subdivision at Relay (BAA 9.0).

The maximum passenger train speed in this segment is 50 mph; the maximum freight train speed is 40 mph.

HALETHORPE – JD

This segment of the Capital Subdivision is primarily double-tracked.[5] The maximum passenger train speed is 70 mph; the maximum freight train speed is 55 mph. There are also a few short yard leads and storage tracks to access yards, serve local industries, and store cars (**Figure 2-7**).

The wye connection to the Alexandria Extension is located in Hyattsville between Riverdale Park (BAA 32.7) and JD (BAA 33.6). This connection facilitates the following three movements, each in both directions (**Figure 2-8**):

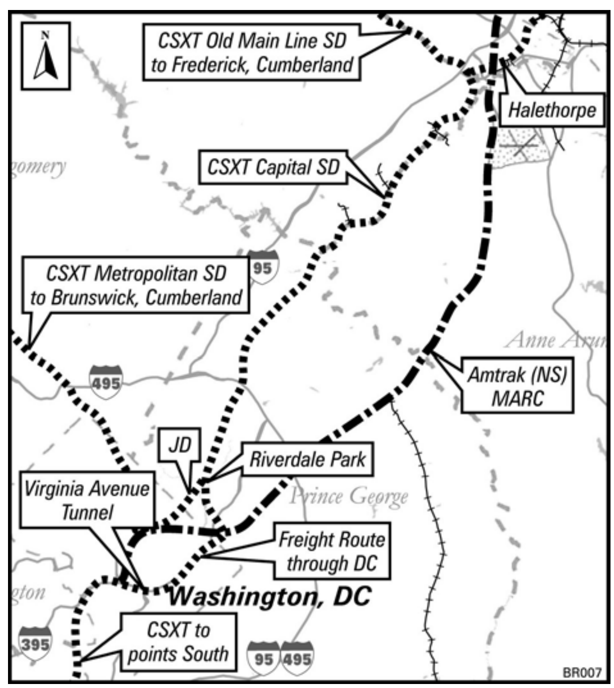

Figure 2-7. Halethorpe to JD (CSXT Main Line)

5 Commuter trains use short sidings at Greenbelt for high-platform access.

1. Between Baltimore and points north and Alexandria, Virginia and points south, via Anacostia and the Virginia Avenue Tunnel in Washington, DC;
2. Between Baltimore and points north and Cumberland and points west,[6] via the CSXT connection and the Metropolitan Subdivision; and
3. Between Cumberland and points west and Alexandria and points south, also via the CSXT wye just north of Union Station and the Metropolitan Subdivision.

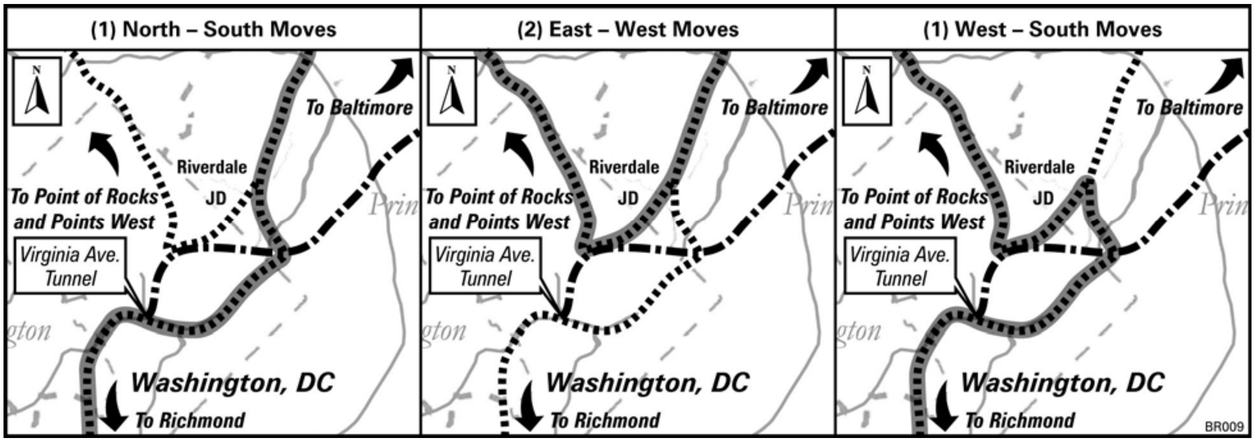

Figure 2-8. CSXT Movements through Washington

Of the three CSXT traffic flows described above, one – the major East Coast north/south movement – is constrained by both the Virginia Avenue Tunnel in Washington and the Howard Street Tunnel in Baltimore and their approaches. (Any analogous NS freight moves via the NEC are similarly constrained by the Virginia Avenue, B&P, and Union Tunnels and approaches.) Thus, to be fully effective, any comprehensive approach to the Baltimore challenge would need to address clearance and other limitations in Washington as well, hence the importance of Washington's rail freight traffic flow and the inclusion of the Capital Subdivision as part of the extended study area.

HALETHORPE – EAST AVALON

At Halethorpe, the CSXT main line crosses over Amtrak's NEC. At Relay, there is a junction between the Old Main Line (to and from Cumberland via Frederick Junction) and the Capital Subdivision (to and from Washington and points west and south). The Old Main Line Subdivision is generally single-tracked west of Relay. The maximum authorized speed (MAS) westward initially is 25 mph; it increases to 30 mph at MP BAC 7.4. (**Figure 2-9**).

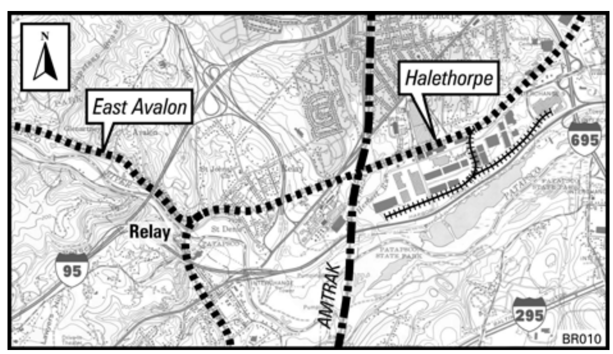

Figure 2-9. Halethorpe to East Avalon (CSXT Main Line)

2.3.2 SELECTED CSXT BRANCHES

SPARROWS POINT INDUSTRIAL TRACK (BAY VIEW YARD – GRAYS YARD)

This CSXT branch extends for approximately six miles from a wye at the west end of Bay View Yard, southward through the Canton area of Baltimore, then eastward to Grays Yard in Sparrows Point. The branch, providing

[6] Historically, CSXT and its predecessors have used two routes for freight trains between Baltimore and points west: one via the Old Main Line and Frederick Junction, the other via the Capital and Metropolitan Subdivisions.

for freight car interchange between CSXT and the Canton and P&BR railroads, is controlled by the yardmaster at Penn-Mary Yard in Canton.[7]

CAMDEN STATION LEAD TRACK (HB TOWER)

Allowing CSXT/MARC commuter trains to access the Camden Station terminal tracks, this 0.7-mile track operates in conjunction with the HB Tower – Halethorpe segment described above (page 2-7; note the configuration leading to Camden Station in **Figure 2-10**).

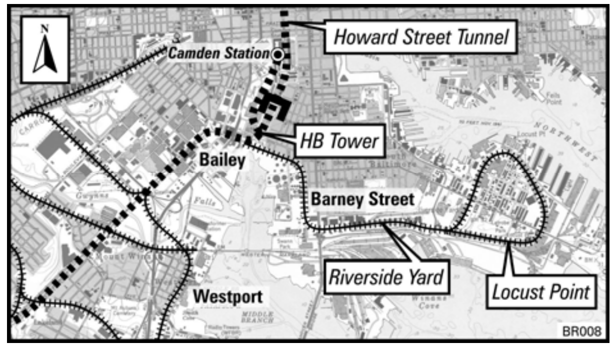

Figure 2-10. Locust Point Branch

LOCUST POINT BRANCH (BARNEY STREET – BAILEY)

The wye connection to the Locust Point Branch is located between HB (BAA 0.4) and Bailey (BAA 0.7). The west wye is the extension eastward of Baltimore Terminal Subdivision Track 2 to Locust Point Yard. The east wye provides a connection to and from the main line and the Howard Street Tunnel. The branch is double-tracked to Locust Point Yard (Figure 2-10).

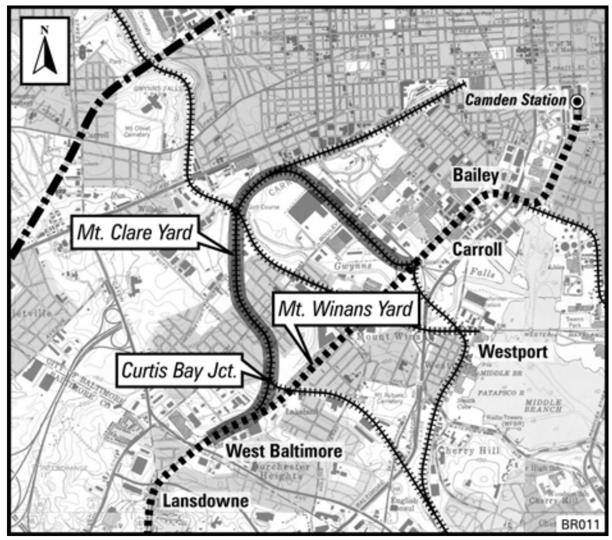

Figure 2-11. Mt. Clare Branch

MT. CLARE BRANCH (CARROLL – CURTIS BAY JUNCTION)

A portion of this line was initially constructed in 1829 as the main line[8] of the B&O west and south of Baltimore. The Mt. Clare Branch provides access to Mt. Clare Yard and an alternate route between West Baltimore and the Baltimore Terminal Subdivision at Carroll. The branch is non-signaled, except for the approach to Carroll. The branch is single-tracked over the historic Carrollton Viaduct and to Carroll. Currently, the MAS for trains is 10 mph (**Figure 2-11**).

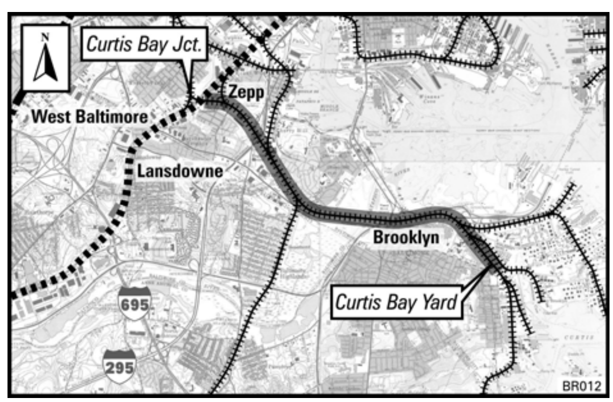

Figure 2-12. Curtis Bay Branch

CURTIS BAY BRANCH (CURTIS BAY JUNCTION – BROOKLYN)

Curtis Bay Junction (BAO 3.3) provides a wye connection to the Curtis Bay Branch from the Baltimore Terminal Subdivision and the Mt. Clare Branch. The branch is single-tracked on the bridge over the Baltimore Terminal Subdivision and double-tracked from Zepp (BAO 3.1) to Brooklyn (BAO 0.0). Curtis Bay Yard extends eastward from Brooklyn. Currently, the MAS for freight trains is 15 mph (**Figure 2-12**).

[7] CSX Transportation, Baltimore Division Timetable No. 4, April 2002, p. 6.
[8] Now known as the Old Main Line west of Relay.

FORMER WESTERN MARYLAND RAILWAY (WM) MAIN LINE: WESTPORT – WALBROOK JUNCTION

Historically, the Western Maryland Railway (WM) linked its freight terminus at Port Covington (south of the Locust Point facility) with southern Pennsylvania, Western Maryland, and West Virginia.[9] The WM's traffic flows reached west Connellsville, PA separately from the B&O. With the WM's absorption into CSXT and the decline of the coal industry in its service area, traffic patterns changed: Port Covington and its connecting bridge across the Middle Branch were abandoned, through freight service to and from Baltimore ceased, much trackage was transferred to short lines or placed out of service, and a portion of the former WM main line became a CSXT local freight service route between Baltimore, MD and Hanover, PA.

Today, CSXT's operations over the former WM begin at Westport, where the Westport Branch connects with the South Baltimore Industrial Track to Curtis Bay. Proceeding west, the Westport Branch passes under CSXT's main line at Mt. Winans Yard and becomes the Hanover Subdivision. A loop track (not currently in service) connects the Hanover Subdivision with Mt. Winans Yard. Following the Gwynns Falls valley for part of its route, the Hanover Subdivision continues northwest, passing under the Mt. Clare Branch and Amtrak's NEC main line. At Walbrook Junction, today's Hanover Subdivision joins the former WM main line from Hillen Street and Baltimore Penn Station (Penn Station) and proceeds northwest to Baltimore County and Hanover, PA.

The Hanover Subdivision – mainly single-tracked, with an MAS of 25 mph – will enter into some of the alternatives discussed later in this study (**Figure 2-13**).

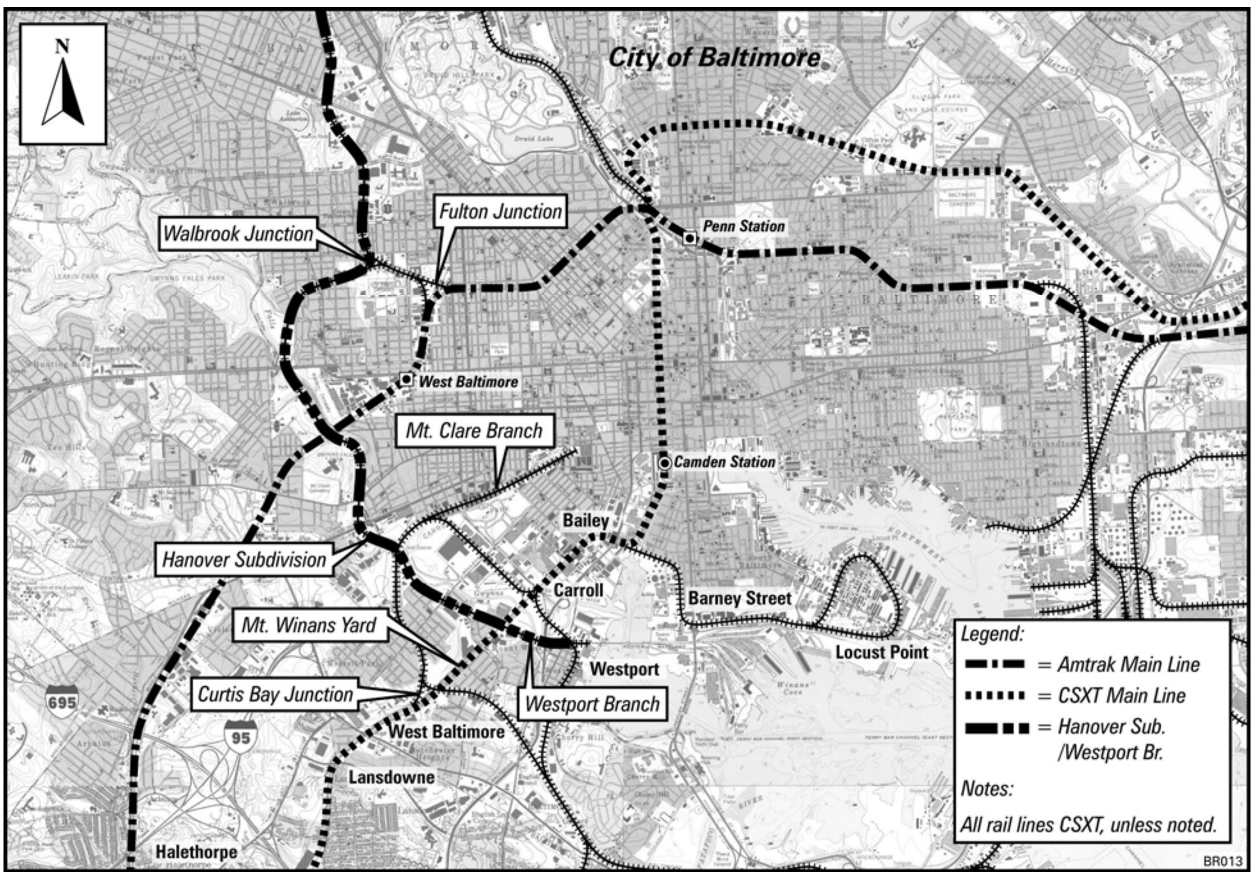

Figure 2-13. Hanover Subdivision and Westport Branch (Former WM Main Line)

[9] The WM also provided service to the east side of Baltimore, including passenger trains to and from Hillen Station near the Jones Falls in downtown Baltimore, via trackage rights on the PRR.

2.3.3 AMTRAK NORTHEAST CORRIDOR MAIN LINE

PERRYVILLE – BWI RAIL STATION

Amtrak's NEC south of Perryville essentially parallels the CSXT main line, but it is closer to the western shore of the Chesapeake Bay. It consists of three- and four-track segments punctuated by several double-track bottlenecks. Between the Jones Falls/Penn Station area and Halethorpe, however, the positions are reversed: the Amtrak line is farther from, and the CSXT more proximate to, the Harbor and the Bay. Double-track segments on the NEC include the Susquehanna River Bridge (immediately south of Perryville); from the Bush River to the Gunpowder River; and the B&P Tunnel (**Figure 2-14**).

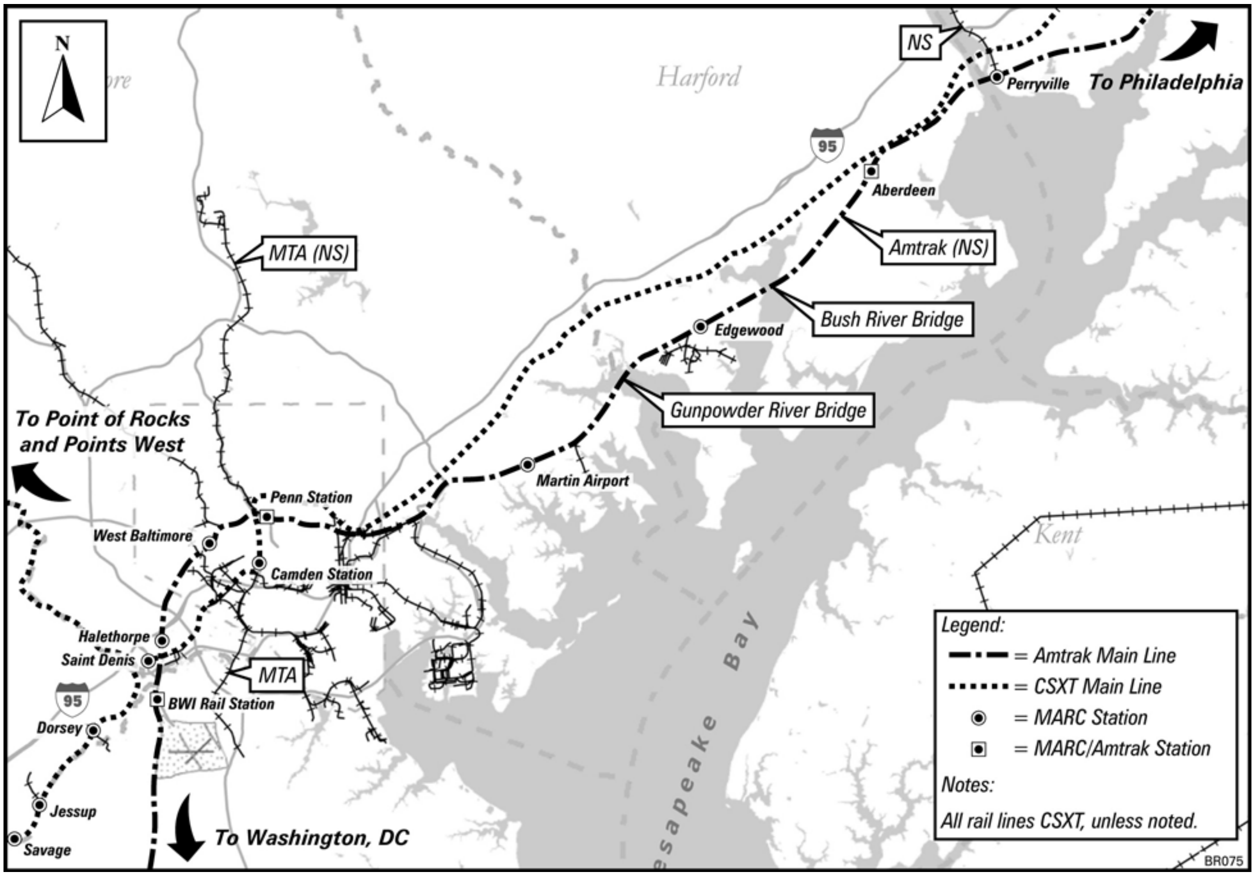

Figure 2-14. Perryville to BWI Rail Station (Amtrak Northeast Corridor Main Line)

Many and varied rail operations make use of the NEC main line in the Baltimore region. MARC Penn Line commuter service links Perryville, Penn Station, and Washington.[10] Amtrak intercity trains connect Boston, New York, and intermediate points with Penn Station, Washington, and points south and west. NS freight trains to and from points north and west, and even points south,[11] serve Baltimore and Wilmington via the Port Road Branch along the Susquehanna River. At Perryville, there is a three-way junction (**Figure 2-15**) between the Port Road Branch and the NEC in the directions of Wilmington, DE and Baltimore, MD.

[10] All services mentioned have additional intermediate stops. Union Station is the main Washington, DC station for all passenger trains serving that city.

[11] Owing to restrictions on freight train access to the NEC and clearance limitations in Baltimore and Washington, NS traffic between the south and Baltimore ordinarily flows via the Shenandoah Valley, Hagerstown (Maryland), Harrisburg, the Port Road, and Perryville rather than via the more direct routing through Washington.

The maximum intercity passenger train speed on the Perryville – Halethorpe segment of the NEC is 125 mph; 50 mph is the maximum freight train speed. Additionally, freight trains are restricted to 30 mph between 6 a.m. and 10 p.m. when most intercity and commuter trains operate. It is expected, however, that this limitation will be lifted when a positive stop signal enforcement system is implemented on the NEC. In some areas, physical and civil limitations reduce the speed, particularly through the B&P Tunnel-Penn Station-Union Tunnel area.

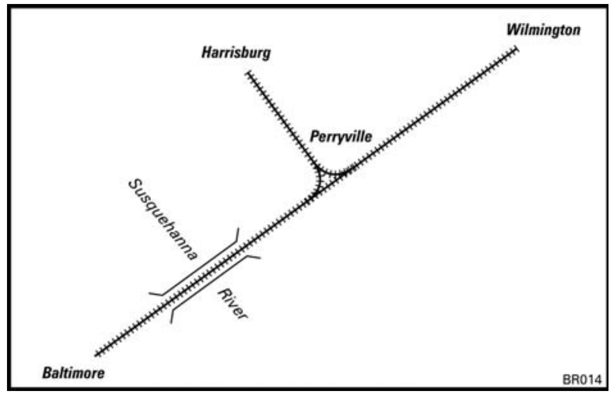

Figure 2-15. Schematic of Perryville for NS

The B&P Tunnel is actually a network comprising three tunnels. Beginning at the east end, these tunnels are the Gilmore Street Tunnel, the Wilson Street Tunnel, and the John Street Tunnel. The total length of the B&P Tunnel network is 1.4 miles and includes an 8 degree curve and a 1.3 percent up gradient beginning at the east portal.

The Perryville-BWI Rail Station segment benefited from an important public investment under the NEC Improvement Program (NECIP) in the 1970s and 1980s, and it continues to receive ongoing maintenance and some betterments from Amtrak. For example, concrete ties have been installed in most tracks throughout the NEC. Previous studies have identified the Susquehanna River, Bush River, and Gunpowder River Bridges, as well as the B&P Tunnel, as needing replacement within the next two decades, although the funding and institutional arrangements for such large capital projects have not crystallized.

2.3.4 NORFOLK SOUTHERN BRANCHES

While accessing Baltimore by means of trackage rights, NS owns and operates some freight trackage in the region. Its principal yard facility is Bayview Yard,[12] located in East Baltimore on the south side of Amtrak's NEC main line.

SPARROWS POINT INDUSTRIAL TRACK (BAYVIEW YARD – GRAYS YARD)

Diverging from the NEC main line east of NS Bayview Yard, this industrial track provides access to the Patapsco & Back Rivers Railroad Grays Yard that serves the OAO Steverstal Steel Sparrows Point complex. The track is within yard limits and is controlled by the NS yardmaster at Bayview.

BEAR CREEK RUNNING TRACK (CANTON JUNCTION – DUNDALK)

Located in NS's Baltimore Terminal area, the 10-mph running track winds through the port and industrial facilities of eastern Baltimore and terminates at the Dundalk Marine Terminal container facility. The running track crosses the Canton Railroad at grade.

2.3.5 SHORT-LINE RAILROAD COMPANIES

CANTON RAILROAD

Connecting with NS and CSXT, the Canton Railroad is a short line in the eastern part of Baltimore City and adjacent Baltimore County. It serves warehouse, distribution, port, and industrial facilities and is involved in numerous industrial development activities.[13]

[12] There are two separate Bay View Yards in Baltimore, but no connection for interchange between the two facilities. Each was originally built by one of the two railroads that were historically completely separate and reliant on divergent routes. Throughout this Interim Report, the CSXT yard is referred to as Bay View; the NS yard as Bayview. The latter is from a NS timetable reference.

2.3.6 PATAPSCO AND BACK RIVERS RAILROAD (P&BR)

The Patapsco & Back Rivers Railroad Company is a common carrier short line operating in the Sparrows Point vicinity of Baltimore County, Maryland, where OAO Severstal has a steel mill.[14] The P&BR connects with CSXT and NS in Grays Yard.

2.4 SIGNALING

The CSXT main line, the Locust Point Branch, and the Curtis Bay Branch are signaled, and CSXT Traffic Control System Rules 265-272 govern train operations. The CSXT Sparrows Point Industrial Track is not signaled; its train operations are under the direction of the yardmaster at Bay View. The Hanover Subdivision is not signaled; CSXT DTC Block System Rules 120-132 govern train operations.

On the high-speed NEC between Perryville and BWI Rail Station, the NECIP replaced a more than 40-year-old signal system so that the average age of the signaling between these two points is now less than 25 years. All main tracks have cab signaling installed with Automatic Train Control (ATC). The Centralized Electrification & Traffic Control (CETC) center in Philadelphia controls train operations.

2.5 HIGHWAY-RAILROAD GRADE CROSSINGS

In the study area, the CSXT and NS trackage has a large number of public and private highway-rail grade crossings, while the Amtrak NEC main line is totally grade-separated. In total, there are 72 public and private crossings in the study area on the main lines and key branches of Class I railroads, as summarized in **Table 2-2**.

Table 2-2. Grade Crossing Summary

SEGMENT	LINE	ROUTE-MILES	NUMBER OF PUBLIC CROSSINGS	PUBLIC CROSSINGS PER MILE	NUMBER OF PRIVATE CROSSINGS	PRIVATE CROSSINGS PER MILE	TOTAL CROSSINGS	TOTAL CROSSINGS PER MILE
CSXT Main Line and Selected Branches								
Philadelphia Subdivision*	BAK	35.1	20	0.57	1	0.03	21	0.60
Baltimore Terminal Subdivision	BAK/ BAA	11.8	24	2.03	6	0.51	30	2.54
Capital Subdivision**	BAA	27.8	6	0.22	0	0.0	6	0.22
Locust Point Branch	BAM	0.5	2	4.00	0	0.0	2	4.00
Curtis Bay Branch	BAO	3.3	1	0.30	0	0.0	1	0.30
Hanover Subdivision	BAS	3.3	1	0.30	1	0.30	2	0.60
Total CSXT		**81.8**	**54**	**0.66**	**8**	**0.10**	**62**	**0.76**
Amtrak								
Amtrak NEC	NEC	49.7	0	0.0	0	0.0	0	0.0
NS Selected Branches								
Sparrows Point Industrial Track	n/a	5.6	2	0.36	1	0.18	3	0.54
Bear Creek Running Track	n/a	5.4	6	1.11	1	0.19	7	1.30
Total NS		**11.0**	**8**	**0.73**	**2**	**0.18**	**10**	**0.91**

* E. Aikin, BAK 54.5, to Bay View, BAK 89.6.
** Halethorpe, BAA 5.8, to JD, BAA 33.6.

[13] Further Canton Railroad information, including a list of shippers, is available on the Canton Railroad's web site at http://www.cantonrr.com.

[14] More information on Sparrows Point appears in Section 8, "Freight Alternatives," under Harbor Sector crossings.

At a minimum, all public crossings have crossbuck passive warning devices. Various combinations of flashing lights, gates, and ringing bells are installed at most crossings.

2.6 PASSENGER STATIONS

Figure 2-16 shows the locations of intercity and commuter stations in the extended Perryville – Baltimore – Washington study area. The location, users, and ownership of the stations are listed in **Table 2-3**.

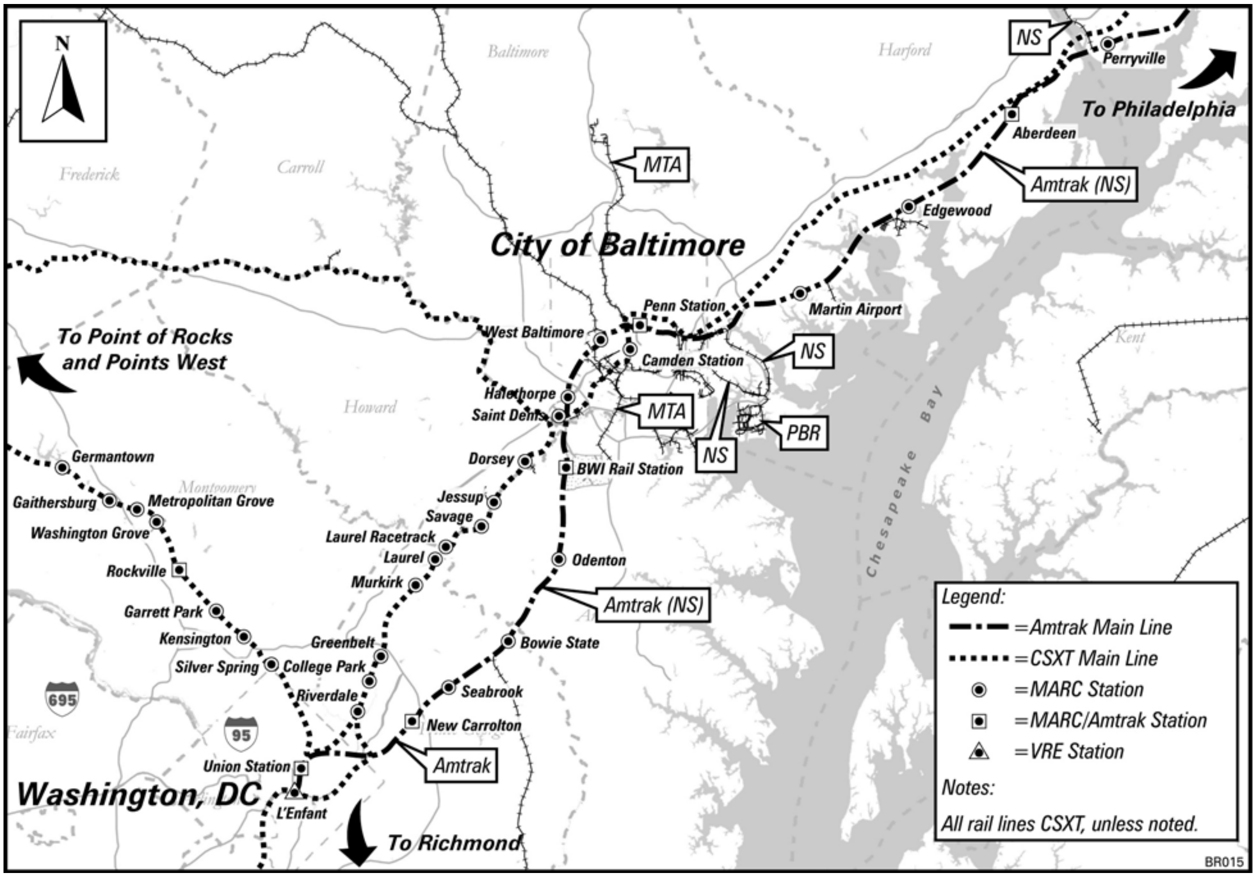

Figure 2-16. Passenger Stations in the Extended Study Area

Two issues concerning the rail passenger stations in the Baltimore region bear mention at this point: the location of the main NEC station (Penn Station) and the lack of a northeasterly "beltway"-type intercity station. There is no counterpart to the BWI Rail Station on the northeast side of Baltimore.

2.6.1 PENN STATION (BALTIMORE)

Amtrak's Penn Station is located on the northern edge of Baltimore's central business district (CBD). As described above, its site was dictated by the PRR's search for a direct route through Baltimore that would also service the (former) Northern Central Railway, thus providing simultaneously for through operations between Washington, Philadelphia, and New York on the one hand and (albeit more awkwardly) between Washington, Baltimore, Harrisburg, the Midwest, and upstate New York on the other. Section 7.2.3 analyzes Penn Station's location as it relates to future rail restructuring opportunities in the Baltimore region.

Table 2-3. Inventory of Stations, Perryville to Relay

MILEPOST	LOCATION	USERS	OWNER LAND	OWNER STATION	OWNER PARKING (NUMBER OF SPACES)
Amtrak NEC Main Line/MARC Penn Line					
NEC 59.4	Perryville	MARC	Amtrak	Amtrak	Amtrak, leased to MTA (219)
NEC 65.5	Aberdeen	Amtrak-MARC	Amtrak	Amtrak	Amtrak, leased to MTA (188)
NEC 75.1	Edgewood	MARC	Amtrak	MTA (Trailer)	Amtrak, MTA, US Govt., Edgewood (294)
NEC 84.0	Martin Airport	MARC	SHA	MTA (Trailer)	SHA (321[1])
NEC 95.7	Baltimore	Amtrak-MARC	Amtrak	Amtrak	City (550)
NEC 98.5	West Baltimore	MARC	City	N/A[2]	City (256[3])
NEC 103.0	Halethorpe	MARC	MTA	N/A[4]	MTA (730 + 300 on street)
NEC 106.3	BWI Rail Station	Amtrak-MARC	Amtrak/MD Aviation Administration	Amtrak	MTA[5] (3,114)
CSXT Baltimore and Capital Subdivisions/MARC Camden Line					
BAA 0.0	Camden	MARC	MSA[6]	MTA	n/a
BAA 6.8	Saint Denis	MARC	CSXT	N/A	CSXT (41 + street)

[1]To be expanded with the construction of MD 43.
[2]Shelters (reclaimable by MTA) and platforms only.
[3]To be expanded to 300+.
[4]MTA to add trailer.
[5]Land owned by State Highway Administration.
[6]Maryland Stadium Authority.
Note: Status as of 2008.
SHA = State Highway Administration (Maryland), MTA = Mass Transit Administration (Maryland)

2.6.2 BELTWAY-TYPE STATIONS

The FRA planning guidelines state:

> One or more suburban stations need to be provided in the larger metropolitan areas with easy access to the local primary road system in order to accommodate potential riders living outside the city centers. Classic successful examples of suburban or beltway stations are Route 128 outside of Boston, MA and New Carrollton, MD outside of Washington, DC. These "beltway"-type stations cater to automobile-oriented riders and thus need to have many hundreds, if not several thousand, parking spaces to fulfill their role in corridor transportation.[15]

Baltimore currently has a "beltway"-type station, BWI Rail Station, that has so successfully attracted passenger traffic from the south and west sides of the region as to become Amtrak's seventh-busiest station on the NEC Acela and Northeast Regional spine routes. However, intercity travelers who originate east of the CBD for northeasterly destinations must currently either double back into the city to use Penn Station or drive to Aberdeen – 30 miles distant and infrequently served.

It should be noted that, as a component of the East Baltimore Development Inc. (EBDI), a $1.8 billion redevelopment of East Baltimore, a MARC commuter rail station is under study. As presently envisioned, Amtrak would not serve this station. As of early 2009, two alternative sites remain under consideration:

- Between the North Bond Street portal (Union Tunnel) and North Broadway; and

[15] Federal Railroad Administration, *Rail Corridor Transportation Plans: A Guidance Manual,* available at: http://www.fra.dot.gov/us/content/1415.

- Between the intersections of East Preston Street/North Wolf Street and East Chase Street/North Chester Street.

Future studies of railway passenger traffic in Baltimore would usefully consider alternatives for a beltway-type station east of the City, the existence of which may affect operating patterns and facility design in the study region as a whole. This topic is outside the scope of this report but worthy of attention nonetheless.

2.7 TUNNEL CLEARANCES

2.7.1 THE IMPORTANCE OF CLEARANCES IN MODERN RAIL FREIGHT TRANSPORT

As the railroad industry matured in its almost two centuries of operation, it consistently sought to increase the ratio of payload-to-gross tonnage by carrying freight in higher, wider, and longer cars. Since 1929 alone, the average capacity of a freight car has more than doubled – from 46.3 to 98.8 tons.[16] Over the ten-year period 1994-2003, the average capacity of multi-level or trailer/container flat cars – of which some types require especially generous clearances – increased by over 28 percent. By 2001, some two-fifths of U.S. carloads were carried in multi-level or trailer/container flat cars.[17] In 2006, over 20 percent of railroad revenue was generated by motor vehicle-related traffic and intermodal traffic.

Thus, the utility of a railway facility increasingly depends on its ability to accommodate modern, high-capacity freight cars. To the extent such accommodation is lacking, the Nation's railroads must route the affected traffic via circuitous routings, thereby incurring additional costs and consuming excess energy.

2.7.2 CLEARANCE PLATE DIAGRAMS

The AAR's publication, *Railway Line Clearances*, specifies the allowable dimensions and weight of rail cars over various segments of individual railroads. Maximum load dimensions are defined in terms of "plates," diagrams that specify cross-sectional areas within which a certain series of railroad cars can be built. Five railroad car plates are presently defined by the AAR as: "B," "C," "E," "F," and "H". A sixth clearance plate has been designated as "Plate L" for the unrestricted movement of locomotives.

Based on two fundamental axes (Top-of-Rail Line and Track Centerline), the plate diagrams are oriented in an upright plane perpendicular to the centerline of a specified track. The diagrams specify the extreme width of a car at a given height above the top of rail (see **Table 2-4**); by this criterion, the limiting factor in tunnels is the height of the eaves at the two upper corners of the car, rather than the maximum height at the center of the tunnel's cross-sectional arch.

Table 2-4. Typical Clearance Plates – Critical Dimensions and Examples of Associated Car Types

PLATE	MAXIMUM HEIGHT ABOVE TOP OF RAIL	WIDTH AT MAXIMUM HEIGHT ABOVE TOP OF RAIL	TYPICAL CAR TYPES SATISFYING PLATE
C	15'6"	7'0"	Conventional box cars, flats (depending on load), gondolas, coal hopper cars
F	17'0"	8'10"	Modern box cars, single-level trailers, double-stack container cars
H	20'2"	8'6-3/8"	Double-stack container cars, tri-level auto rack cars

[16] Association of American Railroads (AAR), *Yearbook of Railroad Facts,* 2007, p. 53.
[17] AAR Economics and Finance Department, *Railroad Equipment Report,* pp. 51, 53, and 65.

2.7.3 OTHER CLEARANCE CONSIDERATIONS

For a variety of reasons, railway engineers do not design and build tunnels and other structures to the dimensions listed for a specific plate. Instead, whether for an upgraded or newly-constructed tunnel, the design requirements incorporate various adjustments to the plate dimensions. These adjustments define the "clearance envelope" – the available space for cars to pass through or the space that is to be checked for a potential obstruction[18] to the passage of a specific car. The adjustments offer the following benefits:

- Allow for the movement dynamics of a car (sway and bounce) as it travels along the track;
- Accommodate the presence of overhead catenary;
- Provide for the effect of curvature on the centerline of the envelope; and
- Provide for the minor horizontal and vertical shifts in the location of the track and catenary, if present, resulting from normal maintenance.

CURVED TRACK

The minimum lateral clearance on each side of a track centerline is increased 1.5 inches per degree of curvature to account for the end of the car swinging outward from the centerline and the center of the car swinging inward from the centerline. The allowance decreases to zero inches when the obstruction adjacent to the track is at least 80 feet beyond, or before, the curve and on tangent track.[19]

CATENARY

The electrification of the NEC, presently alternating current at a voltage of 12.5 kV, 25 cycles,[20] requires vertical and horizontal adjustments beyond those used in non-electrified railroads. The construction clearance must allow for a number of factors[21]:

- The electrical clearance between the structure and live parts of the overhead catenary system[22];
- The loading gage (i.e., the maximal static cross section of the vehicles to be operated);
- The electrical clearance between the contact wire and loading gage;
- The horizontal and vertical dynamic movement of the rolling stock, which creates a kinematic envelope that normally exceeds the loading gage by 1.5 to 2.5 inches;
- The uplift of the catenary system when the contact wire is swept by the pantograph (normally 1 to 2 inches, except 3 inches in tunnels);
- The construction and maintenance engineering tolerances; and
- The depth of the catenary, including wire and hardware.[23]

2.7.4 CLEARANCES IN THE BALTIMORE TUNNELS

All of the factors described above result in limiting the clearances through the Baltimore Tunnels as noted in **Table 2-5**. These clearance limitations have numerous effects on traffic flows in the study area. **Table 2-6** clearly shows that none of the north-south traffic lanes through Baltimore can accommodate the most modern, efficient freight cars (Plate H – double-stack container cars and tri-level auto carriers). NS must

[18] The envelope is defined within a plane, which is perpendicular or radial to the track centerline.
[19] Individual states, railroads, and Canada may require greater clearances than the minimums recommended by the American Railway Engineering and Maintenance-of-Way Association (AREMA).
[20] The conversion to a 25kV 60-cycle system has been evaluated.
[21] AREMA Manual, Chapter 33, Part 2.
[22] The catenary is the system of overhead wires that delivers the power to the train, by means of a power-collecting unit (pantograph) attached to the locomotive. The NEC and its Harrisburg extension are America's only long-distance, electrified passenger railroads; freight service on the NEC, formerly electrified as well, now uses diesel power exclusively.
[23] Since the NEC elevation is lower than 3,000 feet above sea level, an altitude compensation factor is not used.

divert any such traffic to its hilly Shenandoah Valley route some 60 miles to the west[24]; CSXT has no alternate route east of the Appalachian Mountains. Furthermore, for east-west traffic, NS cannot service any local shippers south of Baltimore with the most modern cars, nor can CSXT do so east or north of the Howard Street Tunnel. Moreover, NS faces such tight clearances in the B&P and Union Tunnels as to make the NEC unavailable for any cars exceeding Plate C. The only traffic lanes that benefit from comparatively unrestricted clearances are those of CSXT between points west and the southwestern part of the Port of Baltimore and those of NS and the northeastern sectors of the Port.

Table 2-5. Existing Tunnel Clearance Plates

TUNNEL	PLATE
NEC (Amtrak, NS)	
Union Tunnel Tracks 1 and 2	C+
Old Union Tunnel Track 3	C+
Penn Station, Baltimore: Track 1 lowered for clearance	C
B&P Tunnel Tracks 2 and 3	C
CSXT Main Line	
Howard Street Tunnel	F+
In Washington, DC – Affects traffic flows on both NEC and CSXT	
Virginia Avenue Tunnel	F

Table 2-6. Effects of Clearance Limitations on Rail Traffic Flows

TRAFFIC LANE	LIMITING PLATE	LOCATION(S) OF LIMITATION	ALTERNATE ROUTE
NEC			
NS north-south flows, Virginia and Philadelphia/New Jersey/New York	C	B&P Tunnel	Via NS Shenandoah Valley route and former PRR main line
NS east-west moves, Midwest/ Pennsylvania and all NEC points south of Bayview Yard	C	B&P Tunnel	None nearby
NS east-west moves, Midwest/Pennsylvania and Port of Baltimore via Harrisburg, PA and Perryville, MD and points east of Union Tunnels	No limitation in the study area		
CSXT Main Line			
CSXT north-south flows, Virginia and Philadelphia/New Jersey/New York	F	Virginia Avenue Tunnel, Washington, DC	None nearby
CSXT east-west flows via former B&O to Baltimore Harbor south of Howard Street Tunnel	No limitation in the study area		
CSXT east-west flows via former B&O to all points north and east of Howard Street Tunnel	F+	Howard Street Tunnel	Cincinnati-Buffalo-Albany (Selkirk Yard)
CSXT west-south flows via former B&O and former RF&P, Midwest/Pennsylvania and Virginia/points south	F	Virginia Avenue Tunnel, Washington, DC	None nearby

In order to obtain even the limited available clearances, all CSXT tunnels in the study area have been single-tracked, thus severely constraining capacity.

[24] In the 1980s, Conrail had already diverted as much as possible of its former NEC traffic to its east-west main line via Harrisburg and Bethlehem, PA to northern New Jersey and New York State. At that time, Conrail connected with NS's Shenandoah Valley route at Hagerstown, MD and with CSXT's east-west traffic at Lurgan, PA.

Similar measures took place in the B&P Tunnel. Today, the conditions in the B&P Tunnel – as well as its criticality to the protection of a reliable passenger service – preclude its expanded use for most freight and constrain the flow of commerce to and through the Baltimore region.

2.8 GRADES AND CURVES

A railroad's efficiency as a transportation machine inherently depends on its vertical and horizontal profiles – its grades and curves. The same small zone of contact between steel wheel and steel rail – which reduces rolling resistance and allows a single train, with a minimal crew, to move huge volumes of freight[25] – also demands, for maximal utility, as straight and flat a roadbed as possible. This section examines the relationship of grades and curves to railroad operating performance in general and how they affect Baltimore's rail lines in particular. As a general rule, freight service – with its heavier trains, relatively modest speeds, lower power-to-weight ratio, and need to be able to stop and restart at any point on the line without stalling or slipping – demands easy grades and can tolerate most curves, except as they exacerbate effective grades. Passenger service, on the other hand, can tolerate most grades – the ruling grade on the NEC for passenger service is two percent, in the Penn Station Tunnels of New York City – but suffers from excessive curves due to the speed restrictions they impose for reasons of ride quality and safety. Thus, the two services have different geometric tolerances and requirements.

2.8.1 INFLUENCE OF GRADES AND CURVES ON RAILWAY OPERATIONS[26]

Grade, particularly in combination with curvature, has a major impact on the tractive effort[27] and horsepower required to move a train of a given tonnage over a line. Collaterally, grades affect the speed, schedule, and on-time performance of a freight train, and to a lesser degree, a passenger train.

The total resistance a locomotive has to overcome is determined by adding grade resistance to the train and other resistances. The resistance is higher for a train starting up than for a moving train. Simply stated, on a tangent track, a given number of locomotives would haul fewer and fewer cars up increasingly steeper grades.

The presence of curvature increases resistance as the result of increased friction between wheels and the rail.[28] Curve resistance is measured in terms of the grade that would offer the same resistance as that imposed by the curve. Research in the 20th century concluded that the curve resistance of a one-degree curve equates to the resistance of a 0.04-percent grade.[29]

Thus, for example, a six-degree curve located on a 0.80 percent grade would result in an effective gradient of:

(0.80) + (6 x 0.04), or 1.04 percent

Continuing the example, assume that a 12,000-ton train could operate up a 0.80-percent grade without stalling, but if a six-degree curve were superimposed on the grade, the train would stall.

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[25] In 2006, the average freight train – including locals as well as through freights – had 69.2 cars (versus 47.6 cars in 1929) and carried 3,163 tons of freight (versus 804 in 1929). Also in 2006, the railroad industry generated 4,059 revenue ton-miles per employee-hour (versus 108 in 1929). (AAR, *Yearbook of Railroad Facts,* 2007 edition, pp.35, 37, and 41.) These efficiencies are largely inherent in the mode's configuration of steel wheel on steel rail.

[26] This discussion is based on William W. Hay, *Railroad Engineering*, 2nd Edition, John Wiley & Sons, 1982.

[27] "Tractive effort is the pulling force exerted, normally by a locomotive. When a bare figure for tractive effort is quoted without a speed qualification, this is normally for starting tractive effort, i.e. at a dead start with the wheels not turning." Source: http://encyclopedia.thefreedictionary.com/Tractive%20effort.

[28] The friction is the result of the inside and outside wheels traveling different distances and the rubbing of wheel flanges on the head of the outside rail on the curve.

[29] Amtrak's *MW 1000, Specifications for Inspection, Construction and Maintenance of Track* states that the value for each degree of curvature should be 0.05 percent at locations where trains frequently stop.

To reduce the effective grade to 0.80 percent, the designer would seek ways to reduce the actual grade by –

(6 x 0.04), or 0.24 percent

– to 0.56 (0.80 – 0.24) percent to prevent the 12,000-ton train from stalling.[30]

Such a reduction may not be practical, particularly on an existing route that is criss-crossed by numerous highways, streams, valleys, and other features. The presence of overhead and undergrade bridges and adjacent development may also prevent altering the grade. Consequently, the rail operator has limited options:

- Reduce the tonnage hauled by a train, thus requiring more trains to haul the potential traffic over the line;
- Add a locomotive(s) to the train to prevent stalling, which can be done in several ways:
  - Have the locomotive(s) on the train run from the originating terminal to destination terminal, which means that the train is overpowered for the majority of its route, or
  - Have the locomotive(s) added locally as a "helper" in railroad terminology, which delays the train and requires the helper locomotive(s) to return to the location where they were added, effectively reducing the capacity of that segment of the route, increasing the labor force necessary to conduct the operation, and potentially necessitating facility expansion.

All of the above options would increase the railroad's operating ratio (expenses divided by revenues); thus, they would be detrimental to the company's self-sustainability and status as a going concern.

Curves, in themselves, can severely limit train speeds because of the forces they create as trains pass over them, and these forces raise safety, ride quality, maintenance, and cost issues. For example, allowable superelevation (banking) on curves may differ for passenger and freight service. Where both services regularly share the same trackage, compromises must be made that may result in neither service operating optimally.

2.8.2 CURVES AND THEIR EFFECTS IN THE STUDY AREA

CSXT ALIGNMENTS

Figure 2-17 shows the distribution of curvature in three segments of the CSXT main line.

1. From the Susquehanna River to the south end of Bay View Yard (32.8 route-miles total)

Approximately 77 percent of the alignment is tangent. Twenty-five curves (most of them less than one degree) comprise the remaining 7.6 miles. Three of the curves exceed three degrees and are located in segments of the rail line restricted to 40 mph.

2. From the south end of Bay View Yard to the south end of the Howard Street Tunnel at HB Tower (6.9 route-miles total)

Approximately 58 percent (4.0 miles) of the alignment between the south end of Bay View Yard and the south end of the Howard Street Tunnel (HB Tower) is tangent. However, of the 2.9 miles of curves, 65 percent of the distance (1.9 miles) has curvature greater than three degrees. Thus, the curves between Bay View and HB are more prevalent and severe than those north of Bay View.

3. From the south end of the Howard Street Tunnel to Riverdale Park/JD Tower, near Washington, DC (33.1 route-miles total)

[30] Depending on site-specific circumstances, reducing the actual gradient may have the additional negative effect of lengthening the grade, the distance needed to attain the desired elevation.

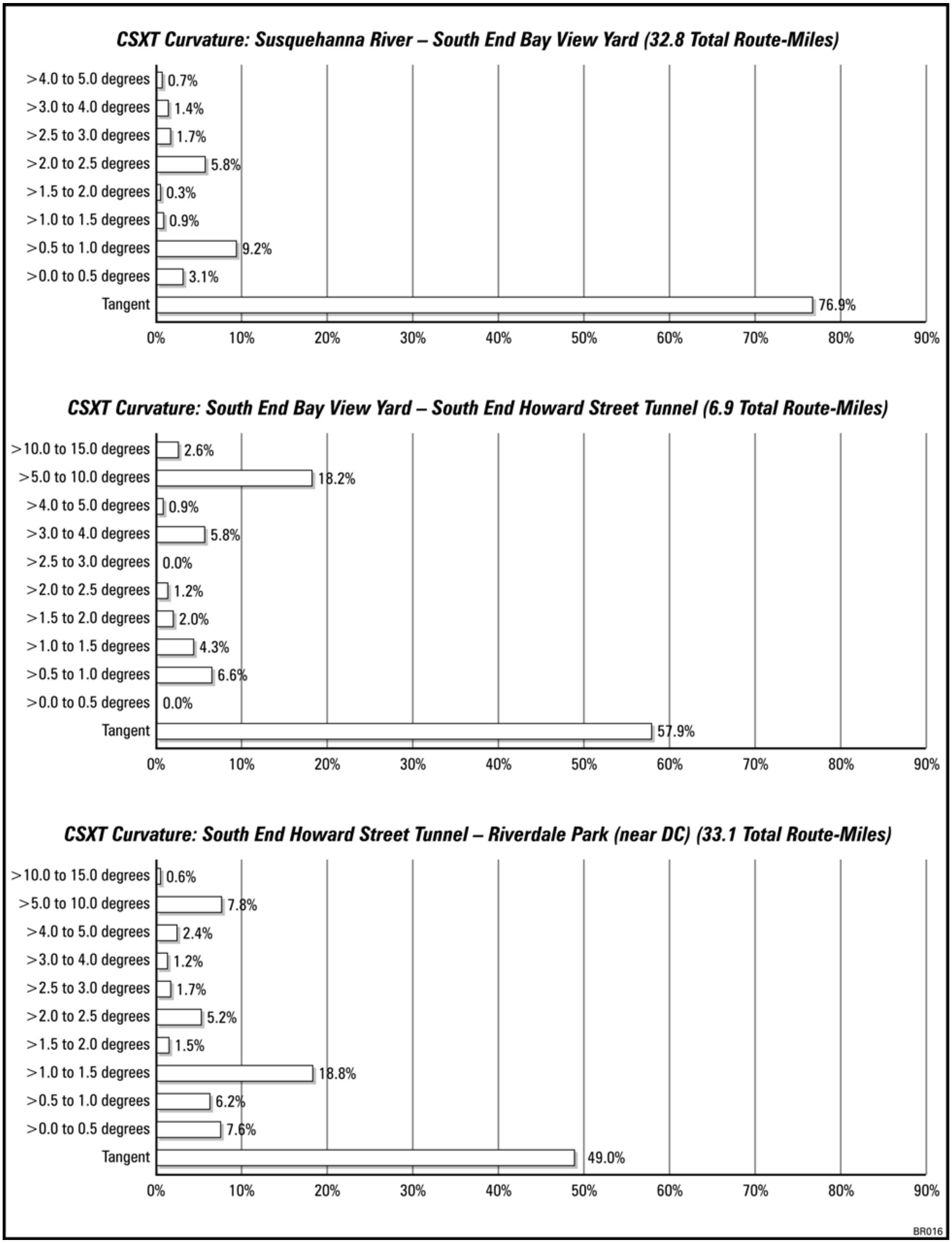

Figure 2-17. CSXT – Percentage of Route Segments by Degree of Curvature

The Riverdale Park and JD Tower Interlockings comprise area for the junction of CSXT's east-west mainline with the freight line to the south, via Anacostia. Approximately 49 percent (16.1 miles) of the alignment between the south end of the Howard Street Tunnel and the Riverdale Park/JD area is tangent. Thirty-seven curves comprise the remaining 17 miles. Of these 17 miles, 6.2 miles (36 percent) of the curved alignment has a curvature between one degree and one degree thirty minutes. The curves immediately south of the Howard Street Tunnel are sharper than those south of MP BAA 10.1 (Elkridge). Twelve of the curves are in excess of three degrees. As a result, the freight speeds between the Howard Street Tunnel and MP BAA 10.1 range between 25 and 45 mph while the maximum freight train speed is 55 mph between MP BAA 10.1 and JD (Hyattsville).

4. Summary: CSXT Curvature

Figure 2-17 clearly indicates that CSXT's curvature problems most seriously affect the segments south of Bay View Yard. The relative age undoubtedly influences the comparative quality of these alignments. The route north of Bay View Yard is a relatively "recent" alignment (the Royal Blue Line completed in 1886), whereas the route from Baltimore to Washington (the "Washington Branch") dates back to 1835, eight years after the B&O's founding.[31] The Howard Street Tunnel with its approaches, completed in 1895, constitutes a special case due to Baltimore's exceptionally difficult railway topography, as described earlier in this report.

NEC ALIGNMENTS

Figure 2-18 presents the curvature pattern for three segments of the NEC between the Susquehanna River and BWI Rail Station. With the exception of the very difficult tunnel alignments on both railroads, the NEC has a more favorable alignment than does CSXT. Between Baltimore (north of the Union Tunnels) and the Susquehanna River, for example, the NEC has only 0.8 miles of route curvature that exceeds two degrees, while CSXT has 3.2 miles. South of the Baltimore Tunnels, the CSXT has a higher percentage of route-miles in sharper curves than does the NEC. These divergences stem both from geography (to the north, Amtrak's route hugging the Chesapeake Bay is gentler than the CSXT's inland, hillier route) and history (the NEC south of the tunnels is of more recent design and construction[32] than the CSXT's legacy alignment).

SPEED EFFECTS OF CURVATURE

Railway engineers develop detailed formulas for calculating maximum authorized speeds (MASs) for various traffic types on specific sections of trackage. Among the many factors that enter into these calculations are:

- The degree of curvature;
- The length of the spirals transitioning from tangent track to the maximum degree of curvature;
- The allowable superelevation (banking) to accommodate the needs of all traffic types making use of the segment;
- Other equipment- and site-specific conditions.

The speeds resulting from these calculations appear in **Table 2-7**.

Figure 2-19 exemplifies the effects of Baltimore's difficult railway configuration on train performance. Especially noteworthy are the restrictions imposed by the B&P Tunnel (30 mph over some two miles, MP 95.9 to 97.7) and the contrast in linear shape between the stop at BWI Rail Station, in which the train approaches and departs the station with only a minor restriction of 90 mph, and that at Penn Station, which takes many miles and minutes to accomplish.

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[31] Timothy Jacobs, ed., *History of the Baltimore & Ohio Railroad,* New York: Smithmark Publishers, Inc., 1995, pp.28, 64, and 68.

[32] The PRR Line was constructed in1873, versus the 1835 completion of the B&O's Washington Branch mentioned above.

Figure 2-18. NEC – Percentage of Route Segments by Degree of Curvature

Table 2-7. Maximum Allowable Speeds[1] on CSXT and Amtrak Main Lines through Baltimore

ROUTE SEGMENT	MAXIMUM ALLOWABLE SPEEDS FOR PASSENGER SERVICE	FOR FREIGHT SERVICE
CSXT Main Line		
North of Baltimore	No service	50 mph
— Except: On curves greater than 3 degrees 15 minutes	No service	*45 mph or less*
South of Bay View (MP BAK 90.6) to St. Paul/Calvert Street Tunnel (MP BAK 03.4)	No service	35 mph
St. Paul/Calvert Street Tunnel (MP BAK 93.4) through Howard Street Tunnel to Carroll (MP BAK BAA 1.5)(total of 4 miles approximately[2])	On passenger tracks: 15 to 45 mph	On freight thru tracks: 25 mph
South of Baltimore	70 mph	55 mph
— Except: On curves greater than 2 degrees 15 minutes but under 3 degrees	*65 mph or less*	*55 mph*
— Except: On curves greater than 3 degrees		*50 mph or less*
Amtrak NEC		
— Perryville (MP 59.4) and MP 85 (10.7 mi. north of Penn Station)	125 mph	50 mph or less
— MP 85 to MP 91.9 (3.8 mi. north of Penn Station)	110 mph	50 mph or less
— In Union Tunnels, north of Penn Station *(speeds gradually lessen on approach to the Station, where all trains stop)*	45 mph	30 mph
— In B&P Tunnel, south of Penn Station	30 mph	20 mph
— From south of B&P Tunnel (MP 97.7) to BWI Rail Station (MP 106.3)	110 mph	50 mph or less

[1] These are general guidelines, always subject to site- and time-specific considerations.
[2] Based on CSXT Baltimore Division Timetable No. 4, April 2002, and *Official Guide of the Railways,* June 1916, p. 526.

As the BWI Rail Station stop demonstrates, it is not the equipment that consumes all of the excess time in stopping at Penn Station, it is the alignment. Moreover, it is not just the Acela high-speed intercity passenger service that loses time in central Baltimore. MARC commuter trains and Amtrak's regional and long distance trains are affected as well.

2.8.3 GRADES AND THEIR EFFECT ON THE STUDY REGION

As described earlier in this section, the railroads in the 19th century made compromises to fulfill their conflicting goals of maintaining their separate multi-purpose rights-of-way, providing passenger service close to the CBD, and avoiding the expense of taking higher value properties in critical areas of the city (i.e., the Inner Harbor), all within a challenging topographical environment. In no domain were these compromises more debilitating than in the maintenance of easy grades, a requisite for efficient freight service[33] and an enhancement to all operations.

These compromises show themselves starkly in **Figure 2-20**, which displays the grades of the CSXT and NEC main lines, each of which is described in the following sections.

PROFILE OF CSXT

1. **Susquehanna River (BAK 56.58) to south end of Bay View Yard (BAK 89.5)**

The CSXT rail line north of Baltimore can be characterized as having a "saw tooth profile," in that the line consists of numerous adjacent crests and sags[34] that can adversely affect train performance. By contrast, the NEC has a flatter profile because it is closer to the Chesapeake Bay and constructed in less rolling terrain.[35] The grades north of CSXT Bay View Yard generally are less steep than those in, and north of,

[33] For example, according to Robert S. McGonigal, "a given locomotive … can haul only half the tonnage up a 0.25-percent grade than it can on the level." (http://www.trains.com/Content/Dynamic/Articles/000/000/003/015kegsf.asp)
[34] The sags are generally located where the rail line crosses the various rivers, streams, and creeks flowing into Chesapeake Bay.
[35] However, the NEC has the disadvantage of requiring major bridges over the Bush and Gunpowder estuaries.

the Howard Street Tunnel. The steepest grade, 0.04 mile 1.17 percent descending (between MP BAK 87.68 and MP BAK 87.72), is near Bay View Yard. Charts showing the prevalence of various grades on the CSXT appear in **Figure 2-21**.

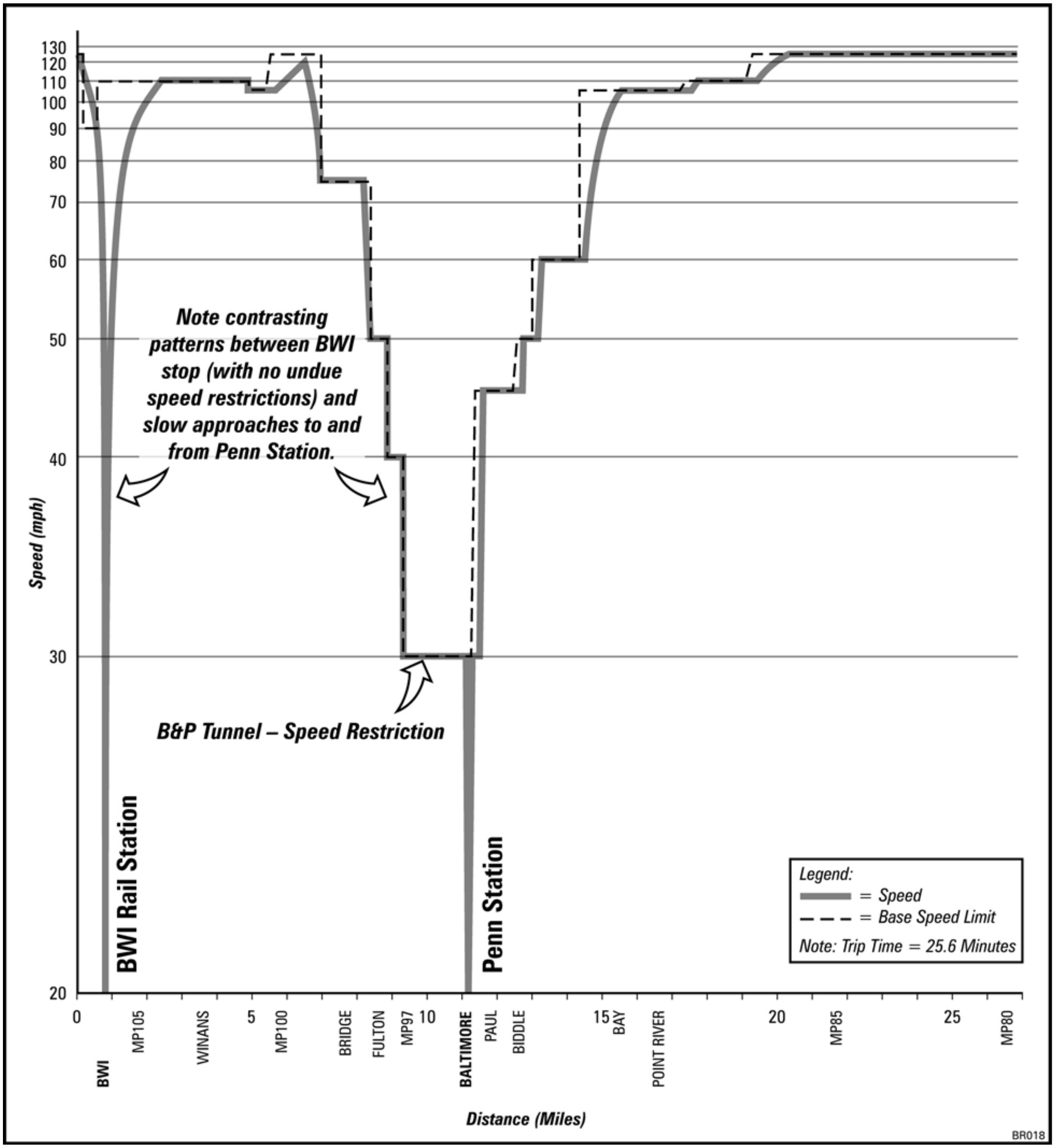

Figure 2-19. Optimal Speeds Achieved by an Acela Trainset Operating Unimpeded between Perryville and BWI Rail Station (Over Existing NEC Track Configuration)

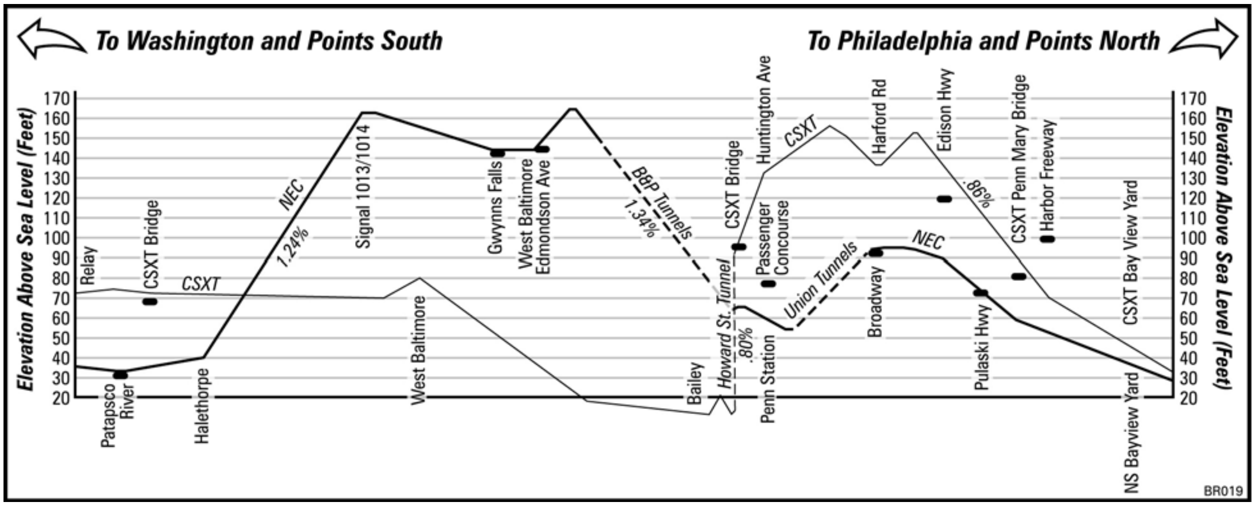

Figure 2-20. Grades through Baltimore on CSXT and NEC Routes[36]

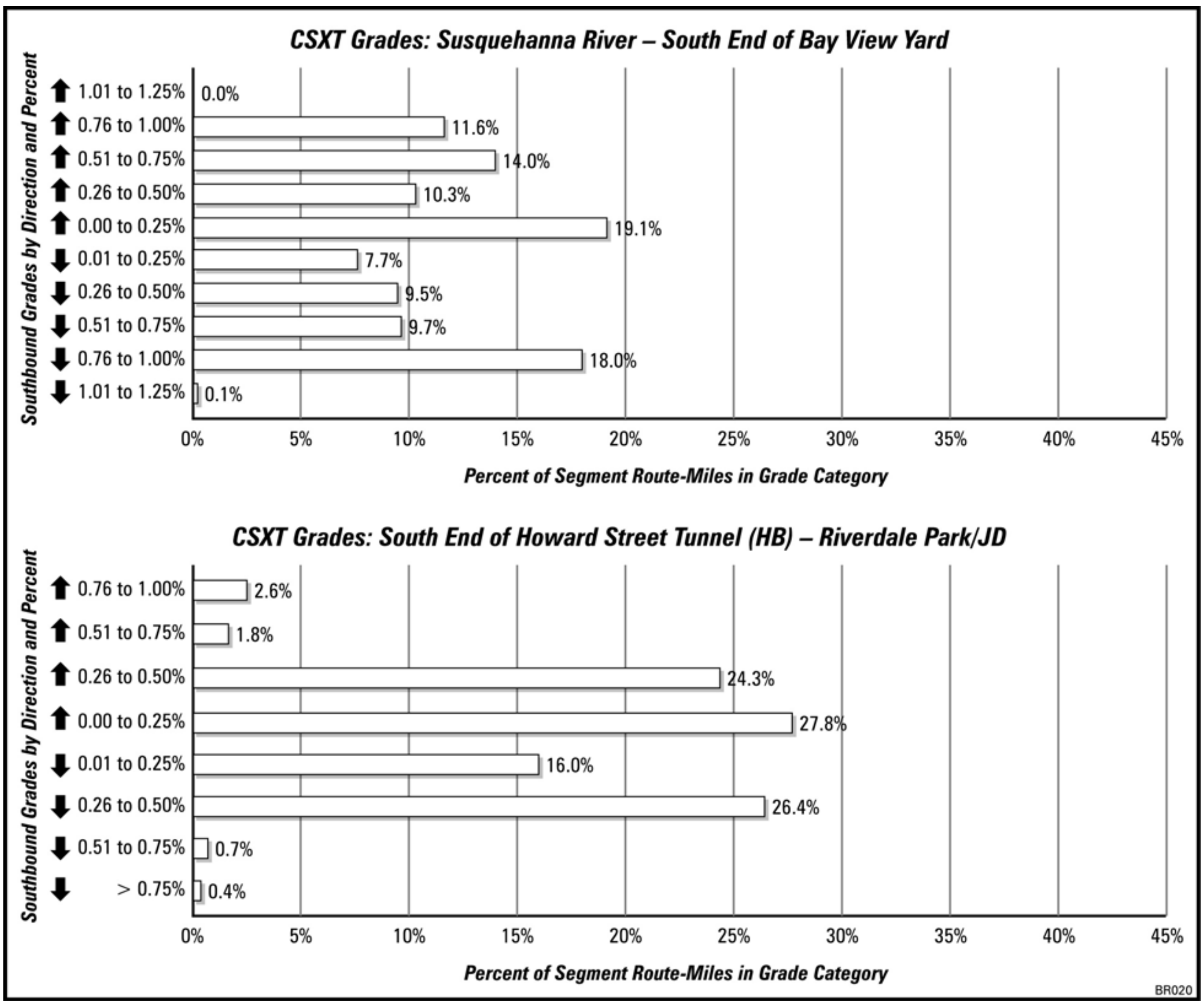

Figure 2-21. Prevalence of Grades of Varying Severity on CSXT

[36] Figure courtesy of Amtrak's Planning Department.

2. South end of Bay View Yard to south portal of Howard Street Tunnel at HB Tower (between MP BAK 89.5 to MP BAA 0.5)

The grade from the vicinity of Camden Station to the north is 0.8 percent ascending through the 7,341-foot, single-track Howard Street Tunnel. The grade continues to climb[37] for approximately 4.5 miles. Between the Howard Street Tunnel portal and Huntingdon Avenue, the northbound uphill grade reaches 1.55 percent – the type of freight railroad incline that is more appropriate to mountain passes than tidewater cities. The elevation at the south end of the tunnel is 11 feet above sea level; to the north, the highest elevation on the grade is 157.1 feet, near the Greenmount Avenue underpass.[38] The presence of three curves of between 3 degrees 15 minutes and 4 degrees 30 minutes in the Howard Street Tunnel and of five curves between 5 degrees 45 minutes and 10 degrees 10 minutes between the north end of the Howard Street Tunnel and Greenmount Avenue further restricts the operating speeds. These curves effectively increase the grades in this segment from 0.13 to 0.41 percent. The grades and the curvature thus combine to aggravate the constraints that make the Howard Street Tunnel a choke-point in CSXT operations between Richmond, VA and Philadelphia, PA.

3. CSXT: South portal of Howard Street Tunnel at HB Tower to Riverdale Park/JD (between MP BAA 0.5 and MP BAA 32.71)

The grades south of the Howard Street Tunnel generally are less steep than those in, and north of, the tunnel. The steepest grade, 0.8 mile of a southward ascent of 0.83 percent (MP BAA 1.9 to MP 2.7), is located north of, and extends through, Mt. Winans Yard. The rail line south of Mt. Winans to Riverdale Park in Hyattsville (the connection to Benning Yard, the District of Columbia, and Virginia) is largely gently rolling and presents a far easier gradient than the segments of CSXT main line north of HB Tower.

PROFILE OF THE NEC

1. Susquehanna River to north portal of Union Tunnel

The grades north of Amtrak's Union Tunnel are generally moderate. The steepest grade, 0.65 percent ascending (MP 62.01 to MP 60.96), is located south of Grace as the NEC climbs out of the Susquehanna River valley. A comparison of **Figure 2-22** with Figure 2-21 underlines the contrast in profiles between the NEC and the CSXT main lines northeast of Baltimore.

2. North portal of Union Tunnel to south portal of B&P Tunnel

The Union Tunnels comprise:

- The original double-track tunnel constructed in 1873 (at the same time as the B&P Tunnel); subsequently, the original tunnel was single-tracked in the 1930s; and
- A double-track tunnel, located south of the old tunnel, constructed in 1934.

Southbound, the grade through the Union Tunnels is descending at 1.17 percent.

The most restrictive grade between Philadelphia and Washington on the NEC is located in the B&P Tunnel, a series of three tunnels spanning 7,669 feet, separated by two short open-cuts. Southbound trains entering the tunnels slow for a sharp (8 degree) curve then ascend on a mile-long 1.34-percent grade.

3. NEC: South of B&P Tunnel (MP 97.7) to BWI Rail Station (MP 106.3)

[37] A short downhill segment of less than ¾-mile is located approximately three miles into the segment.
[38] These elevations are derived from a 1949 B&O track chart.

The grades south of the B&P Tunnel are steeper than the grades located north of the Union Tunnels.[39] The steepest grade, descending 1.24 percent (MP 100 to 100.3), is located south of Wilkins Avenue.

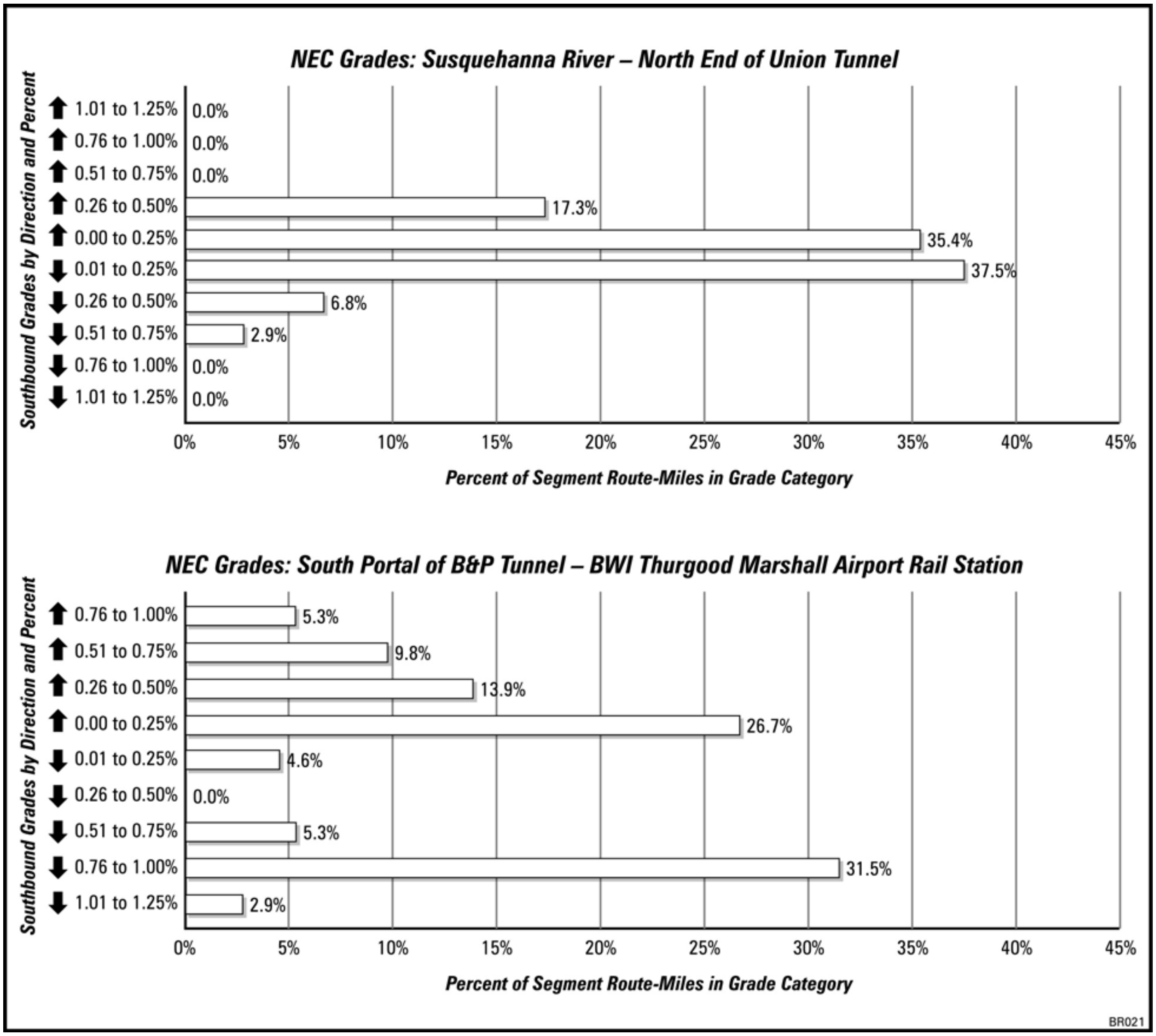

Figure 2-22. Prevalence of Grades of Varying Severity on the NEC

2.9 SUMMARY: THE NET EFFECT OF FIXED PLANT ON OPERATIONS AND THEIR COSTS

As the main line for most freight and all passenger rail traffic along the East Coast, the twin CSXT and NEC routes through Baltimore perform the same function as Interstate 95 does for the highway system but with a critical difference: whereas I-95 has many nearby parallel routing options, there is no other rail option for through passenger service and, some sixty miles to the west, only a limited and circuitous parallel route for NS freight traffic. Indeed, CSXT has no other north-south option short of Cleveland, OH. Yet despite the criticality of the rail infrastructure through Baltimore, its design was last updated a century-and-a-quarter ago, with substandard engineering even for the 19th century. It falls short of 21st century needs in the following ways:

[39] The rail line south of Baltimore is located in the Western Shore Uplands Region, while the line north of Baltimore is located in the Western Shore Lowlands Region and borders tidewater over much of its length.

- **Speed.** Freight trains are limited through several miles of trackage to a maximum speed of 25 to 30 mph and tend to travel even slower due to severe grades and curvature. Passenger trains lose valuable minutes in the restricted speed zones of the approaches to and from Penn Station. By contrast, the Fort McHenry Tunnel of I-95 offers a 55 mph speed limit.
- **Throughput capacity.** The main (CSXT) freight line through Baltimore is single-tracked, and the use of helper locomotives again halves its capacity. The through (NEC) passenger route has only two tracks through the B&P Tunnel, but it must accommodate a growing mixture of commuter, high-speed, and conventional passenger trains that, with freight service, makes active use of three and four tracks elsewhere on the NEC. By contrast, there are eight lanes in the Fort McHenry Tunnel, four lanes in the Baltimore Harbor Tunnel, four lanes on the outer harbor crossing, and approximately six lanes on the Baltimore Beltway around the city to the north, for a total of 22 highway lanes through and around Baltimore.
- **Loading flexibility.** Neither freight route accommodates the most modern, high-value freight cars such as tri-level auto rack cars and double-stack high-cube container cars (Plate H). In addition, the NEC cannot accommodate any cars exceeding Plate C, such as larger box cars, trailers on flat cars, and double-stack containers.
- **Interoperability.** For through traffic, the CSXT and NEC routes are completely separate from each other. In an emergency, there is no way to route CSXT freight traffic over the NEC, NEC freight traffic over CSXT, or any passenger traffic over the parallel route.[40] This lack of interoperability came to the forefront during the Howard Street Tunnel fire, when CSXT had to route trains via Cleveland, OH.
- **Interconnectivity within, and competitiveness of, Port of Baltimore.** Due to capacity, speed, and loading constraints, all rail freight movements between the northeast and southwest parts of the Port of Baltimore are difficult and costly to accomplish. Furthermore, due to clearance inhibitions, the northeast part of the Port cannot route many types of shipments west via the CSXT, and the southwest part has similar limitations to use of NS. This lack of connectivity and routing flexibility detracts from the Port's efficiency and attractiveness.

  The Port is a major economic player in the Baltimore region. According to the Maryland Port Administration, the Port generates $1.5 billion in business revenue annually, and the Port's activities support in excess of 112,000 Maryland workers: 16,000 directly, 17,000 indirectly, and more than 79,000 who benefit from Port-related business. The Port annually puts $2 billion in the pockets of Maryland's workforce.
- **Externalities.** Inefficiency has its costs, and the antiquated rail link through Baltimore has implications for the general public as well as for the carriers and shippers involved. While measurement of these external costs is beyond the resources of this study, they are worth noting:

  Costs to the general public:

  - Highway congestion and its time, energy, and emissions costs due to the substitution of trucking for rail service caused by the inefficient or impracticable rail freight moves across, to, and from Baltimore, as well as on railway corridors outside the study region;
  - Highway congestion and its costs due to rail's inability to further reduce its passenger trip times, enhance its reliability, and divert more automobile traffic;
  - Reduced economic activity at the Port and in the Baltimore Region due to the constraints on its rail access; and
  - Constraints on access to BWI Rail Station due to limited rail capacity.

[40] Connections do exist for limited freight interchange, but these are not for through traffic purposes.

Costs to rail users:

- Added shipping and inventory costs for shippers due to the limitations and inefficiencies in rail freight transit across, and service to, Baltimore. Because this is the main East Coast rail link, these costs are also borne by shippers distant from Baltimore itself;
- Time-penalties for intercity rail passengers and commuters due to slow running through Baltimore.

Costs to carriers:

- Added costs to freight railroads due to inefficiencies in their Baltimore operation;
- Opportunity costs of freight traffic lost due to capacity, speed, and loading constraints;
- Added costs to freight railroads due to circuitous routings around Baltimore;
- Added operating and maintenance costs to Amtrak and MARC due to the slow, difficult, and antiquated movements through Baltimore; and
- Opportunity costs of passenger traffic lost to Amtrak and MARC due to extended travel times through Baltimore.

3 – TRAFFIC LEVELS

Using the infrastructure with its limitations, as portrayed in Section 2, the railroad companies manufacture their product – passenger and freight transportation – and thus generate their revenue by serving their customers. Of concern in this study are not only the present levels of rail traffic, but also those of the foreseeable future, since any contemplated restructuring must be assumed to remain in service for at least as long as the nineteenth-century B&P and Howard Street Tunnels have thus far endured. Furthermore, insofar as engineering economy will allow, restructuring alternatives should provide for future expansion beyond foreseeable service levels, so as to reduce the investment that future generations may be forced to make to preserve the fluidity of their railway network.

After characterizing the region's rail traffic as a whole, the following sections examine each of the major traffic types in turn, both in their present and future aspects. The forecasts make use of various planning horizons ending with the "planning year," 2050. (In the context of this particular study, forty years into the future is not a very long time: it is only one-third the age of the present B&P Tunnel.) The section ends with a recapitulation of the levels of total traffic, passenger and freight, that the network bears currently and must be expected to handle in the future.

3.1 OVERVIEW OF THE EXISTING OPERATION

This section introduces the discussion of traffic levels by summarizing the types and quality of the transportation currently performed.

3.1.1 TRAFFIC MIX

Illustrating the diversity and complexity of the rail traffic mix to, from, within, and through the Baltimore region is the following partial list of today's train movements:

- Through- and local-freight train operations of CSXT between the Camden Station vicinity and Bay View Yard, via the Howard Street Tunnel;
- CSXT through-freight operations between Bay View Yard and Aikin, an interlocking station east of the Susquehanna River;
- Amtrak, MARC passenger, and NS through-freight operations between Perryville and the NS Bayview Yard in East Baltimore;
- CSXT freight operations and MARC commuter operations between the Camden Station area and Washington, DC;
- Intercity passenger and commuter rail operations through the B&P Tunnel and southward to Washington Union Station;
- CSXT and NS local freight yards and related movements in the Baltimore Terminal area; and
- Moves to and from the Canton and P&BR railroads and Maryland Port Administration and private port facilities, in places not readily accessible from the CSXT and NEC main lines.

3.1.2 SERVICE QUALITY

ON THE NEC

Even prior to marked traffic increases foreseen by 2050, the on-time performance of intercity passenger services on the NEC falls short of world-class standards. In the first five months of FY 2009, Acela Express service was 85 percent on-time while the Northeast Regional service was 77.5 percent on-time. Many and varied are the reasons for this performance – congestion outside of the Baltimore region, mechanical difficulties, failures in various system components such as downed electric traction wires, and heavy usage of portions of the NEC not controlled by Amtrak. But the cramped, old, and convoluted facilities in Baltimore do not alleviate the present and can do nothing to relieve the prospective performance challenges faced by Amtrak in its most important corridor. On the other hand, NS freight operations between Perryville and Baltimore are regarded as relatively reliable.

ON CSXT

MARC commuter passenger services between Baltimore and Washington on CSXT, as well as CSXT freight operations between Philadelphia and Washington, incur delays on a regular basis. The lack of capacity to operate existing levels of service is at issue. Over the years, analyses repeatedly have identified choke points, such as the Howard Street Tunnel, and the lack of track capacity between Baltimore and Washington.

The freight-only CSXT mainline between Perryville and Baltimore exemplifies the day-to-day difficulties of many railway operations in the study area. Single-tracked except for several short segments of double-track, the route is equipped with automatic block signals. Freight trains use one or more of the main tracks at Bay View Yard (East Baltimore) and locations in West Baltimore to set off and pick up cars. These operations consume track capacity and result in conflicts with other trains. Southbound freights that are unable to access Track 2 adjacent to Bay View Yard to set off and pick up are held on the signaled siding at Van Bibber, further consuming capacity. Under these circumstances, with so little margin of operating error over a fixed plant that presents challenges even when traffic is flowing smoothly, delays on the CSXT freight line north of Baltimore can escalate, thus affecting freight and passenger flows on CSXT's larger network.

Capacity and service issues like these reinforce the need for a careful scrutiny of the traffic patterns in the study region as a whole.

3.2 PASSENGER SERVICES

Passenger services in the study region include Amtrak's intercity trains (corridor and long distance) as well as MARC's commuter operations. These are described below.

3.2.1 INTERCITY PASSENGER TRAINS

As the owner as well as the operator of the NEC, Amtrak currently operates all intercity passenger trains in the Perryville–Baltimore–Washington corridor. High frequency and high speed (up to 125 mph) characterizes Amtrak service south of New York City.

Amtrak provides two types of intercity passenger service in the NEC: corridor-type services linking Boston, New York City, Philadelphia, Washington, Richmond, and intermediate points, and longer-distance services to and from points south of Washington and Richmond. In general, the corridor trains have fewer, and the longer-distance trains have greater, passenger amenities, in keeping with the contrasting journey lengths of the respective clienteles. This basic operational pattern of intercity passenger service is assumed, for analytical purposes, to continue indefinitely into the future, irrespective of any institutional changes that may occur.

EXISTING TRAFFIC LEVELS – INTERCITY PASSENGER

Corridor Services

Amtrak presently operates two categories of corridor service on the NEC:

- ***High-Speed.*** *Acela* is Amtrak's premium high-speed service, making a limited number of intermediate stops between Boston, New York City, and Washington. *Acela* offers reserved

First Class and Business Class seating. Scheduled trip times between New York and Washington range between 2 hours 45 minutes and 2 hours 53 minutes.[1]

- ***Regional*** – Amtrak's frequent *Northeast Regional* service provides numerous intermediate stops between Boston, New York City, and Washington, with selected trains continuing on to Richmond and Newport News, Virginia. *Regional* offers Business Class and coach seating. Current scheduled trip times between New York and Washington exceed three hours and vary according to the number of scheduled stops and the time of day. A single train[2] in both directions has traditionally operated overnight between Boston and Washington, with either connecting or through train arrangements for traffic to and from Richmond and Newport News. Amtrak groups all these conventional train services together under the category *"Regional."*

Extended Corridor Services

"Extended corridor" services operate in daylight over distances of some 600-650 miles or more, with modest amenities and no first-class accommodations. At present, Amtrak operates three extended corridor trains over the NEC:

- The ***Palmetto***, between New York and Savannah, Georgia;
- The ***Carolinian***, linking New York with destinations in Virginia and North Carolina; and,
- The ***Vermonter***, between Washington and northern Vermont.

Overnight services

Typically offering sleeping, dining, and lounge car facilities, Amtrak's overnight trains mainly accommodate long-distance travel, although some shorter-distance markets are served where schedules permit:

- ***Long Distance Trains*** – Amtrak operates two overnight round-trip trains (*Silver Star* and *Silver Meteor*) linking the NEC with destinations in Florida, Georgia, South Carolina, North Carolina, and Virginia.
- ***Crescent*** – Amtrak's *Crescent* links the NEC with destinations in Virginia, North Carolina, South Carolina, Alabama, Mississippi, and Louisiana.
- ***Cardinal*** – The *Cardinal* links New York–Washington, DC–Chicago on a three times a week schedule.

Amtrak's existing service offered in the NEC via Baltimore is summarized in **Table 3-1**. That the importance of this service to Amtrak cannot be overemphasized becomes clear in **Figure 3-1**.

Table 3-1. Existing Intercity Passenger Train Service through Baltimore

MARKET SERVED	TRAIN	LINE OF BUSINESS	NORTHERN TERMINUS	SOUTHERN TERMINUS
Northeast Corridor/ Virginia	*Acela*	Corridor	Boston	Washington
	Regional	Corridor	Boston	Washington/Richmond/Newport News
NEC-Georgia-Florida	*Palmetto*	Extended Corridor	New York	Savannah
	Silver Star	Overnight	New York	Florida
	Silver Meteor	Overnight	New York	Florida
NEC-North Carolina	*Carolinian*	Extended Corridor	New York	Charlotte
NEC-New Orleans	*Crescent*	Overnight	New York	Atlanta/New Orleans
NEC-Vermont	*Vermonter*	Extended Corridor	St. Albans, VT	Washington
NEC-Chicago	*Cardinal*	Overnight	New York	Washington – Chicago

1 All times are as of 2008, when the analyses for this report were completed.
2 This train, Numbers 66 and 67, has no sleeping car as this report goes to press.

IMPORTANCE OF THE BALTIMORE TUNNELS TO AMTRAK

Amtrak's route through Baltimore is crucial to the viability of all intercity rail passenger service in the United States. As demonstrated in the adjacent chart, fully one-fifth of Amtrak's passenger-trips and *one-third of its total ticket revenues* stem from trips making use of at least one of the NEC's Baltimore tunnels. Most of these trips depend on both the B&P and Union Tunnels.

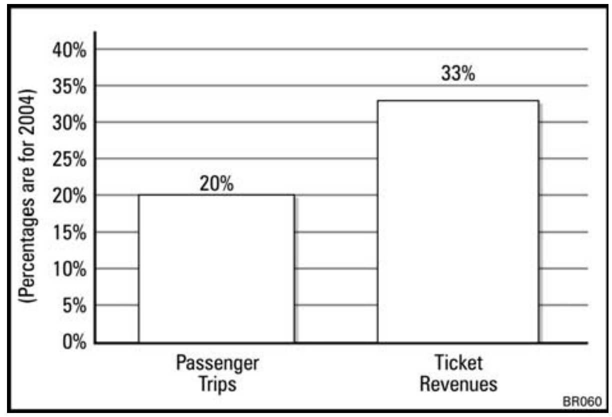

Figure 3-1. Percentage of Amtrak's Total Traffic Dependent on One or Both of NEC's Baltimore Tunnels

PROJECTIONS – INTERCITY PASSENGER

Amtrak has developed a 2015 planning timetable that contains corridor-type (high-speed[3] and *Regional*), extended corridor, and overnight services – the same types that exist today. After service reductions prior to 2008 due to budget constraints and equipment availability issues, Amtrak's train frequencies grow from a smaller base in 2008 than was previously expected. Amtrak expects its train volumes (total movements in both directions) to increase from 2008 to 2015 at a 0.43 percent annual compound rate – from 85 daily trains to 88 daily trains by 2015. From 2015 to 2050, Amtrak train volumes are assumed to grow at a lower annual rate of 0.25 percent, which yields 96 trains per day by 2050 – the assumed upper limit of the NEC's intercity passenger capacity. Significant investment, both in equipment and in bottleneck amelioration, would be required to support that growth rate. Operating longer intercity trains would accommodate some of the market's growth; for example, the *Acela* trainsets were designed to include up to 10 cars, thereby increasing available seating by approximately 85 percent over the present 6-car trainset. Throughput capacity in Pennsylvania Station, New York, constrains NEC operations during peak hours and would require attention and equitable resolution by all participating carriers in order to assure reliable intercity service under the increased frequency assumptions of this report.

This report assumes that all intercity passenger trains in the study region will continue to operate (a) through Baltimore and (b) on the NEC. No intercity passenger trains would originate or terminate in Baltimore, nor would there be any restoration of intercity service on the CSXT in the area under examination.

Table 3-2 summarizes the intercity passenger train volumes projected for 2050 and considered in this study. No increase in the number of overnight trains is foreseen. However, this study assumes the following:

- Corridor train movements would increase to 90 per day;
- Extended corridor services in the New York–Charlotte traffic lane would grow to eight movements per day;
- A new daylight round trip (two movements) would be instituted in the extended corridor between New York and Atlanta; and
- All other extended corridor services would retain their existing frequencies.

[3] Acela and Metroliner-type services.

Table 3-2. Projected Intercity Passenger Train Service through Baltimore, 2050

MARKET SERVED	TRAIN	LINE OF BUSINESS	NORTHERN TERMINUS	SOUTHERNTERMINUS	TRAIN VOLUME (WEEKDAY) ROUND TRIPS	TRAIN VOLUME (WEEKDAY) TRAIN OPERATIONS
NEC/Virginia	*Acela*	Corridor	Boston	Washington	25	50
	Regional (includes Virginia service)	Corridor	Boston	Washington/ Richmond/ Newport News	12	24
NEC-Florida	*Palmetto*	Extended Corridor	New York	Savannah	1	2
	Silver Star	Overnight	New York	Florida	1	2
	Silver Meteor	Overnight	New York	Florida	1	2
NEC-North Carolina	*Carolinian*	Extended Corridor	New York	Charlotte	4	8
NEC-Atlanta-New Orleans	*Crescent*	Overnight	New York	Atlanta/New Orleans	1	2
	Daylight train	Extended Corridor	New York	Atlanta	1	2
NEC-Vermont	*Vermonter*	Extended Corridor	St. Albans, VT	Washington	1	2
NEC-Chicago	*Cardinal*	Overnight	New York	Washington – Chicago	1	2
Total projected intercity passenger train volumes, 2050					**48**	**96**

3.2.2 COMMUTER SERVICE

As shown in **Figure 3-2**, the Maryland Department of Transportation, Mass Transit Administration, operates an extensive commuter rail network through the study region: two lines between Baltimore and Washington ("Camden Line" via CSXT, "Penn Line" via NEC) and an extension of the Penn Line between Perryville (on the Susquehanna River) and Baltimore (with service to and from Washington). Additional services, not directly affecting Baltimore, operate northwest from Washington over CSXT's Metropolitan Subdivision to Montgomery County, Brunswick, and Frederick (Maryland) and to Martinsburg (West Virginia).

EXISTING TRAFFIC LEVELS – COMMUTER

Today's commuter operations are not recent additions, as the B&O and PRR always offered local services in this region; however, today's rush-hour frequencies are greater than those of the mid-1950s.[4] Thus, today's commuter services impose a relatively new pressure on the available capacity of the rail infrastructure that has not changed in most respects in the intervening decades. Future expansion and relocation of personnel to Ft. Meade and Aberdeen Proving Grounds, because of the Defense Base Closing and Realignment Commission (BRAC) program, will bring added commuters to the region. The pressure is all the more intense on the existing infrastructure because of the concentration of both intercity and commuter traffic in the rush hours, particularly in the afternoon.

[4] For example, in 1956, the PRR offered only two afternoon rush-hour (between 4 and 6 p.m.) local departures from Washington to Baltimore; today's Penn Line offers five such departures. The B&O offered two local departures in the same hours from Washington to Baltimore; MARC's Camden line today offers four such departures. Thus, today's rush hour frequencies are at least double those of 1956. *Official Guide of the Railways,* July 1956, pp. 339 (PRR) and 428 (B&O); today's MARC schedules from the Maryland MTA web page, http://www.mtamaryland.com/services/marc.

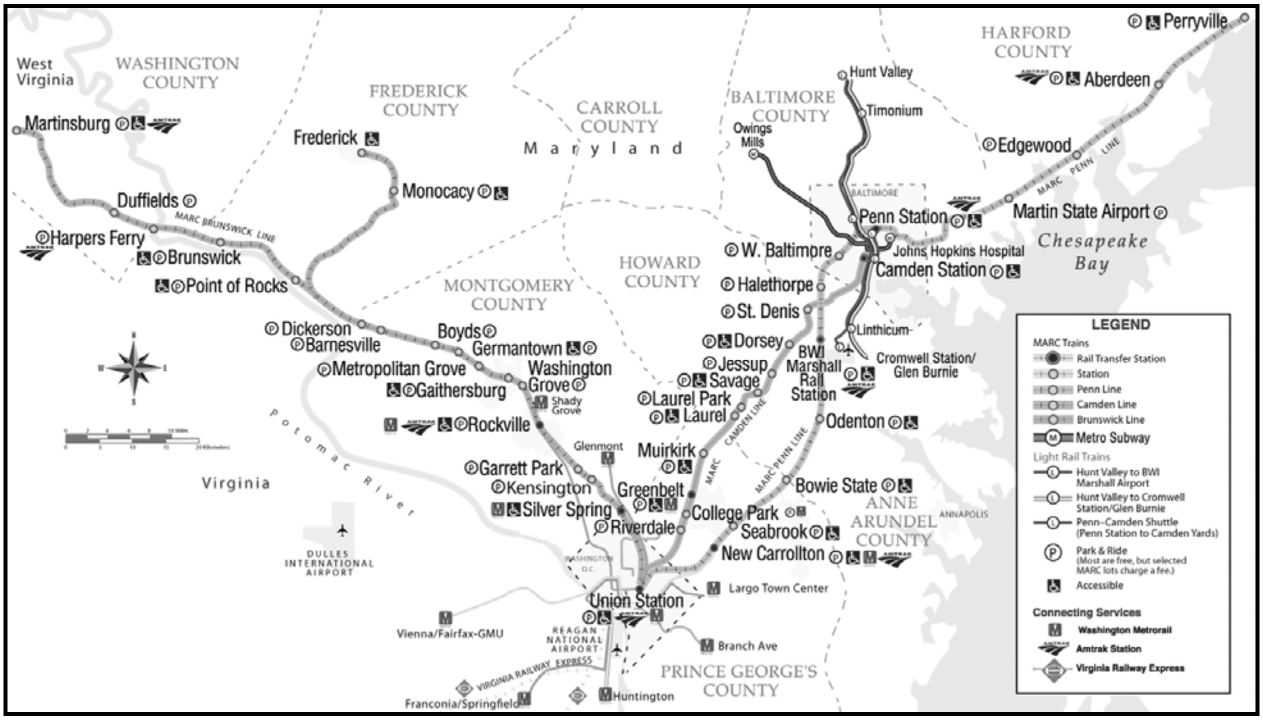

Figure 3-2. MARC System of Commuter Lines

PROJECTIONS – COMMUTER

Over the entire planning period, commuter operations are expected to grow at an annual compounded growth rate of about one percent for the long-established Camden and Penn (Baltimore–Washington) Lines, and at a rate just short of two percent for the newer Penn Line extension between Perryville and Baltimore. However, Baltimore–Washington commuter operations are expected to remain much more frequent than the service north of Baltimore (**Table 3-3**). The expected frequency increases reflect MARC's 2020 planning timetable, extrapolated to 2050 at sharply reduced growth rates for the Camden and Perryville routes, and at a slightly increased rate for the Penn (Baltimore–Washington) segment. That these growth rates are relatively modest results from the assumed use of longer, higher-capacity trains to satisfy surging demand.[5] MARC trains on the Penn Line are assumed to be electrified and operating with 7-car consists, which reduces growth in the number of MARC trains operated on the line, while providing a substantial increase in ridership capacity.

The study team expects commuter train volumes on the Baltimore-Washington Penn Line services to grow some 23 percent between 2008 and 2050. Thus, in any further elaboration of the present study, the Camden and Penn Line commuter projections will have to be compared in detail with likely CSXT, NS, and Amtrak traffic levels to determine the level of capacity improvements that would be necessary to protect the reliability and frequency of all services. Furthermore, since the Baltimore region has numerous rail lines, a widely-distributed population, and severe motor vehicle congestion, new commuter services also are possible by 2050. The feasibility and cost of any such new services would relate closely to comprehensive planning for rail operations and facilities in the study area.

5 Recently, MARC has developed higher train movement projections than used in this report. However, the projections in this report are used to demonstrate the capacity of the passenger tunnels, not to detail the railroad network modifications needed between Washington, DC and Perryville, MD to handle the additional commuter service. In fact, the double-track tunnels can accommodate far more movements than those projected in this report.

Table 3-3. Projected Growth in MARC Commuter Traffic

ROUTE	ROUND TRIPS PER WEEKDAY			TRAIN OPERATIONS PER WEEKDAY			AVERAGE ANNUAL COMPOUNDED GROWTH RATES		
	2008	2020	2050	2008	2020	2050	PERIOD 2008-2020	PERIOD 2020-2050	AVERAGE 2008-2050
MARC Camden Line (via CSXT) – Baltimore and Washington[1]	9	15	18	18	30	36	2.41%	0.60%	2.38%
MARC Penn Line (via NEC) – Perryville and Baltimore[2]	8	12	14	16	24	28	2.41%	0.60%	1.79%
MARC Penn Line (via NEC) – Baltimore and Washington	26	27	32	52	54	64	2.41%	0.60%	0.55%

[1] Does not include any deadhead moves (nonrevenue round trips) between Riverside Yard and Camden Station.

[2] Includes six deadhead trains (the equivalent of three nonrevenue round trips) between Baltimore and Perryville in the base year. The proportion of deadhead to total movements in future years will depend on MARC's operational planning and the availability of storage facilities at appropriate locations.

3.3 FREIGHT SERVICES

The following discussion examines the existing and projected freight services in the Baltimore region.

3.3.1 EXISTING TRAFFIC LEVELS

The predominant rail freight operations in and through the region are those of its two primary Class I carriers, CSXT and NS.[6] However, smaller railroads provide important localized services as well, the protection and furtherance of which will require close attention in any further planning.

CSXT

CSXT operates through- and local-freight services over the length of the study corridor. The route traverses the Baltimore Terminal, which consists of the Howard Street Tunnel and a series of yards in East and West Baltimore that serve local customers and the Port of Baltimore. (CSXT also provides rail service to the Morgantown and Chalk Point Power Plants located on the Popes Creek Branch, which intersects the NEC at Bowie; the unit coal trains operate through Benning Yard, Landover, and Bowie.)

NS VIA NEC

NS currently provides through- and local-freight service between Harrisburg and Baltimore on the NEC. From Harrisburg, through-freight and unit coal trains operate via the "Port Road" along the Susquehanna River to Perryville, and then via the NEC to the NS Bayview Yard. NS operates local-freight trains from Bayview Yard to locations south of the B&P Tunnel. NS has overhead rights to operate between Baltimore and Alexandria, Virginia, then to Manassas and the southeastern United States on its Piedmont Division. Presently, NS does not operate through-freight trains between Bayview Yard and Alexandria. However, NS does operate unit coal trains for the Popes Creek Branch. The trains exit the NEC at Bowie, and CSXT subsequently delivers them.

Most of the comparatively slow freight service on the corridor operates at night to avoid conflicts with the much faster intercity and slightly faster commuter trains. In fact, Amtrak restricts all freight trains to a maximum speed of 30 mph between 6:00 a.m. and 10:00 p.m. Amtrak permits solid intermodal trains and solid empty hopper trains to operate at various speeds up to 50 mph between 10:00 p.m. and 6:00 a.m.

[6] In addition, the Delaware and Hudson Railway (D&H), part of the CP Rail System, has overhead trackage rights over the NEC from Perryville to Alexandria, Virginia to permit it to interchange with railroads serving the southeastern United States.

LOCAL MOVEMENTS

The Patapsco & Back Rivers (P&BR) and Canton Railroads provide important local movements to and from port and industrial sites on the east side of Baltimore Harbor. Access between these smaller carriers, the CSXT and NS, and local industrial and port facilities is provided by means of various interchange and switching arrangements worked out among the carriers and industries. In addition, CSXT and NS need to interchange freight among themselves and move cars between the two sides of the port. All of these additional movements are over and above those shown in the summary table of existing main line railroad services in the study area (**Table 3-4**).

3.3.2 PROJECTIONS – FREIGHT

Forecasts of future freight traffic through Baltimore are difficult to predict for the following reasons:

- Provision of a modernized facility with improved clearances, grades, and curves will constitute a marked "paradigm shift" that will open the door to new traffic flows – originating, terminating, through, and local. Standard forecasting methods are of uncertain value in such a situation;
- Developments in the rail industry – for instance, mergers or improvements in other parts of the grid – could alter some freight traffic flows; and
- The future of the industrial base in the NEC States is unclear, as the recently projected closing of GM's Baltimore assembly plant exemplifies.

In making the following projections, the study team assumed no major structural change in America's freight railroad industry and no significant shift in the economic base of the Baltimore region or of the NEC megalopolis. Any such fundamental modifications would, of course, affect the projections and might alter the conclusions of any follow-on studies. Another source consulted for freight traffic projections was the "National Rail Freight Infrastructure Capacity and Investment Study" prepared for the American Association of Railroads, September 2007.

UNDERLYING GROWTH IN FREIGHT VOLUMES

Freight trains by service type constitute the appropriate unit of measure for this study because the number and performance of trains is the primary, but not the only, determinant of capacity. Other measures such as train weight and length also have a role in the design of betterments, for example, in the determination of siding length.

The four basic service types are:

- "Premium" – intermodal, i.e. trailers or containers;
- "Unit" – single-commodity, e.g. coal;
- "Merchandise" – all other through freight; and
- "Local" – operating within the study area.

Table 3-5 summarizes the annual compound growth rates that were applied to both CSXT and NS traffic levels before some carrier-and site-specific adjustments were implemented.

The projections in Table 3-5 reflect categories[7] by train type for the period 2008-2050. The post-2008 projections use, as their upper limit for the "high" case, the historical growth in tonnage for the Eastern Class I railroads; this maximum growth rate is adjusted downward to acknowledge long-term increases in tonnage per train. The "low" case assumes growth rates on the order of two-thirds of the "high."

[7] NS provided no projections but, warning of the volatility of any such forecasts, took no exception to those adopted in this report. Letter from Steve Eisenach, NS's Director of Strategic Planning, to Richard U. Cogswell of FRA, August 25, 2003.

Table 3-4. Existing Main Line Railroad Services in the Study Area[1]

TYPE OF SERVICE	NEC PERRYVILLE – BALTIMORE[2]	NEC BALTIMORE – WASHINGTON	CSXT AIKIN – EAST BALTIMORE	CSXT WEST BALTIMORE[2]– HYATTSVILLE[3]
Passenger				
Intercity				
Corridor-type services				
Acela Express	32	32		
Regional (includes Virginia and "overnight" NEC services)	42	42		
Total – Corridor Services	**74**	**74**		
Extended corridor services				
NEC–North Carolina (*Carolinian*)	2	2		
NEC–Georgia (*Palmetto*[4])	2	2		
NEC–Vermont (*Vermonter*)	2	2		
Total – Extended Corridor Services	**6**	**6**		
Overnight services				
NEC–New Orleans (*Crescent*)	2	2		
NEC–Florida (*Silver* Service)	4	4		
NEC–Chicago (*Cardinal*-three times weekly)	1	1		
Total – Overnight Services	**7**	**7**		
Total Intercity Passenger	**87**	**87**		
Commuter				
MARC Camden Line				18[5]
MARC Penn Line (includes Perryville)	18[6]	52		
Total Commuter	**18**	**52**		**18**
Total Passenger Services	**105**	**139**		**18**
Freight [7]				
CSXT	0	2[8]	22	33
NS	9	2[8]	0	0
Total Freight Services	**9**	**4**	**22**	**33**
Study Area Total	**114**	**143**	**22**	**51**

1 Total trains on a typical weekday (round trips count as two trains). Because of the variability and directional imbalance of traffic flows, the numbers shown are estimates and vary by day of week and season of year.

2 Amtrak Penn Station and MARC Camden Station, as applicable.

3 "JD", where trains to Benning, Alexandria, and Richmond divert from the CSXT Capital subdivision.

4 Classification of the Palmetto as an "extended corridor" service actually began in 2004. In 2003, it was an overnight service that served Florida as well – but without first-class accommodations.

5 Does not include 10 "deadhead," i.e., nonrevenue train movements, from Riverside Yard, Baltimore to Camden Station.

6 Includes six deadhead trains between Baltimore and Perryville.

7 Includes through-freight, local, and coal trains.

8 Includes local and coal trains that exit at Bowie, MD.

(Number of Weekday Train Operations, Winter 2009 timetable, by Segment. Total Both Directions – Round Trip Counts as Two Operations). Three times weekly Cardinal rounded up to 1 trip per day in one direction.

Table 3-5. Projected Annual Growth Rates in Freight Train Traffic Levels

TIME PERIOD	SERVICE TYPE							
	PREMIUM		UNIT		MERCHANDISE		LOCAL	
	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
2008 – 2012	0.85%	1.36%	0.58%	0.93%	0.67%	1.07%	0.67%	1.07%
2012 – 2020	0.85%	1.36%	0.58%	0.93%	0.67%	1.07%	0.67%	1.07%
2020 – 2030	1.00%	1.61%	0.53%	0.86%	0.78%	1.25%	0.67%	1.07%
2030 – 2050	0.89%	1.43%	0.53%	0.86%	0.67%	1.07%	0.67%	1.07%

Trains in premium service are expected to grow relatively quickly after 2020 on the assumption that capacity and clearance improvements both within and adjoining the study region will allow a fuller range of auto-rack and double-stack container cars to pass through Baltimore, thus better allowing rail to compete with truckers in the I-95 and I-81 corridors. By contrast, growth in unit-train volumes would lag behind that of other service types, while traffic may increase in such cargos as municipal solid waste. Reductions in coal use for electric power generation are possible for environmental reasons.

SITE- AND CARRIER-SPECIFIC PROJECTIONS

Beyond the general projections of freight traffic increases, the study team assumed that NS would, by 2020, divert from its Shenandoah Valley–Manassas–Hagerstown routing a pair of merchandise trains and a pair of premium intermodal trains between Alexandria, VA and Perryville, MD via the NEC through Baltimore.[8] Also assumed was the diversion of a second pair of merchandise trains and a second pair of premium intermodal trains by 2030. This rerouting anticipates both the physical improvements mentioned above and a resolution – mutually beneficial to both the NEC's owner and NS – of the cost of, and appropriate time slots for, running freight on the high-speed passenger corridor north of Washington.

DISTRIBUTION OF FREIGHT TRAIN VOLUME BY SEGMENT AND TRAFFIC LANE

In the study area, CSXT originates and terminates numerous trains to and from the west and south and fewer trains to and from the east and north. Numerous CSXT trains operate through Baltimore. It is projected that these patterns will continue.

NS presently originates local trains in Baltimore that operate between Baltimore and Washington and return. While NS has the rights to operate trains between Baltimore and Alexandria (Virginia) using CSXT tracks south of Landover, Maryland, it presently does not do so. Thus, all NS through-freight trains presently operate between Baltimore, Perryville, and Harrisburg, PA. As mentioned above, it is anticipated that the implementation of capacity and clearance improvements through Washington and Baltimore would result in an increase in the number of NS trains routed to Baltimore, via Alexandria and Washington.

DETAILED PROJECTIONS OF FREIGHT VOLUMES

Table 3-6 provides a breakdown of expected freight train volumes by segment, railroad, and type of freight service.

[8] These trains would use NS's trackage rights over the freight route through Washington, DC, as well as NS's freight line between Anacostia and Landover. CSXT currently owns the entire railroad from Alexandria (where the junction with the NS lies south of the passenger station), across the Potomac River on the Long Bridge, through Southwest DC, and via the Virginia Avenue Tunnel and the bridge over the Anacostia River to the junction with the NS freight route to Landover and the NEC. Historically, however, most of the route belonged to the PRR, Penn Central, and Conrail, and passed into CSXT's ownership (with the NS trackage rights) at the time of the Conrail breakup.

Table 3-6. Projections of Freight Trains by Railroad, Segment, and Year

TYPE OF FREIGHT SERVICE	2008	2012		2020		2030		2050	
		LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
CSXT: Aikin - Baltimore									
Premium	8	8	8	9	9	10	11	12	15
Unit	5	5	5	5	5	5	6	6	7
Merchandise	9	9	10	10	10	11	12	12	15
Locals	0	0	0	0	0	0	0	0	1
Freight Total	22	22	23	24	24	26	29	30	38
NEC: Perryville - Baltimore									
Premium	4	4	4	6	6	9	9	11	13
Unit	2	2	2	2	2	2	3	3	3
Merchandise	2	2	2	4	4	7	7	8	9
Locals	1	2	2	2	2	2	2	2	2
Freight Total	9	10	10	14	14	20	21	24	27
CSXT: Baltimore - Washington									
Premium	15	15	16	16	18	18	21	22	28
Unit	6	6	7	7	7	7	8	8	9
Merchandise	11	11	11	12	12	13	14	15	18
Locals	1	1	1	1	1	1	1	1	1
Freight Total	33	33	35	36	38	39	44	46	56
NEC: Baltimore - Washington									
Premium	0	0	0	2	2	4	4	5	5
Unit	0	0	0	0	0	0	0	0	0
Merchandise	0	0	0	2	4	4	4	5	5
Locals	2	2	2	2	2	2	2	2	3
Freight Total	2	2	2	6	8	10	10	12	13

NOTE: Low and high projections were only estimated for 2020 and later years.

The study team regards these freight projections as balanced between optimism and pessimism, as taking into account both the historical trend lines in tonnage and train payloads and recent evidence of transition from manufacturing to service in certain sectors of the economy of the Middle Atlantic states. However, in such a case as that of Baltimore, there is a danger in equating "balanced," even "low" traffic projections, with "conservatism." To under-design a multi-billion dollar facility that will, if the past is any guide, likely serve the Nation for over a hundred years, could lead to a recurrence of today's impasse and hobble commerce for many decades – until a future generation re-studies the situation and invests in a "fix." Moreover, the incremental cost of added capacity in a project of this magnitude is far less than that of a future expansion, at least in current-dollar terms – particularly if the initial design makes cost-effective provision for possible future expansions. For these reasons, it will be important in any future studies to test a range of traffic assumptions and determine the related costs and benefits of various levels of capacity and utility.

3.4 TOTAL TRAIN MOVEMENTS, ALL TRAFFIC TYPES

Both the CSXT and NEC main lines are largely multipurpose facilities and will most likely remain so.[9] Thus, the interaction among train types and the total traffic burden to be borne by each facility are important considerations in planning. The following sections, therefore, consolidate the traffic statistics and projections for the main facilities under analysis.

[9] However, as will be seen, specific restructuring of alternatives may alter particular line segments to specialized roles.

3.4.1 EXISTING TRAFFIC LEVELS

Table 3-4 portrays the average weekday traffic, in terms of total train operations in both directions, over the main line railroads in the study area.

Passenger operations are almost always scheduled in advance and relatively easy to characterize accurately. Freight operations, however, are less predictable than passenger services, in terms of arrival and departure times, train size, and frequency in a given period. Freight trains' performance capabilities vary significantly, as does their compatibility with passenger trains. For example, unit trains (carrying coal and grain) generally have a lower horsepower-to-tonnage ratio than more time-sensitive trains; the former are usually restricted to lower speeds than the latter. Thus, a general merchandise or intermodal train ordinarily takes less time to clear a given route segment than a unit coal train. An intermodal train (with an average speed of approximately 45 mph) takes less time to clear a given route than a commuter train, which makes frequent stops. Readers should bear these factors in mind when reviewing Table 3-6 and similar traffic summaries. A railway route segment's capacity depends not just on its physical layout and condition or on the sheer number of trains it carries, but on the complex interactions between a variety of train types having widely varying performance characteristics. This is especially true in the Baltimore region with its diverse traffic mix.

3.4.2 PROJECTIONS

Table 3-7 summarizes the mix of services as foreseen for the year 2050. The same projection appears in graphical form, with intermediate years' traffic levels, in **Figure 3-3**. Both displays make use of the "high" projections, which pertain to freight traffic only. An overview of the growth of total train movements for all rail services in the two major traffic lanes – north and south of Baltimore – appears in **Figure 3-4**.

The simple number of daily trains envisioned in Table 3-7 and Figure 3-3 for a typical 24-hour period does not adequately depict the potential congestion in the main lines of the study region. Intercity passenger trains are concentrated into an 18- rather than a 24-hour day since operations between 11:00 p.m. and 5:00 a.m. are minimal. Furthermore, a business-oriented corridor such as the NEC, in which most trips are under 225 miles and take less than 3 hours, will tend toward a schedule with additional train departures at the start and end of the business day. Commuter trains have even more pronounced two- to three-hour morning and evening peaks. Freight operations – typically unscheduled on American railroads – are not only random to a degree but also subject to circumstances that may occur hundreds of miles away from the study area.[10] Thus, an assessment of the potential for congestion requires the analysis of the complex interactions of through-freight, local-freight, and passenger trains in congested portions of the study region over a typical week.[11]

3.5 RECAPITULATION: THE CHALLENGES IN BRIEF

As Figure 3-4 demonstrates, the demand for total train movements of all types is expected to increase by about 37 percent by 2050 from its 2008 levels. In 2050, such a heightened pressure for transport would place a huge incremental load on a rail network that would, if left unchanged:[12]

[10] The same unpredictability currently affects Amtrak's overnight and extended corridor operations over the freight railroads, which then impact NEC reliability.

[11] Multi-day simulations are necessary because of the variability of freight traffic. In any event, detailed capacity analyses of freight and passenger operations and interactions, in a terminal zone of Baltimore's complexity, would make use of computerized train performance and simulation models and are beyond the scope of the present study. For recent examples of modeling techniques of this type, readers are referred to recent transportation planning reports by Amtrak and FRA on the Washington–Richmond, Philadelphia–Harrisburg, and Richmond–Charlotte corridors at http://www.fra.dot.gov/us/content/1240.

[12] This statement assumes that the physical facilities can survive for another half-century – an assumption for which no conclusive engineering backup presently exists. As explained later in this report, the design life for new tunnels is 120 years.

Table 3-7. Projected Railroad Services in the Study Region – 2050

TYPE OF TRANSPORTATION SERVICE	CSXT AIKIN – BALTIMORE	CSXT BALTIMORE – WASHINGTON	NEC PERRYVILLE – BALTIMORE	NEC BALTIMORE – WASHINGTON
Passenger Services				
Intercity				
Acela	0	0	50	50
Regional/Extended Regional	0	0	38	38
Overnight	0	0	8	8
Total Intercity	**0**	**0**	**96**	**96**
Commuter Services	0	36	28	64
Total Passenger Services	**0**	**36**	**124**	**160**
Freight services – *High Volume*[1]				
NS[2]			27	13
CSXT	38	56[3]		
Total Freight Service – High Volume	**38**	**56**	**27**	**13**
Grand Total, Projected Train Operations with Freight Service at High Volume	**38**	**92**	**151**	**173**
Freight services – *Low Volume*[1]				
NS[2]			24	12
CSXT	30	46[3]		
Total Freight Service – Low Volume	**30**	**46**	**24**	**12**
Grand Total, Projected Train Operations with Freight Service at Low Volume	**30**	**82**	**148**	**172**

[1] With respect to freight traffic, which will show daily directional imbalances and volume fluctuations, the numbers shown must be regarded as projected daily averages over time.

[2] Includes through-freight, local, and coal trains.

[3] Includes trains south to Alexandria/Richmond and west to Cumberland.

(Number of daily train movements by segment, total one way trips for both directions.
NOTE: "High" and "Low" ranges apply only to freight.)

- Date back between 100 and 150 years, in some cases even further back;
- Hamper train movements with a geometry more fitting for mountainous terrain than for the tidewater East Coast of the United States;
- Present capacity constraints that already (in 2004) discourage rail transport and favor other modes that themselves are chronically congested;
- Consume crew time and fuel well beyond what an efficient railway would require, thus "ballooning" railway operating expenses for all carriers concerned;
- Add to freight transit times and unreliability, thus imposing costs on shippers up and down the East Coast – not just in the study area;
- Inflate intercity passengers' and commuters' travel time due to slow schedules and erratic performance through Baltimore, thus making auto travel relatively more attractive; and
- Impose social costs due to all of the inefficiencies inherent in the system.

It is the purpose of the balance of this report to describe alternatives that would reverse these inherent difficulties by improving train routings, expanding freight clearances, and enhancing freight and passenger operations and capacities in the Baltimore region.

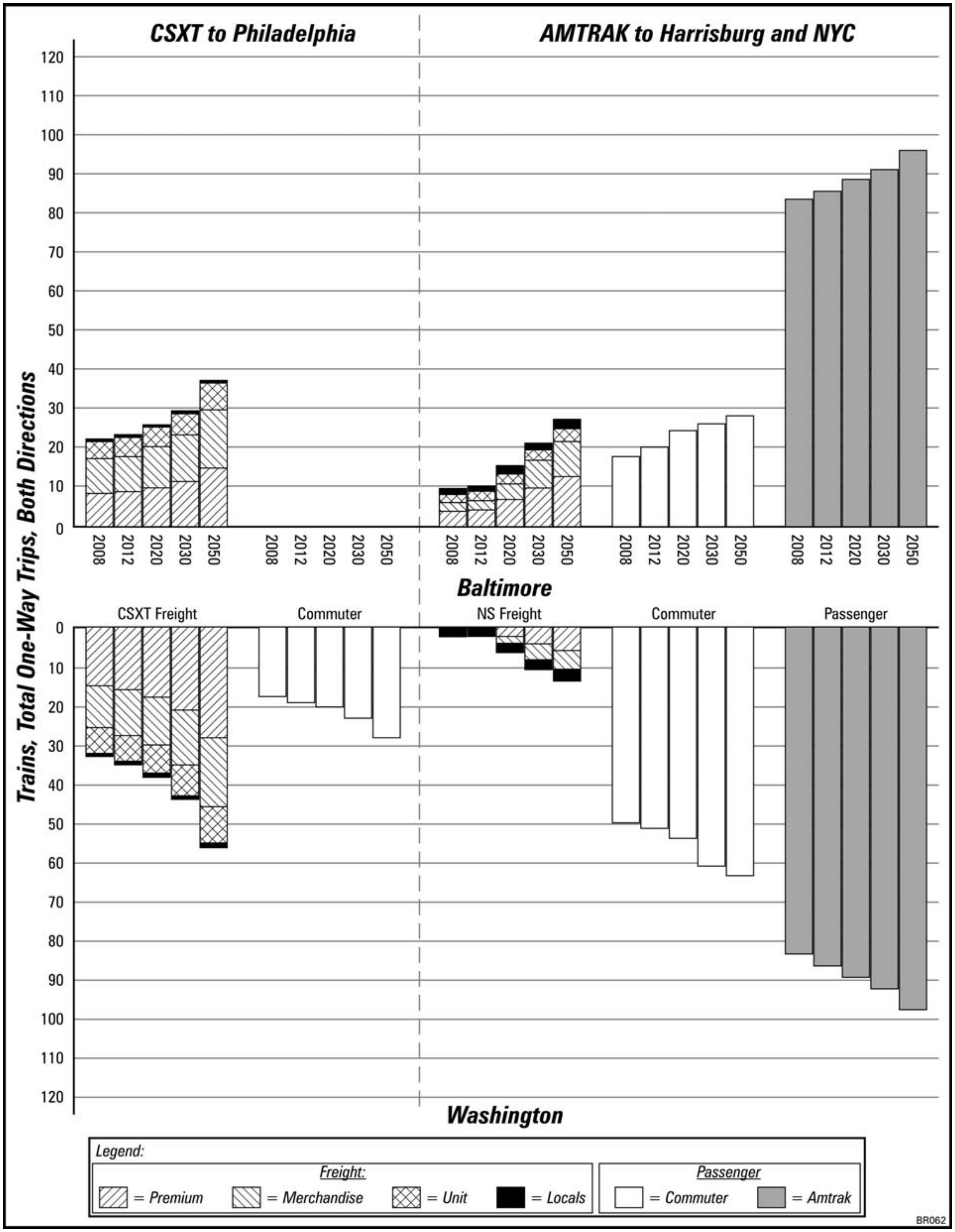

Figure 3-3. Expected Trends in Train Volumes in the Study Region by Year and Service Type, "High" Range[13]

[13] The "high" and "low" ranges pertain only to freight. See Table 3-6.

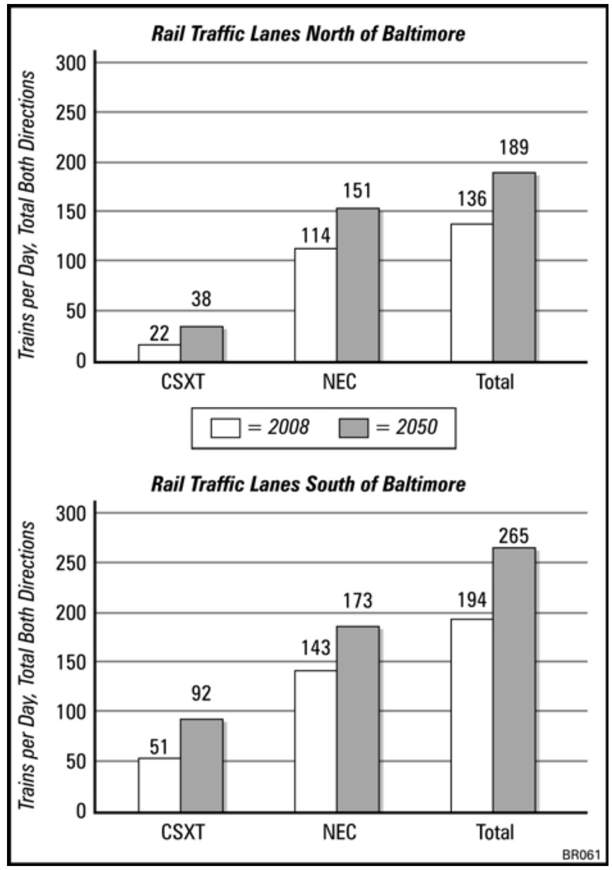

Figure 3-4. Overview of Expected Rail Volume Growth, All Service Types in the Baltimore - North and Baltimore - South Traffic Lanes (With "High" Freight Traffic Levels)

4 – NO-BUILD SCENARIO

4.1 THE NO-BUILD SCENARIO

Absent a replacement for the CSXT Howard Street Tunnel and the Amtrak B&P Tunnels, the railroads will be left with their existing routes through Baltimore. The No-Build Scenario assumes the existing tunnels and tracks are kept in place. However, improvements to approach trackage of the Baltimore-area network are assumed. These assumed improvements enable the trains defined in the future traffic levels (Section 3) to reach the Baltimore region so that the existing track and tunnel network can be simulated to determine maximum capacity.

4.1.1 OPERATIONS

To identify the capacity of the No-Build Scenario, the 2050 passenger service was simulated as a baseline to measure the performance of the network in the absence of any congestion caused by operating freight trains. This baseline passenger service acts as the benchmark by detecting when the overall performance of the network begins to deteriorate in the face of growing freight traffic. Acela high-speed trains and Regional were given first priority, followed by commuter and long-distance passenger trains. Freight trains were dispatched on a first come-first serve basis. Successive simulations were run, increasing the CSXT and NS freight volumes from current 2008 levels to 2020, 2030, and finally 2050 forecast levels and observing how passenger train delays increase as a result.

NS currently operates into Baltimore from the north, entering the NEC at Perryville. Its coal, merchandise, and priority trains operate to Bayview Yard. This involves making a crossing movement against the current of traffic at "Gunpowder" to reach Bayview Yard from the southbound main track. Northbound, these same trains must again make a movement against the current of traffic at "Perry" to reach the Port Subdivision headed north to Harrisburg and Enola Yard. These crossing movements are the primary source of delays for NS freight trains.

CSXT's freight issues occur on the long single-track section through the Howard Street Tunnel (under downtown Baltimore) and Clifton Park. As the number of trains operating through the single-track segment increases, total delays and delays per train increase. At the current (2008) level of trains, delays at Howard Street Tunnel are infrequent (southbound) or of a short duration (northbound), based on the somewhat randomized arrival of trains. As the number of trains increases, the probability of conflicts increases proportionally and the likelihood of a second train being held (and delayed) behind the first train increases. Southbound trains held at Bay View or Clifton Park cannot be given priority through the single-track segment without risking further delays to the MARC commuter trains when northbound trains are held at "Carroll" and "Halethorpe".

CSXT freight trains do not create significant congestion issues for the MARC commuter trains operating between Washington and Camden Yards, nor do the commuter trains add any delays to the CSXT freight trains. The speed differential between CSXT freight (50 mph) and the commuter trains, and the small number of MARC commuter trains, do not produce detectable impact on the MARC service until year 2050 when an additional 1-2 minutes of delay per MARC train is incurred.

4.2 ALTERNATE ROUTES BYPASSING BALTIMORE

If significant improvements to capacity through Baltimore are not made, both freight operators have other routes that could be used to bypass Baltimore. The supporting route structure for NS and CSXT are dramatically different, however, and affect both railroads' current operating strategies and their ability to economically divert traffic away from Baltimore. **Table 4-1** shows the distance and nominal transit time over each bypass route. The running times are based on the timetable freight speeds on each segment of the route. Actual running times would be significantly longer due to terminal dwells, delays on sidings, etc., but this does provide a basis for comparing the transit time difference between the routes.

Table 4-1. Alternate Route Comparison

CSXT	VIA BALTIMORE			VIA CINCINNATI			SAVINGS	
Alternate Routes	Miles	Time	MPH	Miles	Time	MPH	Miles	Time
Waycross–Oak Island	920.0	17:31:00	52.52	1652.7	37:06:37	44.53	732.7	19:35:37
Atlanta–Oak Island	929.4	19:39:49	47.27	1375.6	31:13:03	44.07	446.2	11:33:14
Waycross–Selkirk	1061.1	21:17:04	49.85	1522.4	33:25:21	45.55	461.3	12:08:16
Atlanta–Selkirk	1059.7	23:21:05	45.38	1245.3	27:31:47	45.23	185.6	4:10:41
NS	**VIA BALTIMORE**			**VIA HAGERSTOWN**			**SAVINGS**	
Alternate Routes	Miles	Time	MPH	Miles	Time	MPH	Miles	Time
Manassas–Oak Island	247.5	5:32:25	44.67	359.1	8:49:08	40.72	111.6	3:16:44

NS has a much simpler bypass for its north-south business and has already diverted freight from the traditional "Potomac Yard gateway–NEC" route that would move traffic through Baltimore. The bypass route leaves the NS main line network at Manassas Junction and runs to Front Royal, VA, where it connects to the Roanoke, VA – Hagerstown, MD – Harrisburg, PA inland route. This route is already better for traffic headed to New England, which NS accesses using haulage rights over the Canadian Pacific (former D&H) from Sunbury, PA to Albany. The remaining north-south traffic is generally intermodal traffic or carload freight for north Jersey (or Philadelphia–south Jersey) served by the railroads' joint Conrail subsidiary. As noted in Table 4-1 above, the route via Hagerstown adds 111.6 miles (to Oak Island) and over 3 hours to the transit time. While adding some incremental cost for the added time and mileage, this routing is currently preferred and used exclusively by NS. The primary reason for using this circuitous routing is the Plate C clearance restriction on the B&P Tunnel. Use of the Hagerstown routing eliminates the expensive and time-consuming need to switch out high dimension cars in order for a train to be routed through Baltimore. Any decision by NS to return freight traffic to Baltimore will depend on the available capacity of its Hagerstown route versus an improved Baltimore route, and possibly community resistance to increase freight trains in the Manassas–Front Royal area.

CSXT's route structure does not lend itself to an efficient bypass routing to its current Richmond–Washington–Baltimore route into the Northeast and New England. It lacks a close-in bypass around Washington and Baltimore. Without running through Baltimore, CSXT traffic must operate via Cincinnati–Willard–Buffalo to Selkirk Yard (the latter is its gateway yard to New England). Traffic for the crucial northern New Jersey market would then be back-hauled some 130 miles and nearly four more hours to reach the northern New Jersey terminals. Further, segments of CSXT's bypass route via Cincinnati (Waycross–Atlanta or Atlanta–Cincinnati) are already under severe capacity pressure due to the levels of coal moving to Florida and other southeastern destinations and much of these routes are still single-tracked. While traffic from Atlanta (and points west and southwest) heading to New England via Selkirk might be diverted via Cincinnati at a modest cost in miles and time, traffic heading to north Jersey would suffer disproportionately because of the back-haul from Selkirk to Oak Island. The conclusion is that the north-south freight route through Baltimore is essential to CSXT's markets and operations and that alternatives are significantly longer and have their own capacity constraints that will need addressing in the future.

In order to provide the capacity for the 2050 service levels, the inland NS and CSXT routes would require double-track, which involves considerable expense given the additional grading, bridges interlockings, yard improvements, and signaling. Furthermore, the additional transit time and mileage of the inland routes may negatively affect the competitive position of the potential traffic to the point where it would not be diverted at all to rail; thus, the environmental benefits of rail transport for this traffic would be lost to the states along the I-95 corridor.

4.2.1 RESULTS

Managers of freight service are less concerned with maintaining precise timetable schedules than with sustaining overall traffic flows (fluidity) throughout the network. Given the variability in arrival times for freight trains entering the Baltimore network, a better measure of performance is the running time required for trains to transit the Baltimore region, between JD (Hyattsville, MD)-Aikin (CSXT) and Landover–Perryville (NS). Since the freight railroads operate on different routes, there are significant differences in the interpretation of the freight delay results. The delays to freight trains in **Table 4-2** are calculated against a nominal scheduled running time. Effectively, the freight railroads "budget" a 2-2:30 hour slot to move trains through the Baltimore area. The delays for freight trains are measured against this "budgeted" time standard rather than against the absolute running time differential, as is done for passenger trains. There is an expectation of some delay and a variance in the working times at yards, etc., built into the schedule. The delays reported in Table 4-2 are when trains are held in excess of this standard.

Table 4-2. Year 2050 No-Build Scenario Average Delay Minutes per Passenger and Freight Train

Simulation Alternative		No-Build
Passenger		Existing B&P Tunnel
Service	Dir.	Late/Train
ACELA	N	0:00:48
	S	0:01:06
Regional	N	0:00:36
	S	0:00:19
Long Distance	N	0:00:59
	S	–
MARC	–	0:00:57
Freight		
NS	N	0:00:00
	S	0:04:24
NS Bypass (via Hagerstown, MD)	N	3:16:44
	S	3:16:44
CSXT (via Howard Street Tunnel)	N	0:19:39
	S	0:31:51

The 2050 forecast for NS freight trains includes 10 daily through-freight trains. For the purpose of the No-Build Scenario, these 10 freight trains are not routed through Baltimore, but instead use the Manassas-Hagerstown-Harrisburg bypass route. The reason is that the B&P Tunnel Plate C clearance does not allow for the passage of modern high cube freight cars, particularly tri-level auto carrier cars. It is the current practice of NS to route their through-freight trains on the bypass route, which saves considerable yard time and expense that would be required to switch out the high cube cars from those trains. Table 4-2 includes the additional running time for the NS trains using the bypass route.

4.2.2 TOTAL AND AVERAGE DELAY MINUTES INCURRED

Because of the priority in scheduling given to the passenger service, this service experiences minimal impact by the 2050 increase in freight traffic. Congestion delays to MARC trains on the CSXT line are much less because of the small number of commuter trains operated there in comparison with the NEC services. Average train delay per passenger train ranges between 00:19 seconds and 01:06 minutes (Table 4-2).

Given the large number of passenger trains operated in 2050, it becomes apparent that the freight capacity of the Baltimore network is insufficient to handle the expected freight volumes forecast out to the year 2050. For example, average freight train delay for CSXT is 19:39 minutes northbound and 31:51minutes southbound. NS freight train delay amounts to 3:16:44 hours because of using the bypass route.

4.3 ECONOMIC CONSEQUENCES OF THE NO-BUILD SCENARIO

The impact upon freight and passenger service of not modernizing Baltimore's railroad infrastructure is readily apparent from the above discussion. This degradation also has significant regional/national economic impact as well. Freight railroads are an important element of the nation's economy, providing goods movement connections for industry and agriculture throughout the country. For example, in May 2009, CSXT announced a "National Gateway" program in which three intermodal corridors serving the Mid-Atlantic ports and Midwestern shippers and receivers would be developed. These include the I-95 corridor between Baltimore and North Carolina via Washington, DC and the I-70/I-76 corridor between Washington, DC and northwest Ohio via Pittsburgh. An important aspect of the program is to provide double-stack clearances on the corridors.[1] In particular, the Port of Baltimore and other industry in the Baltimore region will be put at a competitive disadvantage if a double-stack clearance route is not provided through Baltimore.

The economic benefits of the railroads involve items related to transportation utility and efficiency: these include savings to the economy as a whole from efficient and cost-effective movement of goods and the relative benefits of rail versus truck travel in terms of fuel consumption, greenhouse gas emissions, and the effects of trucks on highway congestion and wear-and-tear. Economic benefits also include the direct impact of employment in railroad operations as well as the effects of the billions of dollars of investment in infrastructure involving rail equipment, roadway, and structures.

ANALYSIS BACKGROUND

The potential improvements to Baltimore's railroad network will decrease rail travel time through the region, boost rail capacity, and enhance service dependability. The potential effects of these improvements in terms of rail traffic were quantified through forecasts to the year 2050 for eight routes through the Virginia/District of Columbia/Maryland/Pennsylvania region. These routes are:

- CSXT from Richmond, VA to Washington, DC (One-third of trains assumed to serve Atlanta, GA gateways)
- CSXT from Washington, DC to Baltimore, MD
- CSXT from Washington, DC to Points West
- CSXT from Baltimore, MD to Philadelphia, PA
- NS from Washington, DC to Baltimore, MD
- NS from Baltimore, MD to Perryville, MD
- Amtrak from Washington, DC to Baltimore, MD
- Amtrak from Baltimore, MD to Perryville, MD

The forecasts were subdivided by type of freight train (premium, unit, merchandise, local) and passenger train (intercity and commuter). The analysis in this document quantifies the cost equivalent of

[1] Progressive Railroading Daily News; May 2, 2008.

accommodating projected rail traffic on roadways in the region for both a low level freight growth scenario and a high level freight growth scenario. **Figure 4-1** illustrates the projected growth in daily freight and passenger train traffic for the period from 2008 to 2050 for both forecast scenarios.

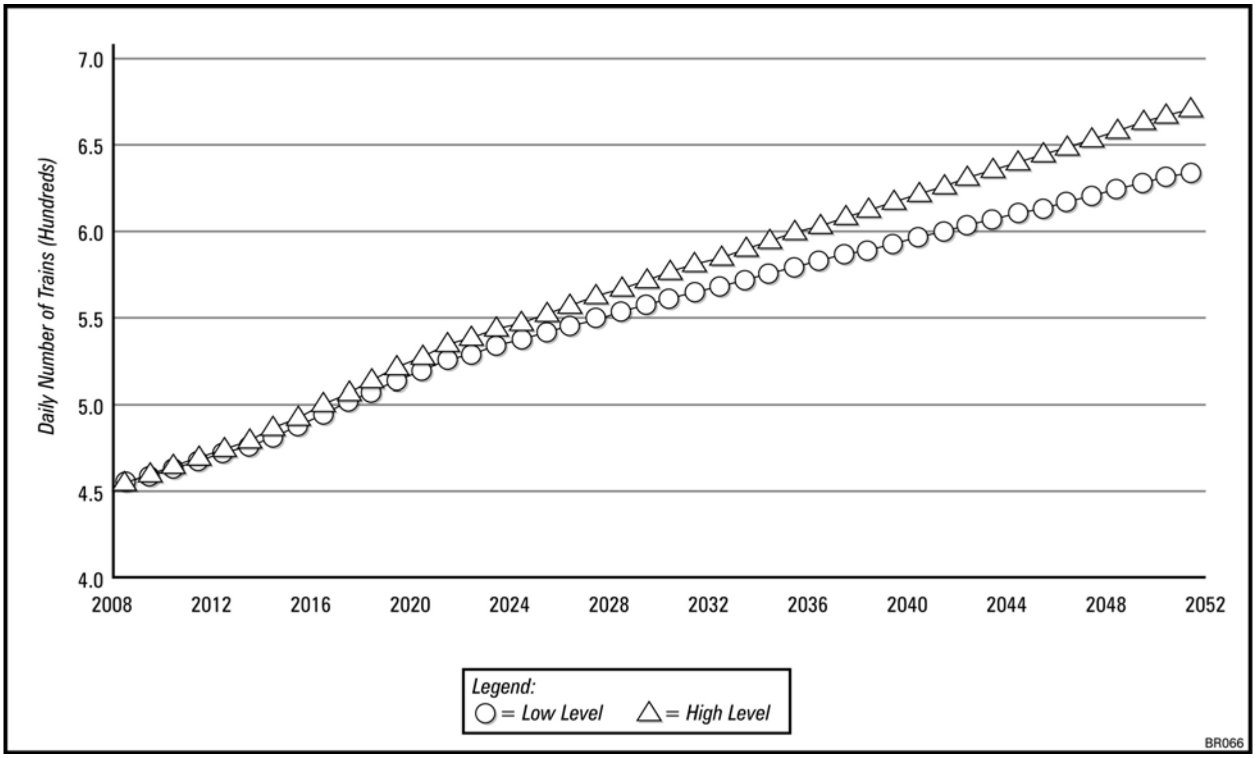

Figure 4-1. Baltimore Daily Freight and Passenger Train Volume Forecasts (Low and High Level Forecasts)

TRANSPORTATION UTILITY AND EFFICIENCY

As part of the world's largest transportation system, America's railroads carry more than 40 percent of the nation's goods, as measured by weight and distance (ton-miles)[2], and they do so at substantially higher efficiencies than trucks, the next highest mode in terms of goods movement. These efficiencies include:

- **Reduced transportation costs for the economy as a whole.** While this varies by type of goods and distance transported, transportation rates are substantially lower for rail than for truck.
- **Reduced fuel costs and air pollution.** Railroads are generally three times more fuel efficient than trucks, with a corresponding benefit in the emissions of nitrogen oxides and particulates. In addition, for every ton-mile of freight that is shifted from truck to rail, greenhouse gas emissions could be reduced by approximately two-thirds.[3]
- **Reduced traffic congestion on interstate highways.** A single rail car carries about 3.8 times more than a tractor-trailer, and a 100-car train carries the equivalent of 380 tractor-trailer trucks on the highway.

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2 "Class 1 Railroad Statistics," Association of American Railroads – Policy & Economics Department, April 21, 2008, http://www.aar.org/PubCommon/Documents/AboutTheIndustry/Statistics.pdf.

3 "Overview of America's Freight Railroads," Association of American Railroads, May 2008, http://www.aar.org/PubCommon/Documents/AboutTheIndustry/Overview.pdf.

- **Reduced wear-and-tear on interstate highways.** The benefits on highway wear-and-tear are based on the same truck reductions that would benefit highway congestion. In addition, lower truck traffic reduces pressures to construct increasingly expensive new roads.

The proposed improvements to Baltimore's railroad network will upgrade rail travel time through the region and enhance rail capacity, allowing the efficiencies cited above to be realized to a higher degree than if the improvements were not made. Conversely, continued deterioration in rail travel time through the region will likely result in increasing amounts of travel shifting to over-the-road truck traffic. Rail traffic provides quantifiable benefits relative to trucks in terms of reduced shipping costs, reduced fuel consumption, decreased air pollution, and reduced need to construct and maintain additional roadway lanes. The analysis below quantifies these benefits for a theoretical scenario where all rail freight and passengers would shift to truck or car. Constraints on rail speeds and capacity through the Baltimore region would obviously only constrain and not eliminate rail travel – the net effect would be that some fraction of these cost benefits would result. This fraction has not yet been determined.

Shipping Costs: Based on the rail traffic forecasts described above, freight shipped via rail in the modeled area ranges from approximately 206.2 million ton-miles per day (low level forecast) to 209.6 ton-miles per day (high level forecast) today to between 321.5 million ton-miles per day (low level) and 382.8 million ton-miles per day (high level) in 2050. **Figure 4-2** shows the estimated costs to shippers for moving these quantities of goods, using either rail or truck, based on assumed shipping costs of 3.5 cents per ton-mile for rail and 6.0 cents per ton-mile for truck. Shifting all goods from rail to truck would increase costs to shippers by between $23.1 and $25.6 billion over the time period from 2008 to 2050, or an average of over $500 million per year.

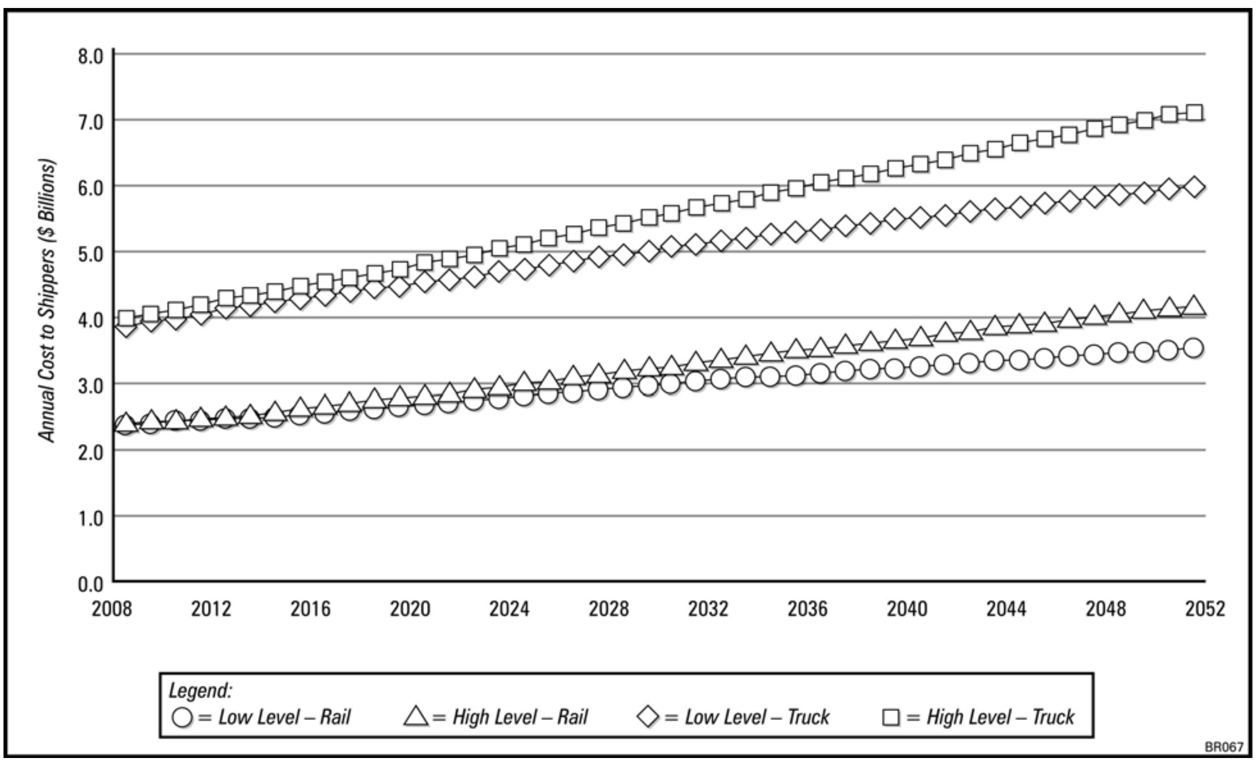

Figure 4-2. Estimated Shipper Costs for Rail and Truck Modes (Low and High Level Forecasts)

Fuel Efficiency and Air Quality: On average, railroads carry a ton of freight 436 miles per gallon of fuel, while trucks carry approximately 150 ton-miles per gallon. Shifting all goods to truck would result in increases of between 4.0 and 4.5 billion more gallons of fuel consumed over the 44 years from 2008 to 2052, an average between 92 and 102 million gallons of fuel per year. Similar ratios of decreased air quality would occur with this same shift of all goods from rail to truck. It is important to note that fuel efficiency continues to improve (in 2007, railroads could move 436 ton-miles per gallon of fuel, an increase in fuel efficiency of 85 percent from the 235 ton-miles per gallon in 1980).

Impacts on the Roadway System: Goods and people carried on the studied rail lines would create the equivalent of over 130,000 cars per day if shifted to the roadway system in 2007.[4] Within the southern and central portions of the I-95 corridor, the vast majority of freeway facilities operate at or over capacity. This analysis assumed, therefore, that in shifting people and goods from rail to roadway modes, additional roadway lanes would need to be constructed and maintained. The middle columns in **Table 4-3** show the number of roadway lane-miles that would need to be constructed to accommodate the combination of trucks for freight and cars for passengers (the daily traffic equivalent). The roadway cost equivalent shows the annual cost to construct and maintain these "new" lane-miles (note that this cost includes amortized construction costs as well as maintenance). As the table shows, these costs increase to over $100 million per year for the high level forecasts in 2050. Note also that this table does not include assumptions for inflation.

Table 4-3. Annual Estimated Roadway Cost Impacts (Low and High Level Forecasts)

	DAILY TRAFFIC EQUIVALENT		ROADWAY LANE-MILES EQUIVALENT		ROADWAY COST EQUIVALENT (IN 2008 DOLLARS)	
YEAR	LOW	HIGH	LOW	HIGH	LOW	HIGH
2007	129,006	130,453	1730.624	1750.044	$243,671,808	$246,406,199
2008	130,009	131,839	1743.879	1768.431	$245,538,096	$248,995,139
2009	131,012	133,225	1757.133	1786.818	$247,404,372	$251,583,909
2010	132,015	134,611	1770.388	1805.202	$249,270,636	$254,172,511
2011	133,018	135,996	1783.643	1823.586	$251,136,889	$256,760,950
2012	134,114	137,393	1799.12	1843.119	$253,316,055	$259,511,189
2013	135,975	139,648	1825.596	1874.9	$257,043,898	$263,985,910
2014	137,837	141,902	1852.069	1906.685	$260,771,283	$268,461,208
2015	139,699	144,156	1878.539	1938.473	$264,498,229	$272,937,059
2016	141,561	146,410	1905.005	1970.266	$268,224,757	$277,413,439
2017	143,422	148,664	1931.469	2002.062	$271,950,882	$281,890,326
2018	145,284	150,919	1957.931	2033.861	$275,676,622	$286,367,699
2019	147,146	153,173	1984.389	2065.664	$279,401,993	$290,845,538
2020	148,840	155,387	2005.936	2094.179	$282,435,723	$294,860,431
2021	150,456	157,545	2028.984	2124.57	$285,680,881	$299,139,487
2022	152,073	159,702	2052.025	2154.962	$288,925,109	$303,418,650
2023	153,690	161,859	2075.06	2185.355	$292,168,444	$307,697,915
2024	155,307	164,016	2098.089	2215.748	$295,410,920	$311,977,278
2025	156,923	166,173	2121.112	2246.142	$298,652,571	$316,256,735
2026	158,540	168,331	2144.129	2276.536	$301,893,427	$320,536,283
2027	160,157	170,488	2167.141	2306.931	$305,133,518	$324,815,919

4 Based on a passenger car equivalency of 3.0 (i.e., each truck is the equivalent of three cars on the roadway system).

YEAR	DAILY TRAFFIC EQUIVALENT		ROADWAY LANE-MILES EQUIVALENT		ROADWAY COST EQUIVALENT (IN 2008 DOLLARS)	
	LOW	HIGH	LOW	HIGH	LOW	HIGH
2028	161,774	172,645	2190.148	2337.327	$308,372,871	$329,095,638
2029	163,390	174,802	2213.15	2367.723	$311,611,515	$333,375,439
2030	164,958	176,969	2236.62	2399.472	$314,916,157	$337,845,606
2031	166,187	178,906	2253.6	2426.088	$317,306,921	$341,593,173
2032	167,415	180,844	2270.579	2452.706	$319,697,583	$345,340,963
2033	168,644	182,781	2287.558	2479.325	$322,088,147	$349,088,971
2034	169,872	184,719	2304.536	2505.946	$324,478,616	$352,837,192
2035	171,101	186,656	2321.513	2532.568	$326,868,991	$356,585,619
2036	172,330	188,594	2338.489	2559.192	$329,259,274	$360,334,249
2037	173,558	190,531	2355.465	2585.817	$331,649,469	$364,083,077
2038	174,787	192,469	2372.44	2612.444	$334,039,577	$367,832,096
2039	176,015	194,406	2389.415	2639.072	$336,429,600	$371,581,304
2040	177,244	196,344	2406.389	2665.701	$338,819,540	$375,330,695
2041	178,473	198,281	2423.362	2692.331	$341,209,400	$379,080,265
2042	179,701	200,219	2440.335	2718.963	$343,599,181	$382,830,010
2043	180,930	202,156	2457.307	2745.596	$345,988,884	$386,579,926
2044	182,159	204,094	2474.279	2772.23	$348,378,513	$390,330,008
2045	183,387	206,031	2491.25	2798.865	$350,768,067	$394,080,254
2046	184,616	207,969	2508.221	2825.502	$353,157,550	$397,830,660
2047	185,844	209,906	2525.191	2852.139	$355,546,963	$401,581,221
2048	187,073	211,844	2542.161	2878.778	$357,936,306	$405,331,935
2049	188,302	213,781	2559.131	2905.418	$360,325,583	$409,082,797
2050	189,169	215,083	2566.974	2918.617	$361,429,998	$410,941,218
				Total	**$13,452,084,819**	**$14,480,626,092**

EMPLOYMENT AND INFRASTRUCTURE INVESTMENT BENEFITS

Improvements to the rail system through the Baltimore region, both for freight and passenger travel, will also provide economic benefits from railroad employment and from the investment in new rail infrastructure.

4.4 RAILROAD OWNERSHIP RIGHTS AND INTERESTS IN BALTIMORE

The potential integration of rail service on joint-use tracks involves numerous issues of which ownership and operating rights are key. Significant improvement to freight train movements through Baltimore will require the joint operation of NS and CSXT on a common route, and that common route could also involve Amtrak. This will require the eventual negotiation of joint operating agreements. The following paragraphs present the existing scope of railroad ownership and associated operating rights in the Baltimore region.

<u>Amtrak</u>: Owns the NEC main line through the city, from southwest to northeast, including Baltimore Penn Station. NS has trackage rights over the NEC through the city and is able to access it to and from Bayview Yard northeast of the city. The rights are granted under a Settlement Agreement incorporated within the Conrail Acquisition proceedings approved by the Surface Transportation Board (STB) in 1997. Access is subject to Amtrak operating authority and dispatching.

CSXT: Owns and operates over the former B&O main line north/south through the city, from southwest to northeast. In addition, they own: the Bay View Yard to the north of Amtrak's NEC line and a connecting line serving Canton and Sparrows Point, via an interchange with Patapsco and Back Rivers Railroad, at Grays Yard. Other lines on the west side connect to Locust Point and the Curtis Bay area. CSXT also has operating rights over Amtrak, as a result of the Conrail Acquisition.

NS has limited operating rights on CSXT. As noted by CSXT, NS trains are restricted to handling only traffic originating or terminating on the former Richmond, Fredericksburg and Potomac RR Co. or routed via lines of CSXT to or from Richmond, VA. Further, NS container, trailer-on-flat-car, and general merchandise trains may not exceed 9,000 tons, 125 cars, or 7,500 feet in length. Finally, NS can only operate a total of five trains daily, two westbound and three eastbound.

NS: Owns and operates all of the former Conrail lines serving Baltimore, inclusive of rights over Amtrak from which they access the NS Bayview Yard, located to the south of the NEC. South from the westerly end of Bayview they own and operate the industrial tracks that serve the industries and marine terminals through the Canton area of the city and down to Dundalk Marine Terminal. From the east end of Bayview Yard, their Sparrows Point Industrial Track runs to Grays Yard, for interchange with the Patapsco & Back Rivers Railroad.

Patapsco and Back Rivers Railroad (PBR): An industrial plant railroad serving the Sparrows Point steel-manufacturing complex, formerly owned by Bethlehem Steel. The line is owned by the steel company, now OAO Severstal. Ownership includes Grays Yard at the northern end of Sparrows Point where PBR interchanges with CSXT and NS.

Canton Railroad: An industrial switching line that serves several industries and the Port of Baltimore. They interchange with CSXT and NS.

Canadian Pacific (CP), as a successor to Delaware & Hudson, has rights over the NEC through Baltimore to Northern Virginia (Potomac Yard). As Potomac Yard has been dismantled, the CP rights are exercised through interchange service agreed to among the affected railroads.

5 – STUDY OBJECTIVES, STANDARDS, & METHODS

This report describes the challenges facing passenger and freight railroads as they serve their customers over an increasingly congested and antiquated collection of facilities in the Baltimore region. It further describes the principles and techniques that guided, and the results that emerged from, the present effort to develop alternative solutions.

This section states the objectives of the planning effort, explains and presents the standards that the study team consistently applied during its investigations, and recounts the methods that the team employed. Subsequent sections explain in some detail the alternatives that survived what was essentially a screening process.

5.1 STUDY OBJECTIVES

To turn the built-in drawbacks of Baltimore's railways into inherent advantages, the study team adopted the following objectives:

1. Make the service quality and capability of the system, both as a whole and in its important parts, no worse than it is today.

Beyond doing no harm:

2. Remove all through-freight service from the Howard Street Tunnel.
3. Provide high-cube, double-stack clearance routes through Baltimore for both NS and CSXT freight trains.
4. Provide grades for freight trains that are less than those now encountered – preferably much less.
5. Provide a replacement for the B&P Tunnel.
6. Increase speeds for both passenger and freight trains wherever economically feasible.
7. Provide capacity to support traffic levels for freight, intercity passenger, and commuter services, based on reasonable projections for the year 2050, for each existing and projected route while making every effort to reduce the future cost of providing still more capacity, should traffic grow beyond the design level.
8. Maintain access to all freight and passenger yards, port facilities, maintenance facilities, as well as CSXT Camden and Amtrak Penn Stations.
9. Provide for CSXT and NS intra-terminal moves in Baltimore.
10. Identify any relatively near-term improvements that could benefit users while long-term projects are progressed.

    Such near-term improvements would, if implemented, foster capital and operating cost-effectiveness; minimize disruptions to the regional transportation system; and maximize use of the region's existing and committed transportation infrastructure.

11. Avoid, minimize, and/or mitigate any significant adverse environmental impacts caused by corridor improvements.

    Any restructuring projects will necessarily –

- Comply with all applicable local, State, and Federal standards and/or procedures such as those for air quality, noise, surface and ground water quality, storm water management, ecosystems, environmental justice, energy consumption, hazardous materials, and river navigation; and
- Minimize community disruption, displacements, and relocations, as well as adverse impacts to public parks, historic resources, and visual resources and aesthetics resulting from mobility improvements in the corridor.

12. In making changes to accomplish all of the above objectives, assure that railway operating expenses in the study area will not increase on a unit basis and will, preferably, decrease.[1]

5.2 STANDARDS FOR THE DEVELOPMENT AND EVALUATION OF ALTERNATIVES

To fulfill the objectives described above, each alternative must promise to meet or exceed core design and performance standards. While subject to elaboration and revision, these standards allowed the study team to develop the initial set of alternatives for presentation and evaluation.

5.2.1 DIFFERENT NEEDS FOR FREIGHT AND PASSENGER SERVICE

Standards for Baltimore alternatives differ for freight and passenger service because the needs of the two types of transportation diverge. The divergence becomes readily apparent with respect to gradient, clearances, and the desirability of passing through Penn Station. While one percent and two percent grade limits may appear very similar (as they are separated by a single percentage point), in railway engineering terms the difference is huge. Similarly, while reliability and uninterrupted train movements are aims common to both freight and passenger service, travel time in the NEC's city-pair markets – for example, through Baltimore itself – is the prime factor for passenger operations. For freight traffic, however, the elimination of circuity and the achievement of consistent, reduced transit times on a national scale (at least, for each carrier involved) constitute the prime ends. While faster freight train transit times within Baltimore would, of course, help the freight carriers, improved clearances and geometric layouts will have an even greater impact on the routing possibilities for modern freight cars and on operating economy. Thus, the priorities of freight and passenger service differ markedly – so much so that the creation of separate freight and passenger pathways may well provide the optimal solution to the Baltimore challenge. This is all the more true because the minimal capacity requirement – two freight and two passenger tracks – already implies the installation of between two and four tunnel tubes. If separate tubes are necessary, their designs can vary to follow their divergent functions and purposes.

Although this dichotomy of needs has always prevailed, only since the mid-20th century – with the replacement of two parallel, competing, all-purpose railroads with an intercity passenger railroad (Amtrak's NEC), a commuter agency (MARC), and two Class I freight railroads (CSXT and NS), the latter of which enters the region over trackage rights – has the institutional structure so changed as to allow comprehensive solutions to emerge, in which separate, dedicated facilities for freight and passenger service may be contemplated.

5.2.2 SUMMARY OF INITIAL STANDARDS

Table 5-1 summarizes the initial standards that the study team applied in developing and screening alternative scenarios for resolving the Baltimore challenge. Selected topics of special interest in the table are discussed in the following section.

[1] This objective is listed here for the sake of completeness and as an expression of the study team's intention. Detailed analysis of operating expenses and the effects thereon of various alternatives fell outside of the scope of this study but would necessarily be part of future development, if any, of the alternatives. For example, this study does not address the terms or prices of trackage rights under the various alternatives, which will be subject to negotiation among the project partners.

Table 5-1. Initial Standards for the Development and Evaluation of Alternatives

	FREIGHT		PASSENGER	
CRITERION	**COMMENTS**	**INITIAL STANDARD**	**COMMENTS**	**INITIAL STANDARD**
Main Priority	The freight carriers wish to optimize flows on their networks. Efficient routings with unrestricted clearances through Baltimore are key.	Nationwide transit times, elimination of circuity, flexibility of operation. (Local flows within Baltimore region are definitely of concern as well.)	NEC's needs are paramount for Amtrak; efficiency and reliability of commuter operations are critical to MARC.	Transit times internal to the NEC and to Baltimore in particular.
Grades	CSXT's maximum grade north and south of Baltimore is less than 1.0 percent.	1.0 percent maximum (0.8 percent desirable maximum)	The ruling grade on the NEC is 1.9 percent in the New York tunnels. (Grades are less injurious to relatively light, amply-powered passenger trains than to freight trains.)	2.0 percent
Curves	Curvature must be considered in conjunction with grades. CSXT's 10-degree curve north of Howard Street Tunnel and the NEC's sharp curves in the B&P Tunnel impact speeds and make train handling difficult.	Reduce curvature, below its present excessive levels, to allow maximum design speeds (below). NOTE: Some of the alternatives impose speed restrictions due to curvature that require careful review given the long life of these improvements.	Curvature in B&P Tunnel adversely impacts through train speeds.	Reduce curvature and improve geometry of high-speed paths to allow maximum design speeds (below).
Maximum Design Speeds[1] (between Gunpowder River and Halethorpe)		50 mph NOTE: Some of the alternatives impose speed restrictions due to curvature that require careful review given the long life of these improvements.	Between Bay View Yard and B&P Tunnel area	125 mph
			North of Bay View and south of the B&P Tunnel area (per Amtrak proposal)[2]	150 mph
Clearances	Need to accommodate the largest freight cars, such as high-cube double stack container cars and tri-level auto racks, neither of which can now pass through the Baltimore tunnels.	Establish Plate H in double-track freight service through Baltimore. To benefit most traffic flows, this will require improvement in Washington, DC's Virginia Avenue Tunnel, as well as investigation and correction of all undue clearance restrictions (e.g., overhead bridges) in the study area.	Only passenger clearances are required, unless interoperability of the freight and passenger services through each other's facility is desired and is feasible and cost-effective.[3]	
Capacity	Capacity must be available to reliably accommodate current and future through, terminating, and originating services, in both north-south and east-west traffic lanes,[4] as well as all local services.	Provide a double-track main line freight route allowing for the most demanding clearances, with multiple tracks and other facilities where necessary to accommodate various types of freight service and yard operations.	Capacity must be available to reliably accommodate current and future services on existing routes. (Any potential new routes[5] were not part of this study.)	Provide at least a double-track main line passenger route with multiple tracks where necessary to accommodate various types of passenger service.
Tunnels: Design Life of Structures	120 years			
Design Life of Key Internal Fittings[6]	50 years			

CRITERION	FREIGHT COMMENTS	FREIGHT INITIAL STANDARD	PASSENGER COMMENTS	PASSENGER INITIAL STANDARD
Fire, Life, and Safety Concerns	Section 5.2.3 p.5-7			
Bridges	Drawbridges are obstacles to water and rail commerce and centers of excessive cost.	No drawbridges are to be added to Baltimore's rail infrastructure.	There are already too many drawbridges in the NEC.	No drawbridges are to be added to Baltimore's rail infrastructure.
Commuter Routings	Does not apply.		No basic restructuring is contemplated. (Any possible future use of the Howard Street Tunnel is beyond the scope of this report.)	CSXT Baltimore-Washington service will continue to serve Camden Station. NEC Perryville–Penn Station–Washington service will continue to use the through passenger route and station.
Motive Power	Status quo assumed to be maintained.	All service: Non-electric.[3]	Status quo assumed to be maintained.	All intercity service and commuter service via "Penn Line": Electrified.[3] Commuter service via Camden line: Non-electric.
Through Passenger Station[7]	If interoperability is deemed a major requirement,[3] or if the optimal routing for freight makes use of the through passenger station location, then the track configuration at the through passenger station must provide for freight needs.		Explorations of realigning to other through passenger station locations revealed fatal flaws, e.g., capital costs many times higher than re-using Penn Station.	For through service: Serve Penn Station as a fixed point.
Freight Yards Location, Design, Operating Method	Some options may require modification of this standard.	Assume existing yards to be fixed in place. Track layouts should allow for through trains to set off or pick up cars without changing direction or backing up ("progressive moves").	Does not apply.	

[1] The actual design speed contemplated for each location will depend upon the projected speeds resulting from braking or accelerating at stations or other constraining points. For example, a northbound Amtrak intercity train ideally could enter the south end of an alternative alignment to the B&P Tunnel at maximum authorized speed (MAS) but immediately begin to brake for the station stop; the curves in the tunnel would be designed to permit operation at the maximum braking or accelerating speed.

[2] The cost-effectiveness of expanding the NEC mileage subject to a 150-mph top speed limit has yet to be determined. Use of this theoretical 150-mph top speed in this report does not imply FRA endorsement of such an expansion.

[3] The issue of interoperability, its feasibility, and its costs, including (among other issues) those of electrification, connectivity with Penn Station, the range of conditions in which sharing of facilities would occur, and what to do about freight trains negotiating steeper passenger grades, would need to be explored in any follow-up analyses.

[4] The terms "north-south" and "east-west" refer to national traffic patterns, not to the localized movements by means of which the railroads satisfy those national patterns. For example, NS traffic from the west approaches Baltimore from the northeast (compass direction), and a portion of CSXT traffic from western points passes through Washington and approaches Baltimore from the southwest (compass direction).

[5] I.e., any possible future commuter services on certain portions of the Baltimore rail freight network that are currently freight only. No new routes for intercity passenger service are presently envisioned for the Baltimore region.

[6] I.e., those fittings requiring tunnel closure for renewal.

[7] The use of Camden Station as a terminus for MARC's Baltimore-Washington commuter service via the Camden Line/CSXT is accepted as fixed.

5.2.3 TOPICS OF PARTICULAR INTEREST

Certain topics in Table 5-1 merit expanded discussion, as follows.

CAPACITY

To be worthwhile, alternative scenarios must be capable of handling projected short- and long-term rail freight and passenger volumes from, to, and through the Baltimore region. These alternatives must overcome existing constraints while improving north-south and east-west train routes and simultaneously enhancing the ability of operators to serve local markets efficiently. The improved routes would upgrade clearances to handle oversize rail cars and furnish sufficient capacity to minimize the train delays that inconvenience freight customers, intercity travelers, and commuters.

The routing solutions developed through the study effort would eliminate, or minimize the effect of, bottlenecks on all types of freight and passenger service for all of the involved carriers.

FACILITIES ASSUMED IMMOVABLE

Based largely on considerations of cost, safety, and the urgent need to maintain that continuity in all modes of transportation that is vital to the economic health of the Baltimore region, the study team assumed the following fixed points and constraints and recognized a number of design challenges:

- Fixed points
  - The port facilities in East and West Baltimore, either existing or proposed[2];
  - The Baltimore Metro Subway Tunnel;
  - The CSXT Capital and Old Main Line Subdivisions west of Saint Denis;
  - The CSXT Philadelphia Subdivision north of Bay View Yard;
  - The NEC Main Line north of Bay View Yard;
  - The NEC Main Line south of West Baltimore Commuter Station; and
  - The location of the Central Light Rail Line main line and shops, and the Jones Falls Expressway northwest of the existing Penn Station, adjacent to the former Northern Central Railway right-of-way.
- Constraints
  - Maintain a maximum Fort McHenry channel depth of 50 feet (55 feet with an allowance for maintenance dredging).
  - Cannot tunnel under the Fort McHenry (I-95) highway tunnel.
- Challenges
  - The existing navigable streams and channels leading to the Patapsco River.
  - Maintain an effective grade of one percent or less for freight tunnel approaches or relocated routes.
  - Find environmentally acceptable routes through or around the city.

PENNSYLVANIA STATION

Baltimore's major passenger station is sited north of the central business district (CBD) and adjacent to the Jones Falls and the former Northern Central Railway. Although prior planning efforts[3] had viewed this location as immovable a priori, initial scenario development for this report disregarded any such restriction for two reasons: (a) a station located in the heart of the CBD might theoretically be preferable; and (b) the current station location and orientation (at an approximate 90-degree angle to the desired flow

2 This includes the existing railroad yards, branches, and industrial tracks serving the port facilities.
3 Specifically, planning for the NEC Improvement Project in the mid-to-late 1970s.

of traffic), and the resultant difficult configuration of the tracks leading to it result in a significant length of passenger train operations at speeds less than 110 mph.[4]

Nevertheless, a review of station relocation options for intercity service concluded that a more central location would be prohibitively expensive. As Baltimore's ridges and valleys run north and south in the CBD area, any direct east-west route would necessarily run at cross purposes to the topography, thus occasioning monumental civil works – as already exemplified by the Orleans Street Viaduct. Such a project would inevitably involve very expensive tunneling under the CBD, its many historical landmarks, and its major commercial buildings. As a truly central station would require at least four tracks and probably more, an enormous cavern would need to be dug out in the heart of Baltimore.[5] Other potential routings for passenger service (for instance, an underwater tunnel or a "beltway"-type route around the north) would entail exorbitant expense and would defeat the prime advantage of intercity rail service – its accessibility at the core of major cities. Finally, although fault can be found in Penn Station's location, it serves commercial and residential areas alike, affords easy access to major north-south arteries (Charles and St. Paul Streets and the Jones Falls Expressway), and is served by the Baltimore Light Rail system. Furthermore, it is at no greater a distance from its City's business center (about 15 blocks) than is 30th Street Station in Philadelphia or Union Station in Washington, DC. For all of these reasons, and in view of the relatively low cost of passenger alternatives that would preserve service via Penn Station, the study team found that retention of the present location would be logical and effective.

For commuter service only, a vacated Howard Street Tunnel could imaginably afford options for some kind of through service with better downtown distribution than presently exists. Such options, their feasibility, and their concomitant requirements – a complex topic – fall outside the scope of this report, although their implementation might be integrated with that of any larger restructuring of Baltimore's railway facilities.

FREIGHT TRAIN OPERATIONS IN PENN STATION VICINITY

The option of creating a freight route through Penn Station, which would require constructing a new freight tunnel and reconstructing the old Union Tunnel, was evaluated. The location of utilities under the tracks through the station and overhead bridge piers were physical constraints that were identified. Additionally, the advisability of operating freight trains through Penn Station in downtown Baltimore from all viewpoints (engineering, operational efficiency, and safety) are also factors for consideration.

FREIGHT YARD LOCATIONS AND TRAIN MOVEMENTS

Existing CSXT and NS yards initially were assumed to be fixed locations. However, preliminary analysis of Harbor Tunnel options, and at least one northern route, indicated that maintaining access to the existing facilities, particularly CSXT's and NS's neighboring Bay View yards, may result in inefficient routing of trains. Further, the analysis of Harbor Tunnel options indicated that extension of the Curtis Bay Branch, which presently ends at Curtis Bay Yard, would be required. Such an extension would require reconfiguration of yard tracks and the possible relocation of the Car Repair Shop.

Maintaining efficient and economical access to, and between, all existing freight yards was one of the primary objectives that ultimately eliminated many potential alternatives. For example, maintaining access for CSXT through-freight trains that currently set off or pick up at Bay View also required that, upon completion of any Baltimore restructuring, freight trains should be able to set off or pick up at Bay

4 A series of Train Performance Calculator (TPC) runs have been performed to document the trip time impact of the slow speed running.

5 An above-ground "central" station in the Jones Falls Valley, oriented in an east-west direction, was also considered.

View in a progressive move as they do today, if possible. The same criterion initially was applied to NS freight trains and the NS Bayview Yard, should NS ever run through-freight traffic on the NEC.

FIRE, LIFE, AND SAFETY CONCERNS

The security systems within all tunnel options would provide full fire and life safety features for the users of the tunnels and emergency crews. These items include:

- Fire detection and alarms;
- Supervisory control and data acquisition for pumps, ventilation fans, lighting, and emergency services;
- Security systems, such as closed circuit television and intrusion alarms;
- Access control; and
- Telephones.

Other systems and design considerations would provide:

- Emergency lighting;
- Pumping;
- Signage throughout the length of the tunnel;
- Walkways throughout the length of the tunnels to allow evacuation in the event of an accident; and
- Cross-passages at regular intervals along the length of the tunnels to connect the adjacent bores.

The ventilation system would:

- Ensure acceptable temperatures throughout the tunnel system to support the normal operations;
- Maintain pollutants to an acceptable level for train crews; and
- Control smoke and temperatures in the event of a fire within the tunnels.

These state-of-the-art standards for security, safety, fire, and ventilation systems would not only benefit all users and operators of the new tunnels but also avoid the heavy expense of post-construction retrofitting.

5.3 METHODOLOGY

The study team began its complex task by gathering and assessing background information on the development, current status, and future prospects of Baltimore's railway infrastructure (See Sections 2, 3, and 4). Based on engineering analyses and contacts with users and government officials, the team derived a set of characteristics that a meaningfully restructured network should possess (See Sections 5.1 and 5.2 of this section). After identifying and screening the general sectors through which improved passenger and freight routes might pass (Section 6), the team developed and evaluated a sufficient number of alternatives to assess the viability of each sector for each type of rail transportation. By an iterative process of elimination reflecting the desired system characteristics and associated engineering requirements, the team arrived at a relatively small number of promising illustrative alternatives, for each of which it prepared initial cost estimates (Sections 7, 8, and 9). Environmental and land considerations were identified (Section 10), as well as clearance improvements to the CSXT Virginia Avenue Tunnel in Washington, DC (Section 11). Finally, a review of the work upon which this report is founded suggested some avenues of further study (Section 12) that would assist planners and policymakers in resolving the Baltimore challenge.

The following sections describe these methodological steps in further detail.

5.3.1 GATHER FUNDAMENTAL DATA

Through personal communications with experts and examination of key documents, the study team reviewed the current status of all rail lines in the study area[6] and their ability to safely and efficiently handle the present and future levels of rail services imposed by freight and passenger railroads. The initial review addressed both facilities and operating patterns.

Figure 5-1 lists the principal elements of the fixed plant that received scrutiny and the universe of evaluative factors that might apply[7] to each element. Specialized documentation—base mapping and geological data—assisted the study team in developing concepts for freight and passenger alternatives in each sector under consideration.

Fixed Plant Elements Considered		Evaluate Factors (Not All Apply to All Elements)
• Track • Roadbed (ballast, subgrade) • Tunnels • Undergrade Bridges • Overhead Bridges • Other Railroad Structures • Signal and Traffic Control Systems • Electric Traction Systems • Short-term Improvement Project Proposals	• Vehicle Maintenance Facilities (passenger and freight)[1] • Yards (passenger and freight) and Their Access • Passenger Stations[2] • Port Facilities and Their Access • Grade Crossings • Maintenance-of-Way Bases • Recently Completed Improvements (post 1992)	• Geometric Design Configuration - Location and Accessibility - Grades - Curvatures - Clearances • Physical Condition • Speeds • Capacity • Routings • Methods and Measures of Operation • Life-cycle Cost (operating, capital)

[1] Identified but not inspected.
[2] Identified but not inspected.

Figure 5-1. Main Components of Data Gathering

CONSULTATIONS AND DOCUMENTATION

Initial and follow-up consultations took place with appropriate staff members of the passenger, CSXT, and NS freight railroads[8] and interested public transportation and planning agencies in the region. These contacts helped to identify the freight and passenger railroads' current and projected traffic levels and operations in the region for traffic lanes through, from, to, and within Baltimore and its port.

The CSXT and NS provided essential track charts[9], curve information, and some data on ongoing track maintenance and upgrading efforts. Amtrak, State and local agencies, and freight rail operators made available relevant maps and documents, including Valuation Maps and As-Built Northeast Corridor

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[6] Both existing and relevant abandoned facilities were considered. The degree of attention was roughly proportional to the facilities' proximity to and impact on the core of the study area in Baltimore City.

[7] The list does not claim to be exhaustive; a railway is a complex machine. Also, the scope of the study did not permit all evaluative factors to be applied to all elements. Only the most important topics – those relevant to determining whether meaningful resolutions of the Baltimore challenge were potentially available and in which general sectors – could qualify for attention in the present analysis.

[8] Any further development of options would require close and continuing coordination with the smaller railroads.

[9] A track chart is a scroll-like line diagram of a particular section of railroad, showing (among other items) each track, the degree of curvature and location of each curve, grades, stations, interlockings (see the Glossary at the end of this volume), and other details of the road's facilities and geometry.

Improvement Project (NECIP) plans for review by the study team. The team also obtained and reviewed current information on use of the railroad lines and pending plans for any betterments.

Limited on-site inspections occurred. The rail lines, particularly key locations, have been thoroughly documented with digital photographs.

BASE MAPPING

Base mapping assisted in the delineation and evaluation of alternative routing concepts and the initial projection of their external impacts. The study team gathered geographic information system (GIS) data from sources including (but not limited to) the following:

- Baltimore City;
- U.S. Geological Survey (USGS);
- The FRA Maglev Deployment Program[10]; and
- The U.S. Army Corps of Engineers.

The data gathered included:

- Maryland County Map information;
- Vector roadway data;
- Environmental resources (wetlands, floodplains, etc);
- Census data;
- Historic Resources data;
- USGS 7.5 -minute quadrangles and digital elevation models; and
- Aerial photography.

The base mapping for this study combined all of these GIS data elements with the available railway-specific information. For example, railroad elevations, grades, and tunnels were entered into the system from track charts and related sources. The mapping and evaluation process enabled the study team to concentrate its efforts on alternatives that would respond to the project's goals and objectives while avoiding obvious "fatal flaws" in their design and external effects. The mapping effort also enabled team members to prepare detailed graphics of the alternatives.

GEOLOGICAL DATA

Because any restructuring of the Baltimore rail network will inevitably involve major civil works, including tunneling, geological information has assumed a special importance in this study. Accordingly, the following sources provided data for incorporation in the study's database:

- Boring data collected in advance of NECIP investigations;
- Available borings from earlier NECIP investigations;
- Boring data from nearby Maryland State Highway Administration highway projects;
- Published geologic data for the project area; and

[10] The FRA Maglev Deployment Program, mandated under the TEA-21 transportation authorization, aims to demonstrate magnetic levitation technology in the United States in a relatively short (less that 50-mile) corridor. A number of corridor projects in several states have competed for available planning funds; a corridor between Baltimore (Camden Station vicinity), BWI Airport, and Washington – sponsored by the State of Maryland – has emerged as one of the leading contenders for implementation should Congress elect to provide additional funds. Current plans do not contemplate a direct intermodal connection at Penn Station, Baltimore between the Baltimore/Washington Maglev project and the NEC through passenger service. There could, however, be design and construction in a number of locations in the Baltimore region if both the Maglev project and a Baltimore rail restructuring plan are implemented.

- Project data on file for earlier Baltimore projects.

5.3.2 EVALUATE THE NETWORK'S CURRENT STATUS AND PROSPECTS

On the basis of the data thus gathered, the study team assessed the current status and prospects of Baltimore's railway network. The assessment considered not just historical conditions but also the limited investments made by Amtrak, Maryland DOT, and NS since 1992. Also taken into account were the current and projected service levels for intercity passenger, commuter, and freight operations. In conjunction with the track charts, the GIS data, and other resources, the traffic projections highlighted areas of concern with respect to operational capacity before, during, and after construction of the various alternatives.

With regard to the traffic projections:

- Forecasts for both intercity and commuter train frequencies relied on schedules recently prepared by the operating entities. Amtrak has a timetable for projected service in the year 2015, and MARC has prepared forecasts for 2035. Extrapolating from those carrier's horizon years, the study team developed train volumes for the year 2050.
- Computerized simulations of the current and projected operations on potential future infrastructure in the Baltimore region were conducted.[11] Accordingly, these forecasts served as inputs to the conceptual development of the alternatives and for initial screening purposes.

5.3.3 DEFINE "SECTORS" FOR INITIAL CONSIDERATION

The prior sections demonstrate the complexity of the Baltimore challenge, with its many traffic types and service lanes. The freight operation, in particular, serves a host of shippers and commodity types on all sides of one of the East Coast's busiest ports; this intricate freight movement pattern involves short lines as well as the major national carriers. However, in its simplest terms, the main challenge devolves into a single question: how best to get the passenger and freight traffic from one side of Baltimore to the other? Addressing this underlying question, the study team noted that there were four broad, concentric arcs in which improvement alternatives might be sited to satisfy the inherent line of traffic (roughly southwest to northeast). These broad arcs are termed "sectors" in this report (**Figure 5-2**).

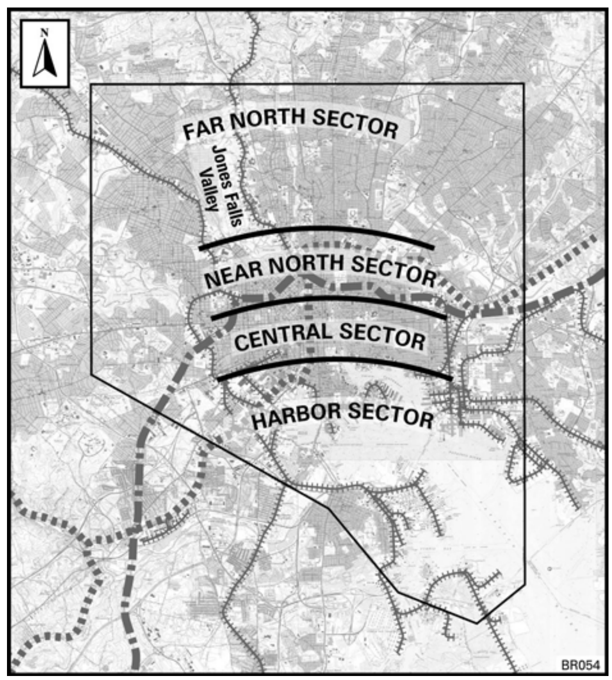

Figure 5-2. The Sector Concept

The study team then subjected the sectors to an initial screening based on common sense in order to eliminate beforehand alternatives that would be frivolous. For example, the sector at the top of the map – many miles removed from the center of Baltimore – could not house passenger "service" worthy of the name and was eliminated accordingly. Most of the sectors, however, offered some advantage for either freight or passenger operations or both and underwent further analysis.

[11] Such detailed simulations will be essential to any detailed evaluation of alternatives (See Section 9).

5.3.4 DEVELOP POTENTIAL ALTERNATIVES WITHIN EACH SECTOR

Once identified, the likely sectors were examined to develop a broad range of alternative solutions, all of which involved tunnels. This analysis considered all of the GIS and geological data amassed earlier in the study, as well as the operational advantages and drawbacks of each alignment with respect to passenger and freight transportation. Also considered were concepts suggested in 20th century studies of the same challenge.[12] The search for alternatives took into account all relevant prior reports and selective site visits, for example, inspections of alternative passenger station locations.

5.3.5 SCREEN THE ALTERNATIVES

The alternatives went through extensive screening both by the study team and by officials of participating organizations. Engineering judgment, railway operating experience, and familiarity with the study region influenced both the initial conceptualization and the ongoing, iterative review of the alternatives. In addition, a formalized screening and comparison of alternatives took place along the following lines:

- Functional/design screening: An evaluation of the railway design features, the operational benefits and liabilities, and potential construction staging problems of each alternative; and
- External impact screening: A preliminary effort to identify potential environmental and societal concerns of each route.

Alternatives passing the functional/design screening were then subjected to the external impact screening, as described below. Not all criteria applied to all alternatives; the Harbor Sector options, for instance, faced some different tests than options in other Sectors.

FUNCTIONAL/DESIGN SCREENING CRITERIA

Functional/design screening was intended to identify and screen out alternatives that would have large negative impacts and that would do little to improve passenger and freight transportation through the Baltimore region. Functional/design screening also allowed the detailed evaluation and discussion to focus on the most important and controversial remaining alternatives. The process enabled a preliminary analysis of alternatives by characterizing them according to the quadrants illustrated in **Figure 5-3**.

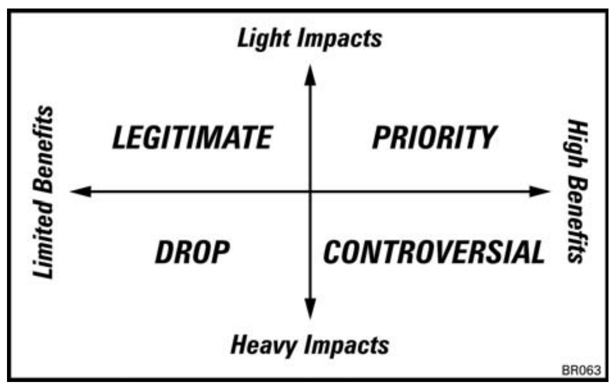

Figure 5-3. Screening Concept

The primary determinants in screening the alternatives were:

- The availability of land to utilize for the tunnel approaches on each side of the river;
- The requirement to –
  - Establish and maintain a maximum one percent freight gradient or two percent passenger gradient.

[12] Baltimore's railway difficulties emerged almost as soon as the network was completed (before 1900) and studies – never implemented – began forthwith. The effect of subsequent growth in the Baltimore and Washington metropolitan regions works against the early-20th century design concepts created by the PRR and the B&O in their desperation to modernize, expedite, and economize on their Baltimore operations. The NECIP in the 1970s and 1980s also devoted planning resources to this issue, but budgetary limitations forbade any but short-term improvements.

- The length and alignment of a tunnel[13] to connect the two potential portals – particularly if the alignment would be constructed for a significant length beneath the Fort McHenry channel; and
- The ease of integration of the train operations on the new alignment with:
  - The existing rail network; and
  - The existing freight and passenger yards and terminals.

For each alternative, the functional/design screening assumed that any significant adverse environmental impacts could be mitigated and that such implementation issues as legislative needs, jurisdictional questions, and public controversies could be addressed. These criteria properly belong to the next level of screening: external impacts.

EXTERNAL IMPACT SCREENING CRITERIA

After functional/design screening had removed the least productive alternatives, the remaining alternatives were evaluated for their external impacts. The following topics were addressed:

- Potential consistency with existing land uses;[14]
- Potential extent of acquisitions, displacements, and relocations;
- Potential to impact resources listed on or eligible for listing on the National Register of Historic Places or Maryland Inventory of Historic Properties;
- Potential to impact parklands and Section 4(f)/6(f) resources;
- Construction impact severity and duration;
- Potential impacts to ecosystems and water resources; and
- Any identifiable implementation issues that are likely to inhere in each alternative, based on engineering judgment.[15]

5.3.6 CONDUCT ADDITIONAL ANALYSES

Within each sector and for each type of service, only a limited number of alternatives passed, without any fatal flaws, both the functional/design and external impact screening. The study team subjected the set of surviving alternatives to some additional analyses:

- Conceptual engineering at a scale of 1"=400', including plan and profile drawings of the proposed route(s) and connections to existing lines and facilities;
- Initial analyses of critical system components and implementation methods, including:
  - Turnout sizes to be installed in interlockings and at the intersection of line segments;
  - Signal system requirements;
  - Temporary facilities required during construction (track, station platforms, signals, electric traction systems, etc.); and
  - Construction techniques and any specialized equipment.

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[13] The analysis assumed that any tunnel in the Harbor Sector would be constructed employing the immersed-tube technique. The construction of the tunnel would require dredging and deep excavations in soils ranging from very soft organic clays and estuarine silts to stiff over-consolidated cretaceous clays of the Potomac Group. The analysis also assumed that the appropriate technique, whether it be the use of a TBM or mining, would be used to construct any land-based tunnel(s).

[14] Consistency with likely future land uses would need to be researched and estimated in any future studies that might build upon this report.

[15] Any of the Baltimore alternatives would be of such a size as to necessitate a formal public participation process, with intensive involvement of all affected governments. All implementation issues would thus be fully aired, but that is for the future, if any such project is progressed.

- Performance of a number of train performance calculator (TPC) runs to compare the expected train operating characteristics of the restructuring alternatives with the existing routes;
- Identification of any betterments near the outer limits of the study area that would be required to support the contemplated Baltimore improvements and capitalize on the efficient through movement of people and goods; and
- A summary level operational analysis.

The study team then prepared initial cost estimates of a limited number of alternatives on the basis of unit cost methods and appropriate contingencies. Although these cost estimates must be regarded as very preliminary, they provide planners and policymakers with a first-ever, contemporary overview of the potential cost of meeting the Baltimore challenge. They also provide an order-of-magnitude comparison of the relative costs by sector.

6 – CONCEPTUAL FRAMEWORK FOR THE ALTERNATIVES

This section presents a conceptual framework for the development of passenger and freight railway restructuring alternatives for the Baltimore region. Sections 7 and 8 then go on to describe and evaluate the passenger and freight alternatives, respectively.

In theory, at least, rail passenger and freight traffic can cross the Baltimore region in one of four sectors, as shown in **Figure 6-1** and described below.

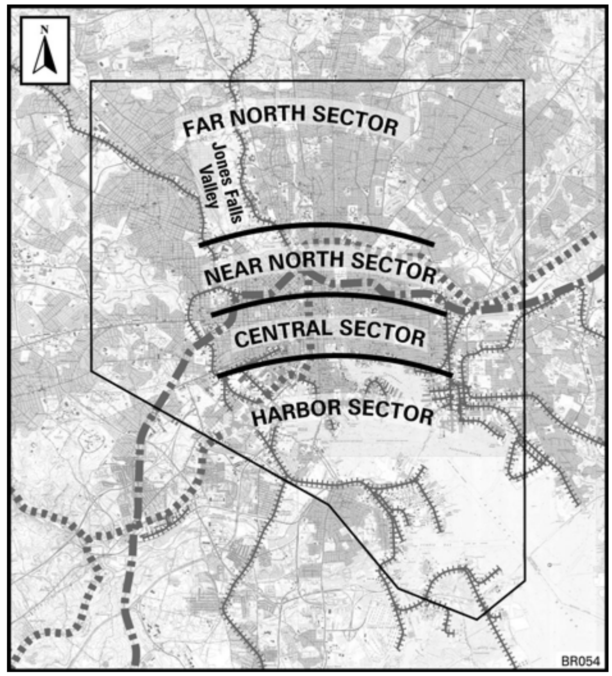

Figure 6-1. The Sectors[1]

6.1 DESCRIPTION

The sectors run roughly southwest to northeast, which is not only the general tendency of the traffic lanes but also a product of topography. Except within the Jones Falls Valley,[1] a radial climb from the Inner Harbor into the Piedmont produces nearly-impossible grades. (The basic problem with the CSXT's Belt Line is that it attempts such a radial climb across the grain of the sectors – and pays a price, with its 1.87 percent compensated grade[2] between Mount Royal Station and Huntingdon Avenue.)

In brief, the sectors are:

- **Far North Sector.** Serving as railroad "beltway," an alternative using this sector would avoid the central areas of Baltimore City entirely.
- **Near North Sector.** This sector lies just north of the CBD and is the location of Amtrak's NEC and the easterly portion of the CSXT's main line.
- **Central Sector.** This sector would cross the CBD proper. This is the natural route through Baltimore (abutting the Inner Harbor near Pratt and Lombard Streets) but was never an at-grade possibility as development in that precise area antedated the invention of the railroad.
- **Harbor Sector.** Because the Harbor is extensive and complex, with multiple inlets and points on both sides, many alternatives are hypothetically possible in this sector.

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1 The Valley is at a 90-degree angle to the direction of traffic – not much use for the purposes in this Report.
2 1.55 percent uncompensated grade on an 8-degree curve, 1.55 + (.04 x 8) = 1.87.

6.2 EVALUATION OF THE SECTORS

Based on all of the considerations described in prior sections, the study team considered the feasibility of using each of the four sectors to improve the movement of passenger and freight trains, respectively, through Baltimore. **Table 6-1** summarizes the findings of this initial analysis, which are described below.

Table 6-1. Initial Evaluation of Sectors for Passenger and Freight Service

SECTOR	PASSENGER	FREIGHT
Far North	Does not serve Central Baltimore	Crosses built-up areas, grades likely to be steep, lacks connectivity with existing network and yards
Near North	Possible	Possible
Central	Likely excessively expensive, but possible; more central station location for businesses	Too expensive, grade problems, and no need for freight to be in CBD
Harbor	Expensive and no closer to CBD than present station	Possible

Legend: May meet all initial standards *Has obvious difficulties* *Eliminated at outset*

6.2.1 FAR NORTH

The Far North Sector would not provide a solution for passenger traffic. It would not only add to the NEC's distance, but also eliminate center-city service, perhaps the foremost inherent advantage of high-speed rail. For freight service, initial studies suggest that a far northern route would cut a swath through built-up areas (Towson, for example), encounter challenging grades in crossing Piedmont hills and valleys, and be far removed from existing freight facilities and shippers. Although studied seriously by the former PRR and B&O in the early 20th century, alternatives through the Far North Sector are unrealistic today and merit no further consideration.

6.2.2 NEAR NORTH

The nexus of Baltimore's transportation system lies at the intersection of the CSXT, the NEC, the former Northern Central Railway (now the right-of-way for the Light Rail Line and support facilities), the Jones Falls Expressway, North Avenue, and the north-south arterials (Howard Street, Maryland Avenue, Charles Street, and St. Paul Street).[3] Clearly, long experience has shown the Near North Sector to be an attractive site for transportation facilities and flows. Whether this sector — with all of these facilities already extant, crammed into close quarters, and occupying horizontal and vertical space — offers opportunities for meaningful improvement to the rail passenger and freight infrastructure is examined in Sections 7 and 8.

6.2.3 CENTRAL

Involving tunneling under the very heart of Baltimore's business district, this sector would inevitably prove to be very expensive and replete with engineering and environmental complexities. Although, as discussed above, passenger service might benefit from a more central location, the requirements for a CBD station – probably involving the digging of a cavern some 125-175 feet wide and 1,200-1,500 feet long beneath the built-up city core – would entail a very heavy expenditure. Despite the cost and in view of the marketing considerations, passenger alternatives utilizing this sector receive treatment later in Section 7.

[3] Also nearby, about one mile to the west, is Baltimore's Metro Subway along Pennsylvania Avenue, which has a bearing on the design of Near North Sector alternatives.

Freight service has no need to be in the heart of the City and incur the associated expense. Therefore, no particular justification exists for considering the Central Sector for freight.

6.2.4 HARBOR

For passenger service, an underwater tunnel would imply a relocated station south of the CBD. The precise location would depend on tunnel alignment possibilities; in the best case, the new station might lie at roughly the same distance from Charles Center (to the south) as that of Penn Station (to the north). While many factors other than distance must enter into any comparison of station locations, a Harbor Sector passenger route cannot be ruled out on the issue of station location alone.

Freight service could potentially benefit from a Harbor Sector location. Indeed, the study team analyzed many alternatives to determine their operational implications and an order of magnitude of their costs.

6.3 INITIAL FINDINGS

The initial review of passenger and freight improvements in the four identified sectors:

- Eliminated further consideration of passenger service in the Far North Sector and freight service in the Far North and Central Sectors;
- Indicated, pending further engineering work, the potential for meaningful passenger and freight betterments in the Near North Sector, and for meaningful freight betterments in the Harbor Sector; and
- Was inconclusive regarding the feasibility and utility of passenger improvements in the Central and Harbor Sectors, although the analysis did identify special challenges to passenger solutions in those sectors.

The following sections describe the range of passenger and freight alternatives in the combinations of services and sectors that remained after the initial findings summarized above.

7 – PASSENGER ALTERNATIVES

Three of the sectors could at least theoretically provide a restructured passenger route through Baltimore: the Near North, Central, and Harbor. Guiding the creation of alternatives (including the search for potential tunnel portals and approaches to them) was the requirement to access the existing Penn Station — or another main station location no farther than Penn Station from the CBD — while efficiently connecting to the NEC south and north of Baltimore. The design of passenger alternatives also took into account the need to minimize conflicts between intercity passenger, commuter, and freight trains, and to provide sufficient capacity for the expected types and volumes of traffic. In this regard, the lack of expansion-room adjacent to certain branch or main lines influenced the design of the alternatives.

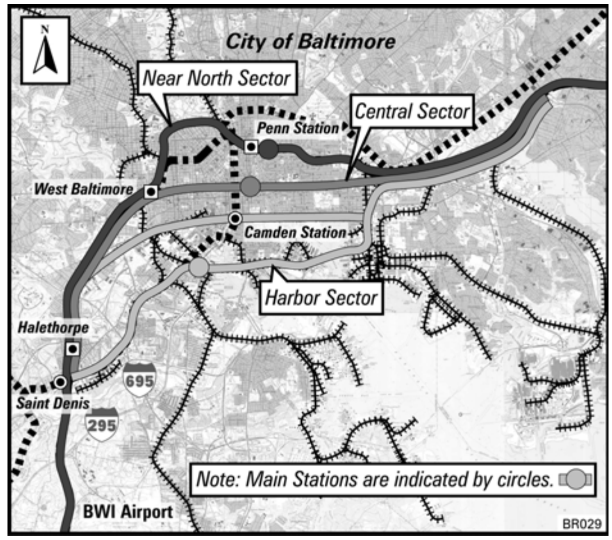

Figure 7-1. Generalized Passenger Alignments and Main Stations

The study team found that use of the Near North Sector would involve retention of Penn Station; that the Central Sector would imply a station in or near the Route 40 corridor; and that the Harbor Sector could include a station just southwest of the Inner Harbor. The generalized passenger alignments and station locations in each sector appear in **Figure 7-1**.

Further, the Maryland Transit Administration (MTA), in conjunction with the Federal Transit Administration (FTA), is proposing a 14-mile east-west Red Line Corridor transit system that would serve Baltimore from Woodlawn in the west to Johns Hopkins Bayview Medical Campus in the east. Because of the east–west orientation of the Red Line Corridor, a number of potential route conflicts develop involving the potential Amtrak and freight railroad alternative alignments and the transit system's potential alternative alignments. These conflict locations are discussed within the text as applicable.

The following sections describe and evaluate the passenger alternatives examined in the course of the study. These are summarized in **Table 7-1**.

7.1 NEAR NORTH SECTOR PASSENGER ALTERNATIVES

All passenger alternatives in the Near North Sector would make use of the existing trackage from Bay Interlocking (at the NS Bayview Yard), through the Union Tunnels and Penn Station, to a new tunnel with a northeastern[1] portal in the Jones Falls Valley and a southwestern portal in the vicinity of Bolton Hill, south of Druid Hill Park. Most options would most likely use two single-track passenger tunnels.

The Near North passenger alternatives are as follows:

[1] Directions in this section follow the compass direction of the traffic lanes, which generally run southwest to northeast through the Baltimore region.

- Employ the existing or parallel alignments:
  - Enhance the existing B&P Tunnel; or
  - Utilize the Presstman Street Tunnel design and right-of-way inherited from the PRR; or
  - Modify the Presstman Street alignment; or
- Employ a "Great Circle" alignment north of Presstman Street.[2]

Table 7-1. Characteristics of Passenger Alternatives

SECTOR	ALTERNATIVES CONSIDERED	STATION LOCATION		LOCATION OF TUNNEL AND APPROACHES BY ALTERNATIVE			
		PENN STATION	OTHER	SOUTHWESTERN APPROACH	SOUTHWEST PORTAL	NORTHEAST PORTAL	NORTHEASTERN APPROACH
Near North	Existing B&P Tunnel	•		BWI Rail Station to Bolton Hill/ Druid Hill Park area	Wilson Street	Jones Falls	From NEC via Union Tunnels and Penn Station
	Presstman Street (PRR)	•		BWI Rail Station to Bolton Hill/ Druid Hill Park area	Presstman Street	Jones Falls just northwest of existing B&P portal	From NEC via Union Tunnels and Penn Station
	Presstman Street (Modified)	•		BWI Rail Station to Bolton Hill/ Druid Hill Park area	Presstman Street	Jones Falls just northwest of existing B&P portal	From NEC via Union Tunnels and Penn Station
	Great Circle Passenger Tunnel	•		BWI Rail Station to Bolton Hill/ Druid Hill Park area	Located just north of existing B&P portal	Jones Falls just northwest of existing B&P portal	From NEC via Union Tunnels and Penn Station
Central	Route 40 alignment (Franklin/Mulberry/ Orleans Streets)		•	BWI Rail Station to West Baltimore	West end of the CBD, just west of IRS Building and Martin Luther King, Jr. Boulevard	Kresson Street south of Route 40, west of NEC Main Line near NS Bayview Yard	From NEC to Kresson Street
Harbor	Locust Point–Canton		•	BWI Rail Station to Herbert Run to Locust Point (generally following CSXT)	Locust Point	Canton	NEC to Canton via old PRR alignment
	Sports Complex		•	BWI Rail Station to Wilkens Avenue, generally eastward to Canton passing between the two sport stadiums	Wilkens Avenue	Canton	NEC to Canton via old PRR alignment

[2] All of these alignments were treated in the NECIP. The "Great Circle" route was conceived under the NECIP but extensively elaborated for this study.

7.1.1 EXISTING AND PARALLEL ALIGNMENTS

In the late 1970s, the Northeast Corridor Improvement Project (NECIP) intended to make major B&P Tunnel improvements that would include decreasing tunnel leakage, rebuilding the drainage system, lowering the concrete invert (floor) of the tunnel to provide clearance for freight cars, and installing a new track system. Early in the NECIP planning effort, it became evident that delays in service might be necessary during renovation and that an improved B&P Tunnel would not provide sufficient capacity for projected traffic. Therefore, the studies were expanded to include evaluation of a possible new Presstman Street Tunnel to be used, in various configurations along with the existing tunnel, to provide capacity for reliable movement of future passenger and freight train volumes.[3] The new tunnel would have followed an alignment along the west side of Presstman Street about 1,200 feet northwest of and parallel to the existing Wilson Street Tunnel (a segment of the B&P Tunnel network). The Presstman Street right-of-way was obtained by the Pennsylvania Railroad in 1931 for a new tunnel planned at that time. The NECIP studies yielded a number of alternatives that proved useful in the present analysis and are described below.

UPGRADE THE B&P TUNNEL

All analyses of the B&P Tunnel, from the NECIP to the present, indicate that its betterment would not be an effective, much less cost-effective, approach to the Baltimore challenge.

NECIP ANALYSES

The NECIP team evaluated construction alternatives that would enable the existing tunnel invert to be lowered one track at a time, with the second track remaining in service during construction. Existing subsurface data, supplanted by additional borings and the installation of piezometers, were utilized.

The tunnel was inspected and evaluated between 1976 and 1978 by Amtrak and NECIP personnel. In summary, the tunnel arch was found to contain many areas of seepage, particularly between John Street and Pennsylvania Avenue. Water also was discharging from weep holes in the tunnel sides, although many of the weep holes appeared to have become clogged. Seepage near the crown of the tunnel was often above the adjacent ground water level and appeared to be from other sources. Brick courses were found to have been removed at a few locations and anchor bolts added to permit clearance for freight cars.

Drainage through the tunnel consisted of pipe drains below the center of each track. The pipes were clogged in some areas resulting in standing water or flow above the pipe to the next inlet. In other areas, the pipe was broken out, leaving a trench. At that time, Amtrak's crews were in the process of performing temporary track repair to correct an uneven track condition that was very evident in some areas as trains passed through the tunnel.

The geotechnical investigations defined subsurface conditions generally surrounding the existing Wilson Street Tunnel and determined the thickness and strength of the concrete invert and sidewalls of the tunnel at several locations.[4] Some of the more pertinent conclusions reached by the NECIP team included the following:

1. The existing ground water table dropped 10 to 20 feet near this tunnel from its general surrounding levels, reflecting drainage through the tunnel walls. Sealing of the tunnel walls would raise water levels and increase tunnel loading. This was considered undesirable as the original tunnel was designed with a ballast invert and was not intended to be waterproof.

[3] At the time of the NECIP studies in the late 1970s, there still remained an important freight service on the NEC and the concept of tunnels segregated by function rather than by corporate ownership had not yet crystallized.

[4] The Wilson Street Tunnel is the middle of three separate tunnels that make up the B&P Tunnel complex. The other two are the Gilmore Street Tunnel (south end) and the John Street Tunnel (north end).

2. Leakage above the springline originated above the ground water table and very likely was coming from leaking utility lines.
3. Drainage along the invert was very poor. An improved drainage system design was needed.
4. As a method for obtaining additional clearance in the B&P Tunnel, the practical limit for lowering top of rail would be approximately 44 inches. If a section requires greater interior dimensions beyond that obtained by maximum rail lowering, the walls should be widened by open cut methods.
5. Lowering of the tunnel invert by about three feet would probably require blasting of rock for a length equivalent to four or five city blocks in the northern portion of the tunnel. Alternative construction methods were evaluated and it was concluded that lowering of the invert three feet, while maintaining train traffic on one track, would be very expensive.

Ultimately, the NECIP – short of funds but long on mandates for speedy service improvement – concentrated its resources on other system components and locations and limited its work in the B&P Tunnel to minor repair of the tunnel lining, drainage improvements, and installation of a new, improved track system after the tunnel invert was replaced.[5] While benefiting passenger safety, ride quality, and reliability in the short term, these improvements did nothing to effect a permanent improvement in passenger service capacity, travel times, or viability.[6]

RECENT B&P EVALUATIONS

Since the NECIP B&P Tunnel Rehabilitation Project was completed, Amtrak has continued to have the responsibility for upkeep of the tunnel. Recent evaluations have concluded that the B&P Tunnel should be replaced within 20 years as the existing tunnel is increasingly difficult and expensive to maintain. At this writing, Amtrak is in the process of developing a list of infrastructure items that will need to be replaced and provide for service expansion. The status of the B&P Tunnel is listed as conceptual and would consist of a two-track tunnel that permits higher speed and full clearances for intercity passenger and commuter cars (bi-level).[7]

Further, a recently completed Mid-Atlantic Rail Operations Study report[8] had the following summary (although emphasizing freight movement, it is relevant to this section):

> "The Baltimore passenger station has the Union Tunnels to the north and the B&P Tunnel to the south. The Union Tunnels (actually two tunnels side by side) are approximately ¾-mile long, and consist of three tracks. Clearances through them are restricted to a maximum height of 17 feet 9 inches. The B&P Tunnel is nearly two miles long, was constructed in the 1870s. The B&P Tunnel consists of a two-track brick arch design built in three separate sections. In the [early 1980s], the invert (floor) was lowered and stabilized after structural problems nearly shut down the bore. Despite this work, the B&P Tunnel does not have clearance for cars greater than Plate E (15 feet 9 inches). The tunnel has [severe] curves, heavy grades and a constant water problem. The repairs [completed in 1982] were intended only as an interim design (30 to 50 years) and ultimately, this tunnel will need to

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5 The contract to rehabilitate the tunnel invert and install a new track structure, one track at a time, was completed in 1982 and was considered one of the NECIP's successes.

6 The tunnel invert, in addition, was not materially lowered and through-freight services (then under Conrail's direction and in the process of being removed from the NEC) derived no clearance benefit.

7 Phone conversation with Stan Slater, Amtrak, June 2, 2009.

8 According to the Executive Summary of the *Interim Benefits Assessment* (I-95 Corridor Coalition, February 2004): "The Mid-Atlantic Rail Operations Study (MAROps) is a joint initiative of the I-95 Corridor Coalition, five member states (New Jersey, Pennsylvania, Delaware, Maryland, and Virginia), and three railroads (Amtrak, CSX, and Norfolk Southern). The Federal Railroad Administration (FRA) and Federal Highway Administration (FHWA) participate as advisors. Over a two-year period, the MAROps participants crafted a 20-year, $6.2 billion program of rail improvements aimed at improving north-south rail transportation for both passengers and freight in the Mid-Atlantic region and helping reduce truck traffic on the region's overburdened highway system."

be replaced. The present clearance through the entire route is restricted by the smaller B&P clearance, and the clearances through both tunnels preclude freight railroads from operating excess dimension car designs, including double-stack cars (maximum 20 feet 2 ins.) through the tunnels. This project consists of re-boring and rehabilitation of the tunnels to eliminate their continuing deterioration of the tunnels and increase their ability to handle modern railcar equipment. The order of magnitude of the cost of this project is estimated to be *$100 million in near term for design, with an additional $900 million in medium term for construction*. Benefit to be derived from this project is the elimination of deteriorating conditions and restrictions on the size of railcar traffic over the NEC through Baltimore."[9] [Emphasis added, regarding costs to rebuild the B&P Tunnel in place.]

<u>OBSERVATIONS BASED ON THE PRESENT STUDY</u>

It should be noted that since the above quote was written, the clearance through the B&P Tunnel has been reduced to Plate C (15 feet 6 inches). The higher Plate E clearance referenced above was achieved by using a gauntlet track on two curves within the tunnel; the gauntlet track is now removed. The gauntlet track had a major operational disadvantage in that the center location of the track reduced the remaining available side clearance so that other trains could not pass in the tunnel. For example, an Amtrak passenger train would have to wait until a freight train completely exited the tunnel before it could enter.

Upgrading the B&P Tunnel would contradict the fundamentals of engineering economy. As prior sections amply demonstrate, the tunnel's basic geometry was substandard when it was completed and is irremediable by any reasonable amount of rehabilitation — whether for passenger or freight service. What's more, the B&P upgrading cost suggested by the MAROps study ($1 billion) would likely exceed that of a brand new, much improved facility achieved by deep-bore tunneling. Because it would neither expedite passenger nor enhance freight service, the B&P Tunnel alternative deserves no further consideration.

PRESSTMAN STREET ALIGNMENT

The PRR in the early 1930s identified Presstman Street as a possible location for a new tunnel roughly parallel to the B&P (**Figure 7-2**). Twenty-seven borings were drilled then, of which the records included only generalized soil and rock types. Therefore, the NECIP study made six additional borings in 1977. The geotechnical investigations defined subsurface conditions for the completion of a preliminary study of the alignment.

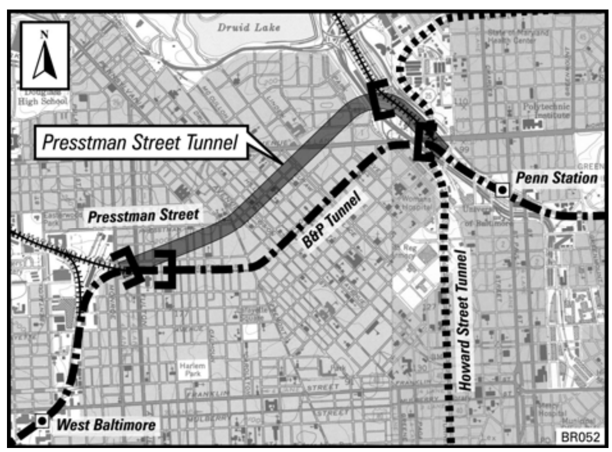

Figure 7-2. Presstman Tunnel Alignment

Based on the geological sections thus developed, the study concluded that the original PRR proposal for the new tunnel along Presstman Street had the following advantages:

- The tunnel would have a uniform vertical compensated grade of 1 percent, which would be a significant improvement over the existing B&P Tunnel (1.5 percent compensated[10]);
- The tunnel would be relatively short; and
- Most of the tunneling right-of-way along this alignment already had been acquired and had passed to Amtrak with its acquisition of the NEC.

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9 I-95 Coalition, *MAROps Final Report,* 2002, Appendix I.

10 Maximum grade of 1.34 percent uncompensated, with a four-degree curve; 1.34 + (4 x 0.04) = 1.5 percent.

The original PRR Presstman Street proposal was determined to have the following disadvantages:

- Construction of the Baltimore Subway Tunnels (since completed) immediately below this alignment could open joints in the rock above, increasing the tendency for costly overbreak when the railroad tunnels are excavated. Even though the transit tunnels were reportedly being designed to take into account this future tunnel loading, special precautions would be necessary during construction to:
  - Limit blasting;
  - Avoid concentrated temporary supports above the transit tunnels; and
  - Maintain and possibly reinforce the rock on either side and between the underlying tunnels.
- Due to the position of the top of the rock along this alignment, a mixed face (soil and rock) tunneling procedure would be involved, resulting in a high cost of excavation.
- Dewatering would be difficult and expensive due to the location of the proposed tunnel mostly beneath existing buildings and the presence of porous soils close to and above the crown of the tunnel.
- Due to the shallow depth of the proposed tunnel, most of the buildings may have to be evacuated during construction as a precautionary measure.
- Possible costly damage to some of the buildings along tunnel alignment.
- Extra cost of noise and vibration attenuation from trains at this shallow depth below buildings.

ADDITIONAL PRESSTMAN STREET ALTERNATIVES CONSIDERED

In an effort to eliminate most of the disadvantages encountered by the PRR's Presstman Street Alternative, three additional alternatives – located below the Baltimore Rapid Transit Tunnels on Pennsylvania Avenue – underwent scrutiny. These alternatives consisted of varying tunnel slopes and tunnel lengths and included the flattening of horizontal curves as necessary.

Advantages of these alternatives included:

- A considerable increase in the length of rock tunnel with a resulting decrease in mixed face tunnel and a significant decrease in the tunneling cost.
- The possible use of a Tunnel Boring Machine (TBM), which would have reduced the construction time and construction costs.
- A substantial reduction of the environmental impact of the tunnel and tunnel construction.
- The work would have been accomplished in an area where, with some exceptions, the tunneling right-of-way was generally already acquired.

Disadvantages of these alternatives were:

- The first alternative required steep grades west of Pennsylvania Avenue.
- The second and third alternatives required longer tunnels and the lowering of the western approach to the tunnel on the NEC main line, which might have affected crossing roadways.
- A new tunnel may disturb the Baltimore Subway tunnels above.

From the geotechnical point of view, these alternatives appeared to be more desirable than the PRR Presstman Street Alternative. However, from a passenger service viewpoint, the 4-degree curves in any of the Presstman

Street alternatives – although much gentler than the 7-degree, 30-minute curve in today's B&P Tunnel – would still hamper the speed of trains through Baltimore. At the high price entailed by any of these parallel B&P/Presstman Street Tunnels, all of which would require conventional instead of the cheaper deep-bore construction methods and would heavily impact the affected neighborhoods at least during the construction process, a more satisfactory travel time payoff should be expected.

7.1.2 GREAT CIRCLE PASSENGER TUNNEL ALTERNATIVE[11]

The Great Circle Passenger Tunnel Alignment (GCPT) would replace the existing B&P Tunnel on an alignment ranging up to some 3,600 feet north of the present tunnel. This alignment would have improved geometry for passenger service, would reduce trip times entering and leaving Baltimore Penn Station, and would retain the existing Union Tunnels and the alignment northward from the Union Tunnels to Bay Interlocking.

GENERAL DESCRIPTION

With portals not far removed from those of the B&P Tunnel, the GCPT would follow a large arc north of the existing and Presstman alignments. By providing a gradual curvature permitting higher train speeds, the alignment would have a continually changing direction, which would minimize the possibility of encountering a weak shear zone.

The route retains the present NEC alignment south of Fulton (MP 97.7) through the West Baltimore MARC station. The route at the northeast end of the GCPT reconnects to the NEC at Charles (MP 95.9). The platforms at Penn Station would not be modified; however, the track alignment between Charles and Paul (MP 95.2) could optionally be reconfigured to enable train speeds to be increased on the approaches to the platforms.[12] Reconfiguration of the Penn Station tracks and platforms, especially if the Penn Freight Alternative[13] is selected, would likely reduce the storage space available to MARC trains in the station, for which substitute facilities would be needed.[14]

The present NEC alignment between Paul (the interlocking immediately east of Penn Station) and Bay (Bay View) would or would not be modified, depending upon the determination of the location of the freight alternative. The selection, side by side with the GCPT, of the Penn Freight Alternative, would require a modification of the NEC between the east end of Union Tunnel (Biddle Interlocking) and Bay to accommodate three freight tracks and two passenger tracks. The selection of any of the other freight alternatives would not modify the NEC between Paul and Bay.

ADVANTAGES OF THE GCPT

The Great Circle alignment would have a number of advantages. First, trains would be operated at much greater speeds than through the other two alignments. Initial train performance analyses have concluded that the Great Circle alternative, albeit longer than the extant route, would save about two minutes in comparison with the B&P alignment.[15] Second, and much more importantly, the Great Circle route follows the ridgeline so the tunnel can be deeper below the surface, in rock strata that would reduce construction costs by enabling a tunnel-boring machine (TBM) to be used (**Figure 7-3**).

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[11] The Great Circle alignment was originally proposed by Mueser Rutledge Consulting Engineers, working for the NECIP, in March 1977.

[12] This option is not reflected in the Train Performance Calculator results reported in this section for the GCPT.

[13] Section 8 defines the "Penn Freight" and "Belt Freight" Alternatives.

[14] The location of any alternate MARC storage was beyond the scope of present analysis. See Section 9, "Railroad Operations/ Simulations."

[15] It would thus reduce Amtrak's Washington–New York travel time by about one percent and the Baltimore–Washington travel time by about six percent. (Times are for Acela Express.)

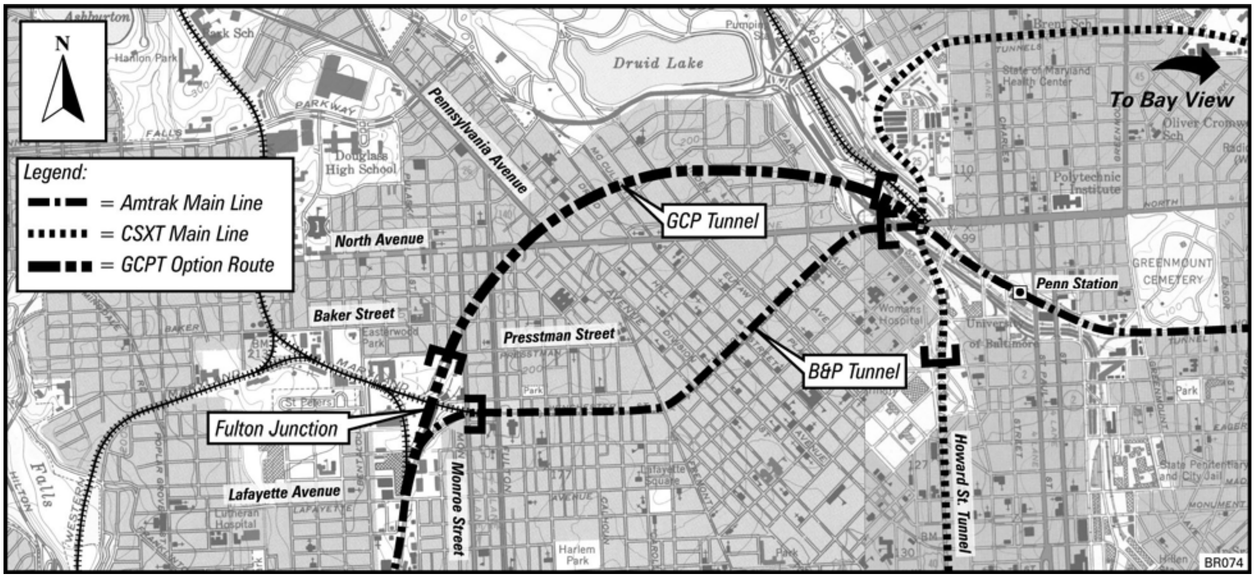

Figure 7-3. Great Circle Passenger Tunnel

CHALLENGES INHERENT IN THE GCPT

Unfortunately, a uniform grade cannot be obtained between the north and south GCPT portals because the profile must go under the Baltimore Subway near the intersection of Pennsylvania and North Avenues. The elevation of the bottom of the Baltimore Subway at that important intersection is about 120 feet. Therefore, to pass under the subway, the elevation of the tracks of the Great Circle Tunnel must be less than 85 feet. The highest elevation on Amtrak south of the B&P Tunnel is about 168 feet near Lafayette Street, which is near the location of the current Bridge Interlocking (MP 98.2). The preliminary conceptual design indicates that the elevation could be lowered to elevation 162 feet at the La Fayette Street Bridge. The distance between La Fayette Street and the subway is about 5,250 feet and the conceptual design indicates that a descending grade of 1.75 percent would achieve a top-of-rail of about 78 feet beneath the tunnel.

The selection of the 1.75 percent, rather than the minimum 1.48 percent grade,[16] is the result of the initial design of the passenger tunnel to be constructible with the Great Circle Freight Tunnel (GCFT), discussed below. This design requires the passenger tunnel to pass over the freight tunnel at a location approximately 1,350 feet north of the Metro Subway. The elevation of the roof of the tunnel at that location (essentially under McCulloh Street) is about 56 feet. The other option is to pass over the subway at a top-of-rail elevation of 155 to 160 feet, then descend to a top-of-rail elevation of about 55 feet beneath the access ramp to the North Avenue light rail station. The distance is about 5,950 feet. Going under the subway is preferable because it would be a deeper tunnel, constructed in better rock conditions. A schematic of the GCPT in conjunction with the GCFT appears in the section that discusses the latter.

7.1.3 EVALUATION OF NEAR NORTH PASSENGER ALTERNATIVES

A major restoration of the existing B&P Tunnel, carried out under traffic, would entail a huge expense – about $1 billion according to the MAROps study – merely to preserve the existing capabilities of the NEC. No geometric characteristics of the tunnel would be altered; its 7-degree 30 minute and 4-degree curves would remain in place. As this option, studied in depth during the NECIP, would lead to no improvement beyond the safety benefit of restoring the tunnel, it constitutes a kind of "status quo"

[16] The minimum grade is that which could be achieved by a passenger train tunnel alignment if there were no requirement to interface with a freight train tunnel.

alternative that does not meet the goals and objectives of the study. If, however, a more comprehensive restructuring is not initiated, then the B&P alternative will ultimately be necessary — at a potentially higher cost than the Great Circle route.

A Presstman Street Tunnel, whether on the PRR or a modified alignment, would almost exactly parallel the existing B&P, would echo its debilities in attenuated form, and would do little to expedite passenger service. On the other hand, as a soft-earth tunnel close to the surface, a Presstman Street project would have tremendous neighborhood impacts and excessive costs in comparison with deep-rock tunneling by means of a TBM. Thus, there is no apparent advantage to a Presstman Street routing in 2009, much as it may have appealed to the PRR's world-class engineers in 1931 with the technology, cost structure, and environmental laxness then prevailing.

Finally, a Great Circle Tunnel would significantly ease the curvature and raise the speed limits on the NEC's approach to Baltimore from the south. Utilizing TBM technology in the deep rock, it could be constructed at a reasonable cost and, because of its depth, with much less risk of impact to the fully built-up neighborhoods above. Therefore, from among the Near North Sector passenger alternatives, this study chose only the GCPT alignment for further analysis and screening. **Table 7-2** summarizes the results.

Table 7-2. Application of Screening Criteria to Near North Passenger Alternative

FUNCTIONAL/DESIGN SCREENING CRITERIA	GREAT CIRCLE PASSENGER TUNNEL
Availability of Land	Probable
Gradient Two Percent or Less	Yes
Beneath Harbor Highway Tunnels	No
Tunnel Length > 4 miles	No
Ease of Integration with Network	Good
Ease of Integration with Yards	Good
Pass/Fail	Pass
Adverse Environmental Impact	Very low

EXTERNAL IMPACT SCREENING CRITERIA	GREAT CIRCLE PASSENGER TUNNEL
Consistent with Existing Land Use	No substantial change
Extent of Acquisitions, Displacements, and Relocations	Low
Impact Listed or Eligible National or State Historic Place	None
Impact Parklands, 4(f)/6(f) Resources	None
Construction Impact Severity	Pass
Impact Ecosystems, Water Resources	No wetlands impacts
Implementation Issues	Nothing substantial
Pass/Fail	Pass

7.2 CENTRAL SECTOR PASSENGER ALTERNATIVES

Hypothetically, the most obvious and direct route for a passenger alternative in the Central Sector would make use of a broad public right-of-way in the U.S. Route 40 corridor from the NEC at West Baltimore Station to the vicinity of MLK Boulevard, then due east in a tunnel under the CBD to a connection with the NEC near Bay Interlocking. Termed in this report the "Route 40 Alternative," this route illustrates the challenges and costs of a Central Sector passenger solution. Other CBD-based passenger alternatives, posited further below, might ultimately merit closer examination should a Central Sector passenger solution be deemed advisable and affordable.

7.2.1 OVERVIEW AND PERFORMANCE EFFECTS OF A ROUTE 40 ALTERNATIVE

Figure 7-4 compares the location and speeds of the present B&P route with an alignment for a Route 40 Alternative. By replacing tortuous curves with a nearly straight line, a Central Sector solution would markedly outperform the existing route.[17] The potential reduction in running time for express intercity passenger service remains to be calculated, as it would depend on the station location, the alignment of its approaches, its track layout, and the resultant train braking and acceleration pattern. At a minimum, the alignment would allow the relatively high speeds northeast of Bay to be extended southwestwardly into the tunnel. If significant time savings are found, they might impact demand and revenue levels for Amtrak's high-speed services between Washington, Baltimore, Philadelphia, and New York, and perhaps affect the economics of the Route 40 alternative vis-à-vis those in the Near North and Harbor Sectors. Whether those economic effects would appreciably counterbalance the higher cost of the Route 40 Alternative is unknown.

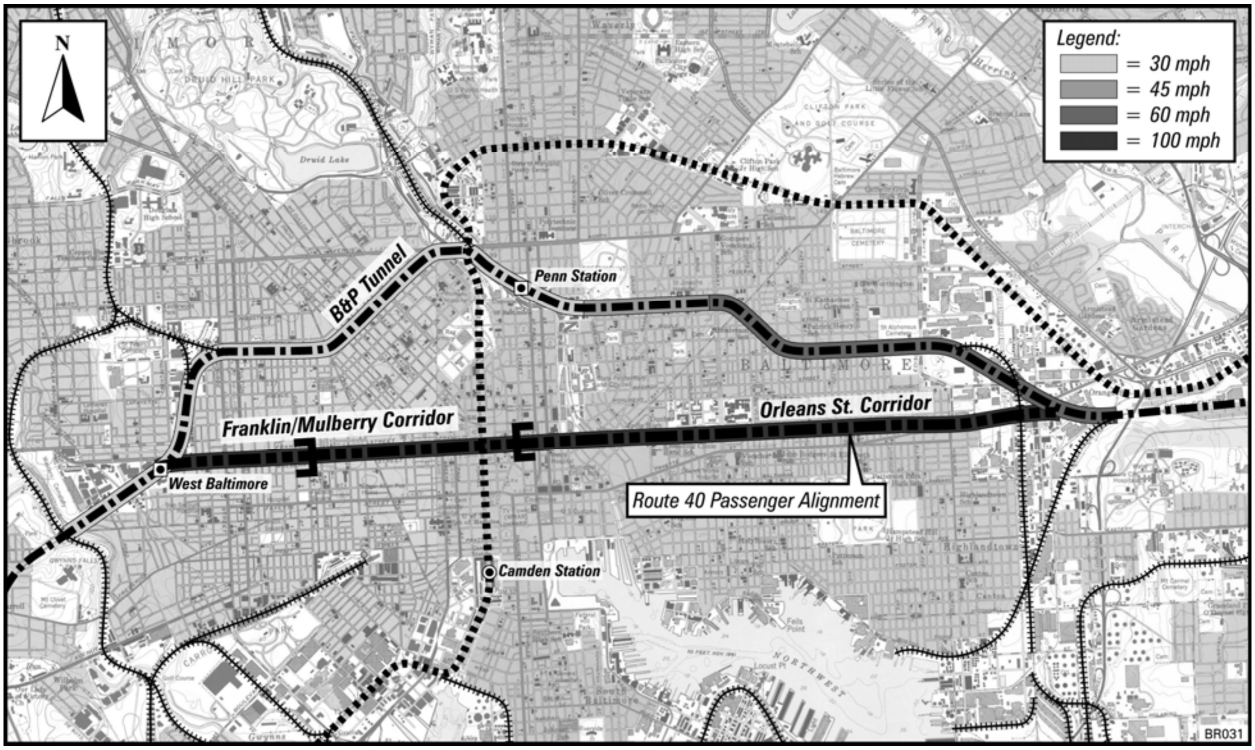

Figure 7-4. Central Sector, Route 40 Alternative, and Existing Route Compared

7.2.2 DETAILED DESCRIPTION OF A ROUTE 40 ALTERNATIVE

This alternative would consist of three main segments (proceeding in a northeastwardly direction): the NEC at West Baltimore to MLK Boulevard; MLK Boulevard to the Jones Falls Valley; and the Valley to the NEC near Bay Interlocking. These segments are addressed sequentially.

NEC TO MLK BOULEVARD

An initial analysis of the Central Sector indicated that there was an isolated segment of the I-70 corridor between the current MARC West Baltimore Station and MLK Boulevard, approximately 7,000 feet long (**Figure 7-5**). The corridor is located between Mulberry Street on the south and Franklin Street on the north. All of the property between the Mulberry

Figure 7-5. I-70 East of NEC in West Baltimore

[17] Interestingly, recent research indicates that PRR and city officials at one time discussed a route that would have used the west end of the corridor to City Hall and then to President Street.

and Franklin Streets was taken for the highway but, after considerable controversy and public participation, the segment of I-70 was never connected to Exit 94 on the west side of Leakin Park. The potential for placing the rail alignment in this broad corridor was evaluated from an engineering standpoint; the rail right-of-way potentially would replace one of the two lane roadways on either side of the median. Space was provided in the median for a light rail line, which would have to be maintained.

Near the West Baltimore Station, Franklin and Mulberry Streets descend westward to pass under the NEC. At the east end of the "orphaned" right-of-way, I-70 ends at MLK Boulevard (**Figure 7-6**), an urban arterial ring road that connects I-395 and the Baltimore-Washington Parkway on the south side with I-83, the Jones Falls Expressway (JFX), on the north, channeling north/south traffic around the CBD.

Figure 7-6. Route I-70 East Approaching MLK Boulevard

MLK BOULEVARD TO THE JONES FALLS VALLEY

The CBD is at a higher elevation than the alignment of Route 40 to the east towards Orleans Street and west towards the NEC. Approaching downtown from the west, the alignment would go into a tunnel that would have to pass under Metro Tunnel, the Howard Street Tunnel, the central Enoch Pratt Free Library, and the Basilica of the Assumption (oldest Catholic Cathedral in the US). The first two locations are at a relatively high elevation and initially it appears that the alignment would be well below them. Most of the tunnel alignment would be in mixed ground (soils and rock). Due to the sensitivity of the historic structures above, expensive low-impact tunneling techniques would have to be implemented. Potentially, the alignment could be diverted to one side or the other, running under either Franklin or Mulberry Streets; this would lengthen the tunnel and might require an unacceptable gradient leaving/accessing the NEC.

The relatively deep Jones Falls Valley is located east of St. Paul Street, where Franklin and Mulberry Streets merge to become Orleans Street, which crosses the valley on a viaduct. The railroad alignment would emerge at, or above, ground level in the valley. This would be a potential station site. The station would be located about four blocks north of City Hall and about six blocks north of the financial district. At this point, there is good access to the Jones Falls Expressway (JFX, I-83), which runs north to the Baltimore Beltway (I-695), allowing easy access to all points on the north side of the city. I-83 continues northward to York and Harrisburg, PA, where it merges with I-81. I-83 also runs southward for a short distance where it connects with several major east-west arterials, some of which lead to I-395. The Jones Falls Valley at this location, which was a rail yard for both the Western Maryland (WM) Railway and Northern Central (NC) Railway, contains a significant amount of vacant land. A large portion of the land currently is used for surface parking. Some marginal industrial activity would need to be relocated.

FROM THE JONES FALLS VALLEY TO A JUNCTION WITH THE NEC NEAR BAY

For illustrative purposes, the alignment was assumed to run northeastward under Orleans Street and Pulaski Highway all the way to the latter's intersection with the NEC, midway between Canton Junction and Bay (Point A in **Figure 7-7**). East of the viaduct over the JFX, Orleans Street is 10+ lanes wide as far as Broadway, where it narrows to 4 to 6. This would be the most difficult part to plan, design, and construct in terms of community issues, due to the proximity of residences.

A connection to the NEC between Bay and Canton Junction might prove suitable. The NEC descends on a 0.5-percent grade while turning from southeast to east to the point where Pulaski Highway passes under it while veering slightly toward the northeast as it heads away from downtown Baltimore. Conceptual engineering would be needed to determine whether the Route 40 Alternative would ramp directly up from under Pulaski into the NEC, or whether some other junction design would be preferred.

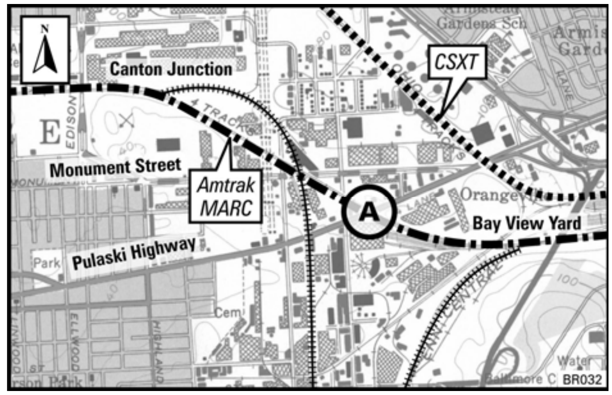

Figure 7-7. Site of Potential Junction, Route 40 Alternative with NEC

7.2.3 OTHER CENTRAL SECTOR ALTERNATIVES

To relocate the NEC main line to the Central Sector would mean choosing a new main passenger station location. This relocation would have to be done in consideration of Amtrak having signed an agreement with Hospitality Partners (Bethesda, MD) to build a $9 million hotel on the upper three levels of the existing Penn Station. The hotel is to be called The Inn at Penn Station.

Any decision to abandon the present Penn Station and move rail passenger service closer to the CBD would require not just an engineering investigation of potential sites, but – even more to the point – a careful marketing and demand analysis of the workplaces, residences, and travel habits of actual and prospective station users, both commuter and intercity. The dynamics of, and factors in, their modal choice decisions must come under careful scrutiny. It is by no means certain, for example, that the origins and destinations of a majority of present and likely future users of Penn Station would be closer and more accessible to a downtown station than to the current one. On the other hand, a more central station might induce completely new travel demands and create perceptible shifts in modal shares that might outweigh any losses of current Penn Station users. Other important issues include the rail service goals and objectives of the various Metropolitan Planning Organizations, transportation agencies, and rail operators in the Baltimore and Washington metropolitan areas, as well as the economic and development impacts on the neighborhoods affected by such a change of venue.

All these complexities – while essential to the station location issue – fall outside the scope of this engineering report. In evaluating the Central Sector for passenger service, the study team identified a number of potential station sites, the existence of which would be the most critical element to be considered in the evaluation of potential alternative alignments. These are shown in **Figure 7-8** and the numbers are cross-referenced to the following list. The envisioned sites were:

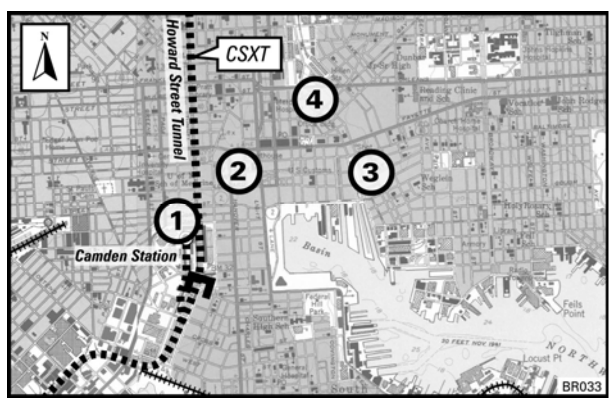

Figure 7-8. Alternate Station Sites, Central Sector

1. Near the original B&O Camden Station;
2. Adjacent to Charles Center Metro Station;
3. Adjacent to, or near, the Market Place Baltimore Subway Station; and
4. The Route 40 Station Site, mentioned earlier.

Identification of possible alignments to serve the first three sites, and of concepts for the layout of all four stations, was beyond the scope of this report. Still, certain probabilities and issues came to light as the array of sites was scrutinized:

- The downtown station most likely would be underground, beneath the most densely developed part of Baltimore City, thus making it more expensive to construct. One preliminary estimate was that such a station would need to be 125 to 175 feet wide and 1,200 to 1,500 feet long – a veritable cavern. Such a project would raise both environmental and cost concerns.
- The Route 40 Alternative site (number 4 on Figure 7-8), although above ground, would have no existing rail transit access and would be in an industrial-type area north and slightly east of the financial district. While precise distances and accessibility issues cannot be known unless and until the station concept were to be better developed, a careful comparison with the existing Penn Station of access, egress, and marketability would need to be made.
- The new site would require commuters, living in the northern neighborhoods of Baltimore but working in Washington, to access a station deeper into the city than is presently the case. Transit availability, traffic conditions, and parking adequacy and prices would likely be important concerns to that group of system users. If Penn Station and the B&P Tunnel are retained for commuter service, then, effectively, two passenger tunnels would have to be constructed (or rehabilitated), maintained, and operated.
- The Charles Center and Market Place Station locations would imply a Baltimore Street alignment. The Metro Subway is located under Baltimore Street between Howard Street and Central Avenue. The potential for utilization of this street for a rail passenger tunnel would be limited.
- Inspection of aerial photos of the Central Sector indicates that access to the alternative station sites (number 1, 2, and 3 on Figure 7-8) from West Baltimore and at Bay would necessarily use more southerly, and more difficult, alignments than that conceived for the Route 40 Alternative.

7.2.4 INITIAL OVERVIEW ASSESSMENT OF THE CENTRAL SECTOR ALTERNATIVE

An initial overview assessment based on detailed local knowledge of the area and a review of available mapping and photography (including aerial photos) indicated that many stretches of the Route 40 Alternative would not pass under or through adjoining residential neighborhoods. For example, there is nothing residential between MLK Boulevard and Asquith Street, and very little residential development between Asquith and Rutland Avenue (east of Broadway). East of Highland Avenue, too, the development is industrial.

On the other hand, the Franklin/Mulberry Corridor in West Baltimore is populated, as is Orleans Street between Rutland and Highland Avenues. While these neighborhoods have always experienced a high level of traffic on Route 40, public reaction to adding railway construction and operation to the ambient noise and activity levels is not known at this time. However, the intense (and ultimately effective) public response to the I-70 project decades ago testifies to the sensitivity of the affected communities to issues of transportation encroachment on their environment. Therefore, even beyond the customary and required environmental processes, early and well-heeded public participation would be of critical importance in any further consideration and development of the Central Sector.

Table 7-3 summarizes the performance of the Route 40 Alternative, illustrative of the use of the Central Sector for passenger service, on the screening criteria developed for this study. It passes "with comment" due to the environmental implications and likely public controversy. Also of great concern is the likely high cost of any downtown station that directly serves the heart of the CBD because it would need to be underground, large, and in close proximity to the Baltimore Subway.

Table 7-3. Application of Screening Criteria to Central Sector Passenger Alternative

FUNCTIONAL/DESIGN SCREENING CRITERIA	ROUTE 40 ALTERNATIVE
Availability of Land	Probable
Less than One Percent Grade Freight; Two Percent Passenger	Likely
Beneath Harbor Highway Tunnels	No
Tunnel Length > 4 miles	Unlikely
Ease of Integration with Network	Good
Ease of Integration with Yards	Good
Pass/Fail	Pass
Adverse Environmental Impact	Potential for Parklands/4(f); Ecosystems; Construction impact

EXTERNAL IMPACT SCREENING CRITERIA	ROUTE 40 ALTERNATIVE
Consistent with Existing Land Use	Probable
Extent of Acquisitions, Displacements, and Relocations	Low
Impact Listed or Eligible National or State Historic Place	No
Impact Parklands, 4(f)/6(f) Resources	No
Construction Impact Severity	Pass
Impact Ecosystems, Water Resources	Low
Pass/Fail	Pass with comment
Comment	Impact of construction: Route 40, beneath Center City, beneath Subway and Howard Street Tunnels

7.3 HARBOR SECTOR PASSENGER ALTERNATIVES

In order to test the feasibility of a Harbor Sector passenger route providing a main station reasonably close[18] to the CBD, the study conceptualized a "Locust Point" Alternative, crossing the Northwest Branch of the Inner Harbor to the north of the Fort McHenry Tunnel. The tunnel route from the southwest to the northeast connects Herbert Run (where the CSXT crosses the NEC) and Bay Interlocking in East Baltimore. Sited south of the CBD, this alternative would link Locust Point with Canton.

At the request of the Maryland DOT, an additional Harbor Sector passenger alternative was conceptualized for serving, in particular, the Inner Harbor area of downtown Baltimore. The Inner Harbor is a natural gathering spot for Baltimoreans and tourists as numerous attractions are located there, including the Maryland Science Center, the National Aquarium, USS Constellation, restaurants, and Harbor place. As a result of the MDOT request, the Sports Complex Alternative was developed.

As both of these alternatives are passenger only, a maximum gradient of two percent was deemed acceptable in developing the alignment.

7.3.1 DESCRIPTION OF THE HARBOR SECTOR – LOCUST POINT PASSENGER ALTERNATIVE

The basic concept for this alternative may be described as follows, proceeding from the southwest to the northeast (numbers refer to points on **Figure 7-9**):

1. At Halethorpe/Herbert Run, northeast-bound passenger trains would divert from the existing NEC to the CSXT main line via a connection that is yet to be configured. The configuration would depend on the operating patterns for other types of traffic through Baltimore. The junction might resemble Union Interlocking in Rahway, NJ, which connects the six-track NEC main line with the double-track branch to Perth Amboy using

[18] "Reasonably close" in this context means "no farther from the CBD than the current Penn Station."

duckunders[19] constructed in the middle and side of the NEC to facilitate the movement of New Jersey Transit branch line trains to and from the NEC.

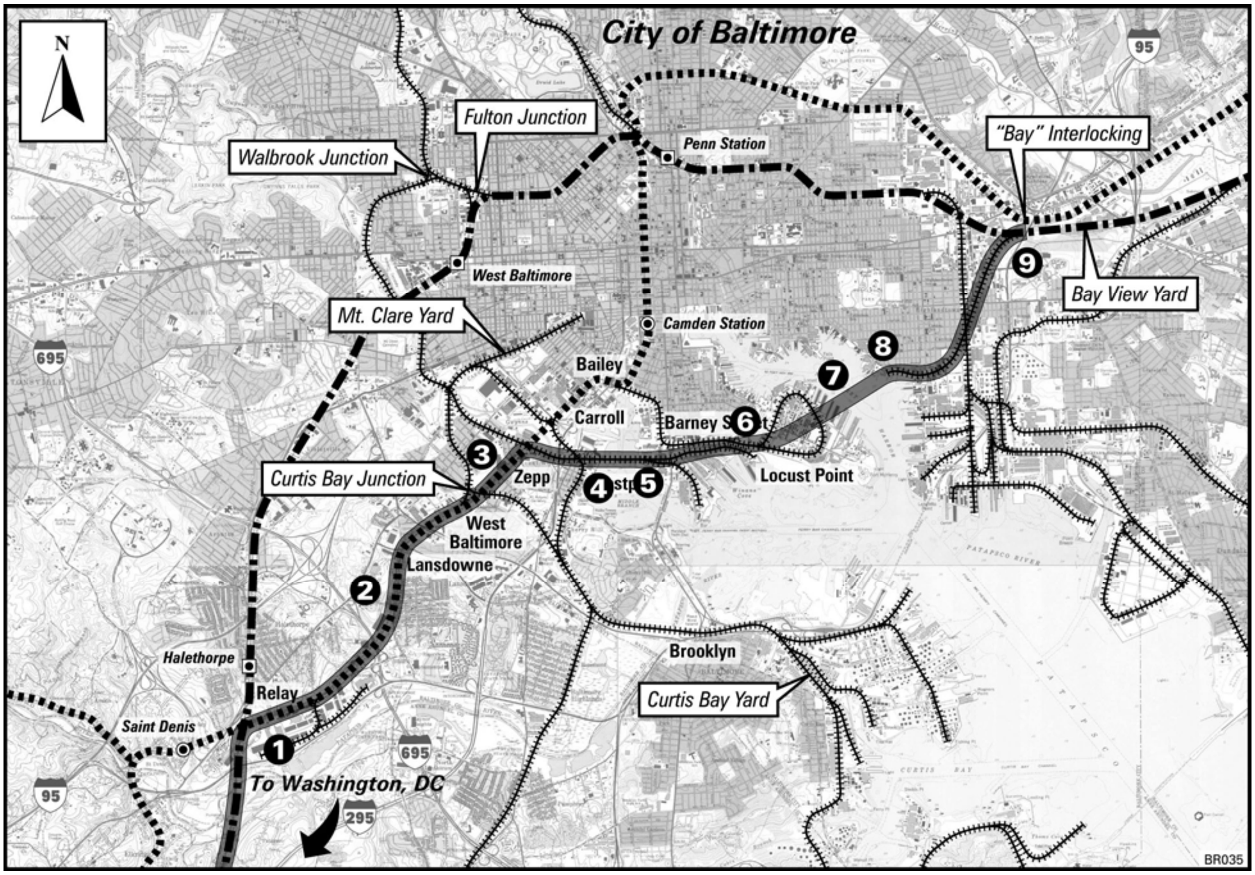

Figure 7-9. Schematic of Harbor Sector – Locust Point Passenger Alternative

2. Between Halethorpe and Curtis Bay Junction, the alternative could potentially have Amtrak, CSXT, NS, and MARC all operating in the already overburdened CSXT corridor. (Which carrier operates where, for what type of traffic, would depend on the resolution, if any, of the freight routing challenge in the region.) Development of a track configuration with sufficient capacity to accommodate all of trans-Baltimore traffic, while minimizing conflicts, was beyond the scope of this study; six tracks might be necessary, with several complex interlockings and track connections and all of the associated signaling and programming.
3. At a location east of Curtis Bay Junction, the passenger alignment would diverge to the northeast from the CSXT right-of-way. It would continue to the northeast, crossing over local roads and streets, to Westport, where it would have an intermodal station stop as it bridges over Baltimore's light rail line (4). Trains would then cross the Middle Branch of the Harbor on an elevated structure located basically above the former Western Maryland (WM) moveable bridge (5).
4. Neither an advantageous station location in either the Locust Point or Canton Alternatives, nor a consequent route through, could be identified within the Locust Point area. There was no obvious solution and no truly CBD station site.

[19] A duckunder is a railway structure in which the branch line, separating from the main, gradually ramps down and, on attaining sufficient vertical distance below the main line grade, smoothly bears away the principal right-of-way and passes beneath it.

5. The option would utilize two single-track passenger tunnels that would pass under a portion of Locust Point before rising to ground level north of I-95 in Canton.
6. Northeast of the tunnel, the alignment – threading its way through freight trackage and other obstacles in the Canton port area (see evaluation below) – would necessarily be slow and circuitous and would not significantly contribute to reducing travel times through Baltimore.[20] Curves immediately east of Northwest Harbor and the curve connecting into the NEC at Bay (9) – both exceeding 2 degrees, 50 minutes – would restrict speed.

7.3.2 EVALUATION OF THE HARBOR SECTOR – LOCUST POINT PASSENGER ALTERNATIVE

From both the engineering and passenger traffic viewpoints, the Locust Point Passenger Alternative presents obvious drawbacks:

- West of the Harbor, the passenger-only line would have to pass beneath I-95. Access beneath the interstate highway, to create a relatively direct and fast route, would require considerable reconstruction of the piers and abutments supporting the highway on its approach to the Fort McHenry Tunnel.
- The alignment would be made more difficult by the requirement to construct a grade-separated alignment (i.e., without a moveable bridge) over the Middle Branch, in the vicinity of the former WM swing bridge that had provided access to Port Covington.
- The Westport Intermodal Station would be farther from downtown Baltimore than the existing Penn Station and would pose difficult barriers to pedestrian access. In Locust Point, no feasible location for a main station was identified during the study. Within the alignment constraints, it would be almost impossible to site a Locust Point station within an equivalent walking distance to downtown as that of the existing Penn Station.
- East of the Harbor, the access of Amtrak intercity trains between the NEC at Bay and the eastern portal at Canton would be constrained by:
  - At-grade railroad-highway crossings;
  - Overhead and undergrade bridges that presently separate the existing freight-only tracks from the city streets; and
  - The need to maintain local freight connections and operations between the CSXT and NS yards and local industries and facilities in Canton and Dundalk.
- Finally, if intercity rail passenger service were diverted to the south, a vicinity already served by MARC's Camden Line, then the Penn Line – providing access to the vast residential areas north of the CBD – may well remain in place. Retention of commuter service to Penn Station would necessitate – alongside the Harbor Sector passenger tunnel – either permanent maintenance or rehabilitation of the B&P Tunnel for commuters, a new tunnel for commuter service alone, or an arrangement for commuter service to share trackage with a Great Circle Freight Tunnel. In the context of this study, none of these outcomes accords with the criteria.

The foregoing engineering and traffic considerations eliminated the Harbor Sector Locust Point Passenger Alternative from further consideration (**Table 7-4**).[21]

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[20] One of the Harbor Sector freight alternatives involves a Locust Point-Canton freight alignment that might be constructed above the Locust Point Passenger Alternative. However, due to grade problems that have not yet been resolved, this particular freight alternative does not survive the screening imposed on it (see further below).

[21] The study team also investigated the very complicated topic of a joint passenger and freight corridor between Locust Point and Canton but dismissed this as not feasible.

Table 7-4. Application of Screening Criteria to Harbor Sector Locust Point Passenger Alternative

FUNCTIONAL/DESIGN SCREENING CRITERIA	LOCUST POINT ALTERNATIVE
Availability of Land	Probable
Gradient Two Percent or Less	Likely
Beneath Harbor Highway Tunnels	No
Tunnel Length > 4 miles	Unlikely
Ease of Integration with Network	Poor; May increase congestion on upgraded CSXT Capital Subdivision
Ease of Integration with Yards	Good
Pass/Fail	Fail
Adverse Environmental Impact	Potential for Acquisitions, Displacements, Relocations; Construction impact

EXTERNAL IMPACT SCREENING CRITERIA	LOCUST POINT ALTERNATIVE
Consistent with Existing Land Use	Low
Extent of Acquisitions, Displacements, and Relocations	Medium
Impact Listed or Eligible National or State Historic Place	No
Impact Parklands, 4(f)/6(f) Resources	Yes, Parkland in Herbert Run
Construction Impact Severity	Pass
Impact Ecosystems, Water Resources	Low
Implementation Issues	Would likely require reconstruction of I-95; Would require approval of Coast Guard; Would increase congestion on upgraded CSXT Capital Subdivision
Pass/Fail	Fail

7.3.3 DESCRIPTION OF THE HARBOR SECTOR – SPORTS COMPLEX PASSENGER ALTERNATIVE

The Sports Complex alignment would divert to the west from the existing Amtrak alignment at MP 101.5 (about ½ mile north of the I-695 Beltway over crossing in southwest Baltimore) and parallel the Amtrak route until reaching Wilkins Avenue. This segment would be in a cut-and-cover tunnel. The alignment would then curve to the east, cross under the Amtrak tracks, and follow Wilkins Avenue for about ½ mile. From Wilkins Avenue, the alignment would be in a tunnel section and would continue eastward to a location between the baseball stadium (Oriole Park at Camden Yards) and the M&T Bank football stadium. This would be the site for the potential downtown underground station. This site provides excellent access for stadium events, affords accessibility to the Baltimore Light Rail Line and MARC Camden Line, and is in proximity to the Inner Harbor attractions. A shuttle bus service could be established to make the Inner Harbor even more assessable. The underground station would be constructed using cut-and-cover methods.

Continuing the alignment eastward, sunken tube tunnels would be used under the Northwest Branch, past Fells Point to a point in the vicinity of Boston Street where the alignment would curve to the northeast. The principal reason for using the Northwest Branch for a tunnel corridor was to avoid complicated construction under buildings that would require underpinning and to avoid poor tunneling soil conditions. Cut-and-cover tunneling would begin in the Boston Street area with the portal located in the vicinity of Eastern Street on an existing NS route. The NS route would be used to Bayview where Amtrak trackage would be rejoined (**Figure 7-10**).

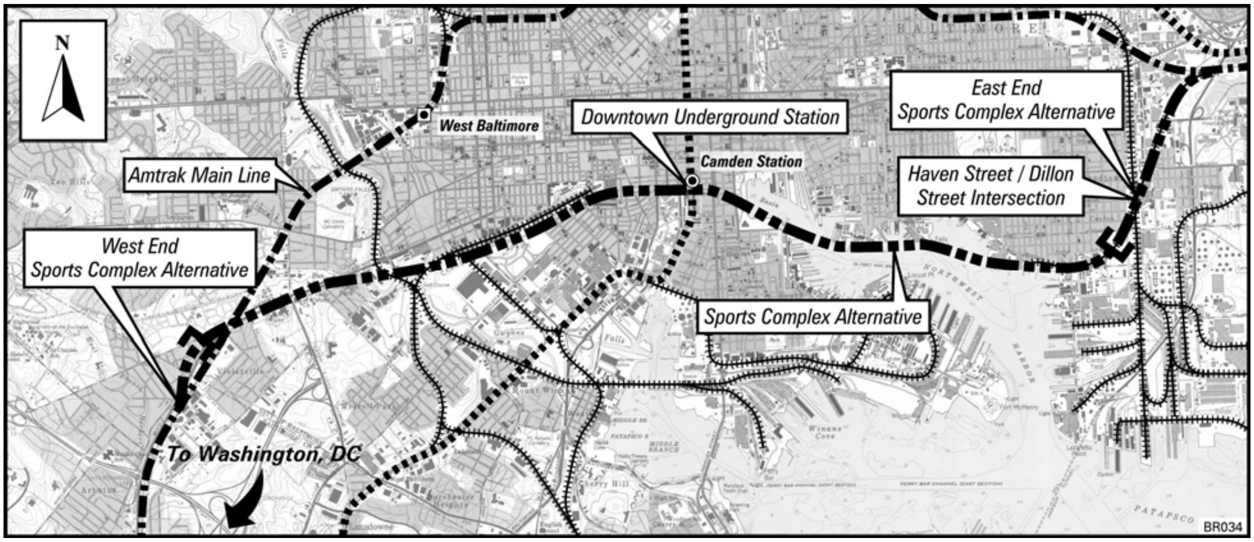

Figure 7-10. Sports Complex Passenger Alignment

The Sports Complex alignment in the Boston Street–Dillon Street–Haven Street area would have to be coordinated with a potential Red Line Corridor transit alignment. Because of the rising gradient from the tunnel portal, Haven Street may have to be closed just south of the Dillon Street intersection.

7.3.4 EVALUATION OF THE HARBOR SECTOR – SPORTS COMPLEX ALTERNATIVE

The Sports Complex alternative exhibits a number of advantages and disadvantages:

Advantages-

- The alignment is easily connected to the existing Amtrak main line.
- The majority of the alignment is in a tunnel, which minimizes surface environmental effects. The portion that is above grade is in an industrial setting.
- The Sports Complex passenger station is located in proximity to the Baltimore Light Rail, bus, and MARC commuter services and is within walking distance of the Inner Harbor.

Disadvantages-

- Immersed tube construction will cause bottom disturbance and short-term silting from dredging and backfill.
- The passenger station would be limited to three to four tracks. Therefore, trains could not be stored on the station tracks but would need to be moved out as soon as possible. The train storage issue is particularly important to MARC commuter service.
- The MARC West Baltimore commuter station would be bypassed and service discontinued.
- As described in the previous alternative, a decision must be made as to whether or not MARC commuter service should be maintained to the existing Penn Station. Continuance of this service carries with it all the ramifications of maintaining or replacing the B&P Tunnel.
- During the construction period, it is probable that the Korean War Memorial at the Canton Waterfront Park would be displaced. It is assumed though, as a cost to the project, it would be replaced when construction is finished.

The evaluation of the screening criteria for the Sports Complex Alternative is provided in **Table 7-5**.

Table 7-5. Application of Screening Criteria to Harbor Sector – Sports Complex Passenger Alternative

FUNCTIONAL/DESIGN SCREENING CRITERIA	SPORTS COMPLEX ALTERNATIVE
Availability of Land	Probable
Gradient Two Percent or Less	Yes
Beneath Harbor Highway Tunnels	No
Tunnel Length > 4 miles	Tunnel is 7.5 miles long and electrified
Ease of Integration with Network	Good; Would tie in with the existing Amtrak alignment at each end of route
Ease of Integration with Yards	Good
Pass/Fail	Pass
Adverse Environmental Impact	Public controversy likely

EXTERNAL IMPACT SCREENING CRITERIA	SPORTS COMPLEX ALTERNATIVE
Consistent with Existing Land Use	No substantial change
Extent of Acquisitions, Displacements, and Relocations	Low; West end tunnel access could displace some small businesses
Impact Listed or Eligible National or State Historic Place	Potential temporary construction impact to Korean War Memorial
Impact Parklands, 4(f)/6(f) Resources	Potential temporary impacts to Rash Field during construction
Construction Impact Severity	Pass
Impact Ecosystems, Water Resources	Wetlands along Baltimore Harbor could be impacted; Baltimore Harbor in Zone AE floodplain
Implementation Issues	Temporary soils/silting impact involving immersed tube placement
Pass/Fail	Pass

8 – FREIGHT ALTERNATIVES

The study team identified two sectors in which viable freight alternatives might, at least theoretically, be found:

- **Near North –** roughly analogous to the existing PRR alignment and the eastern portion of the CSXT Belt Line, but refined due to state-of-the-art engineering and construction techniques; and
- **Harbor –** an underwater solution that would be complex because of the number of potential portal sites, and the multiplicity of port, land transportation, and industrial facilities on either side of Baltimore Harbor.

As explained in previous sections, a Far North Sector freight alternative was ruled out because it would pose severe gradient challenges, bypass important freight yards, and disrupt much parkland and intense suburban development. Likewise, an inevitably costly freight solution in the Central Sector was not pursued as the associated expenditure would far outweigh any foreseeable benefit of such a location at the heart of Baltimore's CBD.

Also noted in the previous section, the MTA, in conjunction with the FTA, is proposing a 14-mile east-west Red Line Corridor transit system that would serve Baltimore from Woodlawn in the west to Johns Hopkins Bayview Medical Campus in the east. Because of the east–west orientation of the Red Line Corridor, a number of potential route conflicts develop that involve the potential Amtrak and freight railroad alternative alignments and the transit system's potential alternative alignments. These conflict locations are discussed within the text as applicable.

8.1 FREIGHT ALTERNATIVES IN THE NEAR NORTH SECTOR

The Near North freight alternatives would involve the construction of tunnels of varying lengths on different alignments. The freight alignments would replace both the existing CSXT route using the Howard Street Tunnel and the NEC route currently available to the NS via the B&P Tunnel. Concentrating all of the cross-Baltimore freight traffic on a single, much-improved route, the Near North alternatives would relieve most of the constraints to commerce that the extant alignments interpose. The Near North freight alternatives would involve a Great Circle Freight Tunnel (GCFT), similar in concept to the GCPT discussed earlier. By following a gentle, long arc bored deeply underground, instead of a cut-and-cover excavation hewing to the vagaries of the City's street layout, a GCFT would help to attenuate the ill effects of Baltimore's challenging topography.

As depicted in **Figure 8-1**, all of the Near North freight alternatives would begin at Herbert Run (near Halethorpe), where northeast-bound NEC freight traffic would join through CSXT traffic on the CSXT Baltimore Terminal Subdivision main line.[1] The connecting track would pass under the CSXT main line and continue to Curtis Bay Junction. The line segment between Herbert Run and Curtis Bay Junction is common to all freight alternatives. At Curtis Bay Junction, the route would curve to the north briefly using the Mt. Clare Branch to reach the Hanover Subdivision (the former Western Maryland Railway) using a new connection. The new connection would require an open cut, a crossing of Gwynns Falls, and impact an industrial building. From the new connection, the route would bear northeast from the Hanover Branch to

[1] Only early conceptual engineering has taken place with regard to the connection at Herbert Run and the joint freight route from that point to the Hanover Subdivision to the proposed tunnel portals. To handle the complex freight moves to, from, within, and through the Baltimore Terminal, connections are required in addition to those described here.

the tunnels' west end portal where the GCFT's alignment begins. The line segment between Curtis Bay Junction and the portal of the GCFT is common to all Near North freight alternatives.

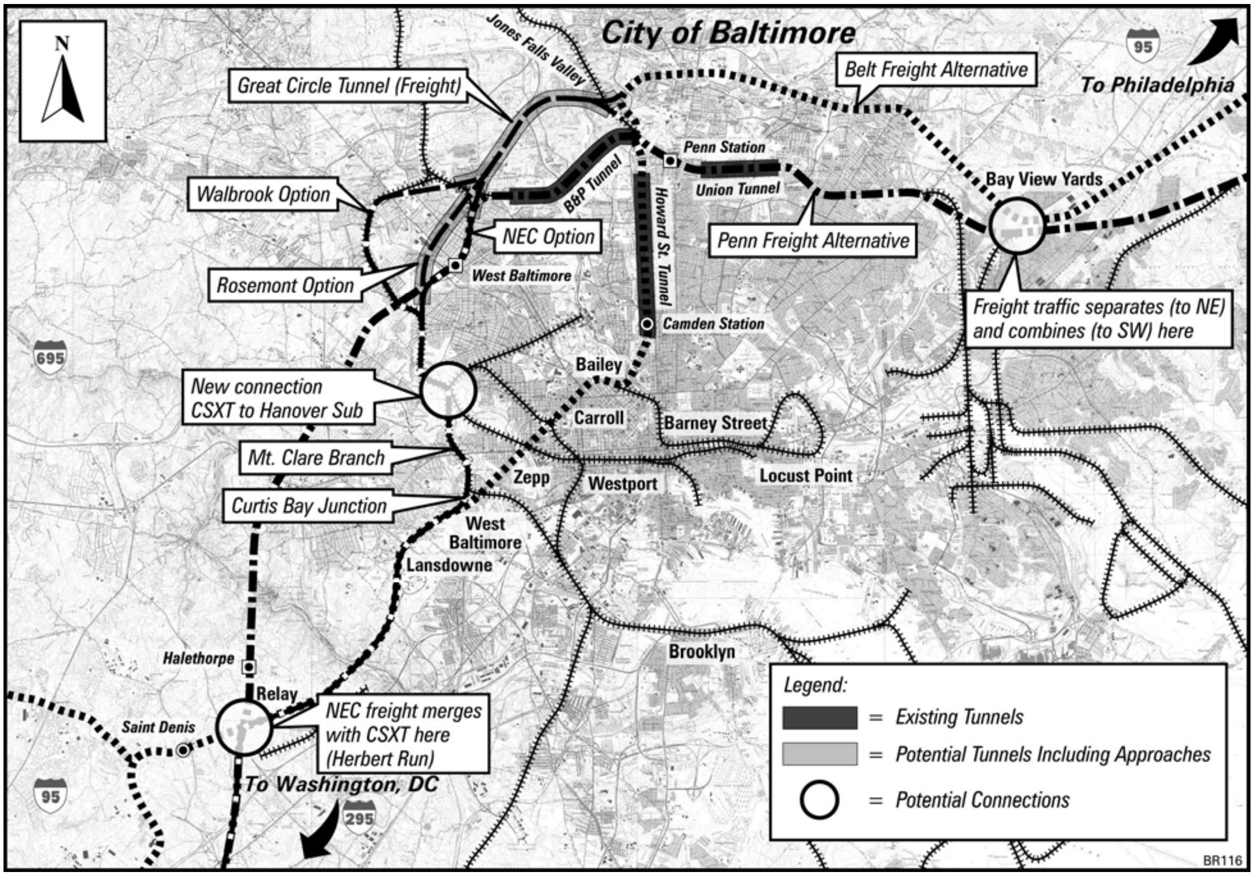

Figure 8-1. Near North Freight Alternatives – "Belt Freight" and "Penn Freight"

In addition, a new connection would be needed for northbound trains from the Locust Point branch to access the new GCFT route. The Locust Point connecting track would link the Baltimore Terminal Subdivision main line to the Hanover Subdivision. It would start in the vicinity of Carroll, running in a southwesterly direction, then crossover and parallel Gwynns Falls, then join the Hanover Subdivision in the vicinity of the I-95 overcrossing. This track would be located in a floodplain and cross Washington Blvd, Hollins Ferry Road, and Maisel Street at grade.

Within this common Near North concept, there are two alternatives, differentiated by their routes across the Jones Falls Valley. In the Belt Freight Alternative, the through-freight route would cross the Valley toward the northeast to a connection with the CSXT's Belt Line through Clifton Park to Bay View. By contrast, in the Penn Freight Alternative, the through-freight route would make use of the NEC right-of-way through Penn Station, a modified "Old" Union Tunnel, and on to Bay View. Under both alternatives, the CSXT and NS-based traffic would split west of Bay View, each company's trains going to their separate tracks.

While the basic concept of the GCFT would remain constant, its design would vary significantly to meet the particular connection requirements of the Belt Freight and Penn Freight Alternatives while also avoiding the Metro Subway tunnel under Pennsylvania Avenue in West Baltimore. The shared freight operation involving the CSXT and NS would occur between the Herbert Run (Halethorpe) and Bay View vicinities.

In the conceptualization of both Near North alternatives, it was assumed that the GCPT must be provided for; therefore, from this point on in this report, the Belt and Penn Freight Alternatives will be referred to without reference to the GCFT in the alternatives' title.

The following discussion first deals with the sub options that may be available at the southwestern approaches to either freight alternative. Then, a discussion and evaluation follows addressing the particulars of the Belt Freight and Penn Freight Alternatives.

8.1.1 SOUTHWESTERN APPROACH OPTIONS (APPLICABLE IN EITHER ALTERNATIVE)

As noted above, the approach to the Great Circle Freight Tunnel from the southwest would make use of the CSXT Baltimore Terminal Subdivision between Halethorpe/Herbert Run and Mt. Clare Yard to access the CSXT Hanover Subdivision (the former WM main line to and from Port Covington). Three alternative route approaches from the Hanover Division to the southwest tunnel portal were evaluated and are shown in **Figure 8-2**. Of these options, two would utilize a common western portal located north of Gwynns Falls; the third would have its portal near Walbrook.

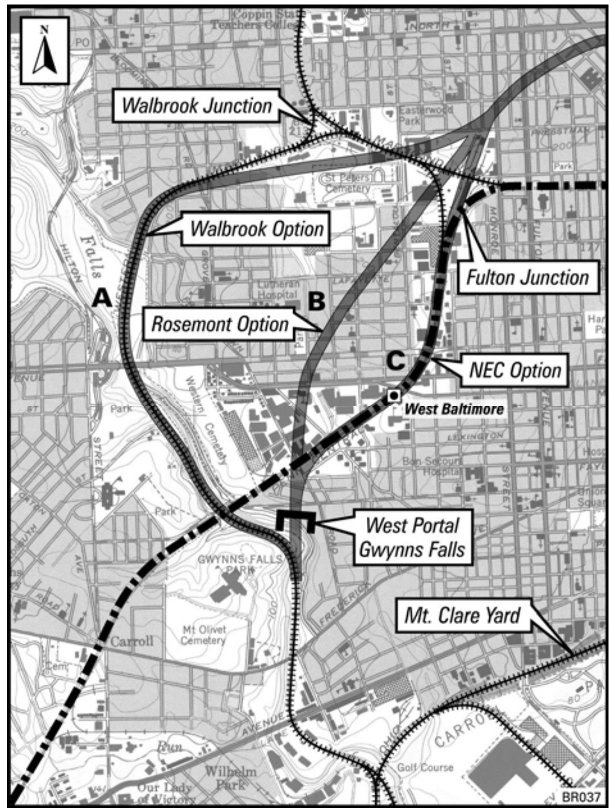

Figure 8-2. Three Southwestern Approach Alternatives to Great Circle Freight Tunnel

GWYNNS FALLS – NEC OPTION (C)

Predicated on the assumption that minimal right-of-way acquisition would be required, the Gwynns Falls–NEC tunnel option (labeled "C" in Figure 8-2) would be constructed underneath the NEC as far northeast as Fulton Junction.[2]

From its portal just north of Gwynns Falls, the tunnel alignment would curve to the northeast from the southwest portal to reach its position underneath the NEC right-of-way. The length and degree of curvature would vary depending on whether it was desirable to minimize the length of alignment rights that would have to be acquired. The longest, least sharp curve would be approximately two degrees 30 minutes and approximately 2,000 feet long, while a 1,215-foot long, three-degree 20-minute curve would result in a maximum speed of 50 mph.

The NEC, just east of Franklintown Road (UG Bridge 98.95), is approximately 1,300 feet north of the contemplated south portal. The elevation of the NEC at Franklintown Road is approximately 134 feet. The roof of the freight tunnel would be approximately 35 to 40 feet beneath the NEC. Warwick Avenue[3] and Franklin Street pass under the NEC; however, the freight tunnel would have to be designed to pass beneath both streets. This requirement would apply to both the Belt Freight and Penn Freight Alternatives.

[2] The feasibility of tunneling underneath the NEC was not evaluated as part of this study and would need careful and early analysis should work on this option be considered.

[3] It was assumed that the tunnel should be located at least 15 feet beneath the road surface of a street.

The alignment would proceed underneath the NEC to Lafayette Avenue, where the NEC is approximately at elevation 168 feet and the roof of the freight tunnel would be at approximately either elevation 135 or 75, depending upon the choice of either the Belt Freight or Penn Freight Alternative. The Penn Freight Alternative would be located beneath the Great Circle Passenger Tunnel at Presstman Street, while the Belt Freight Alternative would be parallel to the Great Circle Passenger Tunnel.

ROSEMONT OPTION (B)

Alternatively, the shorter route between Gwynns Falls and Presstman Street (labeled "B" in Figure 8-2) would pass under the Rosemont section of Baltimore. The alignment would extend northward from the Gwynns Falls portal until it passes under the NEC right-of-way. The alignment would curve to the northeast on a 2,831-foot long one-degree curve. The subsequent 3,980-foot long tangent would pass under the former WM Wye Tracks at Fulton on the NEC. The freight tunnel alignment becomes parallel to the GCPT, but approximately 90-foot lower, near Presstman Street.

WALBROOK OPTION (A)

The third option considered for accessing a GCFT (labeled "A" in Figure 8-2) would continue following the CSXT Hanover Division to the vicinity of Bloomingdale Road, where it would bear to the right (going northeast) to converge with the other options under Presstman Street. Unfortunately, no portal and tunnel configuration using the Walbrook option could be found that would meet the grade or clearance requirements of this study. Accordingly, this option was dropped from further consideration.

8.1.2 BELT FREIGHT ALTERNATIVE

Beginning at the Gwynns Falls portal, the tunnel alignment would ascend on a one percent grade from an elevation of less than 70 feet to pass over the Metro Subway tunnel at an elevation of 150 feet. The gradient is controlled by the need to cross over the top of the GCPT near Baker Street. The option of constructing the GCFT beneath the GCPT was evaluated; however, sufficient clearance between the tunnels could not be established to enable the freight tunnel to cross over the top of the passenger tunnel between Presstman and Monroe Streets. The general route of the Belt Freight Alternative through Near North Baltimore, including the GCFT, is shown in **Figure 8-3**.

Some segments of the Belt Freight Alternative between the south portal and Pennsylvania Avenue would have less than 20 feet of ground cover. However, it does not appear upon first inspection that an open trough, rather than a tunnel, would be an option in these locations. The Belt Freight Alternative option would parallel the GCPT between Baker Street and Newington Avenue. The profile of the Belt Freight Alternative from Presstman Street to Huntingdon Avenue on the CSXT Belt Line is shown in **Figure 8-4**.

Continuing from the north portal, the Belt Freight Alternative would directly access the CSXT Belt Line (the Clifton Park Freight Alignment) east of Jones Falls, by means of a high bridge spanning the valley. Selecting a Belt Freight alignment to cross the valley from the north portal of the GCFT required careful analysis of the location of all important intervening structures. Vertical, as well as horizontal, alignment considerations were critical in the finalization of the analysis. The main elevations are shown in Figure 8-4.

The engineering analysis of the Belt Freight Alternative and its connection across the Jones Falls Valley to the northeastern portions of the CSXT Belt Line through Clifton Park led to the following conclusions, which take into account the conflicting determinants:

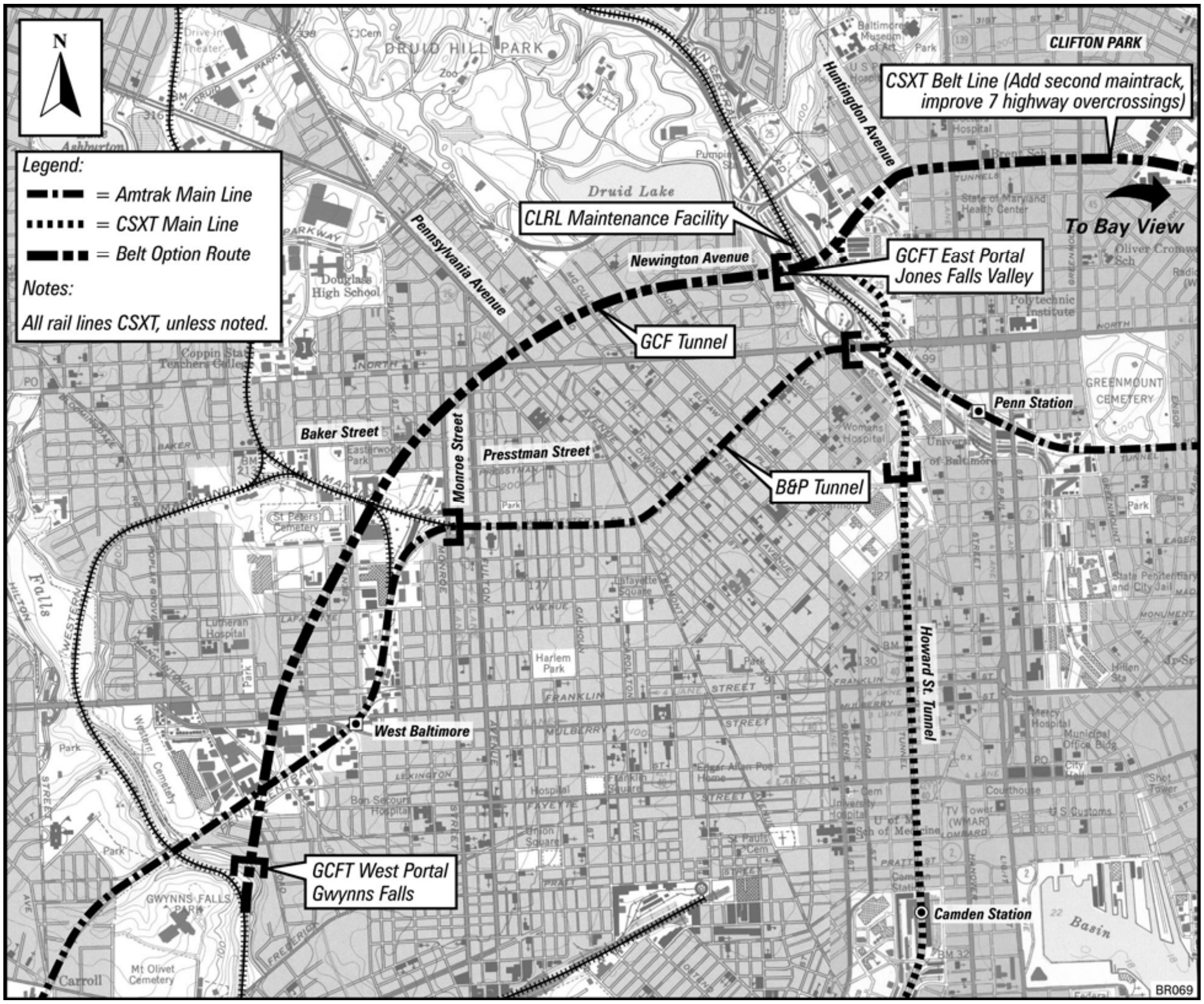

Figure 8-3. Belt Freight Alternative

- Exacting geometry restrictions are imposed by factors including, but not limited to, the following:
  - The Metro Subway tunnel at Pennsylvania Avenue;
  - The proximity of a possible GCPT, which would need to be planned for as long as it is a viable option;
  - The need to pass over or under the JFX with ample clearances;
  - The existence, on the direct path between any likely GCFT portal and the CSXT Belt Line, of the Central Light Rail Line (CLRL) yards, shops, and main trackage;
  - The need to maintain grade separations at Sisson Street and Huntingdon Avenue on the east side of the valley; and
  - The need to adhere to the one-percent grade limitation (or less if possible).

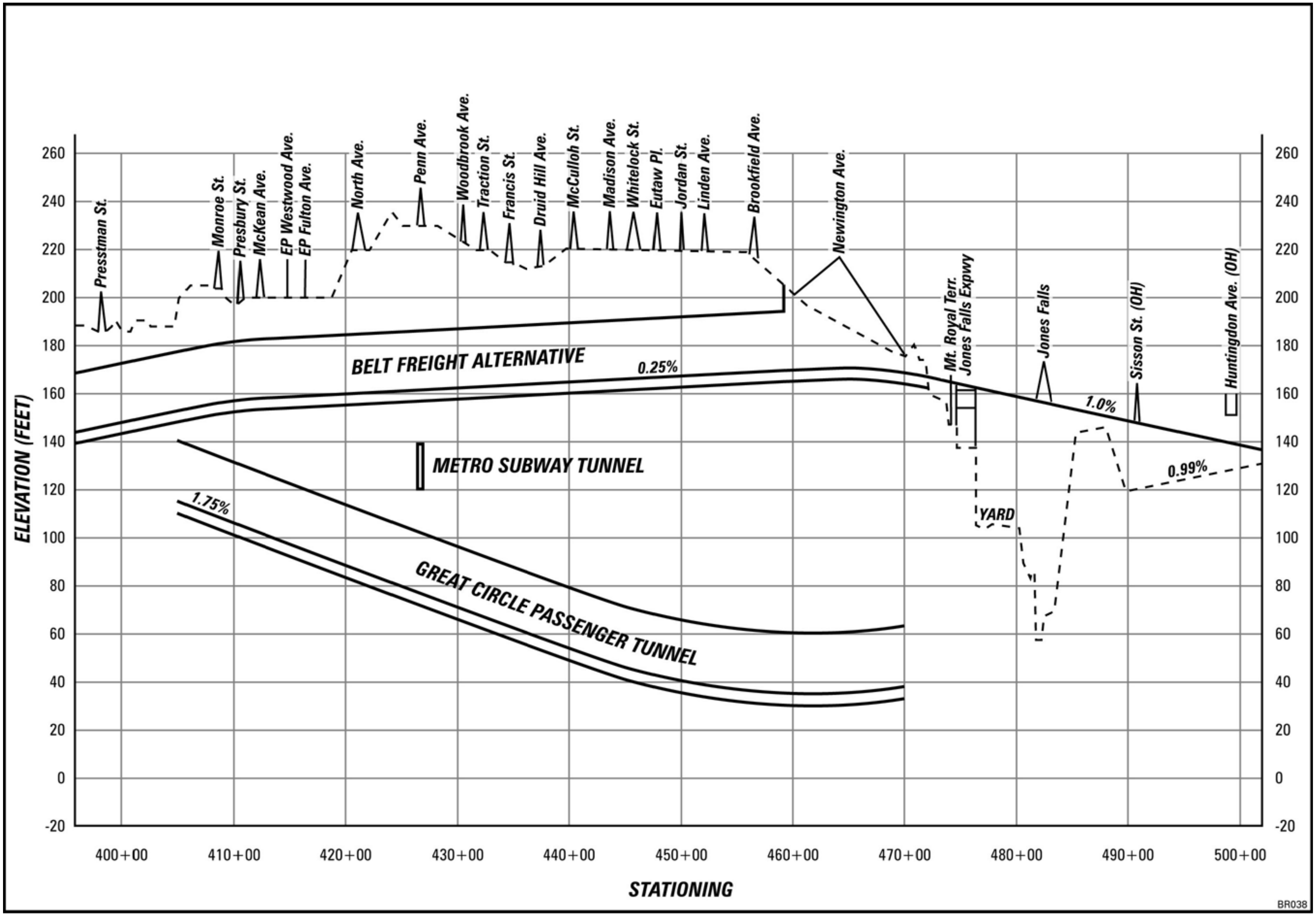

Figure 8-4. East End Profile of Belt Freight Alternative

- The location of the CLRL facilities, coupled with the assumption that these facilities cannot be relocated, prevents the Belt Freight Alternative from passing under the JFX and instead requires a high bridge across the freeway. This in turn –
  - Raises the necessary elevation of the northeast tunnel portal, necessitates cut-and-cover construction through the local area, and requires the bridge over the valley to begin approximately 200 feet west of Mount Royal Terrace, thus markedly affecting the neighborhood between Druid Hill Park and North Avenue. In fact, preliminary estimates indicate that an 1,800-foot strip of Mount Royal Terrace would have to be removed under the Belt Freight Alternative; and
  - Results in a difficult aerial alignment through the CLRL, with a freight train speed limit of 40 mph, which is somewhat lower than the 50 mph speed objective of the project.
- The establishment of a one percent grade east of the GCFT eastern portal, connecting the new freight alignment with the CSXT Belt Line, would result in significantly raising the roadway surface of both Sisson Street and Huntingdon Avenue, or the closing of both streets. As a result of these neighborhood impacts, this option may not be viable. The only other choice (holding constant the horizontal alignment) would be to keep the elevation of the Belt Line constant and adjust the gradient of the connection from the eastern tunnel portal to the east side of the Valley. The resultant gradient becomes 1.6 percent descending to the Belt Line – far beyond that allowable to meet the study objectives.
- Construction of the Belt Freight Alternative would encounter poor-grade rock and soil.
- To meet study specifications, Belt Line improvements through the Clifton Park area would require double-tracking and seven bridge replacements to provide double-stack clearances.
- With fatal flaws seemingly evident both operationally and with respect to neighborhoods on both sides of the Jones Falls Valley, the Belt Freight Alternative as configured above was ruled out for further analysis in this study. However, changes in assumptions and additional engineering investigations might improve its apparent feasibility.

8.1.3 BELT-MODIFIED FREIGHT ALTERNATIVE

In the previous Belt Freight Alternative, important engineering considerations included the location of the CLRL vehicle maintenance facility and poor soils conditions found on the tunnel profile necessary to avoid the CLRL maintenance facility. The CLRL maintenance facility was built on the site of a former Northern Central rail yard. Sharing this site about equally with the CLRL is the NS "Thoroughbred Bulk Transfer Facility" to the north. This facility is where bulk dry and liquid cargo is transferred from railroad freight cars to trucks for final delivery to local destinations. During an interview with NS representatives regarding the conduct of this study, they expressed an interest in the potential relocation of the bulk transfer facility to another site. Based on this potential, an additional freight alignment alternative – Belt-Modified – was developed that would cross the NS site and connect with the CSXT Belt Line. Refer to **Figure 8-5** for the route and **Figure 8-6** for the profile at the east end of the tunnel.

The overall tunnel route of the Belt-Modified Freight Alternative would be longer and deeper than the previous option; however, the western portal would be at the common Gwynns Falls location as described in Section 8.1.2. The deeper tunnel profile would be in hard rock, enabling the use of tunnel boring machine(s), which is far more advantageous than tunneling methods needed for looser soils conditions. The eastern portion of the tunnel would pass under the Jones Falls Expressway and debouch from a cliff face at grade level in NS's bulk transfer facility. The line would then traverse the NS facility, cross over the Jones Falls on a 40 foot high, 400-foot long (±) bridge, proceed through a small cut, and join the CSXT Belt Line. The bridge over the Jones Falls would also cross over an old railroad roundhouse structure that is currently being used for storing road salt by the City of Baltimore. As noted in the earlier discussion, the Belt Line would be double-tracked and clearance improvements would be needed on seven tunnels/bridges through the Clifton Park segment. Beyond Clifton Park, double-track currently exists on the CSXT alignment to Bay View.

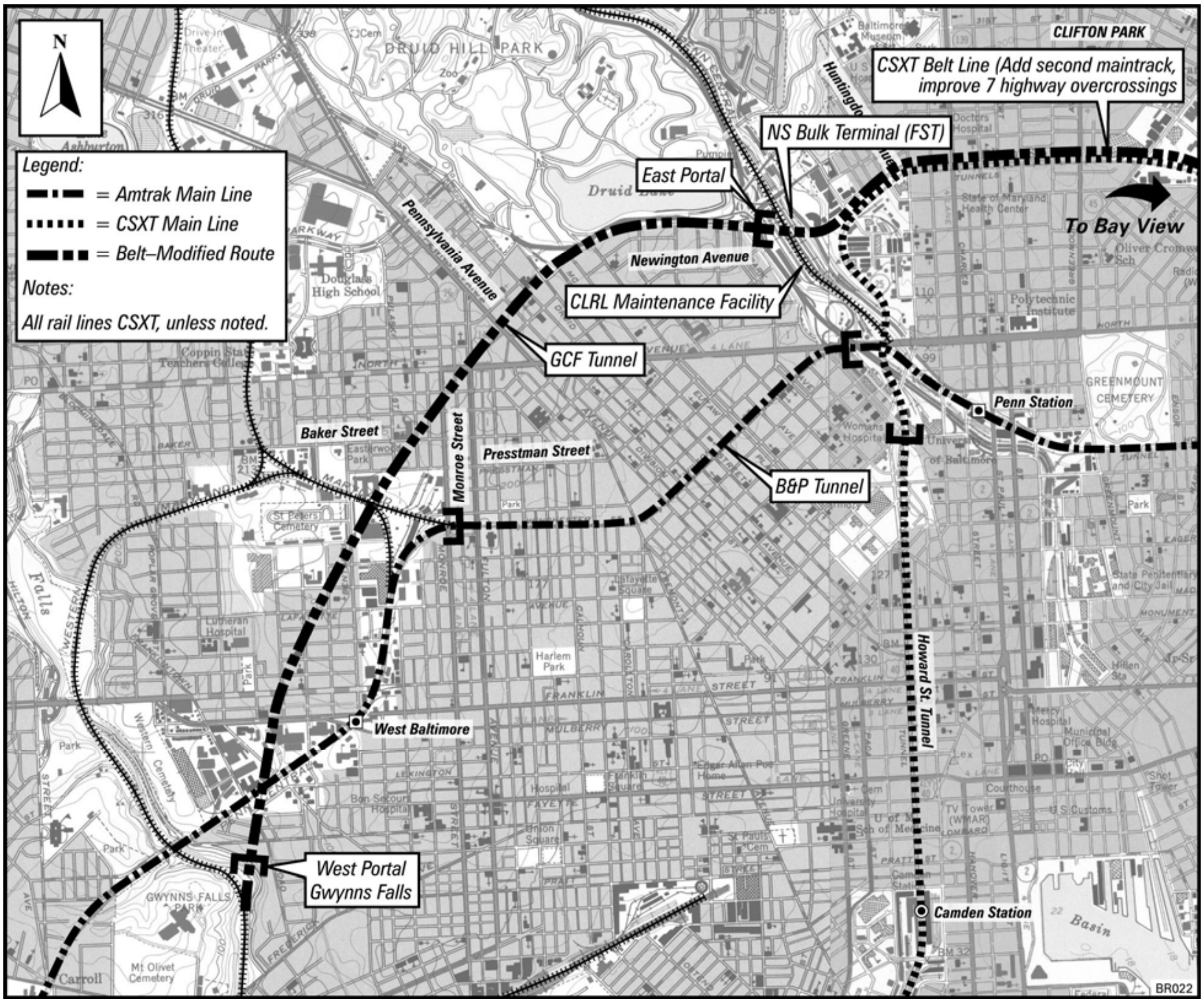

Figure 8-5. Route of Belt-Modified Freight Option

The alignment has a maximum grade of one percent and a maximum design speed of 60 mph but has a speed restriction of 40 mph on the connection to the CSXT across the Jones Falls Valley. While the 40 mph speed restriction does not meet the specific speed goal of this study, it is considerably better than the 25 mph speed currently permitted through the Howard Street Tunnel.

In the Bay View area, a connection from the CSXT Belt Line to the NS Bayview Yard is needed for NS to access its yard and rejoin the Amtrak main line. This connection would begin in the vicinity of Duncanwood Lane, swing to the south on a former railroad right-of-way overcrossing Chase Street, Ashland Avenue, Monument Street, and Kresson Street, and join the north side of the existing Amtrak alignment in the vicinity of Pulaski Highway. Use of the former railroad right-of-way in this segment minimizes construction impacts; however, it is probable that high-tension power line towers and a MDOT highway maintenance building could be affected. From Pulaski Highway, the connecting track route would be adjacent to the Amtrak alignment up to the vicinity of the I-895 Harbor Tunnel Thruway overpass where it would turn to the south, cross over the Amtrak alignment on a bridge, and enter the NS Bayview Yard. The Amtrak alignment under the connecting track bridge would be lowered to provide sufficient overhead clearance. Also, the north abutment of the CSXT Bay View Bridge, carrying the

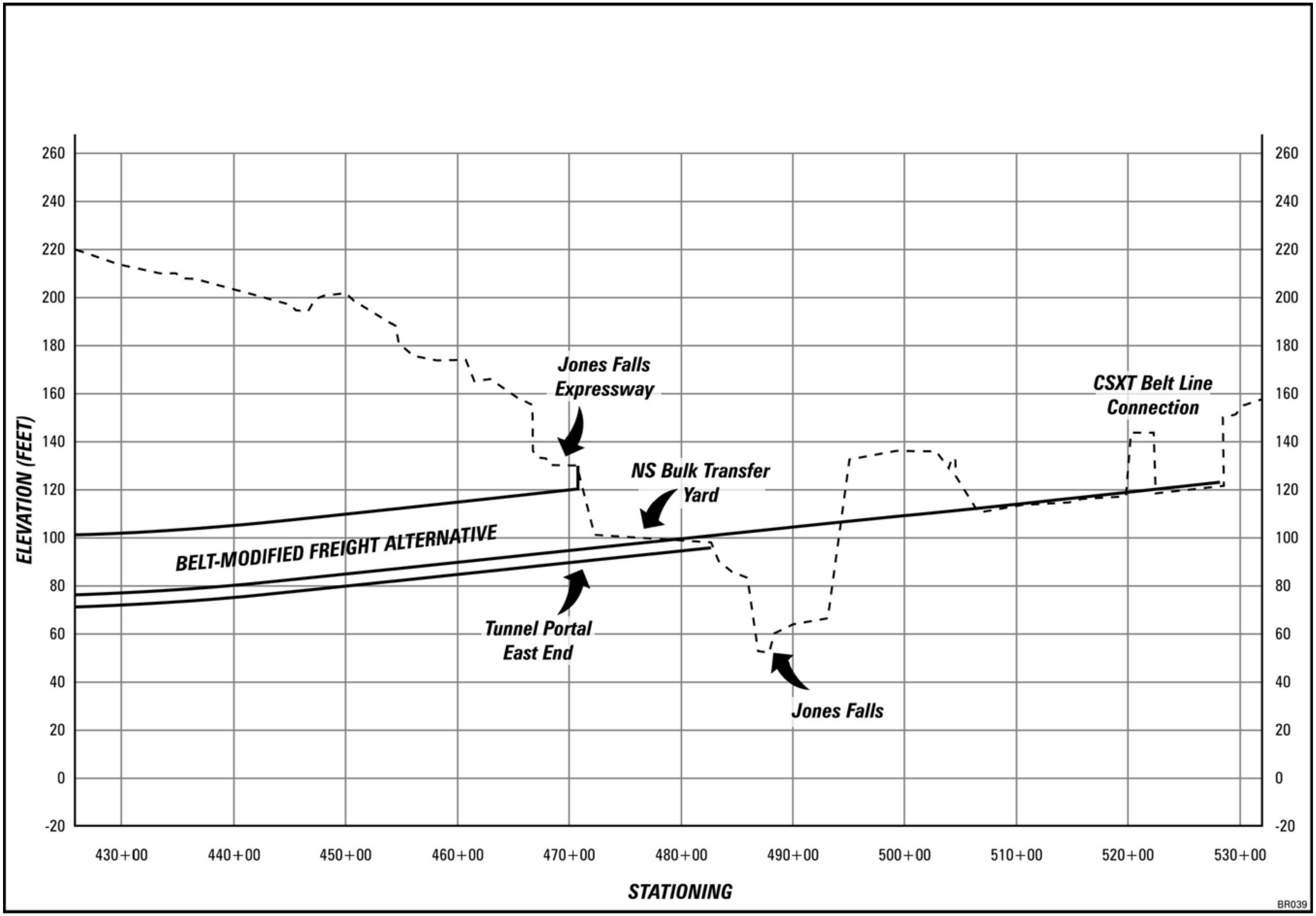

Figure 8-6. East End Profile Belt-Modified Freight Alternative

Sparrows Point Branch over the Amtrak main line, would need widening to accommodate the NS connection. Two tracks are envisioned for the NS connection, each being able to function as a through main line track, or a lead track for the west end of Bayview Yard. The existing west end lead and ladder tracks would probably be reconfigured to accommodate the new connecting tracks. **Figure 8-7** provides a general configuration of the NS connection.

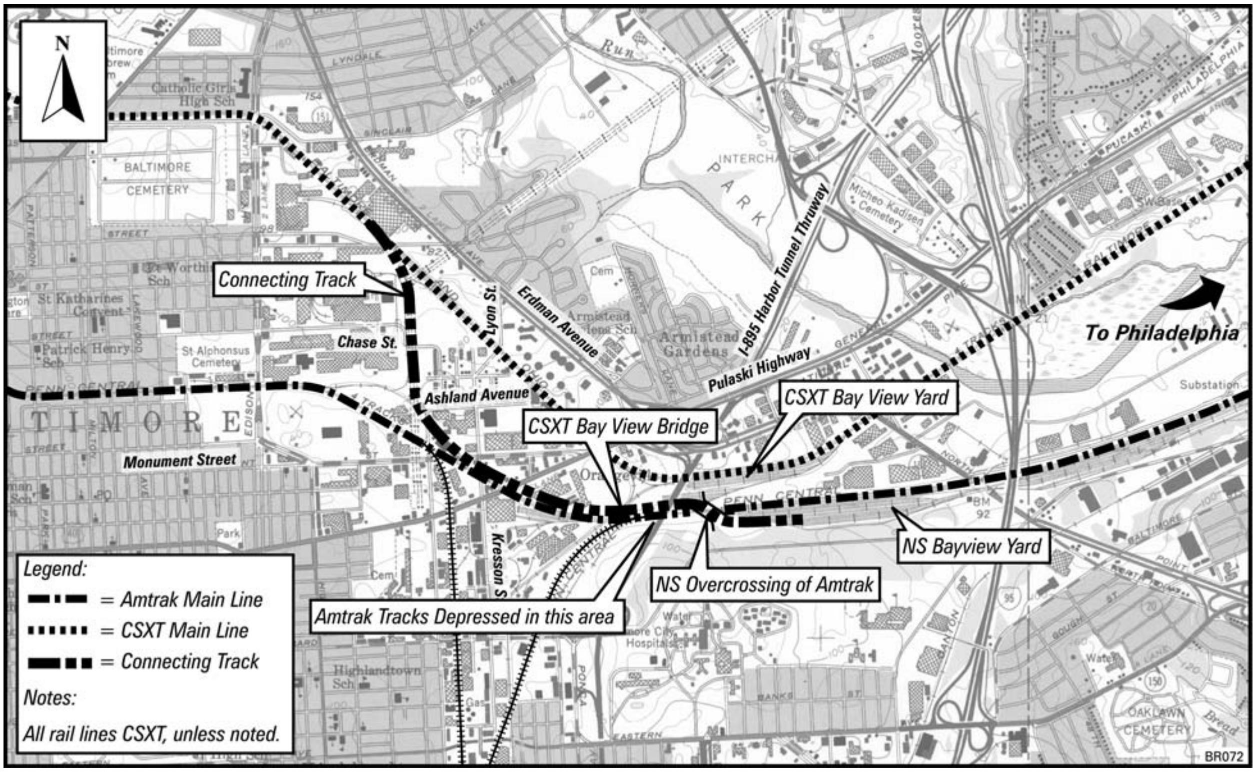

Figure 8-7. NS Connection, Belt-Modified Freight Alternative

The tie-in of the NS connecting tracks to Bayview Yard would require a significant reconfiguration of the yard's west end ladder tracks and tracks serving the intermodal yard and the President Street Industrial track.

8.1.4 PENN FREIGHT ALTERNATIVE

Figure 8-8 provides a general depiction of the Penn Alternative's tunnel and route through the central region of Baltimore.

As noted earlier in this section, the Belt-Modified and Penn Freight Alternatives have similar tunnel alignments; however, the profiles of the two vary significantly in order to meet east end elevation requirements. Approximately 700 feet north of the Gwynns Falls portal, the Penn Freight Alternative would descend on a 0.60 percent grade to pass under the Metro Subway at a top-of-rail elevation of approximately 15 feet. At this location, the freight tunnel alignment would be north of the GCPT alignment. The freight tunnel would then descend for another 1,400 feet prior to ascending on a one percent grade to the Jones Falls portal. The freight and passenger tunnels would have the same gradient and top-of-rail elevation for nearly the last 2,100 feet of their respective tunnels. This is natural, as they would emerge onto the same NEC right-of-way.

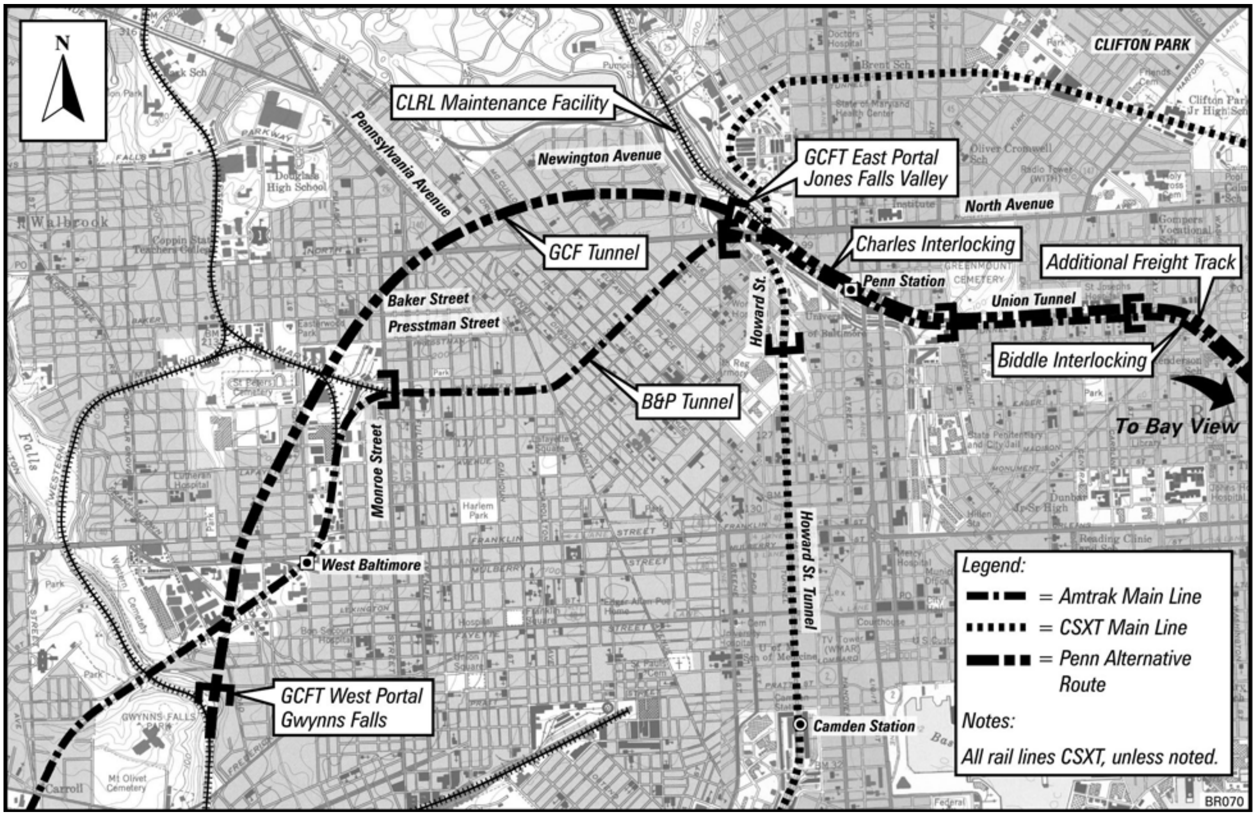

Figure 8-8. Penn Freight Alternative

The initial assessment for this alternative is that it is preferable to construct two single-track tunnels (as opposed to having two tracks in one tunnel) because of inherent alignment challenges at the east end. The twin freight tunnels would remain parallel to each other from the western portal until they were under the JFX. At this location, the outside tunnel would diverge to the north to an alignment that would enable it to pass under a CSXT Railroad Bridge located at North Avenue. The two tracks would emerge from two separate portals[4] in a wall that supports the CLRL and would curve southeast toward Penn Station. The portal of the outside freight track would be located approximately 400 feet northwest of the portal of the inside freight track.

At the CSXT North Avenue Railroad Bridge:

- A bridge pier of the railroad bridge would separate the two freight tracks; and
- The inside freight track would be located adjacent to, and parallel with, the two passenger tracks.

The double-track Penn Freight alignment would connect to the existing NEC near the north portal of the B&P Tunnel; the freight tracks would be located northeast of the double-track passenger alignment to and through Penn Station. A vertical curve is needed to connect the freight tunnel alignments with the NEC; this curve would end east of the Howard Street Bridge. The combination passenger and freight alignment between the east portals of the Great Circle Tunnels and the station would require a

[4] The portal of the outside, northern tunnel is located approximately 350 feet north of the inside tunnel. The locations of the piers for the CSXT Bridge and Howard Street require that the outside track cannot be located parallel, and 14 feet apart, from the inside track. The two tracks (or the tunnels they are located in) are not parallel for approximately the easternmost 3,000 feet of the Penn Station Freight Tunnel alignment.

reconfiguration of Charles Interlocking, located west of the Penn Station platforms. The freight alignment would pass to the north of the Penn Station platform tracks. East of Penn Station, the Penn Freight alternative would utilize a rebuilt Old Union Tunnel to reach Bay View where access to the CSXT main line and Bay View Yard, the NS Bayview Yard, and the NEC, would be provided.

As noted above, the Old (northernmost) Union Tunnel would have to be rebuilt. This rebuilding would include double-tracking and increased clearances. The current grade through the Union Tunnel is 1.17 percent, eastward, which is greater than the specified maximum one percent grade.[5] The elevation at the south end of the Union Tunnel is 51 feet and the elevation of the apex at Broadway is 95 feet, a climb of 44 feet in 3,900 feet. The elevation cannot be lowered at Broadway. Therefore, the only way to make the grade through the Old Union Tunnel meet the one percent requirement would be to raise the elevation at the south end of the tunnel by five feet. This would reduce the rise to 39 feet in 3,900 feet, or one percent. The overhead clearance under Guilford Avenue, the first overhead bridge south of the tunnel portal, would not be adversely impacted. At the completion of the Union Tunnel rebuilding, Amtrak and MARC would have two tracks and the freight train service would have two tracks.

Eastward from the Union Tunnel(s) (Biddle Interlocking), an additional main track would be added to the NEC as far as Bay View, thus providing (in total) a five-track main line between the two points. The assignment would be for Amtrak/commuter service to use the three southern tracks and the freight service to use the two northern tracks.

Although the Penn Freight Alternative has survived this preliminary analysis without the discovery of fatal flaws, questions remain about its feasibility, cost, and consequences. For example, the alignment requires clearance improvements through Penn Station, which would require careful investigation; in particular, the clearance under the Calvert Street Bridge. Further, Greenmount Avenue would require modifications as a result of rebuilding the Union Tunnel.

Because the CSXT trains will be using the Amtrak alignment through Baltimore, a connection is necessary to rejoin the CSXT main line before Bay View Yard is reached. The CSXT connection would diverge from the Amtrak main line in the vicinity of Edison Highway, swing north through the dormant Armco property, and rejoin the existing CSXT alignment in the vicinity of Lyon Street. This segment would be about 4,000 feet long and be on a fill section. Double-track is envisioned for the connection to enable through movements and use of the tracks as a lead for west-end operations at the CSXT Bay View Yard. Another option for providing west-end lead tracks is to use the former Belt Line tracks for this purpose. The Belt Line tracks would be made redundant for through freight train movements by the implementation of the Penn option.

Because freight trains would be on the north side of the Amtrak alignment, NS freight trains would be required to cross the Amtrak main tracks to access the NS Bayview Yard located on the south side of the Amtrak tracks. At-grade crossing movements by long, slow freight trains across the high-speed, heavily used Amtrak tracks would simply not be practical. Therefore, a grade-separated NS/Amtrak crossing is needed that would be similar to that as configured in the Belt-Modified Alternative. Essentially, the NS connection would parallel the north side of the Amtrak alignment, pass under the CSXT Bay View

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[5] Train Performance simulations show that three Dash 8 diesel units cannot start a 4,000-foot train consisting of loaded 315,000-pound capacity cars when the locomotive is stopped at the apex of the grade at Broadway (MP 94.50). Additionally, the same trains, if stopped at the south end of the Union Tunnel, can barely make the grade. The train at the south end makes the grade because, when the locomotive is at the base of the grade, the entire train behind it is on a downgrade. This allows the locomotives to start the train and gain some momentum before the entire train is on the grade. If it were not for the momentum, the train would stall. Needing to depend upon momentum for normal operations is not preferred.

Bridge, and continue to a point just north of the I-895 Harbor Tunnel Thruway overpass. Here, the NS connecting tracks would swing over the Amtrak tracks on a bridge and access NS's Bayview Yard. As with the Belt-Modified Alternative, the Amtrak tracks would be depressed to provide the required clearance under the NS bridge, the north abutment to the CSXT Bay View Bridge would need to be widened, and the NS ladder tracks/access tracks at the west end of Bayview Yard would require significant reconfiguration.

Figure 8-9 presents a general configuration of the Penn Freight Alternative connections at Bay View.

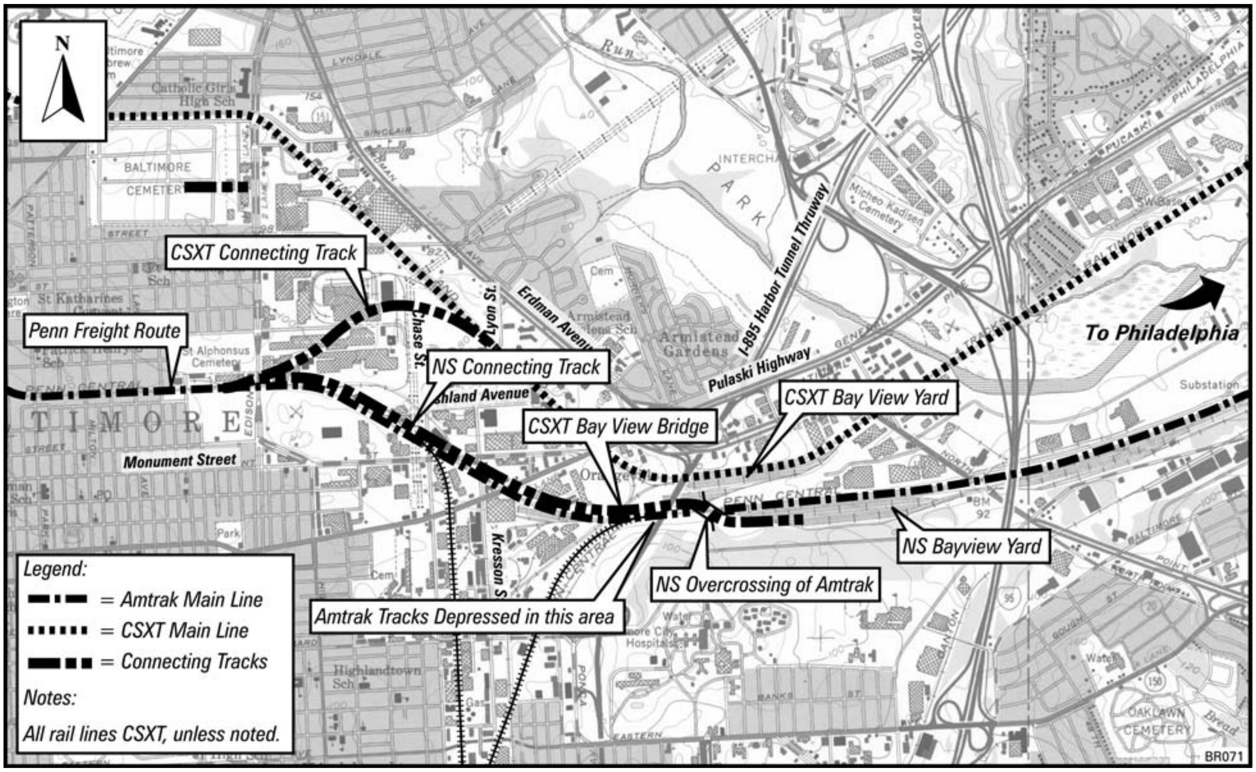


Figure 8-9. CSXT-NS Connections at Bay View – Penn Freight Alternative

8.1.5 SUMMARY AND EVALUATION OF NEAR NORTH FREIGHT ALTERNATIVES

Three alternative Near North Sector alignments to enhance CSXT and NS freight operations into and through Baltimore were evaluated. After careful investigation of the engineering possibilities, the study team tentatively rejected the Belt Freight Alternative but retained the Belt-Modified and Penn Freight Alternatives. Both alternatives would require the construction of a Great Circle Freight Tunnel between Gwynns Falls and the Jones Falls Valley. In the case of the Belt-Modified Freight Alternative, the Jones Falls Valley would be crossed and connected to the CSXT Belt Line. The Belt Line would require double-tracking and clearance modifications to seven bridges overcrossing the route. The Penn Freight Alternative would begin to parallel the existing Amtrak alignment in the approaches to Penn Station and require the rebuilding of the Old Union Tunnel. Either alternative alignment would replace the existing CSXT route using the Howard Street Tunnel and the NS freight route via the B&P Tunnels. **Table 8-1** provides a comparison of the two major alternatives according to the screening criteria of this study.

Table 8-1. Application of Screening Criteria to Near North Freight Alternatives

FUNCTIONAL/DESIGN SCREENING CRITERIA	BELT-MODIFIED FREIGHT ALTERNATIVE	PENN FREIGHT ALTERNATIVE
Availability of Land	Likely	Likely
Gradient of One Percent or Less	Yes	Yes
Beneath Harbor Highway Tunnels	No	No
Tunnel Length > 4 miles	2.9 miles	3.1 miles
Ease of Integration with Network	Good	Good
Ease of Integration with Yards	40 mph NS connection at Bayview	35 mph CSXT connection at Bay View
Pass/Fail	Pass	Pass
Adverse Environmental Impact	Potential for Acquisitions, Displacements, Relocations; Parklands/4(f); Potential noise vibration for residential rowhouses over tunnel	Potential for Acquisitions, Displacements, Relocations; Parklands/4(f)

EXTERNAL IMPACT SCREENING CRITERIA	BELT-MODIFIED FREIGHT ALTERNATIVE	PENN FREIGHT ALTERNATIVE
Consistent with Existing Land Use	No substantial change	No substantial change
Extent of Acquisitions, Displacements, and Relocations	Low	Low
Impact Listed or Eligible National or State Historic Place	No significant impacts	No significant impacts
Impact Parklands, 4(f)/6(f) Resources	Patapsco Valley State Park, Gwynns Falls Park/Trail	Patapsco Valley State Park, Gwynns Falls Park/Trail
Construction Impact Severity	Medium	Medium
Impact Ecosystems, Water Resources	Potential impact to wetlands, Gwynns Falls, Jones Falls	Potential impact to wetlands, Gwynns Falls
Pass/Fail	Pass with comment	Pass with comment
Comment	Construction or rehab of 12 highway bridges	Construct new Union Tunnel, construction or rehab of four highway bridges

8.2 FREIGHT ALTERNATIVES – HARBOR SECTOR

Baltimore Harbor, with its lengthy coastline, is complex and – at least in theory – affords a host of opportunities for underwater railway crossings. Progressively eliminating the impractical while focusing on the feasible concepts, the study team identified the most likely portals, their plausible approaches and connections on each side of the harbor, and the tunnel alignments that would logically connect each pair of portals. While resources did not allow for full-scale investigations of all of the theoretical approach-portal-tunnel-portal-approach combinations, sufficient data emerged to provide useful indications regarding the practicability, desirability, and cost of a harbor-based freight solution to the Baltimore challenge. **Figure 8-10** indicates the general location of the tunnel portals considered herein.

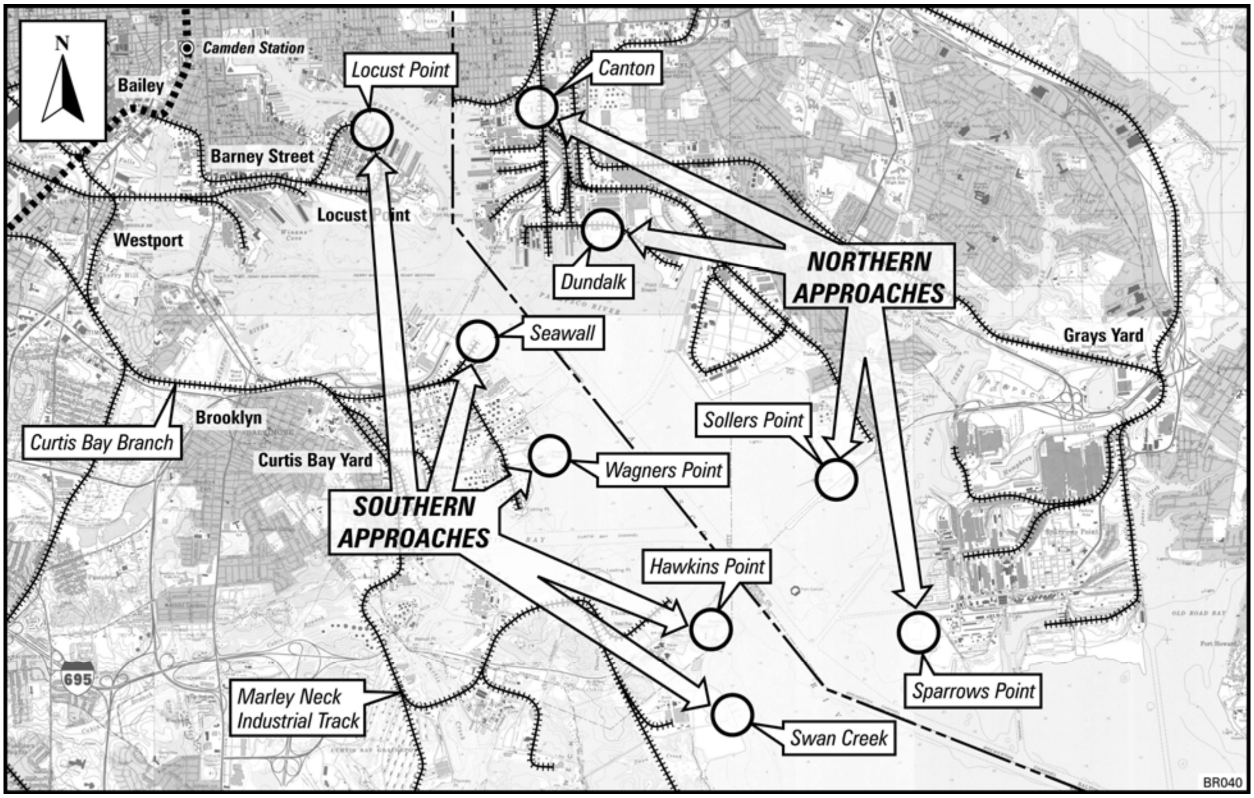


Figure 8-10. Potential Portals and Approaches – Harbor Sector Freight Tunnels

8.2.1 ASSUMPTIONS AND CONCERNS COMMON TO ALL ALTERNATIVES

The following factors guided the conceptual design and screening process.

DESIGN CONCEPT

Based on standard engineering practice for situations analogous to that of Baltimore Harbor, the analysis assumed that a double-tube Harbor Tunnel (with a total of two tracks) would be constructed employing the immersed-tube technique. The construction of the tunnel would require dredging and deep excavations in soils ranging from very soft, organic clays and estuarine silts to stiff over-consolidated cretaceous clays of the Potomac Group.

IMPORTANCE OF CONNECTIONS

Because a Harbor Sector tunnel would be located well to the south and east of the present CSXT and NEC alignments through Baltimore, the analysis focused heavily on the means of connecting the CSXT and NEC/NS freight facilities south and west of the harbor with the respective infrastructures of the CSXT, NEC/NS, Canton, and Patapsco & Back Rivers railroads north and east of the harbor. With so many freight movements to be handled reliably in this major logistical hub, the efficacy of connections among the various roads facilities could make or break any Baltimore rail restructuring project – just as much as such a project's impacts on through moves, clearances, and capacity.

AVAILABILITY OF LAND

The availability of land for the two Harbor Sector tunnel approaches influenced the selection of alternative approach alignments and of potential locations for the tunnel portals. This is because the expansion of railroad capacity through the construction of additional main line tracks and yard leads would generally require the acquisition of adjoining industrial real estate. In limited instances (e.g. near necessary rail-highway grade separations), the need may also arise to acquire residential real estate.

A review of previous reports and an inspection of land uses bordering the existing railroad rights-of-way indicated that the level of residential and industrial development in the sections of Baltimore City and County adjacent to the Patapsco River would, in effect, require the use of existing railroad main lines, branch lines, and industrial tracks to access the proposed tunnel portals.

8.2.2 SOUTHWESTERN APPROACHES

The harbor tunnel alternatives that were evaluated share a common southwestern approach between CSXT Herbert Run (Halethorpe) and CSXT West Baltimore. Existing CSXT branch lines and secondary tracks were then used to access the southwestern tunnel portals.

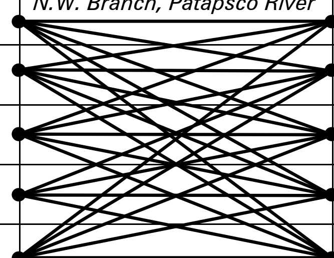
The secondary and branch lines used to access various possible southwestern tunnel portals were:

- The CSXT Locust Point Branch; and
- The CSXT Curtis Bay Branch in west Baltimore, including the Marley Neck Industrial Track that extends southeastward from Curtis Bay Yard.

8.2.3 PORTALS – SUMMARY LISTING

As shown in Figure 8-10 and listed in **Table 8-2**, the portals were located either on or near an existing branch line and/or industrial track.

Table 8-2. Portal Options and Hypothetical Tunnel Connections

PORTAL OPTIONS – SOUTHWEST SIDE OF BALTIMORE HARBOR	TUNNEL ALIGNMENTS HYPOTHETICALLY POSSIBLE	*PORTAL OPTIONS –* NORTHEAST SIDE OF BALTIMORE HARBOR
East end of the Locust Point Branch	*N.W. Branch, Patapsco River* 	Canton, on the CSXT Sparrows Point Industrial Track, near MP 1
East end of the Seawall Industrial Track, northeast of Curtis Bay Yard		Dundalk, on the PRR Bear Creek Track
Wagners Point, southeast of Curtis Bay Yard		Sollers Point, at the east end of I-695's Key Bridge over the harbor
Hawkins Point, east of the Marley Neck Industrial Track		North Sparrows Point, at the north end of the OAO Severstal steel plant
Swan Creek, east of the Marley Neck Industrial Track	*Mouth of Patapsco River*	South Sparrows Point, at the north end of the OAO Severstal steel plant

The analysis addressed potential tunnel alignments linking each of the southwestern with each of the northeastern portals shown in the table. As is evident from both Figure 8-10 and Table 8-2, linking portals closest with portals farthest from the Inner Harbor would require the longest tunnels. Also, as the portal locations become more and more distant from the Northwest Branch of the Patapsco River, both the length and circuity of the resultant through routes increase. The added length of the more distant[6] options, however, gives them more space to overcome, with a gradient under one percent, the significant differences in elevation between the low point in any tunnel (beneath the dredged Harbor Channel) and the NEC and CSXT main lines to the southwest and northeast of the portals. On the other hand, the more distant harbor crossings could add to the time and distance required for through and local moves.[7]

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6 That is, more distant from downtown Baltimore, the Inner Harbor, the Northwest Branch, and Canton.

7 In concept, such an examination would (a) identify and rank the most important local and through movements (e.g., CSXT moves from Curtis Bay to Bay View), (b) evaluate the operating, service quality, and cost effects on each movement of each tunnel alternative, and (c) develop a methodology for synthesizing the results into conclusions useful for planners and decision-makers.

8.2.4 SOUTHWESTERN PORTALS AND ASSOCIATED TUNNEL CONNECTIONS

LOCUST POINT – EAST END OF CSXT LOCUST POINT BRANCH

THE PORTAL

The origin point for the Locust Point Branch is on the CSXT main line at Bailey Interlocking (**Figure 8-11**). A potential Locust Point portal would be located northwest of Fort McHenry and the Fort McHenry Tunnel, and would be west of Locust Point Yard. Driving such a location is the need to maintain a maximum one percent gradient on tunnel approaches and within the tunnels themselves. A maximum top-of-rail depth of minus 90 feet has been assumed for each alternative. This depth is necessary to provide clearance to a maintained depth of minus 50 feet in the Harbor Channel. Depending upon the location of the tunnel alternative alignment evaluated, the portal itself could shift a few hundred feet east or west of the location shown. The portal would be east of Bailey, and generally east of Russell Street and I-395, which pass over the Locust Point Branch. Each of the contemplated tunnels would pass beneath Locust Point Yard.

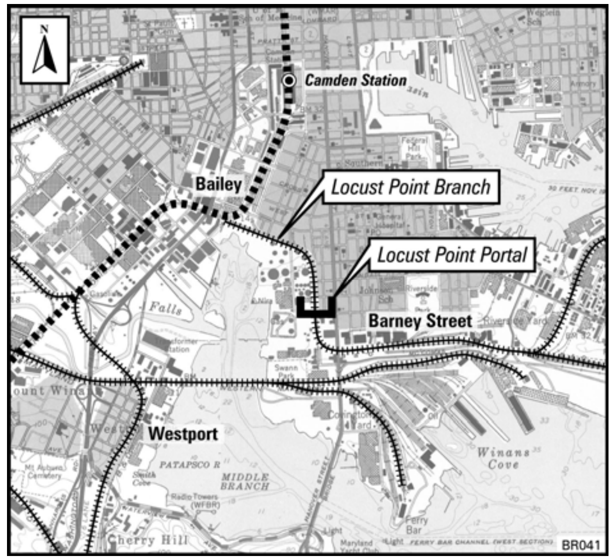


Figure 8-11. Possible Locust Point Portal Location

POTENTIAL TUNNEL CONNECTIONS

Locust Point–Canton. Two alternative tunnel alignments between Locust Point and Canton were evaluated; however, the northernmost alignment would lie almost directly beneath Tide Point, a $63 million conversion of the former Procter & Gamble soap factory into a 15-acre, 400,000 square-foot corporate office complex. Since this valuable waterfront property in Locust Point would be adversely affected by a northern tunnel and its approaches, the southernmost alignment was assumed to be more appropriate, as shown in **Figure 8-12**. Construction in the area of the tunnel approaches and portal would have major impacts on the Riverside Yard and also affect the other yards in Locust Point. In addition, the location of the tunnel portal would require Locust Point/Riverside trains to and from north-of-Baltimore points to make runaround or backup moves to access/egress the tunnel route.

Conceptual engineering indicated that the gradient of the northeastern approach, on the right side of Figure 8-6, would have the most significant effects on the tunnel's vertical alignment. The connection between the tunnel's eastern portal and the freight railroads on the northeastern side of the harbor is discussed under "Northeastern Portals and Associated Approaches" in Section 8.2.5.

Locust Point to other Eastern Portal Locations. Any freight tunnel from Locust Point to Dundalk, Sollers Point, or Sparrows Point would pass beneath the Fort McHenry Tunnel (I-95) and Baltimore Harbor Tunnel (I-895), as shown in Figure 8-12. The proximity of the Fort McHenry Tunnel alignment to the west portal location in Locust Point would cause railway tunnel vertical alignments to exceed the specified limit of one percent. Moreover, due to concerns about the integrity of the existing structures and the consequent risk to the constant flow of vehicular traffic within them, State and Federal agencies most likely would not permit the construction of any new harbor tunnel beneath the Fort McHenry and

Baltimore Harbor Tunnels.[8] All options requiring construction of railway tunnels beneath highway tunnels were therefore dropped from further consideration. As a result, all hypothetical tunnel alternatives linking Canton with points south of Locust Point were excluded.

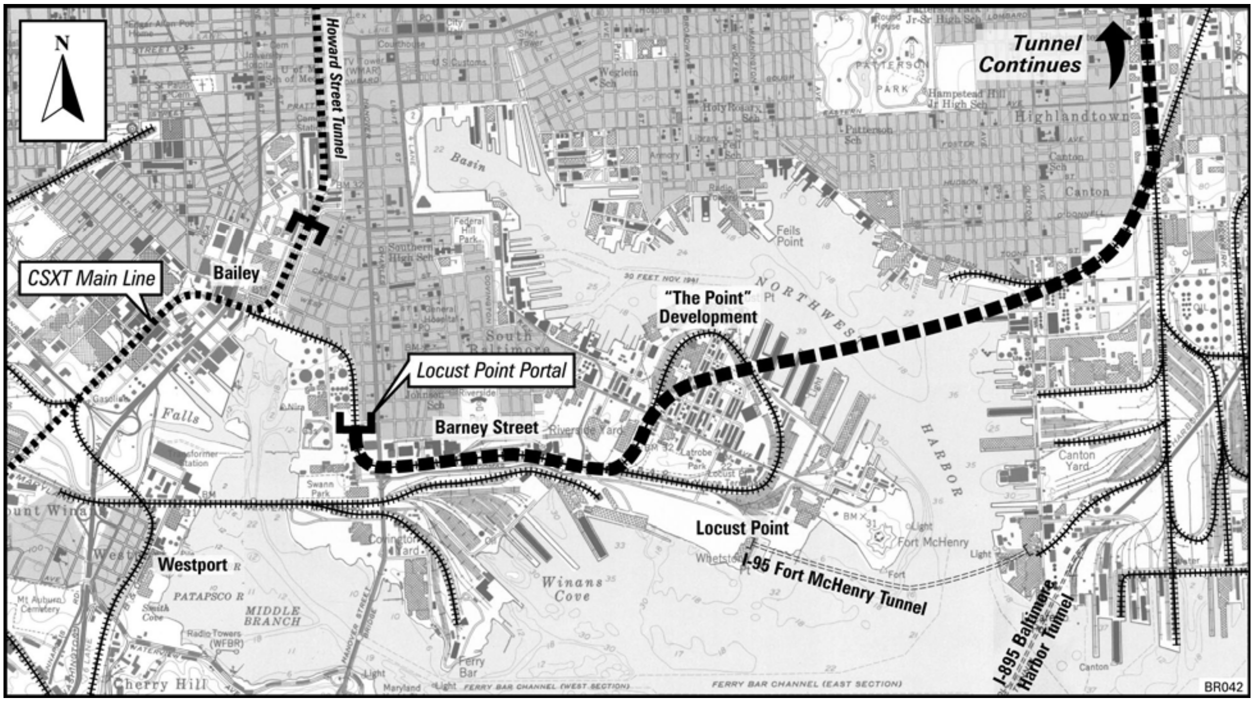


Figure 8-12. Locust Point – Canton Tunnel

Additionally, if crossing under the highways were feasible, any tunnel from Locust Point to Sollers or Sparrows Point would necessarily exceed five miles in length, much of which would underlie the dredged Harbor Channel. This length would make for a costly tunnel, in comparison with shorter, more direct options. As a result of all of these factors, the study team did not develop alignments for tunnels from Locust Point to Dundalk, Sollers Point, and Sparrows Point.

THE SEAWALL PORTAL – 7,000 FEET EAST OF CURTIS BAY YARD

THE PORTAL

The Seawall Portal would lie southeast of the Baltimore Harbor Tunnel (I-895). The location illustrated in **Figure 8-13** is about 7,000 feet east of Curtis Bay Yard; any actual portal site would vary with the location of the low-point of its associated tunnel concept. More likely, the portal for a particular alignment would be positioned farther west toward Curtis Bay Yard.

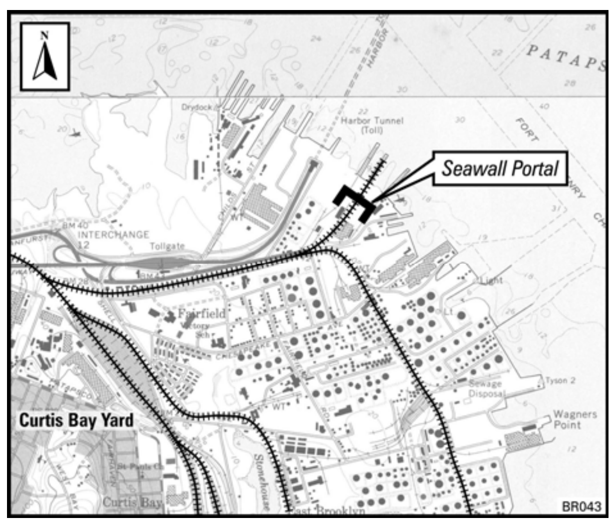


Figure 8-13. Seawall Portal

8 It is assumed that lengthy stoppages of cross-harbor vehicular traffic on account of railroad construction would not be permitted by state authorities.

POTENTIAL TUNNEL CONNECTIONS

Seawall–Canton. Since a tunnel from a Seawall Portal to Canton would pass beneath the existing highway tunnels (**Figure 8-14**), it would not be allowable under the premises of this study.

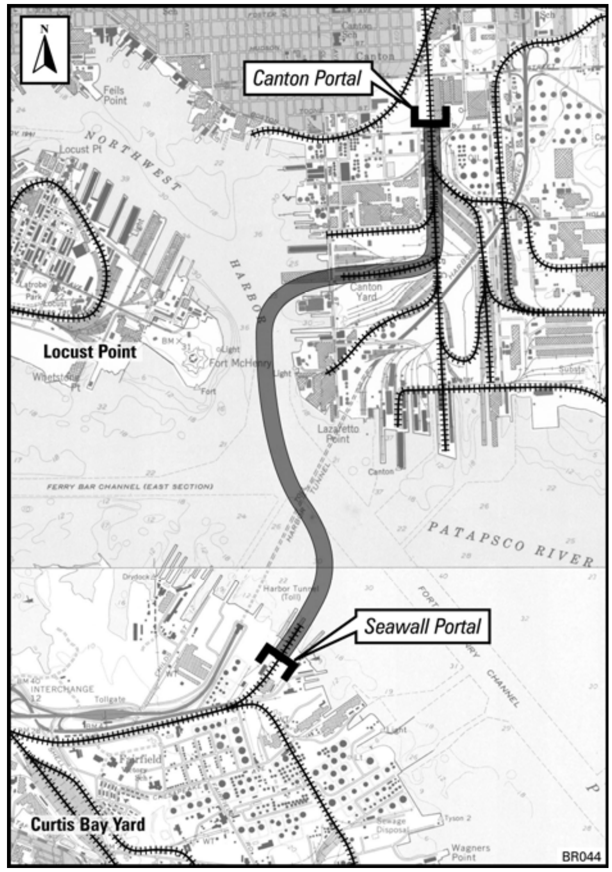


Figure 8-14. Seawall – Canton Excluded

Seawall–Dundalk. As the Seawall Industrial Track is a busy, highly congested access route to numerous port facilities, providing capacity for through-freight trains while facilitating local-freight service would be impractical. The study team, in fact, was unable to develop a satisfactory southwestern approach to a Seawall Portal. Since an acceptable northeastern approach to a Dundalk Portal was not found either (see “Dundalk” under “Northeastern Portals and Associated Approaches” in Section 8.2.5), the Seawall–Dundalk alternative was dropped from further consideration.

Seawall to Sollers Point and North Sparrows Point. The same issues of tunnel length and pathway through the dredged Harbor Channel that would affect the alignments from Locust Point to Sollers Point or Sparrows Point also ruled out those starting at Seawall. Even though the latter options would be nearly 8,000 feet shorter than the former, the Seawall–Sollers or –Sparrows Point options would still rank among the longer, more expensive harbor tunnel alternatives.

As a result of the numerous, obvious difficulties attached to all of the options using Seawall as the southwestern portal, the study team did not further refine these alignments.

THE WAGNERS POINT PORTAL

THE PORTAL

The Wagners Point Portal would be located at the point indicated on **Figure 8-15**. This location is to the right of and about 8,000 feet east of the east end of Curtis Bay Yard.[9]

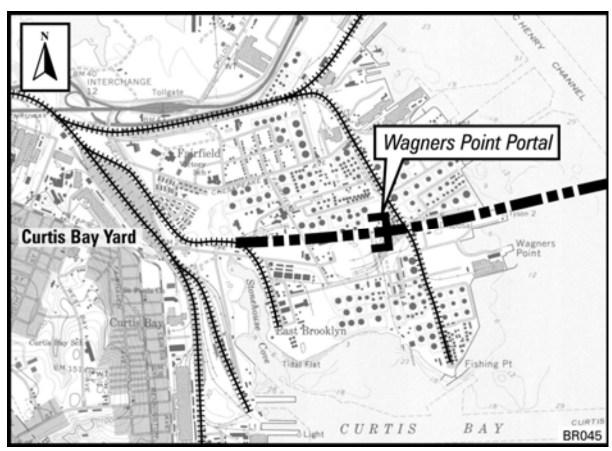


Figure 8-15. Wagners Point Portal and Approaches

The study team regards this portal site as less than optimal because of the potential for conflict with Curtis Bay Yard operations.

[9] As indicated in the discussion of other portals, more definitive locations would depend on specific tunnel designs – in particular, the low point.

POTENTIAL TUNNEL CONNECTIONS

A northeastern portal in Canton is ruled out because of the intervening highway tunnels, and a Dundalk Portal fails the maximum gradient test. Thus, a Wagners Point Portal might be suitably paired only with Sollers Point (which suffers from inherent disadvantages discussed on Page 8-24) or the two Sparrows Point alternatives. While these last portal options appear to allow for proper approaches, they are much more distant from Wagners Point than from the Marley Neck Portals described in the next section. For these reasons, the Wagners Point options were not pursued any further.

THE MARLEY NECK PORTALS (HAWKINS POINT, SWAN CREEK)

CONNECTION TO RAILROAD MAIN LINE

The Marley Neck area would be reached by using the Curtis Bay Branch, Marley Neck Industrial Track, and new construction (**Figure 8-16**). The Curtis Bay Branch would be used between Curtis Bay Junction and Patapsco Avenue. The Marley Neck Industrial Track continues from Patapsco Avenue in a generally southeasterly direction, but with many curves. New right-of-way would be required to accommodate curve modifications for higher speed and a new route from the east end of the Curtis Bay Yard complex, through the GSA Depot, across Curtis Creek, and on to the portals in the Marley Neck area. This new right-of-way is a distance of about 21,000 feet. Included within this segment are two significant bridges: Cabin Branch would be spanned by a 3,000-foot long, 40-foot high structure and Curtis Creek would be crossed on a mile-long structure having a height above water of approximately 60 feet.

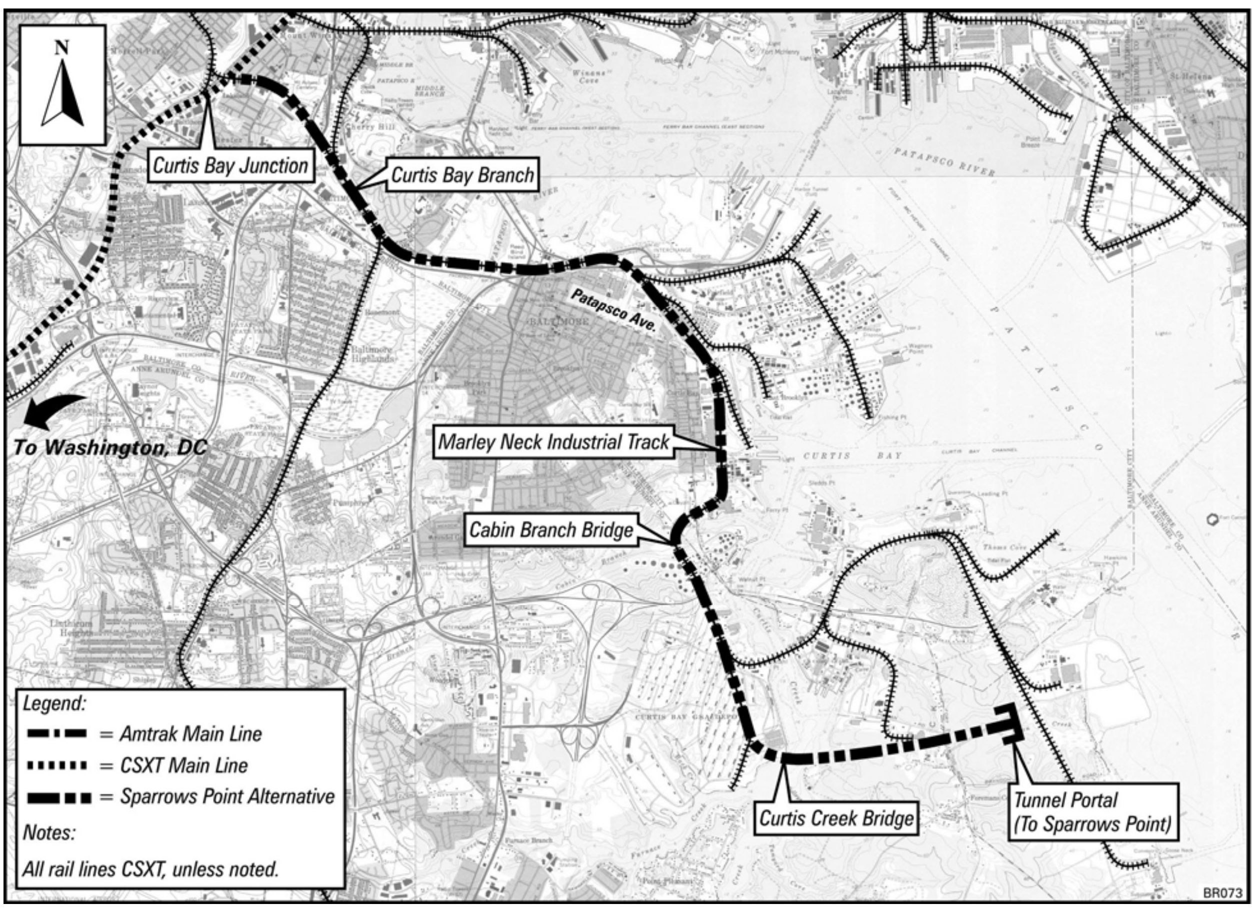


Figure 8-16. Southern Approach, Sparrows Point Alternative

THE PORTALS

The study team evaluated two portal sites to which the CSXT Marley Neck Industrial Track could provide access:

- Hawkins Point, shown in the center of **Figure 8-17**; and
- Swan Creek, shown at the bottom of Figure 8-17.

Both of these portals are in close proximity to Swan Creek; therefore, the portals would require special designs to minimize construction impacts and water intrusion. As is the case elsewhere in this report, the precise site of these portals within the indicated locales depends on more detailed design.

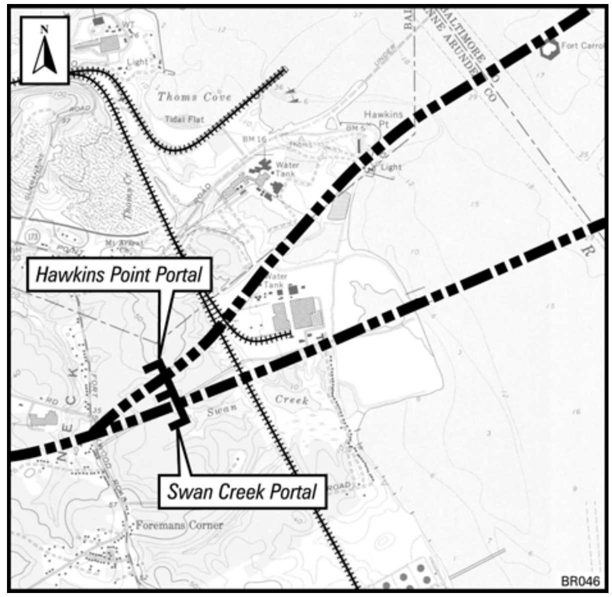


Figure 8-17. Marley Neck Portal Options

TUNNEL CONNECTIONS

Since the northeastern portals at Canton, Dundalk, and Sollers Point were eliminated from consideration (as described below under "Northeastern Portals and Associated Approaches in Section 8.2.5), any Marley Neck tunnel alignments would cross the harbor south of the Francis Scott Key Bridge (I-695) to a northeastern portal in the vicinity of Sparrows Point.

Three options for crossing under the harbor and connecting into the Sparrows Point complex were evaluated: Hawkins Point to North Sparrows Point, Swan Creek to North Sparrows Point, and Swan Creek to Sparrows Point. The northerly route between Hawkins Point and North Sparrows Point would be the shortest route between Curtis Creek and the NS Sparrows Point Industrial Track; however, the southerly route, between Swan Creek and Sparrows Point, would have the shortest tunnel. The Patapsco River is about 1.5 miles across in this area.

As further described in the following section, the eastern portals in Sparrows Point and North Sparrows Point would be located within the steel mill facility, about 3,000 feet inland from the northeastern shoreline.

8.2.5 NORTHEASTERN PORTALS AND ASSOCIATED APPROACHES

Treating the potential railway tunnel portals on the northeastern side of Baltimore Harbor, the following sections describe the connections and difficulties of each location.

CANTON – LOCUST POINT

Because of the assumption excluding a rail crossing beneath existing highway tunnels, the Canton Portal would be available only to a tunnel extending from Locust Point (as described on Page 8-17).

In theory, a Locust Point—Canton rail freight tunnel would present obvious advantages. It would be the least circuitous Harbor Sector option and would preserve direct access to and through the Bay View freight yards from the southwest.

Thus, as shown in **Figure 8-18**, the study team evaluated an alignment that would access the respective Bay View Yards of CSXT and NS, as well as the CSXT and NEC main lines to the northeast, from a tunnel portal in Canton. To restrain costs and to maintain the existing NEC geometry, so vital to passenger service, this alternative assumed no major changes in the railway infrastructure in the Bay View area. For instance, the freight connector from Canton to Bay View would bridge the NEC at Bay (MP 91.9), as the CSXT Sparrows Point Industrial Track currently does.

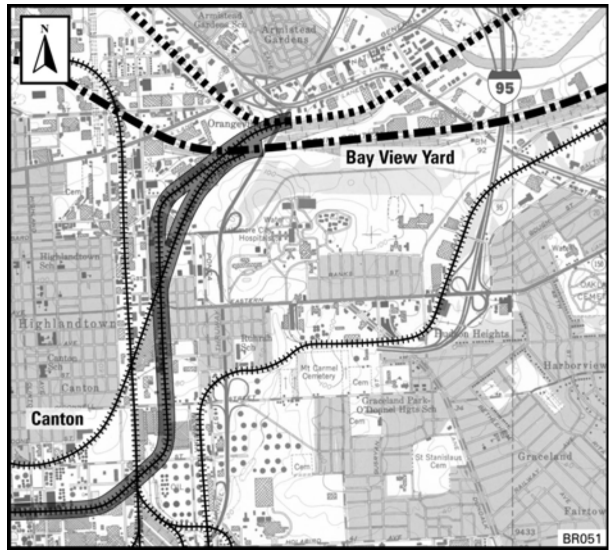


Figure 8-18. Northeastern Approach, Canton–Bay View

Under this assumption, the ascending grade would be excessive in a Canton—Locust Point alignment. The initial analysis concluded that after climbing upgrade from the tunnel mouth, the alignment would require an unacceptable gradient of 1.5 percent or greater. The reasons for this are:

- The top-of-rail in a tunnel connecting Locust Point and Canton, at its maximum depth beneath the channel, would be approximately minus 85 feet;
- The top-of-rail of the existing CSXT bridge over the NEC is +85 feet; and
- The distance between the two locations is approximately 13,000 feet.[10]

This geometry would result in an uncompensated grade[11] of 1.59 percent – worse than those in the Howard Street and B&P Tunnels, and far greater than the project's limit of one percent for freight grades. Even the connection between the critical low point in the rail tunnel, beneath the dredged channel, and the top-of-rail of the NEC beneath the CSXT bridge would not meet the one percent standard.[12]

Because the unacceptable gradient northeastward to Bay View from Canton would be a fatal flaw, the Locust Point–Canton tunnel alignment was dropped from further consideration in the previous Report to Congress study.

CANTON FREIGHT ALTERNATIVE

Because of the seemingly apparent advantages of the Locust Point–Canton route, the alternative was re-engineered to meet study design requirements and to test ultimate viability. In particular, the assumption of no major redesign of the CSXT or NEC/NS facilities at Bay View was eased. This modified alternative is referred to as the Canton Freight Alternative.

As noted earlier, the gradient from the lowest point in the tunnel to a "convenient" connection to Amtrak/CSXT in Bay View requires a gradient above the freight railroad design limit of one percent. The

[10] The distance between these same two points on the hypothetical alignment (the CSXT over the NEC and the critical low point under the dredged channel) would need to be an unattainable 17,000 feet or more to satisfy the project's one percent freight gradient standard.

[11] For a discussion of the relationship of grades to curvature, see Section 2.8.

[12] The top-of-rail of the NEC beneath the CSXT bridge is about (+) 60 feet; the distance between the NEC under the CSXT would need to be no less than 14,500 feet to provide an effective grade of one percent or less. This distance would be greater depending upon the degree of curvature that would be required to connect the alignment under the channel with the alignment between Canton and the NEC at Bay.

reason for this design difficulty is that the natural ground elevation rises from the Canton area toward Bay View. Therefore, the alignment profile must not only overcome the natural rise in elevation, but also rise out of the tunnel. To further investigate this design challenge, a new alignment using a maximum one percent gradient was developed (**Figure 8-19**).

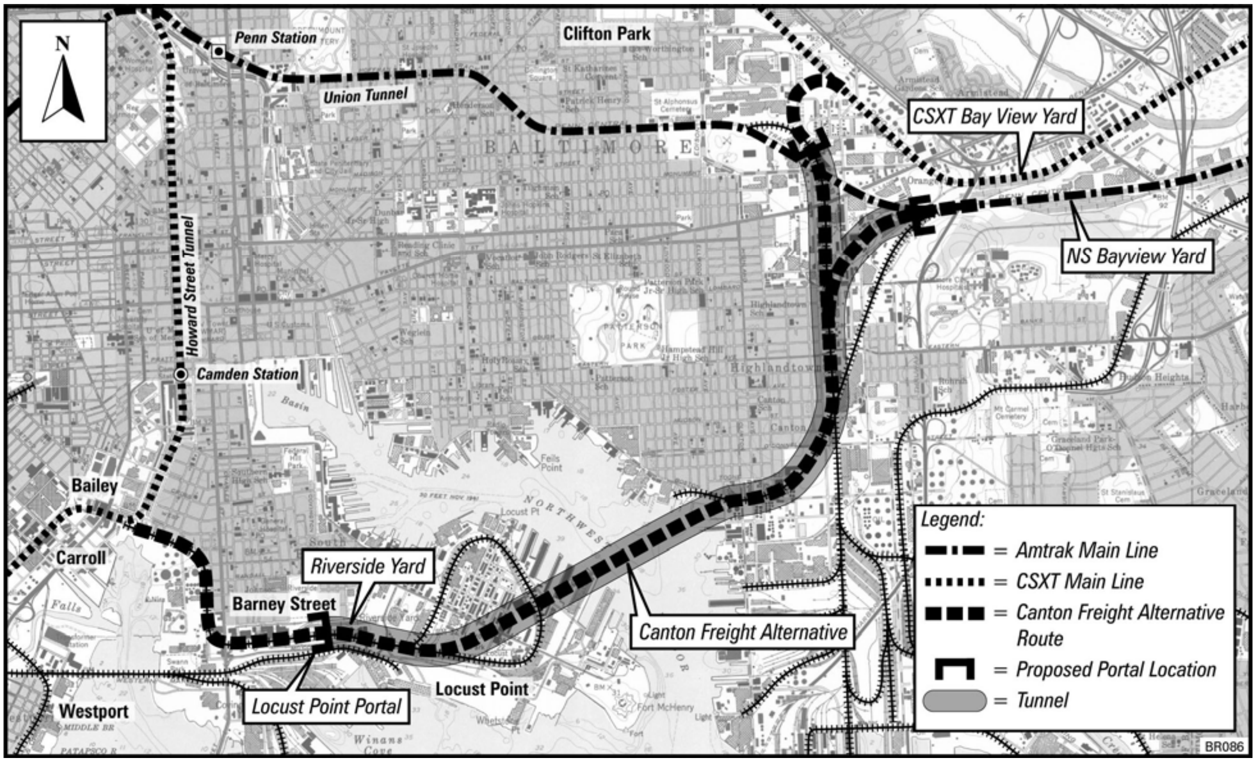


Figure 8-19. Canton Freight Alternative

At the east end, the line would proceed north from the Canton area in a tunnel under an existing railroad right-of-way **(Figure 8-20)**. Before reaching the Amtrak main line, the tunnel would split with the NS connection turning to the east. The CSXT portion of the tunnel would continue northward and cross under the Amtrak main line. The portal would be located just north of the Amtrak main line. From the portal, the connection would make a 180-degree curve to join the CSXT main line. This alignment enables through movements into the west end of CSXT's Bay View Yard.

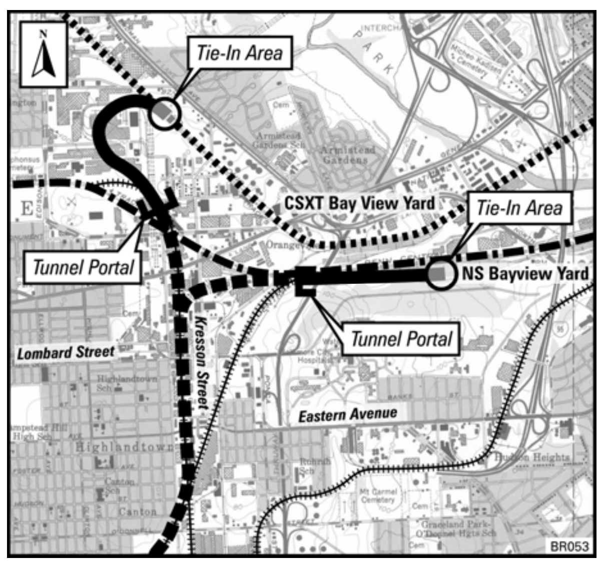


Figure 8-20. Canton Freight Alternative Bay View Tie-Ins

The alignment from the harbor area through Canton to the Bay View area using the existing railroad right-of-way could also be used by a potential Red Line Corridor transit route. The Canton Freight Alternative is in a tunnel in this segment while the transit route alternative is at grade. Engineering coordination would be required in this area should both routes be selected for construction.

The NS line would parallel the south side of the Amtrak main line to the existing NS Bayview Yard and would come to surface about 6,000 feet from the split junction in the tunnel. The point at which the ground level is reached is beyond the west-end ladder tracks of the NS yard. The location of this datum would require a reconfiguration of the through main line and yard tracks and a major change in yard switching operations.

See Table 8-3 in Section 8.2.6 for the application of the screening criteria to the Canton Freight Alternative.

DUNDALK

A Dundalk Portal would not satisfy the vertical gradient standards of this study. The rail alignment would have to pass beneath the complex alignment of interstate and local highways (**Figure 8-21**) between Canton and Dundalk before beginning to ascend either to the +60 elevation of the NEC or to the +85 elevation of the CSXT bridge over the NEC. This cannot be done within the one percent maximum freight gradient limit of this study.

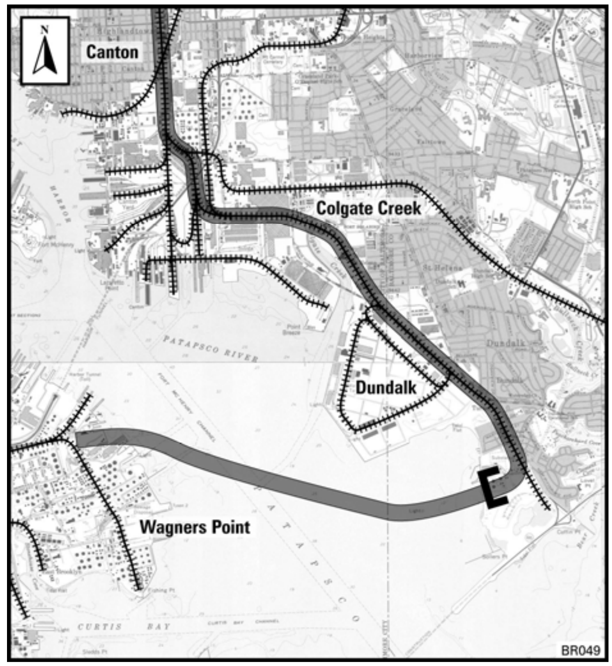


Figure 8-21. Northeastern Approach, Dundalk–Canton

Furthermore, an alignment northward from a portal in Dundalk would not only pass through the complex network of general cargo facilities at the 570-acre Dundalk Marine Terminal, but also conflict with the NS rail network (also utilized by CSXT) that accesses the marine terminal and general cargo facilities.

For all of these reasons, a Dundalk Portal, with its critical connection to the Bay View area, would be fatally flawed. The Dundalk alternatives were therefore dropped from further consideration.

SOLLERS POINT

Located at the eastern end of the Francis Scott Key Bridge, where Bear Creek joins the Patapsco River, Sollers Point would not serve as an adequate tunnel portal site (**Figure 8-22**).

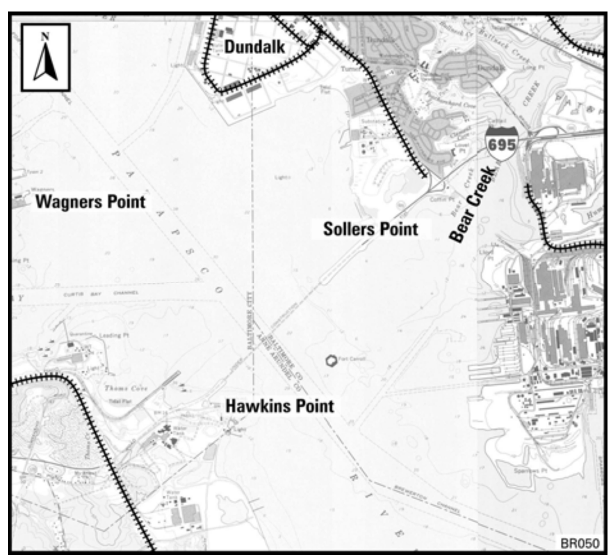


Figure 8-22. Location of Sollers Point

In view of the difficulties already noted in Dundalk and Canton, the most efficient, low-grade access from a Sollers Point Portal to the NEC and CSXT main lines would be via Sparrows Point. In any tunnel leading to Sollers Point, a one percent grade from the critical low point beneath the dredged channel of the Patapsco River would not allow the alignment to rise in the available distance to enable the railroad to cross Bear Creek (a navigable waterway) on a fixed-span bridge.[13] Thus, any Harbor Sector crossing via Sollers Point would need to be extended in a continuous tunnel beneath an I-695 interchange as well as the Bear Creek Channel. This necessity would lengthen a Sollers Point tunnel by a minimum of 2,000 feet. Accordingly, the study team dropped all Sollers Point options from further consideration.

SPARROWS POINT

The study team investigated the concept of linking portals in the Sparrows Point area with the NEC and the CSXT main line east of their respective Bay View Yards. Such a concept would rely on the NS Sparrows Point Industrial Track, a 5.6-mile line that presently links the northeast end of the NS Bayview Yard with the P&BR's Grays Yard serving the former Bethlehem Steel – now OAO Severstal – mill at Sparrows Point (See **Figure 8-23** and **Figure 8-24**). The NS Sparrows Point Industrial Track is advantageous in that its right-of-way permits expansion and it has a favorable geometry, with the exception of a five-degree curve at Eastern Avenue and a three-degree curve north of North Point Boulevard.

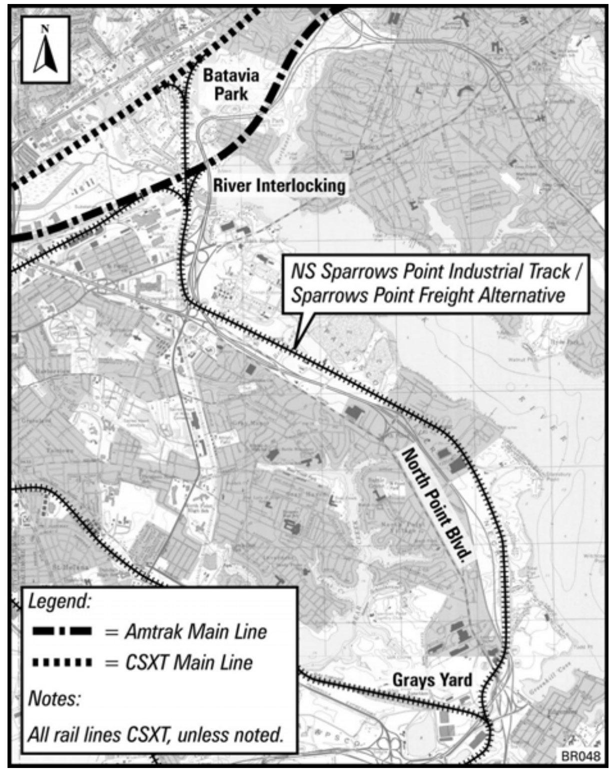


Figure 8-23. NS Sparrows Point Industrial Track

THE PORTALS

As Figure 8-24 shows, both the North Sparrows Point and Sparrows Point portal sites would make use of property belonging to OAO Severstal. According to the *Baltimore Business Journal* web site (March 22, 2008), the plant employs nearly 2,500 people and is capable of making 3.6 million tons of raw steel annually.

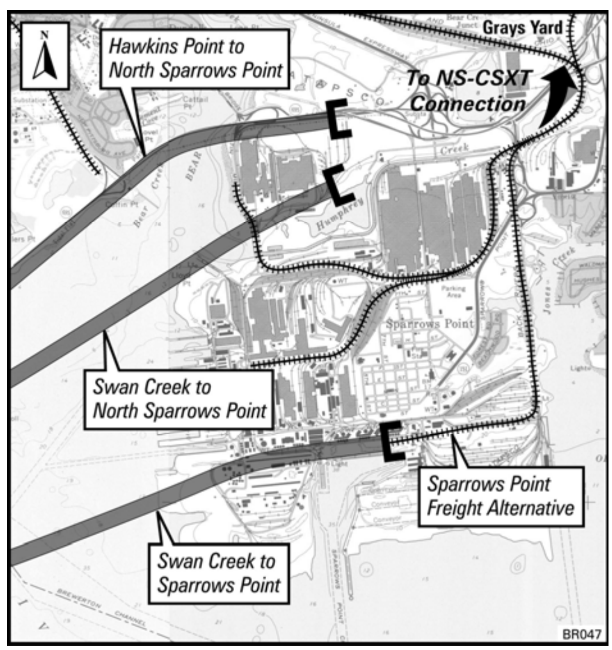


Figure 8-24. East Side of Marley Neck Tunnels Showing Hypothetical Location of Sparrows Point Portals

Potential tunnel alignments have not been discussed with OAO Severstal. Such discussions would be premature in view of the early stage of planning, the availability in the Near North Sector of a land-based – and perhaps preferable – alternative, and the uncertainties affecting the future of rail restructuring in the Baltimore region. However, for the sake of the region's economy, it will be important to not permit or cause any actions that might adversely affect the future of the plant, its owners, and its employees. Should a

[13] A new drawbridge (representing a step backward and a permanent impediment to commerce) would be impermissible under the standards of the study.

Sparrows Point alternative be selected at the end of a multi-year planning and environmental process, the closest public/private cooperation would be necessary, both before and after the selection is made, to assure that no economic harm is done.

CONNECTION TO RAILROAD MAIN LINES

From a North Sparrows Point Portal. Initial perceptions by the study team suggested that a connector linking a North Sparrows Point Portal with freight railroad main lines to the northeast might be somewhat shorter than the alignment from Sparrows Point described below. The need to set study priorities, however, precluded development of a conceptual alignment passing to the north of the steel plant but still located on OAO Severstal property. The determination that a harbor tunnel between Marley Neck/Swan Creek and North Sparrows Point would be longer than a tunnel between Marley Neck/Swan Creek and Sparrows Point would offset the reduction in approach length imputed to a North Sparrows Point Portal.

The eastern portion of the approach alignment would require a speed-restricted curve to connect to North Point Boulevard, and this is a concern that would need further study in any follow-on evaluations of a North Sparrows Point Portal concept.

From a Sparrows Point Portal (Sparrows Point Alternative). The study team developed a concept for a connection between a Sparrows Point Portal and the NS Sparrows Point Industrial Track. As with the North Sparrows Point Alternative, such a connection would require use of the OAO Severstal property and would need to thread its way through many highways and other existing facilities. The NS Sparrows Point Industrial Track would be used from its connection to the OAO Severstal facility trackage at Grays Yard to a connection with the NS/Amtrak tracks in the vicinity of River Interlocking (Figure 8-23). A two-mile bridge structure would be used to cross over numerous highways and railroad tracks between the OAO Severstal facility and North Point Boulevard. New right-of-way would be required north of the Amtrak main line for the connection to CSXT. The CSXT connecting track would be grade separated over the Amtrak main line.

It is noteworthy that a theoretical Sparrows Point alignment was developed that would neither interfere unduly with existing traffic, nor violate the one percent gradient limit for freight, nor prevent trains from virtually maintaining their intended speed maxima. The Marley Neck–Sparrows Point alignment also survives the many tests posed in earlier sections.

While encouraging, this finding must be regarded as extremely tentative for the following reasons:

- It has not yet been proven that the freight route concept can be built through Sparrows Point without adversely affecting the operations and viability of the OAO Severstal steel mill, which is vital to the economy of the Baltimore region.
- It would be very difficult, if not impossible, to adjust this concept to allow through trains to stop at Bay View to drop off or pick up cars as a through, single-direction move. Instead, through trains from the southwest would proceed directly through the tunnel, circle back toward Bay View, complete their switching, and then reverse direction to head northeast from Bay View. This facet is not an improvement over the present operation and would have many disadvantages.
- A Marley Neck–Sparrows Point route would be relatively long when compared to existing routes. Detailed operational analysis would be necessary to assure that the added circuity would be offset by higher overall speeds and the advantages of an unrestricted high-clearance route.

- The specifics of the connections and approaches at both the northeastern and southwestern ends of this route would require significant development to confirm that a Marley Neck–Sparrows Point alignment would fulfill the promise of its concept in an environmentally, economically, and operationally advantageous way.
- Finally, the cost of this Harbor Sector tunnel concept (see Section 12) would require careful comparison with the benefits to be obtained to the carriers, to the Baltimore port and economy, to shippers, and – especially if public financing is involved – to the general public.

8.2.6 EVALUATION OF HARBOR SECTOR FREIGHT ALTERNATIVES

The preceding discussion regarding the Harbor Sector has resulted in the identification of two alternatives that substantially survived the initial evaluation of screening criteria: the Canton Alternative and the Sparrows Point Alternative. **Table 8-3** provides an evaluation of screening criteria in a side-by-side format to enable comparison.

Table 8-3. Application of Screening Criteria to Harbor Sector Freight Alternatives

FUNCTIONAL/DESIGN SCREENING CRITERIA	CANTON FREIGHT ALTERNATIVE	SPARROWS POINT FREIGHT ALTERNATIVE
Availability of Land	Likely, however requires use of un-used industrial property	Likely, however requires use of some OAO Severstal and GSA Depot property
Gradient of One Percent or Less	Yes	Yes
Beneath Harbor Highway Tunnels	No	No
Tunnel Length > 4 miles	4.8 miles	3.3 miles
Ease of Integration with Network	Satisfactory	Difficult
Ease of Integration with Yards	Satisfactory NS Bayview Yard would require reconfiguration at west end	Difficult Requires reverse movements for through trains serving CSXT or NS yards at Bay View
Pass/Fail	Pass - with comments as noted above	Pass - with comments as noted above
Adverse Environmental Impact	Potential for Acquisitions, Displacements, Relocations	Potential for Acquisitions, Displacements, Relocations; Requires 3 large bridges.

EXTERNAL IMPACT SCREENING CRITERIA	CANTON FREIGHT ALTERNATIVE	SPARROWS POINT FREIGHT ALTERNATIVE
Consistent with Existing Land Use	No substantial change	No substantial change
Extent of Acquisitions, Displacements, and Relocations	Requires use of un-used industrial property	Displacement of industrial site and homes; open space changed to industrial land use
Impact to Listed or Eligible National or State Historic Place	No	No
Impact to Parklands, 4(f)/6(f) Resources	Potential impact to Patapsco Valley State Park	Potential impact to Patapsco Valley State Park and Batavia Park
Construction Impact Severity	High	High
Impacts to Ecosystems, Water Resources	Temporary wetlands impacts due to tunnel construction under Baltimore Harbor	Temporary impacts due to tunnel construction under Patapsco River; Rail route would cross numerous wetlands and floodplains
Pass/Fail	Pass	Pass - with comment
Comment		Route about 30 miles long

9 – RAILROAD OPERATIONS

A number of alternatives were developed to replace both the Howard Street Tunnel, the B&P Tunnel, and possibly move the Amtrak Baltimore Penn Station from its current location to one closer to the center of downtown. These alternatives have to provide improved capacity in the face of substantial increases in the number of freight and passenger trains as indicated by the traffic projections for 2050 (see Section 3).

The tunnel alternatives were designed to accomplish several objectives:

- Replace aging infrastructure;
- Increase capacity to handle forecasted growth in trains;
- Reduce running times for freight and passenger trains through Baltimore; and
- Improve reliability of service by eliminating bottlenecks.

9.1 COMMON ASSUMPTIONS

The railroad "world" in the year 2050 would look much different than it does today. Forecasted increases in train numbers and additional NS service in the NEC would dramatically impact the viability of operations though Baltimore. In order to evaluate the alternatives for replacing the railroad tunnels in Baltimore, the same assumptions regarding forecasted volumes and operational patterns must be used to test each tunnel alternative. Further, in order to isolate the performance of each alternative, the tunnels must be the "choke" point for the Baltimore rail network. Capacity constraints elsewhere that might limit the number of trains handled at Baltimore must be addressed in order to fairly measure the benefits of each tunnel alternative.

The northern limits of the Baltimore study area are at the crossings of the Susquehanna River, Perryville on the NEC and Aikin on CSXT. The southern limits are at points where trains enter the NEC at Washington, CP (Control Point) Avenue Interlocking, or Landover from the Landover Subdivision. CSXT's southern limits are at JD (Hyattsville, MD) where trains from the south enter from the Anacostia Branch and at "F Tower" – the connection point to Washington Union Station and also the wye connection for westbound freight destined for Brunswick and beyond. Within the Baltimore terminal, CSXT yards at Canton, Locust Point, and Curtis Bay all provide entry and exit points for trains on the CSXT main lines through Baltimore. NS trains use the major terminal at Bayview Yard to enter or leave the NEC.

Railroad network capacity and overall train performance was determined by simulating operations for the years 2012, 2020, 2030, and 2050 and measuring the resultant train delay. In all alternatives simulated, Amtrak Acela and Regional services were given movement and routing priority. Other passenger services were given priority over freight services. Freight trains were dispatched on a first come – first serve basis.

The 2050 forecast for freight trains through Baltimore includes 10 daily NS freight trains – 3 intermodal and 2 merchandise trains in each direction. In order to operate these trains through Baltimore, a viable freight route is required. However, in the case of the No-Build Scenario, a viable route for these additional NS trains is not offered. The existing B&P Tunnel's "Plate C" clearances preclude a significant portion of the current and future freight car fleet – double-stack container cars, tri-level auto carriers, and high-cube box cars. Rather than accept the operational restrictions and additional train-make-up work to keep clearance-restricted cars out of the No-Build Scenario passenger tunnels, NS has consistently indicated it would continue to use its alternative route via Manassas Junction–Hagerstown-Harrisburg to reach the North Jersey and Philadelphia markets. Before NS, Conrail had a similar aversion to the B&P Tunnel. Therefore, in the No-Build Scenario, the 10 additional trains projected for NS are routed through Hagerstown, not Baltimore. This route adds 111 miles and more than three hours to the running times for the 10 diverted trains.

Further, a viable NS route through Baltimore would leave the available capacity on the Hagerstown route for other trains, particularly those serving New England and Canadian markets that are routed via Harrisburg. However, the time and mileage savings for NS operating these trains through Baltimore would be somewhat moderated by the cost for a new connection on the NEC north of the BWI Rail Station and another connection to return NS trains to the railroad's Bayview Yard. The 10 NS daily trains also add to the 50 (+/-) daily CSXT freight trains moving through the new Baltimore freight tunnel and create additional delay possibilities for the CSXT trains, particularly at locations where the NS freights enter or exit the shared tunnel route.

9.1.1 IMPROVEMENTS ELSEWHERE

In order to isolate the benefits of different tunnel configurations, it is necessary to postulate certain other capacity improvements elsewhere in the Landover–Perryville study area that would allow the rest of the network to handle the forecasted volumes. This would allow the analysis to identify the incremental effects of each tunnel alternative. These capacity improvements are:

- 4th main track between Control Point (CP) Bridge and Landover. Because of the increase in MARC commuter trains between Baltimore and Washington, DC (from 52 to 64 daily trains in 2050), a fourth main track is needed along the NEC. Improvements at BWI Rail Station and New Carrollton provide island platforms and four platform tracks at each station. Interlockings at CP Grove and CP Bowie are expanded to provide crossovers to and from the new 4th main track. Instead of sharing a middle track, operated at speed in both directions, the new track configuration has two middle main tracks in each direction, permitting Acela and Regional passenger trains, and increasingly freight trains, to bypass slower MARC commuter trains operating with station stops on the outside tracks.
- All MARC trains sets on the NEC (Penn Line) would be electric trains that operate in "push-pull" service and consist of a single 7,000 hp (nominal) locomotive and 7 bi-level cars. The electric equipment allows larger trains and improved acceleration from station stops. This both increases the capacity of the MARC Penn Line service and improves MARC train performance on the high-speed NEC.
- A MARC storage and servicing facility north of the Baltimore station. The number of trains and their increased length exceed the storage capacity MARC currently uses at Penn Station. The potential new MARC facility is assumed to be located at the Glen Martin location (or Aberdeen Providing Grounds {APG}), north of NS's Bayview Yard (**Figure 9-1**). MARC trains would operate southbound from "Martin" on A Track and northbound to Martin moving with the current of traffic on Main Track (MT) 1. MARC trains would operate both directions on MT 1 between CP Biddle and Penn Station.

9.1.2 OPERATIONS

AMTRAK

All Amtrak trains operate between Perryville in the north and CP Avenue – the entrance to Washington's Union Station – in the south. Three classes of Amtrak service operate: Acela high-speed trains, Regional trains consisting of a locomotive and 8-10 cars, and Long Distance trains of 10-12 cars and two locomotives. All trains stop at Penn Station, using platform tracks 6 and 7 for scheduled 2-5 minute station stops. Regional trains make stops at BWI Rail Station and New Carrollton. Because of the increased number of Regional trains and MARC trains on the NEC, Acela and Long Distance trains alternate stops at BWI Rail Station and New Carrollton to improve their running times.

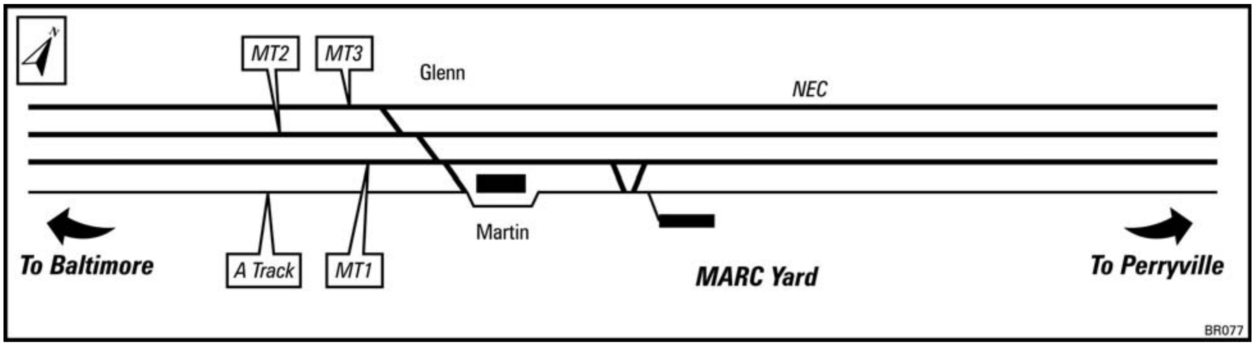


Figure 9-1. Martin Interlocking

MARC PENN LINE

MARC Penn Line service operates a series of train "turns" between Washington and Baltimore. Service to and from Perryville is provided by a smaller number of trains. Some trains go into service at Martin and operate empty to Perryville where they turn and make station stops at Perryville, Aberdeen, Edgewood, Martin, and then continue south to Baltimore and Washington (Figure 9-1). Northbound trains from Washington either "turn" at Penn Station or continue north, making station stops to Perryville. Equipment does not lay over at Perryville but runs empty to and from Perryville and Martin when out of service. The 75% increase between 2008 and 2050 for this MARC Perryville service is the most significant increase in passenger operations on the NEC in the study area.

It is noted that the *MARC Growth and Investment Plan* (September 2007) includes a service extension from Perryville to Elkton and Newark, DE in the 2015 Plan for the Penn Line. At this writing, the layover and deadhead movement pattern for this extended service is unclear; however, it is believed that the assumptions made herein regarding the Perryville service are also representative of the future extended service movements (within the study area).

MARC CAMDEN LINE

MARC Camden Line service operates on CSXT's freight main line between Washington ("F Tower") and a stub-end three-track station at Camden Yards in Baltimore. Trains "turn" on the three platform tracks at Camden Yards Station. Overnight storage and servicing for MARC train sets is provided at Riverside Yard. Camden Line trains are a single 3,000 hp diesel-electric locomotive and a 4-car consist operating in push-pull service.

NS FREIGHT IN THE NEC

Current 2008 NS freight service on the NEC is limited to the north end, between Perryville and Bayview Yard. South of Bayview, NS only operates a week day local turn from Bayview to Landover and return, and a transfer from Bayview to the Bulk Terminal facility at Mount Vernon. Both of these movements operate at night to avoid the busiest Amtrak operating periods. North of Bayview, NS freight trains consist of coal trains for the Consol port operation in Canton and priority intermodal merchandise trains to Bayview Yard. Bayview Yard is a "safe haven" for NS freight operations, where trains can clear the NEC.

In the future, NS freight operations are projected to return over the entire NEC with the addition of priority intermodal, merchandise, and municipal solid waste trains operating between the Landover

Subdivision at Landover and Perryville. This adds an increasing number of slow-moving freight trains (50 mph) to the higher speed Amtrak and MARC commuter trains operating north and south of Baltimore.

CSXT FREIGHT

CSXT continues to be the dominant freight operator in the Baltimore area. Freight trains serve the north, south, and west from Baltimore; trains also originate at a series of terminal locations within Baltimore. Coal trains and priority freight trains (the latter mainly automobile traffic) dominate the Curtis Bay terminal area on the south side of the city; these trains do not use the Howard Street Tunnel. Additional priority intermodal, automobile, and general freight trains operate to the north side of the harbor area via Bay View and Canton – where CSXT's intermodal terminal is currently located. Priority intermodal and automobile trains, general merchandise, and unit trains (municipal sold waste) operate from the south and west of Washington and north toward New York via the Susquehanna River crossing at Aikin. General merchandise trains stop and pick up or set off cars at CSXT's Bay View location, blocking one of the two main tracks there for 30+ minutes to perform this operation. There are daily local trains originating at Locust Point (Riverside locomotive serving facility) that work north to Aikin and return, and a second pair between Locust Point and Brunswick that provide local pick up and delivery service south of Baltimore.

CSXT's major capacity constraint through Baltimore is the 6.7 mile Howard Street Tunnel-Clifton Park segment of single-track connecting its north-south operations. Southbound trains must be held at Clifton Park or Bay View until they can operate through the tunnel and reach the double-track at CP Carroll. Northbound trains are held at CP Carroll if there is a southbound train coming through the tunnel; these northbound trains are stopped in the middle of the MARC Camden commuter service, which must operate around them to reach the Camden Yards Station. North-south trains operating to and from Richmond, VA have a five-minute stop at Halethorpe, on the main line, while crews are changed. East-west trains and trains originating or terminating in the Baltimore terminal do not require this crew change.

CSXT also operates PEPCO unit coal trains on the NEC. Loaded coal trains enter the NEC at Landover, off the Landover Subdivision, and run 8.5 miles to Bowie where they use the Popes Creek Branch to reach the power plants. The returning empty train must operate against the current of traffic on northbound MT 1 back to Landover.

9.2 PASSENGER TUNNEL ALTERNATIVES

Two alternative passenger tunnels were identified to replace the existing B&P Tunnels (south of Penn Station) and either replace or retain the existing Union Tunnels (north of Penn Station) on the NEC. A key issue is whether to replace the existing Penn Station with a new run-thru underground station located in close proximity to the city's CBD and sports complex. Replacing the passenger station is a much more complex and expensive engineering project and needs to be addressed in terms of the benefits of relocating the station versus the significant costs in doing so. Operationally, both alternatives interact only in a limited fashion with the freight operations that are moved to a separate tunnel alignment.

9.2.1 GREAT CIRCLE PASSENGER TUNNEL

This new passenger tunnel is a replacement "in-kind" for the B&P Tunnel. It diverges from the existing alignment at MP 96.1, just south of Charles Interlocking at the Penn Station throat, and re-connects to the existing alignment at MP 97.8. The new tunnel route between common tie-in points is 2.5 miles in length compared to the 2.2 mile length of the B&P Tunnel. The greater length of the GCPT route is offset by its 70 mph running speed, compared to 30 mph in the existing tunnel – the nominal time savings in the new tunnel is between one minute and one and one half minutes. This time savings is offset somewhat because trains would be accelerating or braking for the Penn Station stop at the east end and possibly using 45 mph turnouts at the west end. The net result is that the GCPT is essentially a replacement in kind for the existing tunnel, with improved speeds, clearances, and a new tunnel structure to replace the aging B&P Tunnel.

Because it is a replacement in-kind, passenger operations for the new tunnel are unchanged from current Amtrak and MARC service. The proposed relocation of all freight traffic out of the passenger tunnels further reduces the interactions of freight and passenger trains and makes this passenger alternative a good standard for evaluating the freight tunnel alternatives that are discussed later.

9.2.2 SPORTS COMPLEX PASSENGER TUNNEL

This passenger tunnel alternative provides an underground approach and station in close proximity to Baltimore's sports complex – football and baseball stadiums – as well as the CBD and the Inner Harbor attractions. At the west end, the new tunnel approach would leave the NEC in the vicinity of Wilkins Avenue (MP 101.6). The new route would bypass and not serve the existing West Baltimore MARC Station (Franklin/Mulberry Streets). The alignment would continue eastward under the city and harbor and rejoin the NEC at CP River, MP 89.2 (proximate to the north end of the NS Bayview Yard). The Sports Complex route is slightly shorter (9.9 miles) compared to the NEC's 12.5 mile distance between the connection points because it takes a more direct route through and under Baltimore. It is also distinctly faster since the new tunnel supports 70 mph operation over its entire length. The Sports Complex route replaces the current B&P Tunnel and eliminates the need to rehabilitate and continue to use the existing Union Tunnels east of Penn Station.

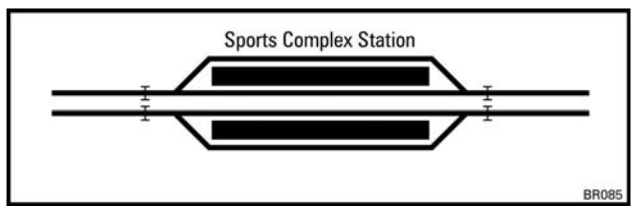


Figure 9-2. Sports Complex Underground Station

A four-track, underground station is envisioned (Figure 9-2). This station eliminates the additional platform tracks that MARC uses to "turn" and store train sets at the existing Penn Station and requires that all MARC trains run through the station and operate to and from the storage facility at Martin/APG. This, in turn, would require construction of a new interlocking at MP 84.0 to allow MARC trains to enter and leave their yard using MT 2 and 3 that connect to the Sports Complex route. These crossovers cannot be installed at the existing CP River Interlocking because of the proximity of curves and the rapidly separating grade of the new tunnel connection from the existing Amtrak right-of-way.

9.3 FREIGHT TUNNEL ALTERNATIVES

Four alternative freight tunnels were identified to replace the existing CSXT Howard Street Tunnel under downtown Baltimore and to relocate NS freight trains out of any new passenger tunnel. The separation of freight and passenger tunnels permits each tunnel design to reflect the operating concerns and design parameters that best fit the operation – in the case of freight trains, long, diesel-powered, heavy trains. Ruling grade considerations are paramount for freight service, while curvature and resulting speed restrictions are more important for passenger operations. By 2050, the expected CSXT trains through the tunnel would be over 50 (+/-) per day, with an additional 10 NS through trains. Having to queue this number of trains over a long single-track section would produce excessive delays, so it is imperative that the CSXT route have a continuous double-track section.

Because the freight trains would be operated with diesel locomotives, it is imperative that crews are not stopped in the tunnel for any lengthy time due to concerns over the diesel exhaust. Interlocking "hold points" at each end of all freight tunnels are provided to hold trains in the open air until the route to the other end is sufficient to clear the head-end locomotives. Only one train in each direction is permitted in the tunnels at a time.

9.3.1 COMMON CONNECTIONS – ALL FREIGHT TUNNELS

All freight tunnel alternatives propose to combine CSXT and NS freight movements through Baltimore in a double-track tunnel through the city. Freight operations north of Baltimore to the Susquehanna River would remain separate, with NS using the NEC as far as Perryville. All of the freight tunnel alternatives require construction of a 1.7 mile freight connecting track from the NEC at MP 105 to the CSXT main line at Halethorpe (**Figure 9-3**). All of the freight alternatives maintain a double-track route for CSXT and NS freight trains through Baltimore.

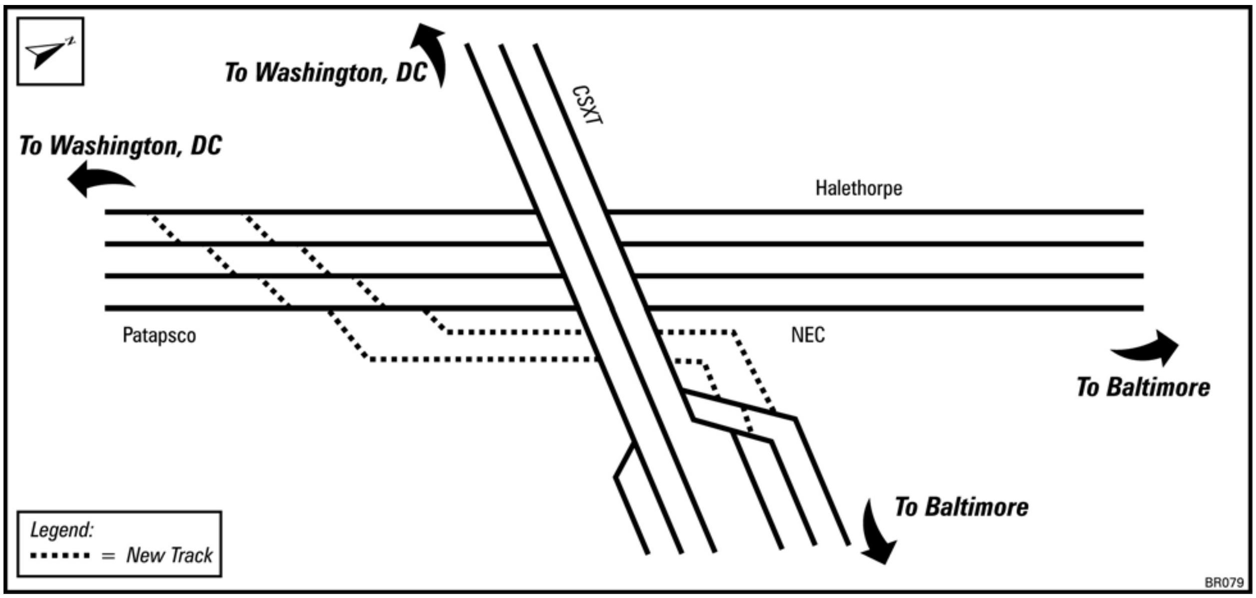


Figure 9-3. CP Herbert Run/Herbert Run Connection

In addition to the connecting track, a new interlocking, CP Herbert Run/Herbert Run, would be required to cross southbound NS freight trains over to the southbound NEC tracks. If this interlocking were not built, freight trains would have to run south against the current of traffic on MT 1, through the BWI Rail Station, and cross over at CP Grove (MP 112).

9.3.2 BELT-MODIFIED FREIGHT ALTERNATIVE

The Belt-Modified Freight Alternative runs from a connection with the CSXT Mt. Clare branch to a connection with the existing CSXT right-of-way south of Bay View at about MP BAK 93.4. Trains from the south, both CSXT and NS via CP Herbert Run, use the Mt. Clare Branch and Hanover Subdivision to enter the tunnel right-of-way. A connecting track is provided so trains and light engines from the CSXT servicing facility at Riverside and Locust Point can enter the tunnel route northbound.

Trackage through the Mt. Clare area is re-arranged so that a double-track right-of-way is maintained from Halethorpe to the tunnel. An extra crossover at Halethorpe provides access to the Metropolitan sub main tracks (**Figure 9-4**).

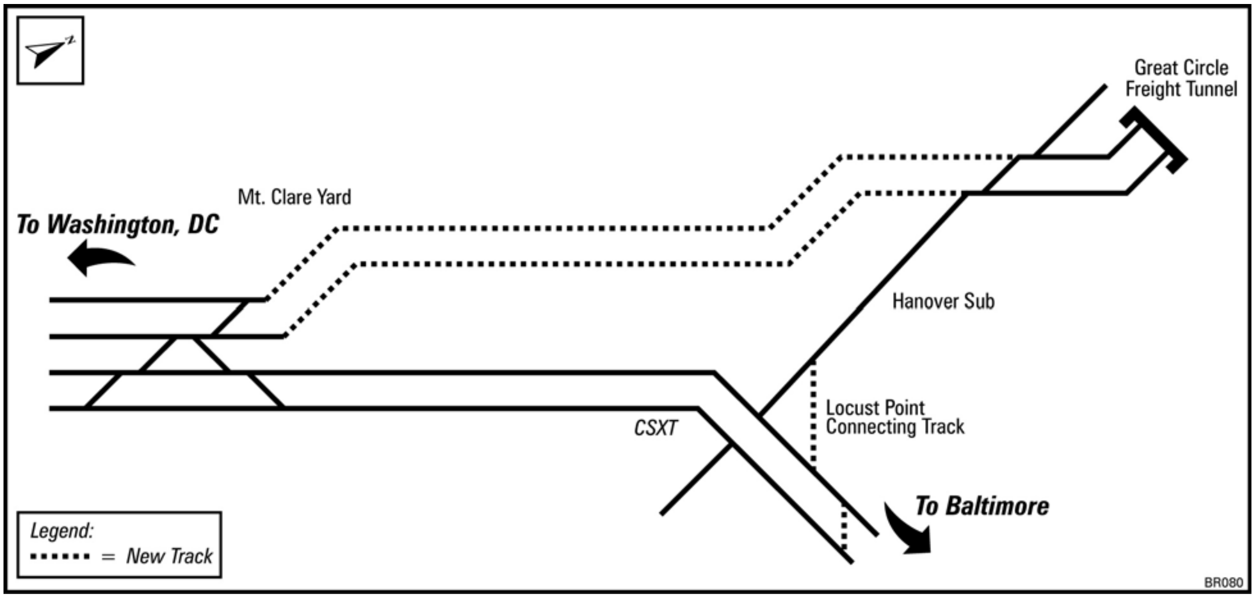


Figure 9-4. Belt–Modified and Penn Alternatives, Common Connections at Mt. Clare

East of the new tunnel, double-track would be extended through Clifton Park to meet CSXT's existing double-track to Bay View. Access for northbound NS trains to Bayview Yard would use a double-track connection from "CP Armco", through the old ARMCO Steel property that crosses over the Amtrak NEC and connects to the west end of yard (**Figure 9-5**).

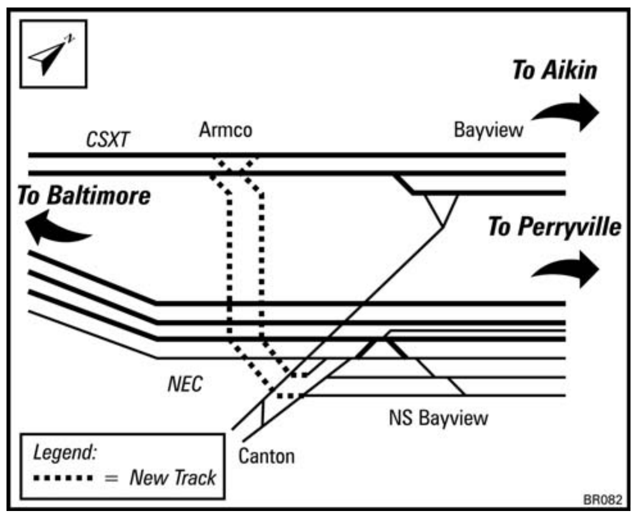


Figure 9-5. Belt-Modified Connections at Bayview

9.3.3 PENN FREIGHT ALTERNATIVE

The Penn Freight Alternative is identical to the Belt-Modified Alternative from Halethorpe to the west portal of the new tunnel. However, the new tunnel for the Penn Freight route follows a different alignment and profile. At the eastern portal, the elevation is low enough to allow the freight tracks to run along the north side of Penn Station. The Penn Freight route would require enlargement of the existing single-track Union Tunnel to accommodate double-track and Plate H clearance. The enlarged tunnel would accommodate MT 3 and a new MT 4 for exclusive freight use. This would force all passenger movements between Biddle and Paul onto two main tracks, MT 1 and MT 2, through the tunnel complex. MT 4 is a new freight track constructed on the north side of the NEC.

CSXT freight movements would remain basically unchanged but would have a double-track connection built through the ARMCO Steel property to reach Bay View Yard. NS trains would require a double-track main line/lead that would cross over the NEC and connect to the NS Bayview Yard. An interlocking connection at about MP 93.5 splits the CSXT and NS freight routes (**Figure 9-6**).

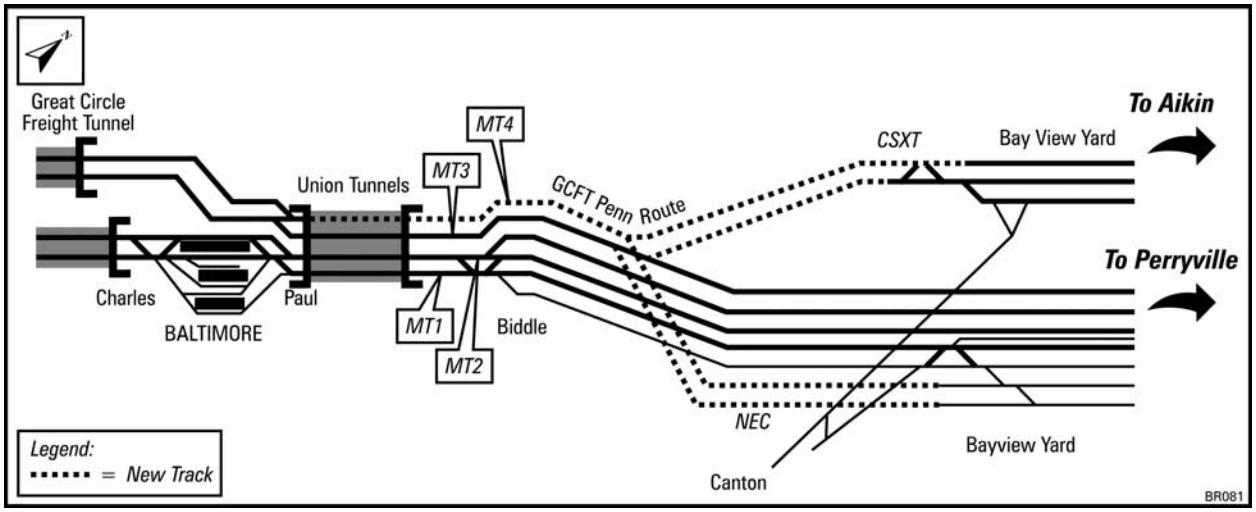


Figure 9-6. Penn Freight Alternative, Connections at Bayview

9.3.4 CANTON FREIGHT TUNNEL

The Canton Freight Alternative would use the existing CSXT main line from Halethorpe to the Riverside Yard and Locust Point area. The new tunnel portal would be located adjacent to the Riverside Yard. The tunnel would curve and descend under the harbor (paralleling the Fort McHenry highway crossing) before rising again on the Canton side of the harbor. Separate connections are made to both the CSXT and NS yards at Bay View. Because of grade differential, NS's connection extends about 2,000 feet beyond the beginning of the west end ladder tracks of Bayview Yard. The CSXT connection requires a curved, 30 mph alignment through the old ARMCO Steel property to access the west end of Bay View Yard and the Canton Branch. The latter capability is necessary so that trains can operate directly to and from the intermodal terminal, coal pier, and other facilities in the Canton/Penn Mary area (**Figure 9-7**).

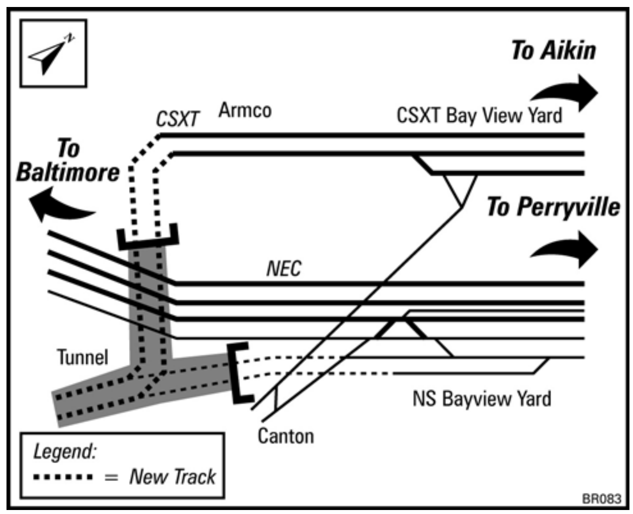


Figure 9-7. Canton Connections at Bayview

9.3.5 SPARROWS POINT FREIGHT TUNNEL

Sparrows Point Freight Alternative uses the existing CSXT line from Halethorpe, through Curtis Bay Junction to Curtis Bay Yard. At "Brooklyn", the new route diverges, runs alongside Curtis Bay Yard, and then continues south to a tunnel portal at Swan Creek. The tunnel crosses under the harbor to Sparrows Point, roughly paralleling the Key Bridge highway crossing, and then continues to connect with NS's Wise Avenue Branch. At the north end of the Wise Avenue Branch, large wye connections are made to both CSXT and NEC/NS.

Additional crossovers and interlockings are required for both freight operators. CSXT would need a crossover at MP BAK 86.6 (Schafer) to permit simultaneous north-south movements on the double-track connection to the tunnel. A lead from the tunnel would connect at MP BAK 87.7 and permit trains to move directly to Bay View and Canton terminals. North-south CSXT trains that need to pick up or set off at Bay View would have to "head-in" to Bay View, pick up or set off, then run power around the train and depart northward. This action adds at least 30 minutes to the working time required for trains at Bay View. Crossovers at BAK 88.2 are required so that trains can arrive, work, and depart at Bay View without fouling the route for Canton trains to and from the Sparrows Point Tunnel. The circular route from Canton to the south adds some 18.5 train miles and 22 minutes running time to the Canton – south trains (**Figure 9-8**).

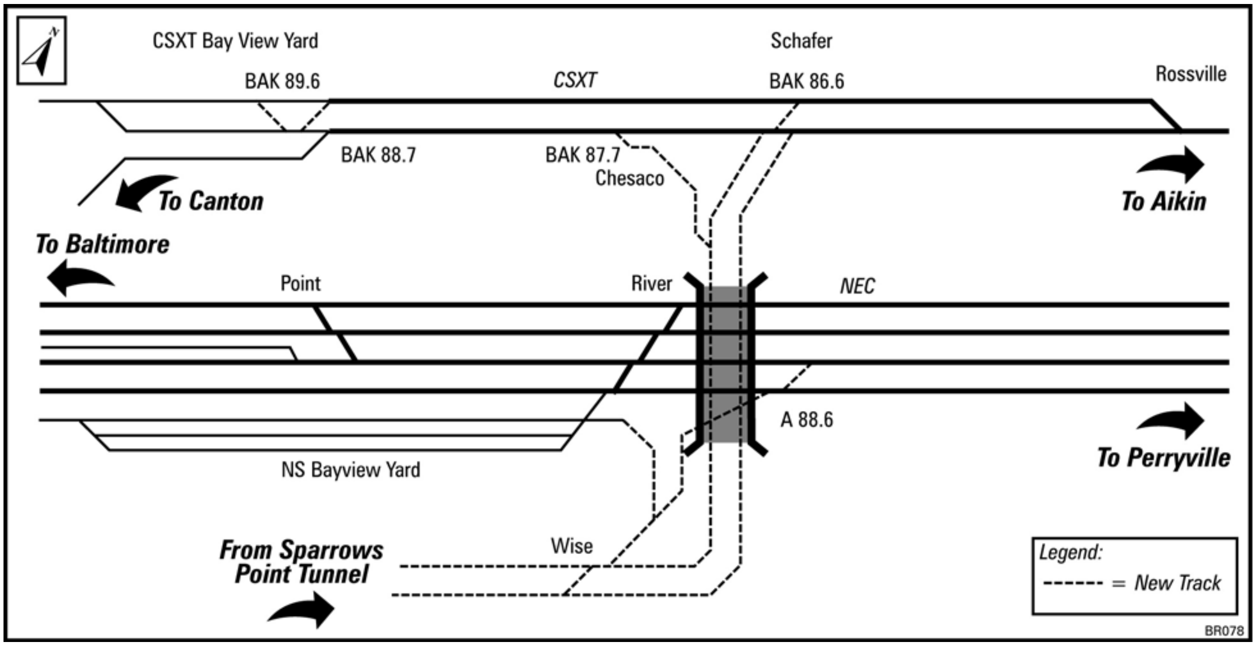


Figure 9-8. Sparrows Point Freight Alternative, Connections North of Bay View

NS trains would use a northward crossover wye connection at MP A 88.6 to reach the new tunnel connection. The existing Wise Avenue branch would be used to connect the tunnel to Bayview Yard. The NS and CSXT freight connections join at Wise Interlocking. Northbound trains, for both railroads, are held at Wise until a route onto the main lines or into the respective Bayview Yards is available. There is not enough room to clear the crossover at Wise if the trains pull up to the connection points. North-south trains needing to pick up or set off at Bayview would be required to "head-in" to the NS yard, do their work, and run-around the train with the locomotive to depart. No trains are planned or currently operated between Canton and the south, but these trains would now have a direct route instead of having to reverse direction in Bayview Yard.

9.3.6 OPERATIONAL COMPARISON – PASSENGER SERVICE

There are three passenger tunnel alternatives – No-Build Scenario retains the existing tunnels and passenger and freight operations, while the GCPT and Sports Complex involve new tunnel configurations and separation of passenger and freight services. The complete simulation for each case involved pairing a passenger tunnel alternative with a freight tunnel alternative. In each simulation, the 2050 freight and 2050 passenger train timetables were identical, with the exception of running MARC trains through the Sports Complex station to and from the proposed new service facility at Martin/APG. The only change – the independent variable in each test – is the paired tunnel alternatives. The results indicate how operations through a particular freight and passenger tunnel combination interact to increase or reduce train delays.

The upper portion of **Table 9-1** shows an overall summary of the simulation results in terms of Total Delay Minutes and Average Delay Minutes per train to each type of passenger train service. When evaluating the passenger times of the tunnel alternatives, it is important to note the following important assumptions:

- The No-Build Scenario (the apparent best passenger performer) assumed that the 10 NS through trains projected for 2050 service were diverted from Baltimore and would run via Manassas Junction-Hagerstown-Harrisburg as is current practice. However, two NS local trains are assumed to continue operating through the B&P Tunnel.
- All other alternatives included the 10 NS through trains within the Baltimore railroad network; therefore, the No-Build had a distinct advantage in terms of providing on-time performance for passenger service.
- The Sports Complex Passenger Alternative assumed freight service would use the Belt-Modified Alternative only.
- All four freight tunnel alternatives were simulated in conjunction with the GCPT option.
- Acela and Regional trains were given first priority in train movements.

In spite of the No-Build Scenario advantage, there are only seconds of difference, on a per train basis, for most passenger trains in all of the alternatives. This indicates that all alternatives exhibit similar passenger service performance characteristics.

9.3.7 OPERATIONAL COMPARISON – FREIGHT SERVICE

Each freight tunnel alternative was simulated using the same forecasted year 2050 timetable and line-up of CSXT and NS freight trains (CSXT – 30 northbound and 30 southbound trains; NS – 16 northbound and 16 southbound trains). Each freight alternative was tested using the GCPT Alternative so that the only variable in the operation was the different tunnel alignments, connections, and approach tracks required to use each freight tunnel alternative. As noted earlier, the No-Build Scenario assumes that through NS trains are routed via Hagerstown as no replacement for the B&P Tunnel is constructed.

Referring to the lower portion of Table 9-1, a comparison of the Average Delay Minutes per Train between the different freight tunnel alternatives indicates the relative performance of each freight alternative. Unlike the passenger trains that are tightly scheduled against their running times, freight train "lateness" is measured against an allotted running time for each train service, which includes some delay "pad" in the schedule. When a freight train is "late", then it has failed to meet even this generous schedule time standard. The consequences of the No-Build Scenario are readily apparent with a total freight and passenger delay of slightly over 59 and 1/2 hours as compared to the range of 24–33 hours for the other alternatives. Table 9-1 also indicates that all freight tunnel alternatives, except one, have similar performance characteristics. The exception is the combination of the GCPT with the Sparrows Point Freight Alternative. The reason for this exception is that freight train congestion is caused north of the two Bay View Yards by numerous trains having to enter and depart these yards, which this alternative effectively stub ends.

It is appropriate to include the delay time that is saved by the 10 NS trains that do not have to use the longer Hagerstown route when comparing shared tunnel alternatives that do handle these trains (NS Diverted No-Build, Table 9-1). Those No-Build Scenario delays are eliminated by operating the trains through Baltimore and accepting the additional trains and accompanying delays in the various tunnel alternatives.

Another comparison of the freight alternatives shows the differences in distances and running times for each alternative between JD (Hyattsville, MD – near Washington, DC) and the Susquehanna River (**Table 9-2**). The time differentials are compared with the No-Build Scenario. The times are based on an intermodal train making one stop, but no dwell. The best performer is the Belt-Modified Alternative with a time savings of 1:41 minutes.

Table 9-1. Year 2050 Average Delay Minutes per Passenger and Freight Train

Passenger Tunnel		Existing B&P Tunnel			Great Circle Passenger			Great Circle Passenger			Great Circle Passenger			Great Circle Passenger			Sports Complex Passenger		
Service	Dir.	Trains	Late	Late/Tn	Trains	Late	Late/Tn	Trains	Late	Late/Tn	Trains	Late	Late/Tn	Trains	Late	Late/Tn	Trains	Late	Late/Tn
ACELA	N	25	0:20:06	0:00:48	25	0:27:22	0:01:06	25	0:19:36	0:00:47	25	0:26:49	0:01:04	25	0:30:46	0:01:14	25	0:36:51	0:01:28
	S	25	0:27:22	0:01:06	25	0:33:18	0:01:20	25	0:37:41	0:01:30	25	0:33:56	0:01:21	25	0:34:50	0:01:24	25	0:25:49	0:01:02
Regional	N	20	0:12:02	0:00:36	20	0:17:26	0:00:52	20	0:10:41	0:00:32	20	0:19:03	0:00:57	20	0:13:25	0:00:40	20	0:05:49	0:00:17
	S	18	0:05:38	0:00:19	18	0:15:37	0:00:52	18	0:22:41	0:01:16	18	0:11:22	0:00:38	18	0:25:11	0:01:24	18	0:12:48	0:00:43
Long Distance	N	4	0:03:55	0:00:59	4	0:00:02	0:00:00	4	0:02:33	0:00:38	4	0:00:02	0:00:00	4	0:03:32	0:00:53	4	0:11:34	0:02:54
	S	4	0:00:00	–	4	0:00:00	–	4	0:00:00	–	4	0:00:00	–	4	0:00:00	–	4	0:02:37	0:00:39
MARC	–	83	1:19:01	0:00:57	83	1:37:13	0:01:10	83	1:03:21	0:00:46	83	1:18:33	0:00:57	83	1:38:43	0:01:11	99[1]	2:01:23	0:01:14
Total Passenger Delays		**2:28:04**			**3:10:58**			**2:36:33**			**2:49:45**			**3:26:27**			**3:36:51**		
Freight Tunnel		**Existing Howard Street**			**Belt–Modified**			**Penn**			**Sparrows Point**			**Canton**			**Belt–Modified**		
NS	N	10	0:00:04	0:00:00	14[2]	0:23:15	0:01:40	14[2]	0:31:16	0:02:14	14[2]	0:22:26	0:01:36	12[2]	0:34:00	0:02:50	14[2]	0:05:44	0:00:25
	S	11	0:48:19	0:04:24	16[2]	0:11:17	0:00:42	16[2]	0:43:38	0:02:44	14[2]	1:34:39	0:06:46	15[2]	1:13:43	0:04:55	14[2]	0:13:17	0:00:57
NS Diverted	N	5	16:23:38	3:16:44															
	S	5	16:23:40	3:16:44															
CSXT	N	28[2]	9:10:05	0:19:39	30[2]	7:18:33	0:14:37	30[2]	8:14:26	0:16:29	30[2]	17:08:22	0:34:17	30[2]	7:04:02	0:14:08	30[2]	7:18:33	0:14:37
	S	27[2]	14:19:55	0:31:51	27[2]	12:42:41	0:28:15	27[2]	14:20:37	0:31:52	27[2]	11:13:31	0:24:57	27[2]	16:02:23	0:35:39	27[2]	12:42:41	0:28:15
Total Freight Delays		**57:05:41**			**20:35:46**			**23:49:57**			**30:18:58**			**24:54:08**			**20:20:15**		
TOTAL DELAYS		**59:33:45**			**23:46:44**			**26:26:30**			**33:08:43**			**28:20:35**			**23:57:06**		

[1] Includes MARC movements to new service facility at Martin/APG.

[2] The freight train counts are those trains that "entered" and "exited" the track network and were successfully processed within the simulation day. The slower the operation, the fewer trains handled during each day. The number of trains handled, in addition to the delays amounts, reflects the performance of the option. The simulations assumed a base train count of 30 northbound and 30 southbound trains for CSXT, and 16 northbound and 16 southbound trains for NS.

A further comparison of the freight tunnel alternatives is to examine where the train delays occur and how many minutes of total signal delay (here defined as holding a train at a Stop Signal waiting for a cleared route at an interlocking Home Signal) result. All of the freight tunnels reduce total signal delay compared to the No-Build Scenario, but the Belt-Modified performs the best. Of more interest is where the delays occur and how the delays shift from interlocking to interlocking in the different scenarios on the NEC (**Table 9-3**) and on CSXT (**Table 9-4**).

Table 9-2. Freight Tunnel Distances and Running Times

FREIGHT TUNNEL	JD HYATTSVILLE TO NORTH OF SUSQUEHANNA RIVER			
	MILES	DIFFERENCE (MILES)	RUNNING TIME	DIFFERENCE (TIME)
No-Build	72.4		1:37:14	
Belt-Modified	71.9	-0.5	1:35:33	-0:01:41
Great Circle – Penn	72.6	0.2	1:36:06	-0:01:08
Canton	72.7	0.3	1:36:50	-0:00:24
Sparrows Point	80.3	7.9	1:41:08	0:03:54

On the NEC, substantial delays occur at Magnolia and Gunpowder, where the Amtrak line is constricted to two main tracks over the bridge and where the increased numbers of MARC commuter trains operating north of Baltimore and NS's forecasted increases in freight trains is the greatest. All simulated operations use "A track" and MT 1 for freight and commuter trains, leaving MT 2 and MT 3 for through passenger trains between Gunpowder and Baltimore. This creates further train delays for MARC trains entering or leaving the yard and stopping at the Martin station in front of freight trains to and from Bayview.

In the same fashion, the end of CSXT double-track at Rossville (the east end of Bay View Yard) creates substantial delays at Van Bibber siding (about 12.3 miles east of Rossville) and at Rossville as the large number of CSXT trains must transit the 12.3 mile single-track between the latter two locations. Delays to southbound trains stopped at Van Bibber would be reduced dramatically by the two-track freight tunnel alternatives. The existing single-track Howard Street Tunnel–Clifton Park segment backs up southbound trains all the way to Van Bibber waiting to transit.

At the south end of the freight tunnel alternatives, all northbound delays to freight trains at Carroll – waiting for the single-track tunnel – were eliminated. Northbound delays cascading back from Carroll to Halethorpe and Dorsey would be further reduced for the same reason (i.e., trains would no longer be held waiting their turn through the Howard Street Tunnel).

The remaining signal delays are steady from alternative to alternative, meaning the tunnel alternatives have little or no effect on activities at that interlocking. Perryville at the north end of the simulation area is an example of that situation.

The Sparrows Point Freight Alternative illustrates an interesting trade-off. The longer route (see Table 9-1) adds running time (and delay against the schedule) to all of the CSXT trains, but it does reduce the signal delays southbound at Van Bibber and West Aikin, where trains stack up waiting to work through the CSXT terminal at Bay View. The Sparrows Point Alternative allows through trains to bypass CSXT Bay View Yard and reduce or eliminate delays that occur moving through that location.

Table 9-3. Year 2050 Signal Delay Minutes – NEC Interlockings

INTERLOCKING	DIR.	NO-BUILD	GCPT AND BELT-MODIFIED	GCPT AND PENN	GCPT AND SPARROWS POINT	GCPT AND CANTON	SPORTS COMPLEX AND BELT-MODIFIED
Prince	S						2.32
Perry	N	0.32					0.37
Perry	S	5.62	12.05	13.13	14.73	13.12	20.47
Grace	N						2.73
Oak	S	3.75	14.48	14.48	14.48	23.92	19.87
Aberdeen	N		1.45	1.77	1.45	1.77	3.53
Poplar	N	1.83	13.18	1.85	12.77	0.12	3.00
Bush	N		3.38	3.02	3.35	31.93	6.13
Bush	S	7.52	21.72	21.72	21.72	21.72	57.35
Wood	N	8.32	44.15	48.82	38.42	55.63	50.35
Magnolia	S	33.05	75.97	77.87	77.32	70.03	76.63
Gunpowder	N	23.15	87.65	60.40	69.90	56.02	64.32
Gunpowder	S	23.92	47.73	44.82	47.58	45.00	37.08
Martin	N		2.52	14.73	13.45	12.95	12.48
Martin	S	41.93	51.97	34.42	30.97	40.58	48.33
River	N	36.42	30.72	52.05	25.02	17.40	21.93
River	S	7.62	7.02	0.88	9.48	1.03	
Biddle	N	2.83	6.10	4.18	1.75	6.10	
Biddle	S	10.07	6.58	6.43	6.22	6.18	
Sports Complex	N						18.02
Sports Complex	S						17.57
Charles	N	56.55	23.03	28.85	22.57	23.52	
Charles	S	18.00	31.23	26.65	34.12	44.20	
Bridge	N	68.12	24.50	14.27	25.82	14.73	
Bridge	S	2.63	6.58	5.62	82.55	12.02	
West Baltimore	N						35.73
Patapsco	N	2.83	1.30	1.30	4.60	1.30	2.02
Patapsco	S	1.50	0.07		40.40	0.07	5.83
BWI	S	0.05	0.87	7.32	7.07	2.32	7.48
Grove	N	0.03	0.20	9.73	0.20	9.73	0.50
Grove	S	0.70	1.80	7.25	0.70	0.75	3.07
Odenton	S	1.87	1.58	1.30	1.30	1.73	1.90
Bowie	N	1.47	3.10	3.60	3.10	3.60	1.63
Bowie	S	20.38	26.40	27.32	25.05	26.42	31.45
Popes Creek	S		7.38	7.38	7.38	7.38	7.38
Landover	N	0.00	4.37	4.30	3.83	6.43	3.83
Landover	S	24.02	35.60	28.67	21.32	36.43	38.02
NY Avenue	S	29.30	24.68	25.20	24.48	24.68	17.83
CP Avenue	N	63.17	59.95	61.32	56.65	60.78	56.13
TOTAL - Delay minutes		**496.95**	**679.32**	**660.63**	**749.73**	**679.60**	**675.30**

Table 9-4. Year 2050 Signal Delay Minutes – CSXT Interlockings

INTERLOCKING	DIR.	NO-BUILD	GCPT AND BELT-MODIFIED	GCPT AND PENN	GCPT AND SPARROWS POINT	GCPT AND CANTON	SPORTS COMPLEX AND BELT-MODIFIED
West Aikin	S	1249.62	560.40	594.00	92.38	593.73	560.40
Belcamp	N					7.82	
Belcamp	S		14.60	14.60	16.65	14.60	14.60
Van Bibber	N	1.10	90.18	104.43	69.98	43.40	90.28
Van Bibber	S	566.28	318.83	328.13	131.20	346.72	318.83
Rossville	N	70.27	155.62	169.48	178.17	91.70	155.62
Bay View-CSXT	N		22.20	30.13	134.12		20.58
Bay View-CSXT	S	115.20	18.07	15.08	8.47	12.58	17.63
Wise	S				19.65		
Works	S				4.25		
Armco	N		1.50				5.87
Armco	S			5.07		1.50	
North Portal	N					45.80	
North Portal	S			10.30	7.25	14.32	
Arundel	S				21.22		
Camden	N	144.18				2.25	
Camden	S	8.33					
Locust Point	N	30.68					
Locust Point	S	164.85	0.97	0.97	0.97	29.72	0.97
Carroll	N	344.80				26.45	
Carroll	S	55.82			7.58	26.98	
Claremont	N			1.17			1.20
Claremont	S		1.70	0.43			
Halethorpe	N	113.22	17.98	8.57	8.00	65.02	18.92
Halethorpe	S	19.25	21.57	31.08	42.20	23.30	21.97
Dorsey	N	133.28	24.95	28.02	16.52	18.98	24.95
Dorsey	S				0.50		
Jessup	S				5.88		
Jessup	N	29.15	3.15	3.15	3.15	3.15	3.15
Savage	S	7.52	6.00	6.00	20.32	22.40	6.00
Ammendale	S	8.22	17.17	11.65	13.75	16.17	17.17
"JD"	N	44.93	48.08	51.10	48.30	49.23	48.08
"JD"	S	1.32	1.52	8.18			1.52
"F"	N	5.12	6.13	6.13	6.22	6.13	6.13
"F"	S					1.38	
Brooklyn	S			0.52	23.05	0.52	
TOTAL - Delay minutes		**3113.13**	**1330.62**	**1428.20**	**879.77**	**1463.85**	**1333.87**

10 – ENVIRONMENTAL/LAND OWNERSHIP CONSIDERATIONS

An environmental review has been carried out for two passenger and four freight route alternatives that have been developed at the conceptual design level in this study. This environmental review supports the comparison of alternatives and development of recommended alternatives for further investigation. The information identified in this environmental review includes potential areas of effect that may need to be addressed in refining recommended alternatives in the next phase of project development. The freight and passenger alternatives are listed below:

- Great Circle Passenger Tunnel
- Sports Complex Passenger Alternative
- Penn Freight Alternative
- Belt-Modified Freight Alternative
- Canton Freight Alternative
- Sparrows Point Freight Alternative

The environmental reviews assessed the potential for environmental impacts within one-quarter mile on each side of the conceptual alignments and above or below subsurface or elevated alignments. This information has been used to indicate the potential of encountering a natural or built resource within this band-width, but it does not necessarily indicate that there is or will be an impact.

Seven aspects of environmental effects were considered that had the most potential to identify measurable differences among alternatives and aid in developing recommendations for further study. For some alternatives, these environmental concerns were used during concept development to modify conceptual alternatives in order to avoid or minimize potential impacts. Within this context, in terms of environmental considerations, all six of the alternatives have the potential to be implemented with appropriate mitigation or minimization of the identified potential effects and avoidance of some potential impacts through further alternative definition and design refinements.

Each alternative route consists of existing trackage and new construction. For the overall study, all aspects of each route have been taken into account in evaluating and comparing alternatives. For the environmental review, only the new construction portions of each route have been addressed. **Figure 10-1** and **Figure 10-2** show the freight and passenger alternatives, respectively, and the associated new construction areas. The seven categories of environmental effect addressed in this review include:

- Wetlands and Other Waters of the United States
- Flood Hazards or Floodplain Management
- Transportation and Utilities Impacts
- Land Use: Existing and Planned
- Environmental Justice
- Historic, Archeological, or Cultural Resources
- Section 4(f) Protected Properties

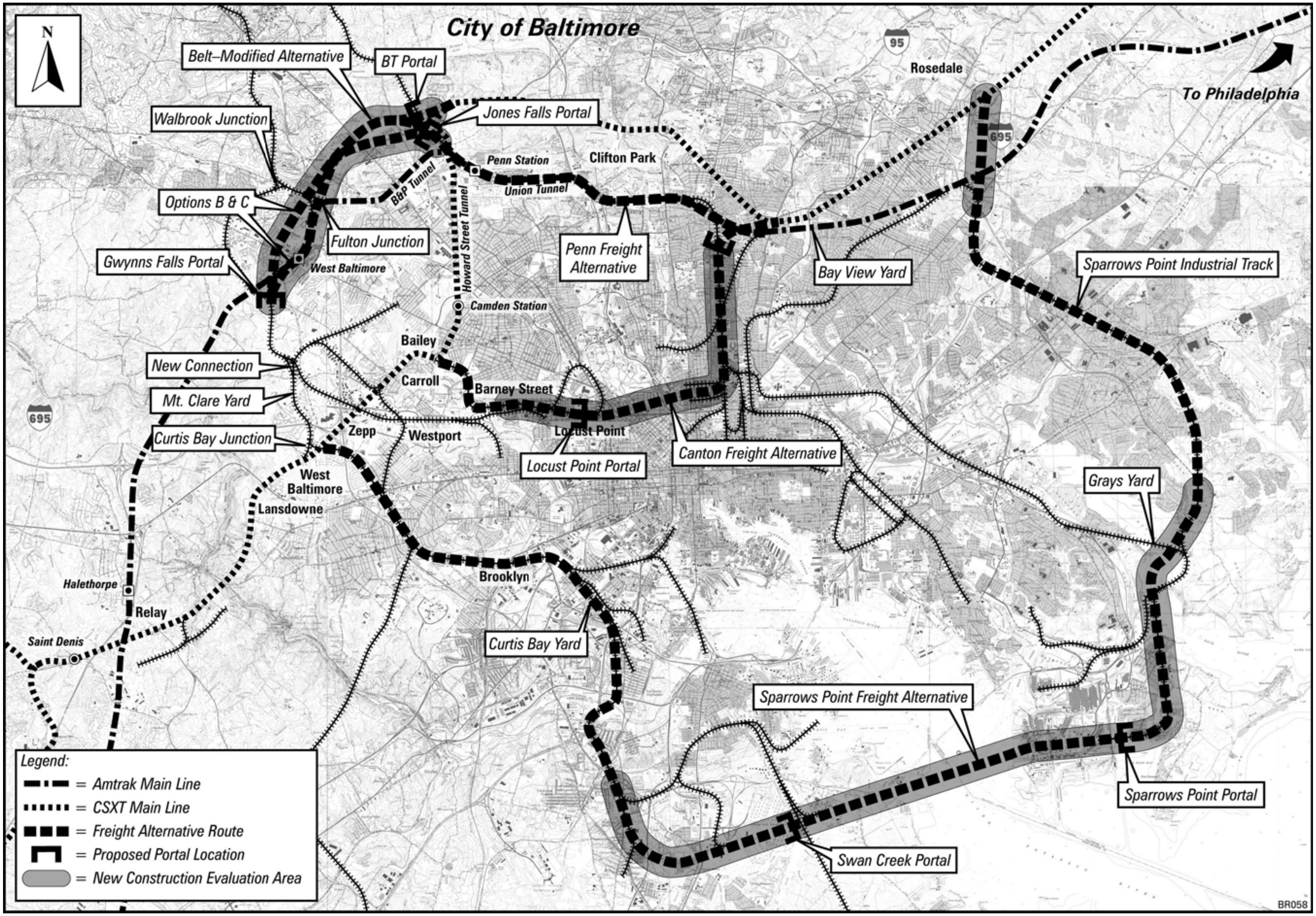


Figure 10-1. New Construction Areas – Freight Alternatives

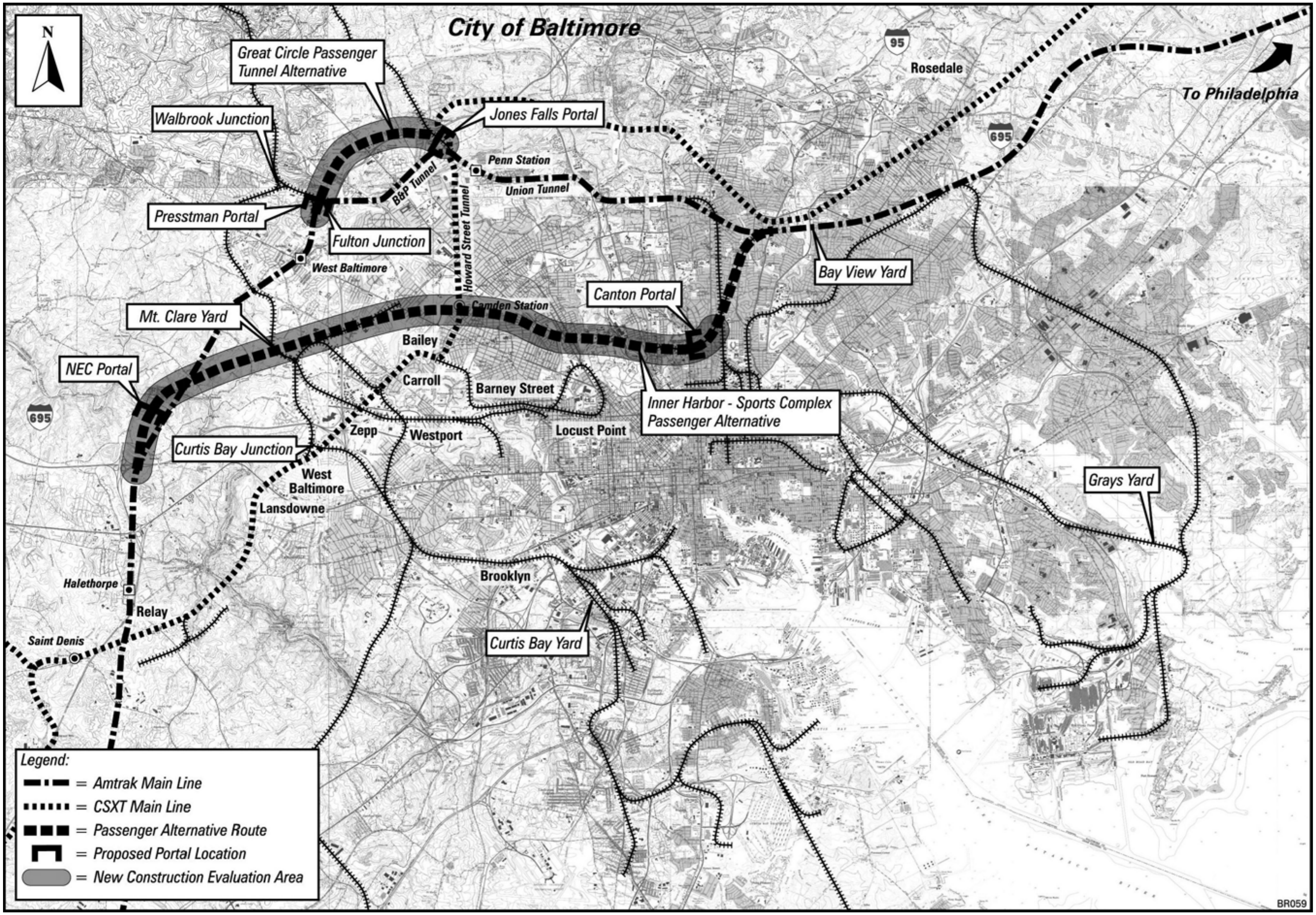


Figure 10-2. New Construction Areas – Passenger Alternatives

These categories were used at this stage of the study because they have the most potential to identify measurable differences among alternatives and sufficient geographic information system (GIS) data for these aspects were obtainable at the conceptual level of design.

FREIGHT ROUTE ALTERNATIVES – NEW CONSTRUCTION

New construction environmental reviews for the four freight alternatives are summarized below and in **Table 10-1**.

Table 10-1. Environmental Review Summary – Freight Alternatives

ENVIRONMENTAL CATEGORY	PENN	BELT-MODIFIED	SPARROWS POINT	CANTON
Wetlands and Other Waters of the US	Potential impacts to two wetlands (~0.6 acre) and Gwynns Falls	Potential impacts to two wetlands (~0.6 acre) and Gwynns Falls	Potential impacts to 27 wetlands and 5 Waters of the US	No wetlands, Baltimore Harbor regulated by Coast Guard and Corps of Engineers
Flood Hazards or Floodplain Management	Gwynns Falls Zone A floodplain – no fill allowed in floodway	Gwynns Falls Zone A floodplain – no fill allowed in floodway	All drainage is in Zone A floodplain - no fill allowed below floodway	Baltimore Harbor in a Zone AE floodplain – no fill allowed in floodway
Transportation and Utilities Impacts	Re-route or close Ellicott Drive	Re-route or close Ellicott Drive, bridge over Jones Falls Parkway, relocation of NS Bulk Terminal Yard, potential impact to roundhouse	Bridge over Amtrak NEC and overhead electric lines at Rosedale, Patapsco River maritime traffic impacts during construction	Baltimore Harbor maritime traffic and Locust Point Yard rail traffic impacts during construction
Land Use: Existing and Planned	No substantial change	No substantial change	Displacement of industrial building and homes, open space changed to industrial land use	No substantial change
Environmental Justice	Low-income, minority communities above tunnel	Low-income, minority communities above tunnel	Low-income, minority communities adjacent to route	None
Historic, Archeological, or Cultural Resources	No significant impacts	No significant impacts	No significant impacts except for light house near right-of-way	Portion of Fort McHenry boundary within study area, but no impacts to fort expected
4(f) Protected Properties	Gwynns Falls Park Gwynns Falls Trail	Gwynns Falls Park Gwynns Falls Trail	Batavia Park impacted at Rosedale	None

NEAR NORTH SECTOR: PENN FREIGHT ALTERNATIVE

The route of the Penn Freight Alternative from the southwest would make use of the CSXT Baltimore Terminal Subdivision between Halethorpe/Herbert Run and Mt. Clare Yard to access the CSXT Hanover Subdivision. From the Hanover Subdivision, the alternative crosses over Gwynns Falls and Gwynns Falls Park to a portal north of Gwynns Falls. From the portal just north of Gwynns Falls, there are two tunnel options (Options B and C) that were reviewed. Option C is part of the Penn Freight Alternative. Both tunnel options join at Baker Street and continue adjacent to the Great Circle Passenger Tunnel Alternative to the Jones Falls Portal. The Penn Freight Alternative would serve to bypass the Baltimore & Potomac (B&P) Tunnel and the Howard Street Tunnel.

From the Jones Falls Portal, the double-track route would proceed on the north side of the passenger tracks at Penn Station, pass through a rebuilt Union Tunnel, and continue to Bay View. A new track would be added to the Amtrak alignment between the eastern portal of Union Tunnel (Biddle Interlocking) and Bay View. A new CSXT connecting track in Bay View would be needed; this track would use new right-of-way through unused industrial property.

The principle effects of the Penn Freight Alternative route would be minor wetland and floodplain impacts at the Gwynns Falls portal, relocation of Gwynns Falls Trail to accommodate the portal and new bridge across Gwynns Falls, possible land acquisition within Gwynns Falls Park subject to Section 4(f) regulations, and environmental justice considerations in passing below areas with predominantly low-income and minority households. The rebuilding of the Union Tunnel for an additional track would have no impact on the adjacent Greenmount Cemetery.

NEAR NORTH SECTOR: BELT-MODIFIED FREIGHT ALTERNATIVE

The Belt-Modified Freight Alternative would utilize the same route as the Penn Freight Alternative starting between Halethorpe (Herbert Run) and the Gwynns Falls Portal as discussed above. However, the Belt-Modified Alternative would utilize only the tunnel Option B route to Baker Street, where it continues on a more northern route south of Druid Lake and then to Jones Falls. The tunnel emerges from a portal west of the Jones Falls Expressway (JFX), continues at-grade across the existing Norfolk Southern's (NS) Bulk Terminal Yard, and crosses Jones Falls with a 400-foot-long bridge, where it connects to the CSXT Belt Line. The Belt Line through Clifton Park is currently single-track; however, under the Belt-Modified Alternative, an additional track would be emplaced in this segment requiring modifications to seven overhead highway crossings. Beyond Clifton Park to Bay View, the Belt Line has double-track. At Bay View, a connecting track from the Belt Line to the NS Bayview Yard would be constructed.

The principle effects of the Belt-Modified freight route would be displacement of the NS Bulk Terminal Yard and possibly a railroad roundhouse and an elevated crossing of the Jones Falls valley. NS has expressed willingness to discuss the possible relocation of the Bulk Terminal Yard. The roundhouse on the east side of Jones Falls is currently used by the Baltimore City Highway Maintenance Division as a storage facility. The roundhouse is not on the National Register of Historic Places. Other potential effects would be minor wetland and floodplain impacts at the Gwynns Falls portal, relocation of the Gwynns Falls Trail to accommodate the portal and new bridge across Gwynns Falls, possible land acquisition within the Gwynns Falls Park subject to Section 4(f) regulations, and environmental justice considerations in passing below areas with predominantly low-income and minority households. In the Clifton Park area, reconstruction of the seven highway overcrossings would cause temporary indirect construction impacts.

The connecting track in Bay View would require new right-of-way, possible relocation of electric transmission lines, and the potential displacement of MDOT highway maintenance facilities. In addition, some reconfiguration to the west-end lead and ladder tracks in the NS Bayview Yard would probably be needed.

HARBOR SECTOR: SPARROWS POINT FREIGHT ALTERNATIVE

The Sparrows Point Freight Alternative would link the CSXT line at Curtis Bay Junction with the CSXT line at Rosedale to the east. New construction would occur from the Marley Neck Industrial Track to Sparrows Point Industrial Track, including a tunnel under the Patapsco River between Swan Creek and Sparrows Point and a bridge across Curtis Creek. New construction would also occur on the eastern end of the alternative route where the new track would tie into the CSXT line at Rosedale. The Rosedale connection would require the track to span the Back River floodplain and the NEC line, as well as traverse through Batavia Park.

The principle potential effects of the Sparrows Point freight route would be numerous wetland and floodplain impacts to the Patapsco River, Jones Creek, Swan Creek, Curtis Creek, and Back River. All of the drainage areas would be subject to local, U.S. Army Corps of Engineers, and/or U.S. Coast Guard authorizations and potential wetland mitigation. At the Rosedale connection, the freight track must span the Amtrak NEC and Back River area. There are high-voltage overhead electric lines that run along the Sparrows Point Industrial Track, cross over the track south of Back River and the NEC connection, and continue north over the I-695 corridor. There is a large, light-manufacturing building and several homes in the vicinity of the manufacturing building that would be displaced by the new alignment. Residential neighborhoods adjacent to the new alignment would also potentially be affected by construction and operation of the new tracks. Batavia Park is located along the northern portion of the Rosedale alignment and land acquisition within the park (if required) would be subject to Section 4(f) regulations.

HARBOR SECTOR: CANTON FREIGHT ALTERNATIVE

The Canton Freight Alternative would connect the CSXT line south of the Howard Street Tunnel to the Bay View Yard via a tunnel from Locust Point to Bay View. The western portal would be located in Locust Point, northwest of Fort McHenry National Monument and the Fort McHenry Tunnel, and west of Locust Point Yard. At the eastern end, the tunnel would split into two portals, one each for the CSXT and NS connecting tracks. The portal for the CSXT connecting track would be located north of the Amtrak alignment, and from there, the connecting track would make an 18-degree curve to connect at the west end of Bay View Yard. The portal for the NS connecting track would be located south of the Amtrak alignment; however, the connecting track would not come to grade until passing the west-end lead and ladder tracks of the NS yard. This would probably require a reconfiguration of these tracks.

The principle potential effects of the Canton freight route would be impacts from tunnel construction to Baltimore Harbor, which is regulated by the U.S. Army Corps of Engineers and U.S. Coast Guard. The harbor and Locust Point Yard rail traffic could be disrupted during construction activities.

The potential Locust Point Portal and tunnel positions are currently located outside the Fort McHenry National Monument boundary. The one-quarter-mile study area does incorporate a portion of the monument that could be affected by visual changes, noise distractions, and traffic congestion during construction and operation activities. However, the actual Star Fort at Fort McHenry is located outside the one-quarter-mile study area.

PASSENGER ROUTE ALTERNATIVES

New construction environmental evaluations for the two passenger alternatives are summarized below and in **Table 10-2**.

NEAR NORTH SECTOR: GREAT CIRCLE PASSENGER TUNNEL ALTERNATIVE

The Great Circle Passenger Tunnel Alternative starts at the existing Amtrak NEC track near Penn Station, enters the proposed Jones Falls Portal, loops around to the north through a new tunnel, emerges from Presstman Portal north of Lafayette Street, and reconnects to the Amtrak NEC. This alternative would bypass the B&P Tunnel. New construction would occur along the entire proposed route.

The principle effects of the Great Circle Passenger Tunnel route would be minor and subject to environmental justice considerations in passing below areas with predominantly low-income and minority households.

Table 10-2. Environmental Review Summary – Passenger Alternatives

ENVIRONMENTAL CATEGORY	GCT PASSENGER	INNER HARBOR – SPORTS COMPLEX
Wetlands and Other Waters of the US	No wetland impacts	Wetlands along Baltimore Harbor could be impacted, Baltimore Harbor impacts regulated by Corp of Engineers and Coast Guard
Flood Hazards or Floodplain Management	None	Baltimore Harbor in Zone AE floodplain – no fill allowed in floodway
Transportation and Utilities Impacts	None	Baltimore Harbor potential impacts to maritime traffic and docks during construction
Land Use: Existing and Planned	No substantial change	No substantial change
Environmental Justice	Low-income, minority communities above tunnel	None
Historic, Archeological, or Cultural Resources	None	Korean War Memorial and numerous other cultural resources within study area could be directly or indirectly impacted requiring extensive regulatory compliance
Section 4(f) Protected Properties	None	Potential temporary impacts to Rash Field during construction

CENTRAL SECTOR: SPORTS COMPLEX PASSENGER ALTERNATIVE

The Inner Harbor - Sports Complex alignment would divert from the existing Amtrak alignment about one-half mile north of the I-695 Beltway in southwest Baltimore and parallel the Amtrak route until reaching Wilkins Avenue. From Wilkins Avenue, the alignment is in a tunnel section and continues to a location between Oriole Park at Camden Yards and the M&T Bank football stadium. An underground passenger station would be located at this site between the two stadia.

Continuing the alignment eastward, sunken tube tunnels would be used under the Northwest Harbor, past Fells Point to a point in the vicinity of Boston Street where the alignment would curve to the northeast. Cut-and-cover tunneling would begin in the Boston Street area with the alignment coming to daylight north of O'Donnell Street on an existing NS/Amtrak route. The route would continue on existing right-of-way to Bayview Yard where the Amtrak NEC track would be rejoined.

The principle potential affects of the Inner Harbor – Sports Complex route would be from tunnel construction to Baltimore Harbor, which is regulated by the U.S. Army Corps of Engineers and U.S. Coast Guard. The harbor maritime traffic and port facilities could be impacted/disrupted during construction of the tunnel. There are numerous significant cultural resources within the study area, which could cause direct or indirect impacts and extensive regulatory compliance. For example, portions of the Korean War Memorial may have to be temporarily moved to construct a tunnel underneath.

COMMENTS ON PROPERTY REQUIREMENTS

As a component of the route configuration process, land use settings and property impacts were reviewed. The following paragraphs describe this process and findings.

APPROACH TO PROPERTY IDENTIFICATION

Property impacts were considered for a width of 200 feet on either side of the centerline for the analyzed routes. It is noted that the drawings for the proposed alternative routes are conceptual and subject to shifting as various data are developed. Minimal horizontal width was presumed to be 100 feet and depth surface to top of tunnel case 75-100 feet. Four of the five routes studied would run below surface for most of their length. Impact upon surface parcels was applied to portal locations and those required for vents and emergency shafts. Properties abutting cut-and-cover segments were included for the potential need for underpinnings and construction easements.

A physical inspection was made of each route. Available information was gathered for all parcels presumed to be affected. This included: property street address, property identifier number (assessment rolls), size, owner, type, zoning, current use, improvements, and age of improvements. If a parcel is improved with a multi-story structure or is zoned to permit such, a notation was made as the existing or potential depth of foundation could pose a problem. All data used were presented to be current as of 2007/08. Sources included: Maryland Department of Planning, City of Baltimore Department of Planning, City of Baltimore GIS Mapping Department, City of Baltimore Office of Assessment and Taxation, Greater Baltimore Board of Realtors Multiple Listing Service, Costar Systems Property Data Service, MRIS Property Sales Database, Google Maps, Maps Live, and consultation with local realtors and appraisers.

PROPERTY INTERESTS CONSIDERED

For all parcels potentially impacted, it was important to identify the current owner and type of owner (i.e., private, corporate, institutional, public, etc.). Included in the bundle of rights inherent in fee ownership is subsurface ownership (in some instances those rights may have been excepted in prior conveyances of the property but this can only be ascertained by title research). The interests to be acquired include: full fee for the surface parcels, subsurface easement for tunneling, and temporary easement for construction staging and access. A subsurface easement represents a fractional interest in the property.

APPLICABLE STATUTES OR PROCEDURES

While no specific state statutes could be identified with regard to acquisition, Maryland Property Law applies as to the nature of property interests held and legal means of transfer for all or part of those rights (i.e., sale, lease, etc.). For the purposes of this project, it is presumed that a portion of the funding will be from Federal sources and this mandates that all requirements of the Uniform Federal Acquisition, Appraisal, and Relocation Act must be adhered to.

APPROACH TO VALUE

Utilizing market data developed from the above described research, a grid was made for each route. The surface parcels impacted were given an estimated value based upon the comparable data from the marketplace. The proposed tunnels were considered to have minimal impact upon the remaining interest in the properties, given the planned depth of the use. For subsurface easements, a range of value of $1,000 to $2,500 was applied, depending upon the area of surface ownership and the percentage of the easement area to that amount. Factors considered included the angle at which the easement traverses the parcel and what is the current, planned, and/or permitted use of the parcel.

The most recent project involving extensive tunneling in the eastern U.S. was the Washington, DC Metro Rail System. Persons familiar with the valuation and acquisitions for that project were consulted to gain insight into the process and procedures followed. The experience of the more recent acquisition for the L.A. Metro Rail system was also examined.

While the value of a subsurface easement may be nominal, the attendant required and imposed costs for appraisal, title, legal, and acquisition management generally result in a final cost greater than the value of the easement.

Table 10-3 shows the estimated number of impacted parcels and the estimated total cost to acquire for each alternative. It is stressed that these amounts were not arrived at by formal appraisal of each property, but they were calculated based upon an informed opinion of the marketplace, the circumstance of the affected properties, and the planned use of the interests to be acquired. An average cost per parcel was applied. The market data utilized covered the period 2004 to 2007. Some consideration was given to 2008 sales but the current market is considered skewed; thus, the estimates place more weight on the data of the prior years.

Table 10-3. Estimated Impacted Land Parcels and Estimated Total Cost to Acquire

ALTERNATIVE/ SEGMENT	NUMBER OF PARCELS		LAND USE	TOTAL ESTIMATED COST			COMMENT
	SURFACE IMACT	WITH TUNNEL		SURFACE	TUNNEL	COMBINED PLUS CONTINGENCY	
Common Freight Track Segment (Connection) 60+							
BW Parkway Sta. 60+00	1		Park & Wet Land	100,000			
	1		Power Line	25,000			
	1		CSXT Right-of-Way	100,000			Assume to Pay
Total	3	0		$225,000		$315,000	
Common Freight Track Segment 85+/110+00							
Sta. 85+/-00 to Sta. 110+00	1		Industrial Parking Lot	50,000			
	1		Light Industrial Building	500,000			
	1		Public Street	100,000			Wilmarco Avenue
			Park Land	250,000			Gwynns Falls
Total	3	0		$900,000		$1,260,000	
Bel- Modified Freight Alternative							
Southwest Portal*							
Northeast Portal**							
Mid-Section / Tunnel	3	259	Residential Rowhouse	450,000	530,000		
		13	Industrial		50,000		
		1	Institutional		10,000		Vo-Tech High School
	1		Bulk Terminal Yard	10,000,000			
Monument Street to Duncanwood Lane	3		Vacant Industrial	200,000			
	1		Former RR Spur	20,000			
			Wood Land	100,000			May be owned by Electric Utility
Total	8	273		$10,770,000	$590,000	$15,904,000	
Penn Freight Alternative							
Lyon Street to Sta. 80+00l*	2		Vacant Industrial Property	300,000			Part of Gravel Pit
Northeast Portal**	1		Industrial Building	1,000,000			Former Steel Facility
Total	3	0		$1,300,00		$1,820,000	

ALTERNATIVE/ SEGMENT	NUMBER OF PARCELS SURFACE IMACT	NUMBER OF PARCELS WITH TUNNEL	LAND USE	TOTAL ESTIMATED COST SURFACE	TOTAL ESTIMATED COST TUNNEL	TOTAL ESTIMATED COST COMBINED PLUS CONTINGENCY	COMMENT
Great Circle Passenger Tunnel Alternative							
Southwest Portal	2		Industrial	300,000			
Northeast Portal							
Mid-Section / Tunnel	2		Residential Rowhouse	300,000			
		25	Industrial/ Residential		50,000		
		115	Rowhouse		230,000		
		47	Residential Multi-Family		94,000		
		1	Religious		2,000		
Total	4	188		$600,000	$376,000	$1,366,000	
Sports Complex Passenger Alternative							
Southwest Portal/I-695 to Wilkens Avenue	4		Commercial/ Industrial	500,000			Start immediately north of I-695
		8	Commercial/ Industrial		16,000		Includes gas station, McDonalds, Jiffy Lube
		2	Single Family		6,000		
		314	Residential Rowhouse		630,000		
		3	Institutional		9,000		
		41	Neighborhood Commercial		82,000		
		3	Religious		15,000		
	4**		Rowhouse	500,000			Shafts; Residential Rowhouse assumed
MLK Blvd. to Light Street	146		Residential Multi-Family	750,000			Cut-Cover section on Lee Street
	4		Commercial	20,000			
	1		Residential Multi-Family	25,000			173-unit Apartment Building
Harbor to O'Donnell Street	9		Light Industrial	1,000,000			Portal Area
Total	168	371		$2,795,000	$758,000	$4,974,000	
Canton Freight Alternative							
Locust Point	1		Residential	325,000			Shaft
Fort Avenue to Piers		200	Rowhouse		400,000		
		10	Industrial		20,000		
		17	Commercial		34,000		
		2	Religious		4,000		
Locust Point to Canton							Under Harbor
Haven/O'Donnell Streets		9	Light Industrial		25,000		Portal Area (land costs high)
Lombard Street to Sta. 285+/-00 Portal		1	Old Rail Bed		25,000		Ownership Uncertain, may be RR
Portal to Sta.344+53		3	Light and Heavy Industry		350,000		Former Steel Mill, Many Issues

ALTERNATIVE/ SEGMENT	NUMBER OF PARCELS		LAND USE	TOTAL ESTIMATED COST			COMMENT
	SURFACE IMACT	WITH TUNNEL		SURFACE	TUNNEL	COMBINED PLUS CONTINGENCY	
		1	Industrial Vacant Land		200,000		May Have to Take Whole Parcel
		1	Old Spur Track		25,000		Ownership Uncertain
		1	CSXT Right-of-Way		100,000		Assume to Pay
NS Bayview to Sta. 260+00		1	NS Right-of-Way		100,000		Assume to Pay
		4	Industrial		13,000		
Total	1	250		$325,000	$1,296,000	$2,270,000	
Sparrows Point Freight Alternative							
Wye at CSXT Main Line	1		Public Land	50,000			Wet Lands
Wye at NEC	2		Public Land	50,000			Wet Lands
	1		Power Line	50,000			
	1		Residential	10,000			
Total	5	0		$160,000		$224,000	

* Area up to portal is city-owned and vacant
** Under I-83 and into railroad property
*** Shafts
Contingency: Contingency Purchase 15%, Acquisition Support 25%

To reach a more realistic estimate of final cost, a deviation of 15% above or below the totals should be considered in doing any comparison exercise without benefit of appraised values for each. Also, the related acquisition costs referred to above can add 15 to 50 percent to the cost. For example, if necessary to condemn an easement having an appraised value of $2,500, the related costs could well exceed $10,000.

GENERAL COMMENTS

- Shafts: An assumption was made for the number required for each route. A more refined count can be inserted when the number and locations are determined.
- Multiple Ownerships: Several of the easement parcels run beneath condominium ownerships of varying size. A liberal estimate of cost was applied as there was no experience or case history guidance.
- Public Ownership: All of the routes traverse publicly-owned property, such as street, parks, maritime sites, and recreational areas. No cost was applied as it is presumed a policy and an agreement would be reached with the agency or authority involved.
- Sparrows Point Route: The route runs over existing railroad and will traverse publicly-owned land and the former steel plant property. Additional research is required to verify the ownership of all three. The mill was recently acquired (May 2008) by OAO Severstal, a Russia-owned company. To estimate an easement cost requires a more defined location of the path of the proposed rail line into and around the point. The track within the mill complex is reportedly owned by the mill. The track serving the facility to the switch point is reportedly owned by CSXT.
- The Sports Complex Passenger Alternative: The segment from MLK Blvd. to Light Street is proposed cut-and-cover tunnel construction. This is an area of fairly high property values.

Also, the work runs through the Oriole Park at Camden Yards parking lot. It is presumed that there would be an attendant cost for replacement parking for the stadium during construction. The easement acquisition cost listed includes a cost for that item.

- Ground Rents: There is a unique aspect to use and occupancy of land in Baltimore. Many parcels are occupied with structures or have other surface uses in which the owners do not own the land. They pay ground rent to the fee owner of the land. In many cases, the rents have been in place for generations and are normal. It is safe to assume that many parcels located in the proposed paths of the Great Circle routes have this condition. Depending upon the number of affected parcels, the acquisition costs will be tempered because the surface users do not have legal standing to object to the proposed subsurface use, and the land owners may welcome receipt of payments offered for the easements as that payment will far exceed the amount of annual ground rent received (typically $100).

11 – VIRGINIA AVENUE TUNNEL

11.1 INTRODUCTION

There is interdependence between the Baltimore, MD and the Washington, DC rail networks with regard to the development of a north-south high-dimension freight route (Plate H, 20 feet 2 inches). Such a route would not only require clearance improvements to the Baltimore network but also to the Virginia Avenue Tunnel in Washington, DC. Further, there may be clearance improvements needed to overhead structures on the CSXT route between Baltimore and Washington, DC. This section addresses each of these topics.

11.2 VIRGINIA AVENUE TUNNEL (WASHINGTON, DC)

The following paragraphs describe alternative ways to upgrade the existing CSXT Virginia Avenue Tunnel to allow double-track operations and to provide the additional clearance required for passage of high-cube double-stack container and tri-level auto rack cars.

11.2.1 BACKGROUND

The CSXT north-south freight line in the Washington, DC region branches from the Amtrak main line at Landover, MD and proceeds south through Benning Yard on the east side of the Anacostia River, crosses the Anacostia River and passes through the Virginia Avenue Tunnel (under Virginia Avenue from 15th Street and M Street, SE to 2nd Street and Virginia Avenue, SE), crosses the Potomac River (at Long Bridge), and then continues on to Alexandria, VA. **Figure 11-1** presents the general location of the Virginia Avenue Tunnel.

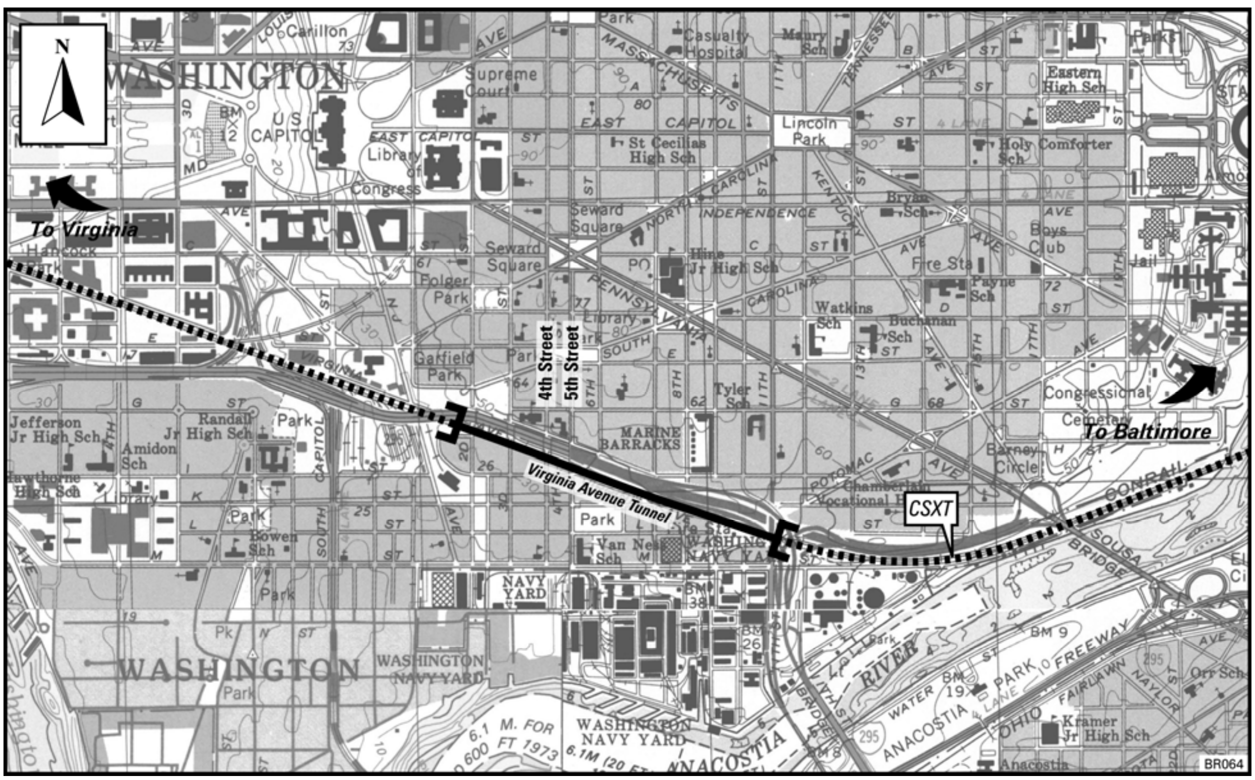


Figure 11-1. General Location of Virginia Avenue Tunnel

Utilizing cut-and-cover methods, the Virginia Avenue Tunnel was built in 1872. The tunnel was extended in 1904 because of a track relocation from K Street to Virginia Avenue. The Virginia Avenue Tunnel is constructed of ashlar stone sidewalls up to the spring line where brick/stone continues to make the arch. The northern portion of the tunnel from approximately 8th Street to the North Portal utilized rubble backing of the sidewalls and arch, whereas the 1904 extension, south of 8th Street, used concrete for backing material of the stone sidewalls. With the exception of the area repaired in 1986, the tunnel is assumed to have inside dimensions of 28 feet wide at spring line, 10-foot high sidewalls above the base stone foundation, and the arch having a rise of an additional 8.67 feet above the sidewalls. The base stone foundation is assumed to be approximately 4 feet high and the wall thickness being nominally 8.25 feet. The tunnel invert consists of a ballasted track section built directly on a cinder base. The tunnel is 3,788 feet long.

In late 1985 and early 1986, tunnel repairs were performed between 4th and 5th Streets. These repairs involved reinforcement of the sidewalls as well as replacement of the original brick arch with a new flat roof. It is understood that this repair was designed and constructed not to encroach on the minimum clearance envelope required for the new train configuration, assuming single-track operation is maintained.

11.2.2 ALIGNMENTS

Due to the extensive amount of reconstruction required to modify the existing tunnel to accept a double-track alignment with the required clearances, it is felt that it would be best to look at alternatives that could provide unrestricted access to complete the work. Both alternatives studied provide this access by placing a new single-track tunnel in service prior to rehabilitation of the existing tunnel.

Two alternatives were considered for the alignment of the new single-track tunnel. Alternative 1 looks at an alignment running along the north side of the Southeast Expressway. Alternative 2 considers an adjacent tunnel directly south of the existing alignment.

The Alternative 1 alignment parallels the Southeast Expressway, leaving the current track just east of the New Jersey Avenue bridge with a portal being created in the existing Virginia Avenue retaining wall. The alignment proceeds in a cut-and-cover box structure through the parkland, staying north of the existing pier foundations and turning east following Virginia Avenue past 7th Street. For estimating purposes, it was assumed that temporary decking would be required to maintain traffic on Virginia Avenue during construction. The alignment would continue easterly from 7th Street, staying on the north side of the Southeast Expressway, crossing under 11th Street and, ultimately, the at-grade portion of the Southeast Expressway to tie back into the existing track near a projected intersection at 14th and M Street.

While it appears the numerous underground obstructions created by the pier foundations of the Southeast Expressway would make Alternative 1 impossible to construct, these problems may be eliminated with the anticipated realignment of the Southeast Freeway ramps and revised traffic patterns contemplated under DC DOT's 11th Street Corridor Reconstruction Project. Of course, additional investigation of easements and utility locations will be required to advance the position.

11.2.3 ALTERNATIVE 1 (NORTH SIDE OF SOUTHEAST EXPRESSWAY)

Alternative 1 is a new single-track tunnel envisioned to be a cast-in-place concrete box structure constructed using conventional cut-and-cover methods, as shown in **Figure 11-2**. Note that the dimensional data in all figures are approximate as conservative sections for invert, walls, and roof were utilized for this comparison. While it is not anticipated to construct a fully tanked (waterproofed) structure, waterproofing was assumed to be necessary for the walls and invert to decrease maintenance costs.

Support of excavation for the entire length is anticipated to be soldier piles and lagging with cross-lot bracing. Traffic-rated decking, installed under night closures, was assumed to be required in the following locations:

- Virginia Avenue crossing between 2nd Avenue and the existing railroad retaining wall;
- Virginia Avenue between 3rd and 7th Streets;
- 8th Street crossing;
- 11th Street crossing; and
- At-grade Southeast Expressway crossings.

Upon completion of the new tunnel and the installation of track work and permanent utilities, the concept is to reroute all rail traffic into this tunnel to allow unfettered access to the existing tunnel to enable a cost-efficient rehabilitation.

11.2.4 REHABILITATION OF THE EXISTING TUNNEL

Figure 11-3, **Figure 11-4**, and **Figure 11-5** provide a concept for the reconstruction phasing of the existing tunnel.

Phase 1 would begin prior to switching rail traffic from the tunnel and include trenching down to the existing arch over the top of the tunnel walls and placing dowels into the walls. Next, concrete would be poured to the bottom of the proposed roof height, the vertical supports reinforced, then backfilled to grade (Figure 11-3).

Phase 2 would also be completed under traffic and would include excavating over the top of the arch in small increments and installing either precast or cast-in-place concrete roof panels. This work is planned to be done at night under full closures. Utilities would be temporarily hung or previously relocated. The area over the roof panels would then be backfilled with surface grade restored (Figure 11-4).

Phase 3 would commence after the rail traffic is routed to the new tunnel. This phase includes the removal of the existing track structure,

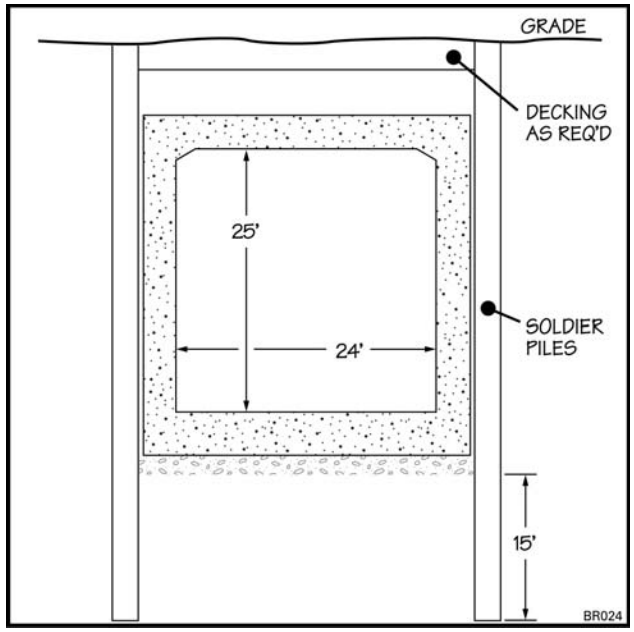


Figure 11-2. New Single-Track Tunnel

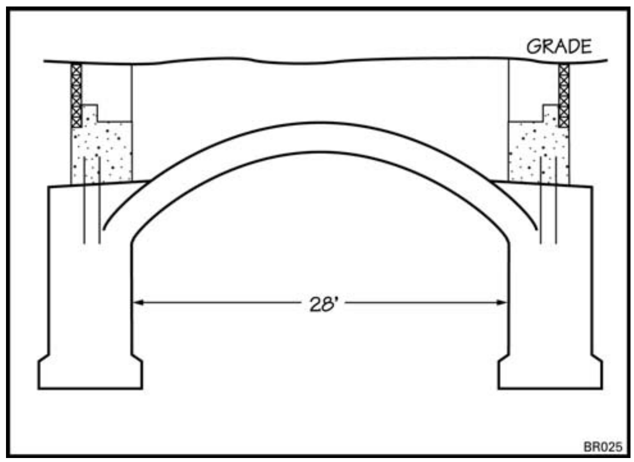


Figure 11-3. Rehab Existing Tunnel – Phase 1

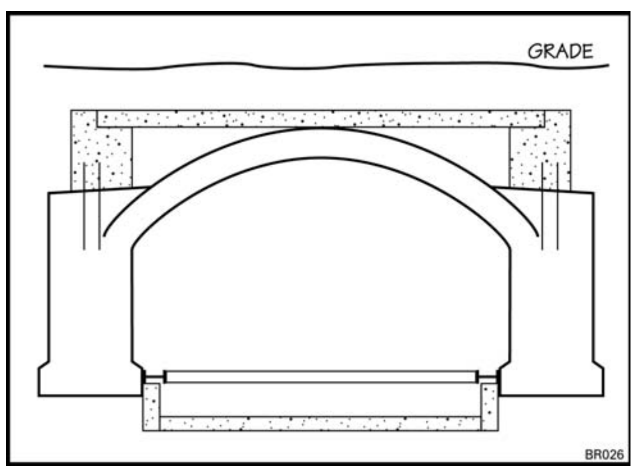


Figure 11-4. Rehab Existing Tunnel – Phase 2

installing the permanent concrete invert, demolishing and removing the arch, and then replacing the track structure (Figure 11-5).

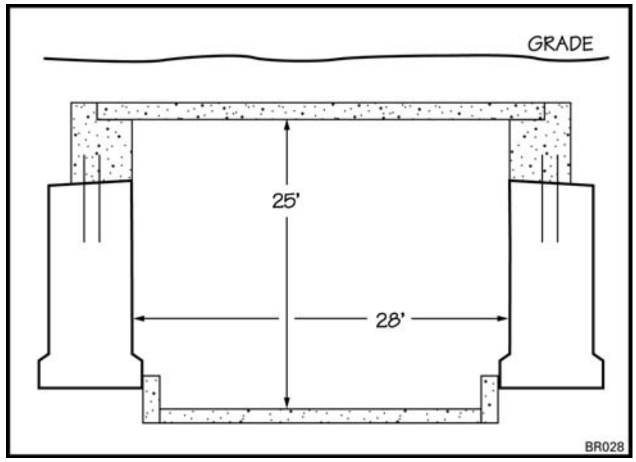


Figure 11-5. Rehab Existing Tunnel – Phase 3

11.2.5 ALTERNATIVE 2 (SOUTH OF EXISTING TUNNEL)

It is envisioned that the Alternative 2 alignment construction procedure will be similar, in some aspects, to the repair procedure that was performed in the mid 1980s. The major difference would be that the soldier pile wall that is installed through the tunnel arch would be designed to be considerably stiffer to allow the lateral loads to be taken without any intermediate strutting between the invert and the top of the tunnel. Alternative 2 is shown in **Figure 11-6.** The following steps would be performed in sequence to construct this alternative.

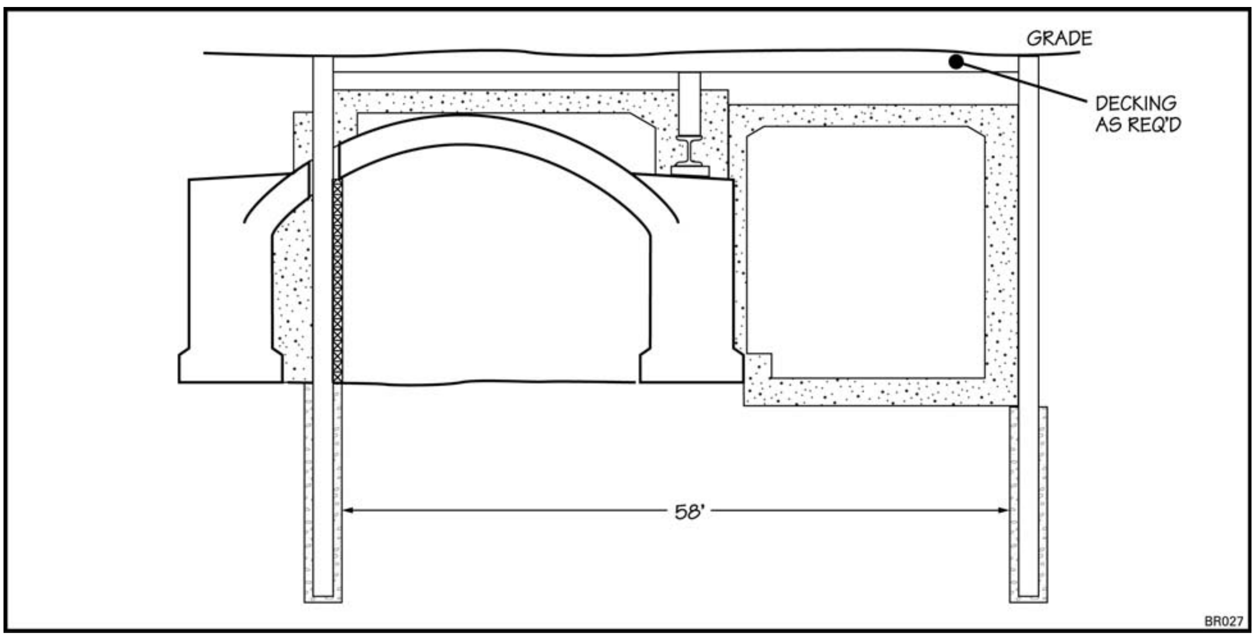


Figure 11-6. Configuration of New South Side Tunnel with Reconfigured Existing Tunnel

Working with track outages as necessary, perform the following:

1. Install heavy 2-inch soldier pile and backfill up to tunnel invert with structural concrete.
2. Lag the inside face of the pile through tunnel envelope with stay-in-place material.
3. Backfill space between lagging and tunnel wall with structural concrete. Reinforce if necessary.

The following work can then be done without impacting rail traffic through the tunnel:

4. From surface, construct new roof slab by installing reinforcing steel and fill with structural concrete up to the bottom elevation of new roof slab, then backfill.
5. Drill and install soldier piles along the south wall of new adjacent tunnel.

6. Excavate for and install deck beams in areas where traffic is to be maintained. Outside of roadway area, install first level of struts and wales. Decking work is contemplated to be done at night with full closures.
7. Excavate for new single-track tunnel to invert, bracing as necessary.
8. Form and pour concrete invert, walls, and roof, waterproofing as required for single-track tunnel.
9. Form and pour wall and roof slab for existing tunnel.

At this point, surface restoration can begin and progress is not on the critical path.

10. Install permanent track work and utilities in new single-track tunnel.
11. Tie into existing track and switch rail traffic out of existing tunnel into new single-track tunnel.

After rail traffic is switched out of the old tunnel, it can be improved in a fashion similar to that previously described.

It should be noted that a conflict currently exists with the expansion and reconstruction of the tunnel and the foundations for Piers 5 and 6 of the Southeast Expressway Ramp WS. While the future of this ramp is dependent on the outcome of DC DOT's upcoming 11th Street Bridge Replacement Project, we believe these foundations can be underpinned and maintained in their current position by creating a dual structure combining the pier foundation with the tunnel walls. Further investigation will need to be conducted as the design advances.

11.2.6 BASIS FOR CONSTRUCTION COST ESTIMATES

Table 11-1 provides summary-level cost information for each alternative. The cost estimate was prepared using all available information and the production-type cost estimating method where practical. The costs include Owner's Contingency at 30 percent of CM + Total Cost + Markup + Design + Contractor's Contingency and Casual Overtime. The estimate was prepared in 2008 dollars.

The cost estimate does **not** include:

- Right-of-way and land acquisition;
- Costs for obtaining permits; and
- Allowances for encountering contaminated material.

Table 11-1. Cost Estimate Summary

DESCRIPTION	NORTH ALTERNATIVE 1	SOUTH ALTERNATIVE 2
Estimate Recap		
Direct costs (Labor, materials, equipment, consumables, sub contracts, etc.)	77,600,000	76,500,000
Indirect costs (Insurance, bond, fringe benefits, etc.)	14,400,000	13,900,000
Total Cost	**$92,000,000**	**$90,400,000**
Add-ons		
Markup (Design, CM, contingency {30%}, etc.)	72,500,000	68,400,000
Total Cost with Add-ons	**$164,500,000**	**$158,800,000**

11.3 CLEARANCE ENVELOPE ON THE CSXT ROUTE BETWEEN WASHINGTON, DC AND WEST BALTIMORE

In conjunction with the clearance improvements in Baltimore, MD and Washington, DC, the question arises whether or not there are any overhead structures between the Virginia Avenue Tunnel and West Baltimore that could prevent emplacing Plate H clearance on the CSXT route.

Currently, the route is cleared for a height of 19 feet (double-stack containers up to 18 feet). This is 1 foot 2 inches shy of the Plate H clearance of 20 feet 2 inches. Typically, the easiest way to gain the additional clearance of this modest scale is to under-cut the tracks at the overhead structure. **Table 11-2** presents a listing of all overhead structures on the CSXT route between the Virginia Avenue Tunnel and West Baltimore, a distance of about 36 miles.

Table 11-2. Overhead Structures – CSXT-West Baltimore to Virginia Avenue Tunnel

NAME	MILEPOST		APPARENT PLATE H COMPLIANT	NOTES
Patapsco Av	BAA	3.3		
Hammonds Ferry Rd	BAA	3.6		
Lansdowne Rd	BAA	3.6		
Washington Blvd	BAA	6.4		US 1
Metropolitan Blvd	BAA	6.6		I-195
Rolling Rd	BAA	6.8	Questionable	
Harbor Tunnel Thwy	BAA	9.3		I-895
MD 100	BAA	13.3		Replaces Dorsey Rd
Jessup Rd	BAA	15.8		Annapolis Rd on track chart
Guilford Rd	BAA	17.8		
Patuxant Fwy	BAA	17.9		MD 32
Dorsey Run Rd	BAA	18.2		
Whiskey Bottom Rd	BAA	20.3		
Fort Meade Rd	BAA	21.7		MD 198
Bowie Rd	BAA	21.9		
Cherry La	BAA	22.4		
Contee Rd	BAA	23.6		
Muirkirk Rd	BAA	25		
Powder Mill Rd	BAA	27.2		MD 201
Capital Beltway	BAA	28.6		I-95/695
Greenbelt Rd	BAA	29.9		MD 193
Berwyn Rd	BAA	30.3		Pedestrian Bridge
WMATA Green Line	BAA	31.8		
East-West Hwy	BAA	32.4		MD 410
Balto. Wash. Pkwy	BAR	2.1		
Kenilworth Av	BAR	2.2		MD 201
Benning Rd	BAR	4.9		
Anacostia Fwy	CR	133.9		I-295
Anacostia River lift bridge	CR	134.3	Questionable	
Pennsylvania Av	CR	134.8		
11th St Br ramps to SE Fwy	CR	135.2-3		To be replaced

Note: Clearance is based on visual estimate. Field check will be necessary to verify actual conditions and dimensions.

Funding for this project did not enable a detailed clearance review of each overhead structure, but a visual inspection was made of each structure to ascertain if there were any apparent physical reasons why the tracks could not be lowered 1 foot 2 inches. Those structures having apparent existing Plate H clearance are noted in Table 11-2. It is stressed, however, that all of these structures need to be field checked to determine actual conditions and measurements.

12 – INITIAL ASSESSMENTS AND PATHS FOR ANALYSIS

This study of the railway network in the Baltimore region has achieved the following:

- Developed a conceptual framework and methodology for analyzing the complex and longstanding challenges presented by the subject matter;
- Winnowed through the available sectors through which practicable solutions might be designed;
- Screened and further eliminated a large number of alternatives;
- Performed initial conceptual design for a few illustrative alternatives; and
- For those alternatives, prepared rudimentary measures of performance and preliminary estimates of investment costs.

This section presents limited performance data and preliminary costs for the few alternatives that survived the triage process well enough to merit focused attention. It then goes on to recapitulate the study's assessments. Recognizing that this report represents but the beginning of a planning process that—even if recommenced immediately on a priority basis—would require many years to yield tangible results, the study team identifies a number of technical avenues that would inevitably need attention, whether next year or 100 years from now.

12.1 ILLUSTRATIVE ALTERNATIVES

The following alternatives survived the initial screening of Phase One.

Passenger:

- Near North Sector: Great Circle Passenger Tunnel
- Central Sector: Sports Complex

Freight:

- Near North Sector: Great Circle Freight Tunnel (Belt-Modified Freight Alternative)
- Near North Sector: Great Circle Freight Tunnel (Penn Freight Alternative)
- Harbor Sector: Canton Freight Tunnel
- Harbor Sector: Sparrows Point Freight Tunnel

A *Graphics Supplement* has been developed that provides route-of-line drawings for the above alternatives.

12.2 PRELIMINARY PERFORMANCE AND COST MEASURES

This section presents the performance and cost data on the illustrative alternatives that was assembled utilizing the resources available to the study.

12.2.1 AVAILABLE COST DATA

Figure 12-1 summarizes the preliminary cost estimates for the illustrative alternatives. The underlying numbers appear in **Table 12-1**.

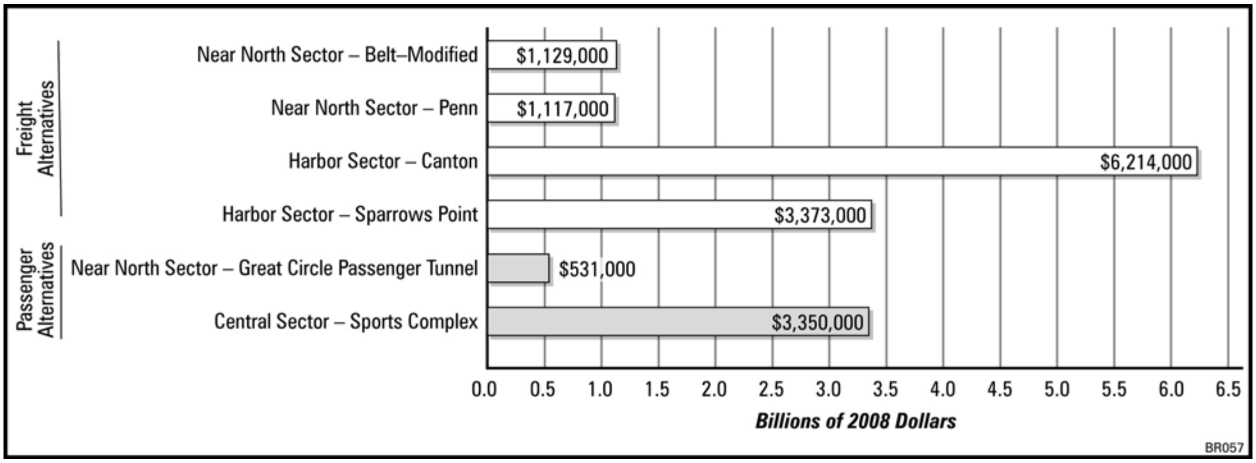


Figure 12-1. Preliminary Cost Estimates for Alternatives

These preliminary estimates include contingencies of between 30 and 40 percent (with the higher figure applied to tunneling costs) and add-on fees of 58 percent to cover design, construction management, environmental mitigation, property costs, burden, and project management.

Table 12-1. Major Components of Preliminary Cost Estimates ($ in thousands)

ALTERNATIVE	WESTERN APPROACH	TUNNEL	EASTERN APPROACH	TOTAL ESTIMATED COST
Passenger Alternatives				
Near North Sector Great Circle Passenger Tunnel	12,200	512,200	6,600	531,000
Central Sector – Sports Complex	330,000	3,006,300	13,700	3,350,000
Freight Alternatives				
Near North Sector Great Circle Freight Tunnel – Penn	113,800	654,800	318,400	1,117,000
Near North Sector Great Circle Freight Tunnel – Belt-Modified	113,800	663,600	351,600	1,129,000
Harbor Sector – Canton Freight Tunnel	4,500	6,203,000	6,500	6,214,000
Harbor Sector – Sparrows Point Freight Tunnel	330,200	2,744,500	298,300	3,373,000

The significant difference in cost between the land- and water-based tunnels largely reflects, first, recent advances in the cost-effectiveness of deep boring techniques to which the geology of the Great Circle alternatives is projected to be conducive and, second, the need for elaborate new approaches to the Harbor Sector tunnel alternatives.

12.2.2 BENEFIT-COST ANALYSIS

As described in Section 4, four major efficiencies and cost benefits would accrue from the proposed rail alternatives (reduced overall transportation costs for the economy as a whole, reduced fuel costs and pollution, reduced traffic congestion, and reduced wear and tear on interstate highways). In the following analysis, the benefits were quantified as two valuations: 1) cost savings in terms of roadway construction and maintenance that would accrue based on shipping goods and moving people by train rather than by truck or car; and 2) cost savings to shippers and; therefore, to the economy as a whole. Each of the four efficiencies/benefits are reflected to some degree (but not entirely) by these two measures (and, it could be argued, there is some overlap between the two measures). For example, the roadway infrastructure cost savings estimates (based on the cost to build and maintain additional roadway lane-miles to accommodate shifting people and goods from rail to highway) directly reflect costs relative to wear and tear on the highways and reflect only a fraction of costs related to traffic congestion. As indicated, shipper cost savings reflect overall savings to the shippers themselves but these costs are ultimately borne by the economy as a whole so savings to shippers provide a reasonable proxy of increases in overall transportation efficiency. On balance, the two measures provide tools for a broad assessment of the overall benefit-cost for the proposed alternatives, as well as a way to assess differences between the alternatives.

Table 12-2 summarizes the estimated costs for each of the alternatives and the estimated savings in terms of roadway costs and shipper cost savings. Cost savings were calculated on a year-by-year basis from 2007 to 2050 based on the forecasted changes in freight and passenger rail traffic. Roadway cost savings reflect the expenditures that would be required to build and maintain additional roadway lane-miles to accommodate shifts in the movement of people and goods from rail to highway. Shipper cost savings reflect the fact that, on average, shipping goods by rail is over 40 percent cheaper (per ton-mile) than shipping by truck.

Table 12-2. Summary of Benefits and Costs (unless noted, all costs are in $ billions)

	FORECAST RANGE	BELT-MODIFIED FREIGHT	PENN – FREIGHT	CANTON FREIGHT	SPARROWS POINT FREIGHT	GREAT CIRCLE PASSENGER	SPORTS COMPLEX PASSENGER
Total Estimated Cost		$1.129	$1.117	$6.214	$3.373	$0.531	$3.350
Total Amortized Cost [1]		$3.152	$3.118	$17.347	$9.416	$1.482	$9.352
Roadway Cost Savings [2]	Lower	$9.499				$1.919	
	Upper	$10.528				$1.919	
Benefit-Cost Ratio (based on Roadway Cost Savings) [3]	Lower	3.01	3.05	0.55	1.01	1.29	0.21
	Upper	3.34	3.38	0.61	1.12	1.29	0.21
Shipper Cost Savings [4]	Lower	$91.215					
	Upper	$101.071					
Total Savings [5]	Lower	$100.714				$1.919	
	Upper	$111.599				$1.919	
Benefit-Cost Ratio (based on Total Savings) [6]	Lower	31.96	32.30	5.81	10.70	1.29	0.21
	Upper	35.41	35.79	6.43	11.85	1.29	0.21
Total Fuel Savings (billions of gallons) [7]	Lower	15.956					
	Upper	17.680					

Notes:

[1] -- Total of annualized costs from 2007 to 2050 assuming 6 percent interest rate.

[2] -- Total of annualized savings from 2007 to 2050 for roadway construction and maintenance costs.

[3] -- Ratio of Benefits (as measured by Roadway Cost Savings) to Total Amortized Costs.

[4] -- Total of annualized savings from 2007 to 2050 for shippers using rail rather than truck.

[5] -- Sum of shipper cost savings and roadway cost savings (2007 to 2050)

[6] -- Ratio of Benefits (as measured by Total Cost Savings) to Total Amortized Cost.

[7] -- Total of annualized fuel savings from 2007 to 2050 based on shipping goods on rail versus truck.

Benefit-cost ratios are reported in Table 12-2 based on roadway cost savings alone, and based on combined roadway and shipper cost savings. Based on the roadway cost savings alone, all of the Great Circle (freight and passenger) alternatives would provide a benefit-cost ratio greater than 1.0 (indicating that the benefits outweigh the costs). The Sparrows Point Freight Alternative would provide benefit-cost ratios of just over 1.0. The higher-cost Canton Freight and Sports Complex Passenger Alternatives result in benefit-cost ratios of less than 1.0.

The inclusion of the shipper cost savings into the benefit-cost calculations results in all of the freight alternatives providing benefits in excess of costs. However, because shipper's costs are not a factor in the benefit calculations for passenger services, the Sports Complex Passenger Alternative would continue to result in a benefit-cost ratio of less than 1.0.

12.3 COMPARISON OF ALTERNATIVES

Dividing the region into four sectors—Far North, Near North, Central, and Harbor—provided a useful conceptual framework for the derivation of passenger and freight alternatives, respectively. **Table 12-3** and **Table 12-4** provide side-by-side comparisons of the Screening Criteria for the passenger and freight alternatives that remained for evaluation at the end of Phase One.

Table 12-3. Screening Criteria and Evaluation of Passenger Alternatives

SCREENING CRITERIA	GREAT CIRCLE ALTERNATIVE	SPORTS COMPLEX ALTERNATIVE
Functional/Design		
Availability of Land	Probable	Probable
Less than One Percent Grade Freight; Two Percent Passenger	Yes	Yes
Beneath Harbor Highway Tunnels	No	No
Tunnel Length > 4 miles	No	7.5 miles, tunnel is electrified
Ease of Integration with Network	Good	Good, would tie-in with the existing Amtrak alignment at each end of route
Ease of Integration with Yards	Good	Good
Pass/Fail	Pass	Pass
Adverse Environmental Impact	Very low	Public controversy likely
External Impact		
Consistent with Existing Land Use	No substantial change	No substantial change
Extent of Acquisitions, Displacements, and Relocations	Low	Low
Impact Listed or Eligible National or State Historic Place	None	Korean War Memorial and numerous other cultural resources within the study area could be directly or indirectly impacted, thereby requiring extensive regulatory compliance
Impact Parklands, 4(f)/6(f) Resources	None	Potential temporary impacts to Rash Field during construction
Construction Impact Severity	Pass	Pass
Impact Ecosystems, Water Resources	No wetland impacts	Medium – short term Low – long term
Implementation Issues	Nothing substantial	Temporary soils/silting impact involving immersed tube placement
Pass/Fail	Pass	Pass

With respect to passenger alternatives, initial assessments included:

- The Far North Sector does not allow for a central station and no reasonably close-in, accessible station site for a Harbor Sector tunnel was found.
- The Central Sector offers the prospect of a station in or near the heart of the CBD, but at such prohibitive cost in excavation and disruption to the downtown area as to raise questions about the practicability of this class of alternatives.
- By process of elimination, only a Near North alternative utilizing the existing Penn Station appears to provide a cost-effective long-term solution to the challenges posed by the existing B&P Tunnel.[1]

[1] Regarding cost effectiveness: analyses by others imply that the cost of a Great Circle Passenger Tunnel could conceivably be less than that of rebuilding of the existing B&P Tunnel. See Section 7.1.1 "Upgrade the B&P Tunnel." Any such inference would, of course, require detailed substantiation in the course of additional investigations.

Table 12-4. Screening Criteria and Evaluation of Freight Alternatives

SCREENING CRITERIA	BELT-MODIFIED FREIGHT ALTERNATIVE	PENN FREIGHT ALTERNATIVE	CANTON FREIGHT ALTERNATIVE	SPARROWS POINT ALTERNATIVE
Functional/Design				
Availability of Land	Likely	Likely	Likely	Likely
One Percent Grade Freight	Yes	Yes	Yes	Yes
Beneath Harbor Highway Tunnels	No	No	No	No
Tunnel Length > 4 miles	2.9 miles	3.1 miles	4.8 miles	3.3 miles
Ease of Integration with Network	Good	Good	Satisfactory	Difficult
Ease of Integration with Yards	Good	Good	Satisfactory	Difficult
Pass/Fail	Pass	Pass	Pass with comments	Pass
Adverse Environmental Impact	Potential for Acquisitions, Displace-ments, Relocations; Parklands/4 (f); Potential noise vibration for residential rowhouses over tunnel	Potential for Acquisitions, Displacements, Relocations; Parklands/4 (f); Impact National Historic Place	Potential for Acquisitions, Displacements, Relocations	Potential for Acquisitions, Displacements, Relocations; Requires three large bridges
External Impact				
Consistent with Existing Land Use	No substantial change	No substantial change	No substantial change	No substantial change
Extent of Acquisitions, Displacements, and Relocations	Low	Low	Low	Low
Impact Listed or Eligible National or State Historic Place	No significant impacts	No significant impacts	No significant impacts	No significant impacts
Impact Parklands, 4(f)/6(f) Resources	Gwynns Falls Park/Trail; Patapsco Valley State Park	Gwynns Falls Park/Trail	Patapsco Valley State Park	Bativa Park; Patapsco Valley State Park
Construction Impact Severity	Medium	Medium	High	High
Impact Ecosystems, Water Resources	Potential impacts to wetlands and Gwynns Falls, Jones Falls	Potential impacts to wetlands and Gwynns Falls	Wetlands, Baltimore Harbor regulated by Coast Guard and Army Corps of Engineers	Temporary impact due to tunnel construction under Patapsco River; Potential impacts to 27 wetlands and 5 Waters of the U.S.
Implementation Issues	Public controversy likely	Public controversy likely	Public controversy likely	Public controversy likely
Pass/Fail	Pass with comment	Pass with comment	Pass	Pass with comment
Comment	Construction or rehab of 12 highway bridges	Construct new Union Tunnel; Construction or rehab of four highway bridges		Route about 30 miles long

With respect to freight alternatives:

- Neither the Far North Sector nor the Central Sector merits further study—the former because of its circuity, cost, and distance from freight facilities and shippers, and the latter because there is no purpose to be served in bringing freight, at enormous expense, closer to the downtown district.

- Both the Near North Sector and Harbor Sector appear, on the basis of this study's analyses, to provide alternative freight routes suitable for consideration by the stakeholders at the conclusion of Phase One.
- The cost of a land-based Great Circle Freight Tunnel appears to be one-third that of a Harbor Tunnel.

12.4 ANALYTICAL PATHS

This section describes some of the topics worthy of further attention for the implementation of the project.

12.4.1 FURTHER REFINEMENT OF THE ALTERNATIVES

The present study does not claim to be the final word on the desirability of the alternatives it considered, or on the feasibility of other possible approaches. Additional conceptual design work might therefore be devoted to such options as described in the following subsections.

12.4.2 OPERATIONS ANALYSIS

For each alternative under consideration, operational studies would be necessary to verify the degree of improvement they promise, with respect to both the present situation and each other. The techniques employed would be as follows:

TRAIN PERFORMANCE CALCULATOR RUNS

Train performance calculators (TPCs) model the acceleration, speed, running time, and fuel consumption of an individual train over a predefined segment of railroad. For each alternative, refined TPC runs would need to be performed—not just for main line traffic over the contemplated alignment, but also for the important and typical local movements within the Baltimore region. An alternative that expedites through service but harms the quality of most local operations is not likely to meet the objectives for a Baltimore restructuring. This is particularly true of freight traffic, with its complex set of origins and destinations in the region.

MODELING OF TRAIN MOVEMENTS FOR CAPACITY REVIEW

In a complex situation like that of Baltimore, a TPC run—modeling a single train—serves only as a preliminary screening device. To verify the practicality of a particular alternative requires a simulation of *all* train movements and interactions within a given operating region over an extended period of time, for example, a week. Such a simulation, dealing with both scheduled and unscheduled trains, would offer the best available analytical proof of an alternative's capacity and its built-in bottlenecks. Knowledge of the latter can be fed back into the design process in an iterative manner.

The simulations, whether for passenger or freight alternatives, would have to cover not just the tunnels and approaches, but also the junctions between freight and passenger routes, and any other links and nodes of the network where capacity is at issue. To do less would be to ignore potentially serious operating conflicts, which must be avoided if a given alternative is to fulfill the first objective of any restructuring—to make the situation no worse than it is today (see Chapter 5).

SIGNAL LAYOUT

The placement of signals, at yards and interlockings and on main line tracks, has a significant impact on operations and would be reflected in simulation results. Therefore, a signal layout would need to be designed to accompany any alternative, prior to the simulation of train interactions.

SUPPORT FACILITIES

Both passenger and freight support facilities would require careful attention.

Passenger

For passenger service, significant issues remain unresolved and would need study if any alternatives are to be progressed:

- Station configurations for all affected stations would require attention, with respect to platform locations and lengths, track layouts, and connections to the approach tracks. In some cases, the choice of a freight alternative would affect the passenger station configurations.
- The station configurations could affect the ability to store commuter trains during the day and overnight. Thus, the location, size, cost, and operational characteristics of MARC storage facilities within each of the passenger and freight alternatives would require scrutiny.

Freight

As discussed in Chapter 8, some of the alternatives could affect the design, operation, or both of certain freight yard facilities. All such affects would be identified and analyzed.

12.4.3 GEOLOGY/UNDERGROUND UTILITIES

With tunneling so integral to any railroad restructuring in Baltimore, development of any alternatives would necessitate a comprehensive search for past boring information, new borings along potential routes, and the assembly and analysis of all utility maps of the affected areas. This intensive effort would supplement the initial searches undertaken within the scope of this work.

12.4.4 CONFIRM RIGHT-OF-WAY/PROPERTY LINES

Studies of the affected rights-of-way would be needed to refine the cost of land takings and review options for not taking land, wherever possible.

12.4.5 CONSTRUCTION STAGING

For each alternative under continued scrutiny, a preliminary staging sequence would be developed and any required temporary facilities would be identified.

12.4.6 REFINE CONSTRUCTION COST ESTIMATES

On the basis of all of the foregoing analytical work, it would be necessary to develop updated estimates of the capital investment required for each alternative.

12.4.7 INSTITUTIONAL ARRANGEMENTS

To successfully implement the Baltimore rail line restructuring would require well-designed institutional structures and relationships. For example, cost sharing would be an issue of profound importance. The creation or adaptation of such institutions and the resolution of cost and operational issues before any construction begins are of utmost importance.

12.4.8 ENVIRONMENTAL DOCUMENTATION

Engineering and operational analyses like those described above would help to support the important task of preparing all necessary environmental documentation for a restructuring of Baltimore's railway network.

PHASE TWO

13 – FURTHER ENGINEERING AND ANALYSIS REFINEMENTS FOR THE TWO SELECTED ALTERNATIVES

Phase One (the previous 12 sections) presented the project's background and history and identified and characterized more than eight passenger and 20 freight tunnel alternatives for the Baltimore rail network. An initial screening process was undertaken within those sections that narrowed the field under consideration to two passenger and four freight tunnel alternatives. Various data and comparison tables were provided that enabled the relative merits of each alternative to be compared to one another. As required by the scope of work for this project, these data were given to the various stakeholders (including FRA, MDOT, Amtrak, CSX, NS, MARC, City of Baltimore, Port of Baltimore, and others) for evaluation to determine which alternatives should be studied further in Phase Two, the selection being limited to one passenger and one freight alternative.

MDOT coordinated the document for evaluation to the various parties and reported the following selected alternatives:

- The Great Circle Passenger Tunnel Alternative
- The Belt-Modified Freight Alternative

The principal reasons stated for the selection of the Great Circle Passenger Tunnel Alternative were that it was the most cost-effective, the least costly, and the least disruptive to existing passenger travel flows. The principal reasons cited for the Belt-Modified Freight Alternative were that it provided the most easily accomplished separation from passenger service and that it did not limit passenger capacity in the Union Tunnel area as did the other comparable freight alternative.

In Phase Two, additional engineering and analysis refinements have taken place regarding each selected alternative. The following sections in this report describe this additional work and provide further detail on the two alternatives. Each alternative is addressed in a separate section, as it is most likely that the two tunnel projects will proceed independently of one another after this report is presented to Congress. Within each section, the topics addressed include:

- Further Discussion with Users
- Procedures to Control Rail Congestion
- Refined Engineering
- Tunnel Construction
- Preliminary Program of Projects
- Project Costs
- Construction/Phasing Schedule

Phase Two concludes with a discussion of institutional issues that need to be addressed before the projects can be implemented. Such issues include dispatching control, tunnel ownership, and liability.

As noted earlier in this report, this report is a feasibility study, the NEPA process is not preempted by this effort, and no agreements have been made by any of the stakeholders. Further, the selection of alternatives documented herein is not binding upon any of the participating stakeholders.

14 – GREAT CIRCLE PASSENGER TUNNEL ALTERNATIVE

DISCUSSIONS WITH STAKEHOLDERS

During Phase Two of the project, additional discussions and meetings were conducted with the stakeholders. Site visits were made to the CSXT alignment in many areas, including Herbert Run, at the overcrossing of Amtrak. NS site visits included those to the throat area of the Bayview Yard. At Bayview, the vantage point provided the opportunity to observe the CSXT Sparrows Point Industrial Track overcrossing of Amtrak and the area where the Amtrak main line would potentially be depressed. The insights gained from the site visits, comments, and personnel interviews have been incorporated, to the extent possible, into the track layouts and the train operation strategy supporting those layouts. These factors are discussed in the following paragraphs. **Figure 14-1** presents the general configuration of the Great Circle Passenger Tunnel (GCPT) alignment.

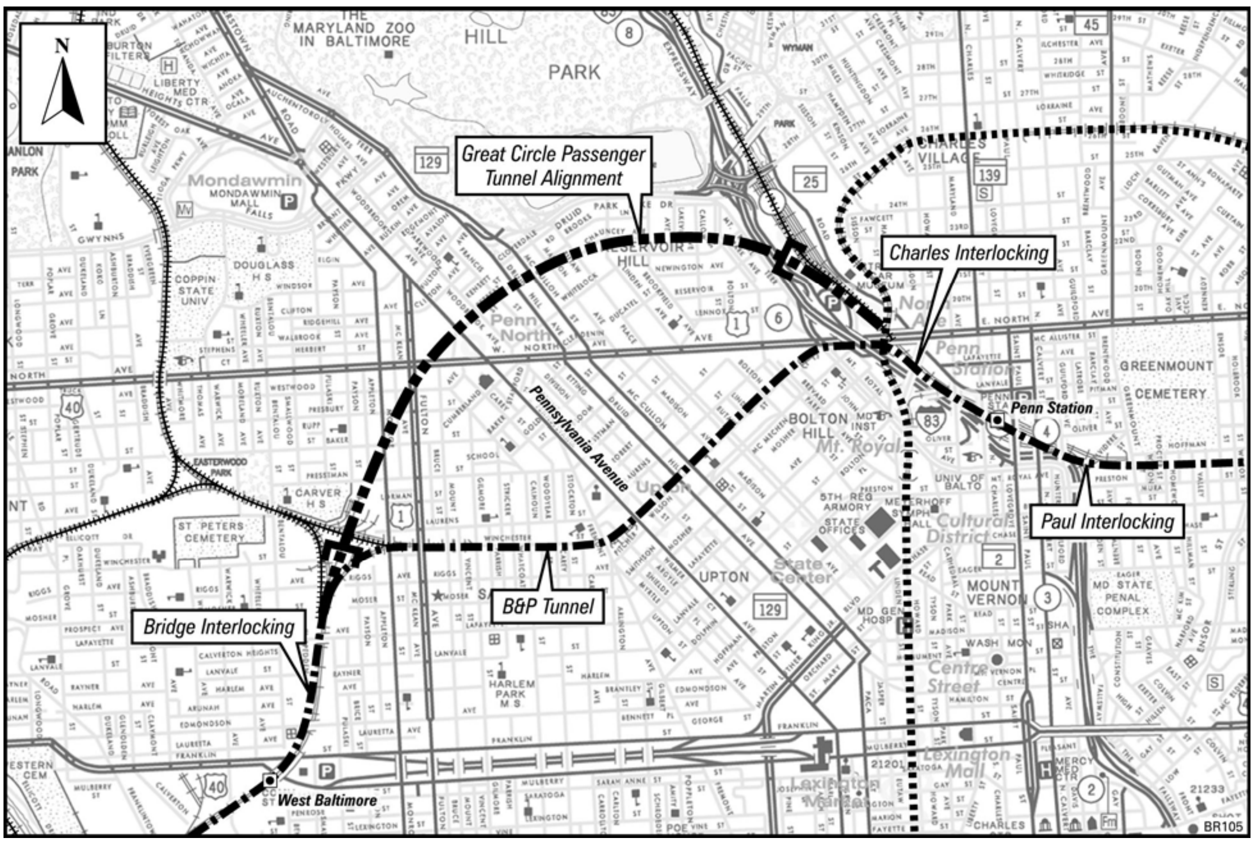


Figure 14-1. General Configuration of the Great Circle Passenger Tunnel

The new GCPT is basically an improved replacement in kind of the B&P Tunnel. The existing B&P Tunnel has two tracks and the GCPT would also have two tracks. However, the GCPT has improved curvature compared to the B&P Tunnel. The maximum benefit of the more favorable curvature is not fully realized, however, because of the need to slow down for the Baltimore Penn Station stop. The GCPT time savings is 1 - 1½ minutes.

The GCPT was designed to accomplish several objectives:

- Replace deteriorating infrastructure;
- Increase capacity to handle forecasted growth in trains;
- Reduce the running times of passenger trains through Baltimore;
- Improve reliability of service by eliminating bottlenecks; and
- Provide a tunnel structure that meets all current Fire, Life, and Safety guidelines (NFPA – 130).

14.1 COMMON ASSUMPTIONS OF RAIL LINE CAPACITY ANALYSIS

During Phase Two, additional rail line capacity simulations were performed to further test the main line capacity of the new passenger tunnel. The northern limit of the main line study was north of the Susquehanna River at CP (Control Point) Bacon on the NEC. The southern limit was at the point where trains enter the NEC at Washington, DC, CP Avenue Interlocking, or Landover from the Bennings Branch for NS freight trains (refer to **Figure 14-2**).

Railroad network capacity and overall train performance were determined by simulating operations for 2050 and measuring the resultant train delay. Because of revisions received from MARC during the course of Phase Two activities, it is important noted that the schedules and train numbers used for the MARC Penn Line service in this section are significantly different from those used in the in the Phase One simulations (Section 3). The MARC Penn Line weekday train movements for 2050 increased to 97 one way trips as opposed to 52 one way trips used in the Phase One 2050 simulations. The odd number of one way trips is explained by unsymmetrical positioning movements. In all scenarios simulated, Amtrak Acela and Regional services were given movement and routing priority. Other passenger services were given priority over freight services. Freight trains were dispatched on a first-come, first-serve basis.

14.1.1 IMPROVEMENTS ELSEWHERE ON THE MAINLINE CORRIDOR

In order to isolate the ability of the GCPT to handle the 2050 traffic levels, it was necessary to postulate certain other capacity improvements that would be in place elsewhere on the CP Avenue–CP Bacon NEC that would allow the rest of the network to handle the forecasted volumes. This would allow the analysis to identify whether the new tunnel design would support the forecasted train volumes. The postulated capacity improvements include:

- 3rd main track between CP Avenue and Landover (replaced by a new interlocking at CP Hanson).
- 4th main track between CP Bridge and Landover. Because of the increase in MARC commuter trains between Baltimore and Washington, DC (from 52 to 97 daily trains in 2050), a fourth main track is built along the NEC. Improvements at BWI Rail Station and New Carrollton provide island platforms and four platform tracks at each station. Interlockings at CP Grove and CP Bowie are expanded to provide crossovers to and from the new 4th main track. Instead of sharing a middle track, operated at speed in both directions, the operation has two middle main tracks in each direction, permitting Acela and Regional passenger trains, and increasingly freight trains, to bypass slower MARC commuter trains operating with station stops on the outside tracks.
- Landover Interlocking is replaced with a new interlocking (CP Hanson) slightly to the north in conjunction with adding the 3rd main track to the south and a 4th main track to the north.
- The middle track (Track 3) of the three-track main north of Edgewood is upgraded to the same high-speed standards as the outside tracks.

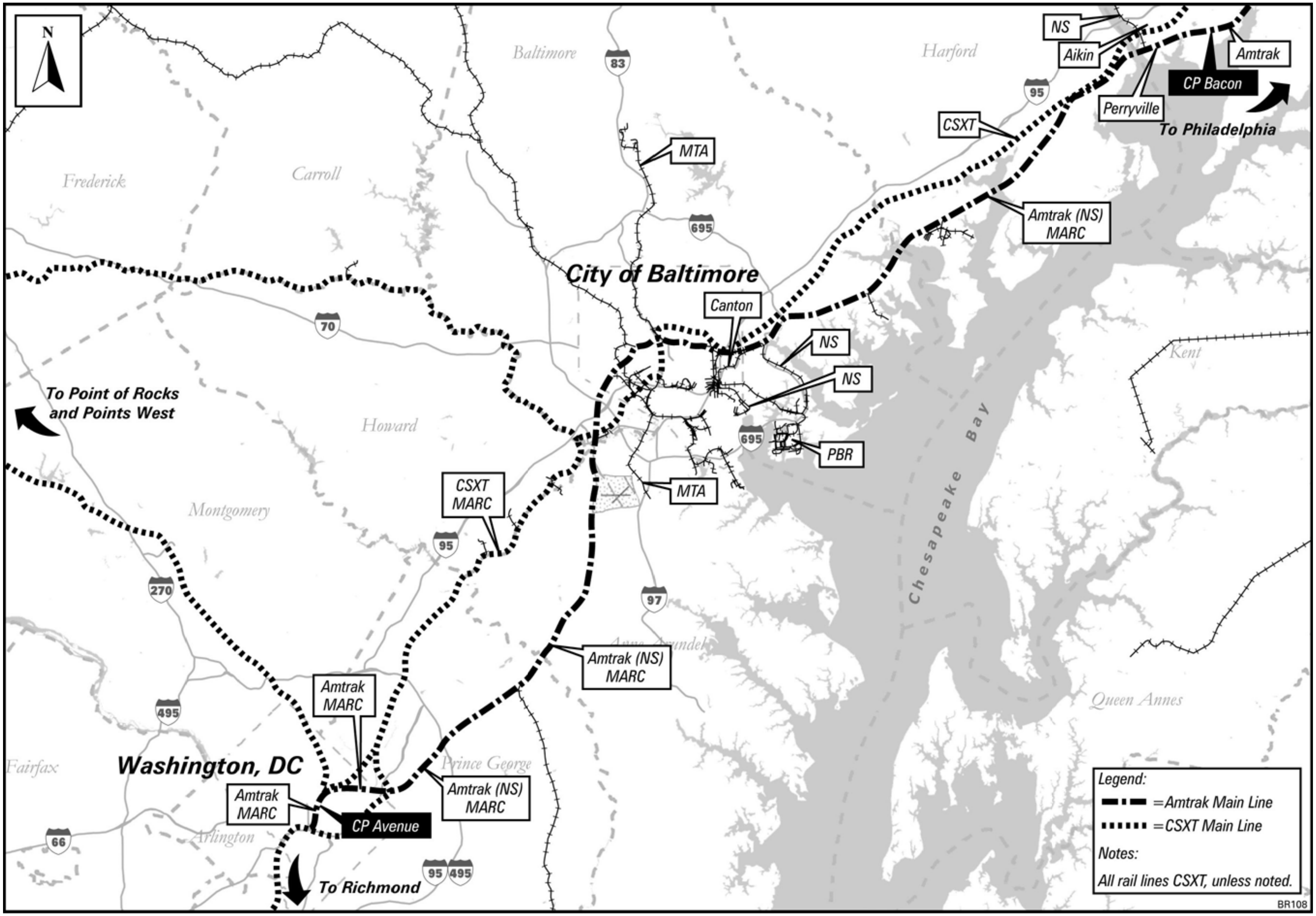


Figure 14-2. Limits of Passenger Train Operational Study

- High-speed #32 turnouts are installed at interlockings along the corridor, where needed, to accommodate 80-mph crossover movements.
- Track speeds on tangents are increased to 160 mph for Acela equipment and 125 mph for Regional trains. A signal system upgrade supports these higher speeds.
- Bridge replacements at Gunpowder (4 tracks) and Bush (3 tracks) eliminate two-track choke points; a new bridge over the Susquehanna is expected, but it remains a two-track bridge.
- All MARC train sets on the NEC (Penn Line) are electric trains that operate in "push-pull" service and consist of a single 7,000 hp (nominal) locomotive and 7 bi-level cars. The electric equipment allows larger trains and improved acceleration from station stops. MARC Penn Line trains have a maximum speed of 110 mph, particularly helpful when operating dead-head or express service on the NEC. This increases both the capacity of the MARC Penn Line service and improves performance on the high-speed NEC.
- A MARC storage and servicing facility—designated as "APG"—is required north of the Baltimore station. The number of trains and their increased length exceed the storage capacity MARC currently uses at Penn Station. The potential new MARC facility is currently assumed to be located at the Edgewood Arsenal (or Aberdeen Providing Grounds [APG]), north of NS's Bayview Yard. (As of this writing, a firm location decision for the APG has not been made). MARC trains would operate southbound from the storage facility on Track 1 and northbound to the facility, moving with the current of traffic on Track A. Increased MARC operations north of the facility and the need to dispatch and receive train sets from Newark, DE would require a wye or other connection to the NEC to avoid having to stop and reverse train directions on the main tracks when operating between the north and the storage facility.
- MARC station platforms are extended to handle up to 7-car trains (700 ft) and would be high-level platforms to speed boarding.
- The increased train speeds (125-160 mph) and the number of trains needing to cross the NEC right-of-way to reach the storage facility (or NS freight trains from the north that need to run to Bayview Yard) require a grade-separated crossing of the main passenger tracks. This is shown at Magnolia in conjunction with the MARC storage yard.
- Construction of a new Gunpowder River bridge crossing.
- Freight train operations are not to be affected and will be, potentially, improved.

Figure 14-3 presents the 2050 Northeast Corridor track configuration described above. It should be noted that this simulation was to test the capacity of the passenger tunnel only. The work of others, including Amtrak's *NEC Master Plan*, is recognized, and the resultant configurations may vary depending upon the specific operating plan adopted.

14.2 OPERATIONS

14.2.1 AMTRAK

All Amtrak trains operate between CP Bacon in the north and CP Avenue – the entrance to Washington's Union Station – in the south. Amtrak's long-range plan, *NEC Master Plan – Conceptual 2030,* is used for planning future Amtrak service. It operates five classes of Amtrak service:

- **Acela** high-speed trains of 6 cars and two power units, which operate at speeds up to 160 mph;
- **Regional** trains consisting of a locomotive and 8-10 cars, which operate at speeds up to 125 mph;
- **Southeast High-Speed Rail (HSR)** trains consisting of a locomotive and 6 cars, which operate at speeds up to 110 mph;
- **Long Distance** trains of 10-12 cars and two locomotives, which are limited to 90-110 mph; and
- "**Delmarva**" trains (1 pair) operate to/from Ocean City, MD; diesel-powered, 7 cars including a "cab" control car at one end, limited to 110 mph.

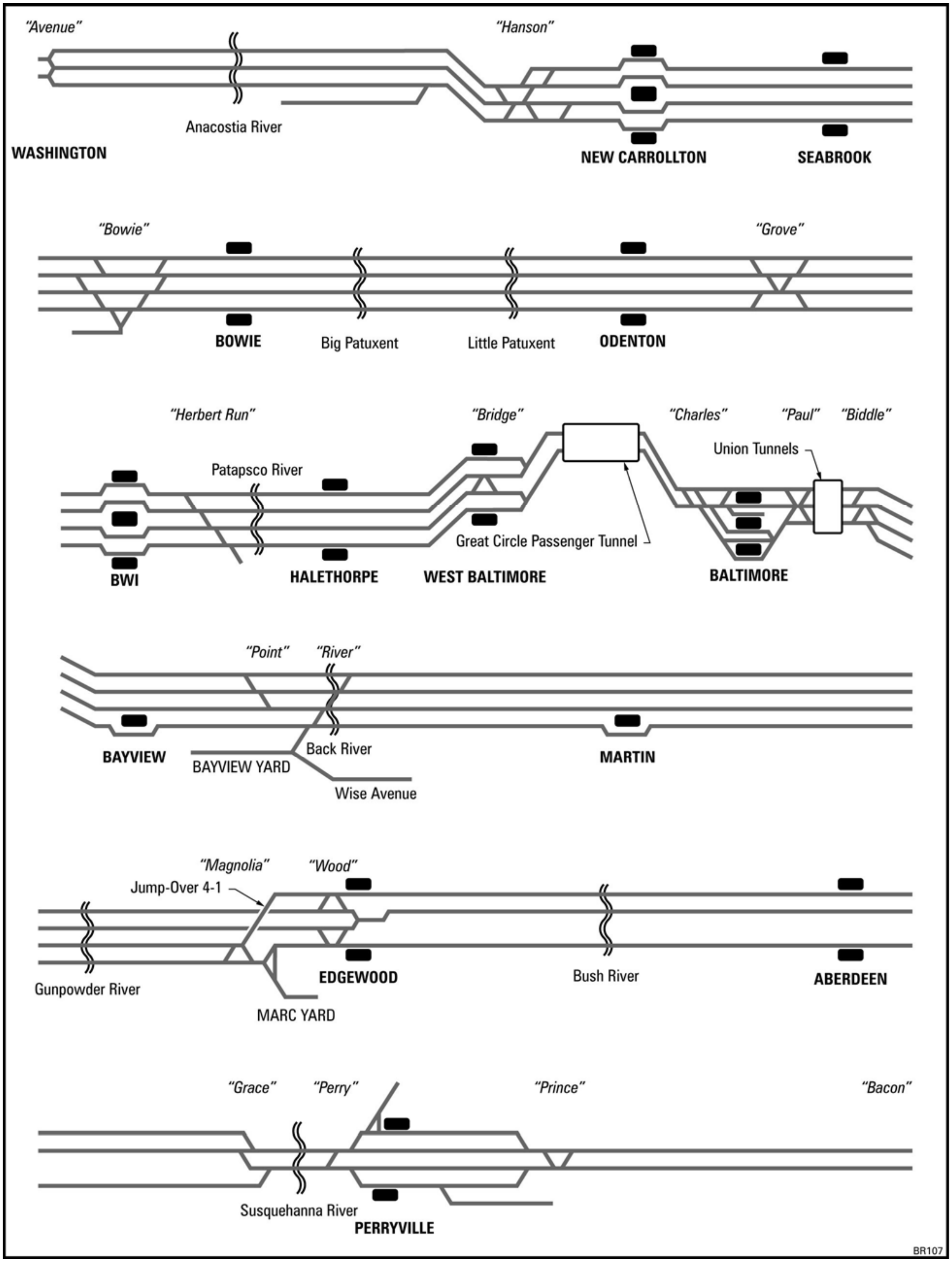


Figure 14-3. 2050 Northeast Corridor Configuration as Simulated Herein

All Amtrak trains stop at Penn Station, Baltimore using platform tracks 6 and 7 for scheduled 2-3 minute station stops. Some Acela trains make an additional stop at BWI Rail Station. Regional trains have a variety of additional stopping patterns at BWI Rail, New Carrollton, or Aberdeen. Because of the increased number of Regional trains and MARC trains on the NEC, Long Distance trains make no station stops, except at Baltimore, to improve their running times. Southeast HSR trains stop at Baltimore and some also at BWI. The Delmarva trains stop at New Carrollton, BWI, Baltimore, and Aberdeen.

Amtrak's *NEC Master Plan* projects a full-service level of 106 weekday trains to and from Washington by 2030, increased from the current (2010) 84 weekday trains (26% increase). These trains would all have to be operated through the new passenger tunnel and use the platform capacity at Penn Station, Baltimore.

MARC PENN LINE

MARC Penn Line service operates a series of train "turns" between Washington and Baltimore. Service to and from Perryville is provided by a smaller number of trains. Some trains go into service at APG and operate northbound, empty to Newark, DE or Perryville, where they turn and enter revenue service, making station stops at Aberdeen, Edgewood, Martin, Bayview, and then continue south to Baltimore and Washington. Northbound trains from Washington either "turn" at Penn Station or continue north, making station stops to Newark. Equipment does not lay over at Newark, but runs empty ("dead-head") to and from Newark and the APG facility when out of service.

MARC plans significant increases in its service by 2035 (MARC *Growth and Investment Plan, December 2007*). MARC trains north of Baltimore (to Newark or Perryville) are planned to increase from the current (2010) 18 trains/weekday to a total of 56 weekday trains by 2050, including ten dead-head movements back and forth to the APG. North of the APG facility, these trains will interact with the Amtrak and NS freight services on the three-track main line and also over the 2-track Susquehanna River bridge.

The number of MARC trains between Baltimore and Washington, DC is forecasted (by MARC) to increase from the current (2010) 52 trains/weekday (26 each way, including through trains to Perryville and two empty positioning moves) to 97 weekday trains. This is a most significant increase in passenger operations and places the greatest stress on the two-track passenger tunnel capacity. While Amtrak's projected increase from 2010 is 22 more trains, MARC proposes to operate 50 more trains south of Baltimore—hence, **the absolute requirement for the 4th main track from West Baltimore to Landover and three tracks into Washington.**

NORFOLK SOUTHERN FREIGHT IN THE NEC

Current 2010 NS freight service on the NEC is limited to the north end, between Perryville and Bayview Yard. South of Bayview, NS only operates a weekday local turn from Bayview south to Landover and returns and a transfer from Bayview to the Bulk Terminal facility at Mount Vernon. Both of these movements operate at night, avoiding the heavy daytime Amtrak passenger operations. North of Bayview, NS freight trains consist of coal trains for the Consol port operation in Canton and priority intermodal merchandise trains to Bayview Yard. Bayview Yard is a "safe haven" for NS freight operations, where trains can clear the NEC.

NS freight operations over the entire NEC are projected to return with the addition of priority intermodal and merchandise (municipal solid waste) trains operating on the NEC between the Bennings Branch at Landover and CP Bacon. These trains will leave the NEC right-of-way on the new Herbert Run freight connection, operate via the new freight tunnel, and return to the NEC via Bayview Yard. This adds an increasing number of slow-moving freight trains (50 mph) to the high-speed Amtrak and MARC commuter trains operating south of Baltimore.

14.3 PASSENGER TUNNEL

Prior alternatives analyses have identified the GCPT route as the best one to replace the existing B&P Tunnel south of Penn Station, Baltimore. This retains the existing Baltimore Penn Station location and continues to use the existing Union Tunnels north of the station on the NEC. It diverges from the existing alignment at MP 95.8, just south of the Amtrak station platform at Penn Station and re-connects to the existing alignment at MP 98.1. The new tunnel alignment is 2.9 miles in length, compared to the current 2.4-mile distance. The greater length of the GCPT route is offset by its 70-mph running speed, compared to 30 mph in the existing tunnel; however, the time savings in the new tunnel northbound is one minute and four seconds, and southbound, one minute and 37 seconds. The net result is that the GCPT is essentially a replacement in kind for the existing tunnel, with improved speeds, clearances, a new tunnel structure to replace the deteriorating B&P Tunnel, and a structure that meets NFPA 130 Fire, Life, and Safety Standards.

14.3.1 SIMULATION

Operations over the NEC and through the new passenger tunnel were simulated using Parsons' proprietary ***TrackMaster©*** simulation tool. An entire weekday's schedule was simulated to test the new two-track tunnel's ability to handle the combined 2050 MARC and Amtrak train frequency. A successful tunnel operation would allow all trains to operate without imposing delays or adding to trains' lateness. Performance tests include on-time arrival at each train's destination, no additional delays to trains that are late entering the simulation operating area, and limited signal delays at interlocking points on the NEC.

Southbound passenger trains enter the simulation at CP Bacon. Freight trains come off the NS Port Road Branch at Perryville. Passenger trains are randomly arriving +1 minute ahead of schedule—3 minutes behind schedule. Freight train arrivals are slotted into 2-3 hour late-night, early-morning, or mid-day windows, with the actual arrival time at Perryville randomly generated within the time window.

Northbound passenger trains enter at CP Avenue, from Washington Union Station. Freight trains come onto the NEC at Landover (CP Hanson) from Bennings Yard. The expectation is that NEC passenger operations by 2050 would be "precise"—trains would be expected to depart original terminals on time since equipment availability and mechanical reliability would improve by that future date. Northbound trains from Washington Union Station are simulated to have on-time departures. Long distance trains are randomly up to two hours late northbound, due to their long trips over freight railroads south of Washington. The southeast high-speed trains are scheduled with a higher level of schedule reliability, but can be up to 10 minutes late departing from Washington.

The purpose of "perturbing" the train arrivals in the simulation is to force the operation—and the GCPT—to deal with a less-than-perfectly choreographed operation. Realistically, trains would be slightly late or would arrive ahead of schedule when given the "pad" introduced into the timetable schedules. Penn Station, Baltimore serves as a "time-keeping" station where trains arriving early would hold for their scheduled departure time—this can have trains on the platform tracks for longer than the scheduled one minute dwell time for the Acela and 2-3 minute dwells for other trains. This creates congestion at the station approaches. Since the MARC and Amtrak timetables were developed independently of each other, the original schedules had trains arriving or departing Penn Station at the same time. These schedules were modified to produce a scheduled train line-up of two-minute headways northbound (arriving at Penn Station) and southbound (departing Penn Station) through the new passenger tunnel. This train line-up is then "perturbed" by late arriving trains and by signal delays en route to Baltimore on the NEC.

The AM peak (6:30 a.m. – 8:30 a.m.) at Penn Station averages seven southbound trains per hour, predominantly MARC commuter trains bound for Washington; the first Acela train from the north does not reach Baltimore until 8 a.m. The average AM peak headway is +8 minutes between trains (ranging from 3 minutes to 20 minutes between departing trains). For simulation purposes, a conservative approach was taken for dispatching trains through the GCPT. Southbound trains at Penn Station were routed through the GCPT only when the train ahead had cleared the tunnel at CP Bridge. As a result, trains do not stop in the tunnel during normal operations and only one southbound train operates in the tunnel at a time. It is pointed out; however, that the tunnel is physically able to accept multiple following trains as signal spacing permits.

The PM peak (4:00 p.m. – 7:00 p.m.) at Penn Station averages nine northbound trains per hour and consists of an even mix of MARC commuter trains and northbound Amtrak service. The average PM peak headway is 6-minutes, 40 seconds (ranging from 3 minutes to 13 minutes between arriving trains). Northbound trains destined to Penn Station are queued into the GCPT from CP Bridge. A northbound train is not routed through the GCPT until the route ahead is clear to the home signal at CP Charles, the entrance to Penn Station. Thus, in the simulation, only one northbound train is operating in the tunnel at a time. Again, it is pointed out that the tunnel is physically able to accept multiple following trains as the signal spacing permits.

Signal delays are measured to show where and for how long trains are held at interlockings waiting for their next route segment to be cleared. Signal delays north and south of Penn Station and the GCPT area serve to further "perturb" the line-up of trains operating through the GCPT. Signal delays are shown in **Table 14-1**.

The signal delays on the 2050 NEC simulation show where train conflicts are occurring:

- Perry: southbound trains waiting for another train to clear the Susquehanna Bridge or NS freights waiting at Perryville from the Port Road Branch to enter the NEC.
- Grace: northbound trains waiting to use the two-track Susquehanna River Bridge and NS trains crossing over to the Port Road Branch connection on the southbound side at Perryville.
- Wood: southbound passenger trains merging from Track 4 to Track 3 to Baltimore, and freight and commuter trains holding for trains ahead of them through Magnolia on Track 1.
- Biddle: southbound trains waiting for an open platform at Penn Station.
- Baltimore: southbound trains waiting for their "slot" to operate through the new passenger tunnel.
- Charles: northbound trains waiting for a platform to open up at Penn Station.
- Bridge: northbound trains waiting their turn to operate through the new GCPT.
- Patapsco, Grove, Bowie: trains held behind other trains in both directions.
- Hanson: southbound trains merging from two main tracks to a single-track, especially if the 3rd main (Track 2) is being used by a northbound train.

The signal delays at Baltimore southbound and at CP Bridge northbound are the key points in terms of the GCPT. The GCPT sees 101 southbound trains per weekday; 11 of those trains are held (11%) for an average delay of 1 minute, 50 seconds — for southbound Amtrak trains, basically the time for the train ahead to traverse the GCPT. MARC trains must cross over the interlocking (CP Charles) at the south end of Penn Station and then have a clear run through the tunnel. Northbound trains at CP Bridge have to merge to a single-track through the tunnel; 15 of 101 northbound trains (15%) are delayed at CP Bridge for an average of 1 minute, 58 seconds. Half of those delays are created by trains ahead waiting at CP Charles to enter the platform tracks at Penn Station.

Signals delays do not necessarily result in "late trains", especially since train schedules incorporate a modest amount of "pad" into their running times — Amtrak's standard schedule "pad" is 7%. The new GCPT does permit Amtrak train service to maintain its schedule performance. **Table 14-2** indicates overall train performance for the assumed train schedules and track configuration.

Table 14-1. Signal Delay Report

SIGNAL	DIRECTION	INTERLOCKING	2050 NEC		
			DELAY MINUTES	TRAINS	DELAY/TRAIN
		Totals:	**226.88**	**103**	**2.20**
Track 3	S	Perry	9.45	4	2.36
Track 4	S	Perry	25.22	2	12.61
C&PD	S	Perry	4.83	1	4.83
Track 1	N	Grace	0.80	1	0.80
Track 3	N	Grace	9.88	2	4.94
Track 2	N	Wood	0.27	1	0.27
Track A	N	Wood	3.60	3	1.20
Track 3	S	Wood	0.68	2	0.34
Track 4	S	Wood	33.68	2	16.84
Bayview Yard	N	River	0.08	1	0.08
Track A	N	River	6.40	3	2.13
Track 1	S	River	5.85	3	1.95
Track 3	S	River	12.57	4	3.14
Track 1	N	Biddle	0.38	1	0.38
Track 1	S	Biddle	0.50	1	0.50
Track 3	S	Biddle	24.72	15	1.65
B3 Track	S	Baltimore	1.45	1	1.45
B4 Track	S	Baltimore	4.55	4	1.14
B5 Track	S	Baltimore	3.18	2	1.59
B7 Track	S	Baltimore	12.60	5	2.52
Track 2	N	Charles	7.47	8	0.93
Track 3	S	Bridge	1.92	1	1.92
Track 1	N	Bridge	15.42	7	2.20
Track 2	N	Bridge	13.92	8	1.74
Track 4	S	Patapsco	3.42	1	3.42
Track 1	N	Patapsco	4.35	3	1.45
Track 2	N	Patapsco	5.23	3	1.74
Track 2	N	Grove	2.50	3	0.83
Track 1	N	Grove	2.63	3	0.88
Track 1	N	Bowie	1.95	2	0.98
Track 2	N	Bowie	4.55	1	4.55
Track 3	S	Hanson	1.82	2	0.91
Track 4	S	Hanson	0.47	2	0.23
Track 1	N	Hanson	0.55	1	0.55

REFINED ROUTE ENGINEERING

A *Graphics Supplement* has been developed that provides route-of-line drawings, profiles, and signal diagrams of the GCPT as described in the following paragraphs.

Table 14-2. Overall Train Schedule Performance for the Year 2050

SOUTHBOUND	TRAINS	LATE TRAINS	LATE MINUTES	AVERAGE LATENESS
Acela	19	2	3:07	1:33
Regional	23	5	19:04	3:48
SE HSR	5	1	0:59	0:59
Long Distance	5	–	–	–
Delmarva	1	–	–	–
All Amtrak	**53**	**8**	**23:10**	**2:53**

NORTHBOUND	TRAINS	LATE TRAINS	LATE MINUTES	AVERAGE LATENESS
Acela	19	4	14:40	3:40
Regional	23	5	3:36	0:43
SE HSR	5	3	17:47	5:55
Long Distance	5	–	–	–
Delmarva	1	–	–	–
All Amtrak	**53**	**12**	**12:03**	**1:00**

<u>Tie-in at East Portal of GCPT</u> The tie-in at the east end portal would consist of connecting the new track going to the GCPT with the existing track. From the connection with the existing tracks at the west end of Penn Station, the new track would parallel the existing track to a point where the existing track begins to curve to the right to enter the B&P Tunnel. From there, the new track would continue for approximately 800 feet farther north, on a slight curve, into the portal of the GCPT. The tunnel portal is under and in close proximity to the Baltimore light rail line's North Avenue Station; therefore, a portion of the station may have to be on a box culvert or bridge structure over the tunnel portal area. Should this be required, the construction staging plan for the North Avenue Station would be to take tracks out of service one at a time; this process would leave two tracks operational at all times.

Construction in the east portal area would consist of laying new track, turnouts, and modifying the overhead catenary system. As construction is off the operating railroad, train operations would not be affected except when the new tracks are connected to the existing tracks. This connection would be accomplished in a matter of hours as opposed to days. Staging and temporary structures may be necessary for the construction in the area of the North Avenue Station.

<u>Tie-in at West Portal of GCPT.</u> The tunnel portal at the west end is to the north of the B&P Tunnel portal, and as such, the two tracks from the GCPT would tie directly into the tracks from the B&P Tunnel. The new overhead catenary system would also require tie-in to the existing system.

<u>GCPT Tie-ins and MARC Long Range Planning (B&P Tunnel).</u> The MARC *Growth and Investment Plan* (2007) discusses the potential for rehabilitating the B&P Tunnel for MARC commuter service. Should the B&P Tunnel be rehabilitated, a new interlocking configuration at CP Charles and CP Bridge would be required. Initial evaluations indicate that site constraints would not permit the installation of an interlocking that would permit all of the four main line tracks from the two tunnels to access all Baltimore Penn Station platform tracks. It is probable that specific mainline tracks would have access only to a specific limited number of station tracks. For northbound trains, the initial sorting decisions for station platform tracks would probably take place at Bridge Interlocking. Also, a major reconfiguration of Bridge Interlocking could require the relocation of the West Baltimore MARC station. The reconfiguration planning for the Bridge and Charles Interlockings must wait for further B&P rehabilitation project development and until decisions are made regarding train platform assignments at Baltimore Penn Station.

ENVIRONMENTAL ASPECTS

The vast majority of this project involves tunnel boring through hard rock. The tunnel roof is at least 40 feet below the surface for about 80 percent of its length and about 140 feet below the surface at its deepest location. Surface construction activities would be limited to the approach tracks to the tunnels. In these areas, new alignments would be used, and they would have some potential effects that are noteworthy from an environmental standpoint. These are listed below. The environmental aspects of this project would be subject to full analysis and quantification in documentation required by the NEPA process, which would take place subsequent to this report.

GCPT West Portal. The approach track alignment to the west portal would bisect a construction aggregate operation in a cut as the alignment lowers into the portal. It is probable that aggregate operation would be closed or relocated.

GCPT East Portal. From the east portal of the tunnel to Charles Interlocking, a new alignment would be required, a distance of about 1,000 feet. Turnouts for a reconfigured Charles Interlocking would be placed in this area. Also, it is anticipated that the existing box culvert across the Jones Falls waterway can be used without significant modifications. All of this area is in a corridor having existing railroad trackage; therefore, a new land use is not introduced at this location.

TUNNEL CONSTRUCTION

Engineering indicates that approximately 10,400 linear feet of tunnel is required and the selected configuration must accommodate two tracks. The two basic options for the tunnel segment are: (1) twin, single-track tunnels or (2) a single, double-track tunnel (refer to **Figure 14-4**). Cross sections for both options would be sized to accommodate Plate H clearance. Even though the tunnel/s would be primarily for passenger service, constructing to Plate H clearance would enable high dimension freight service in the future. However, high dimension movements through Baltimore using the GCPT would also require passage though the Union Tunnel, and clearance improvements to Union Tunnel are not considered a component of the GCPT project.

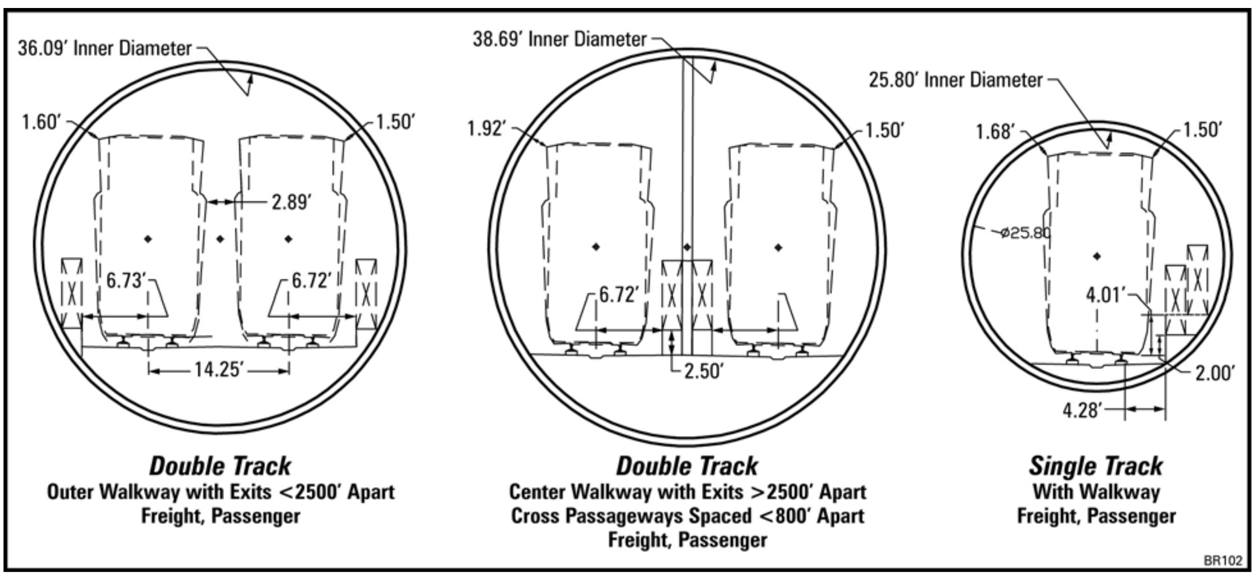


Figure 14-4. Passenger Tunnel Cross Section Options

Both cross section options would have to meet the NFPA 130 Standards. Substantial supplementary facilities would be needed to satisfy the NFPA 130 emergency egress requirements.

The first cross section option considers two single-track tunnels, and two alternatives exist for meeting the NFPA 130 guidelines with this option. The first alternative would provide exit shafts to the surface spaced no more than 2,500 feet apart, and these shafts must be connected to both tunnels. This solution would require four shafts at approximately 80, 150, 190, and 140 feet tall, respectively. These shafts would be connected to cross passages at tunnel level and would require surface egress headhouses or hatches at grade, which may require right-of-way acquisition. The second alternative would interconnect the single-track tunnels with cross passages no more than 800 feet apart, using the other tunnel as a point of safety. Clearly, construction of the four deep shafts and associated elements would far exceed the cost of the additional 10 cross passages (each approximately 33 feet long) required by the cross passage solution. Therefore, the deep shaft alternative is not considered for any further analysis.

The second cross section option considers a single bore, double-track tunnel. A double-track tunnel with no center wall between its tracks would require surface exit shafts spaced no more than 2,500 feet apart. A double-track tunnel with a fire-rated center wall separating its tracks would require either surface exit shafts spaced no more than 2,500 feet apart or 1 ½ hour fire-rated doors in the center wall (acting as cross passages) no more than 800 feet apart. This would allow using the non-incident track as a point of safety.

The single-track passenger tunnels would require an inside diameter (ID) of about 26′-0″ with a final lining 15 inches thick. This, then, requires an excavated outside diameter (OD) of about 28′-6″, which has a cross sectional area of 638 sq. ft. To maintain a minimum pillar width of one tunnel diameter between the two bores, a tunnel spacing of 60 feet is needed. The double-track passenger tunnel without a center wall would require an ID of about 36′-4″ with a final lining 19″ thick. This double-track tunnel has an OD of about 39′-6″ with a cross sectional area of 1,225 sq. ft. The double-track passenger tunnel with a center wall would require an ID of about 39′-0″ with a final lining 21″ thick. This double-track tunnel has an OD of about 42′-6″ with a cross sectional area of 1418 sq. ft. Initial calculations indicate that ventilation can be accomplished using wall-mounted jet fans that fit within the cross sections and that no intermediate ventilation shafts would be needed.

The electrification system (catenary) can be accommodated in all tunnel section options. Using the smallest cross section option as an example (single-track tunnel), from the top-of-rail to the tunnel inner crown is 23 feet. Amtrak requires a minimum of 1 foot 3 inches of clearance between the top of a freight car and the contact wire; considering a Plate H clearance (20 feet 2 inches), a total of 21 feet 6 inches is required from top-of-rail to the contact wire. This leaves 1 foot 6 inches to mount the catenary system.

A major design consideration for the profile of the tunnel sections is the need to pass under the MTA Metro Tunnel, which crosses the GCPT alignment at Pennsylvania Avenue (Figure 14-1). Initial engineering has determined that the large diameter single bore double-track tunnel options would have reduced separation under the MTA Metro Tunnel based on typical engineering criteria. Two options exist for handling this situation. The first option would have the railroad tunnel lengthened and deepened; however, this would require the relocation of the West Baltimore commuter station and Bridge Interlocking. With the second option, a reduced separation between the tunnels may be acceptable because of the hard rock conditions in the crossing area. This determination would require additional soil boring samples and analysis to verify. Until this issue is studied further, the single bore double-track option remains under consideration. The two bore single-track option would have about a 30 foot separation below the MTA Tunnel.

GEOLOGY/CONSTRUCTION METHODS

The GCPT profile transitions from at-grade sections at both ends of the tunnel, where the tunnel penetrates existing slopes, and descends to its completely underground alignment, reaching a depth of approximately 170 feet below the surface. The general subsurface conditions encountered along the GCPT route consist of four general strata:

- **Fill** – This stratum generally consists of loose to medium compact light brown and brown micaceous silty fine sand or clayey fine sand with traces of medium to coarse sand and gravel. This stratum is generally less than 20 feet thick.

- **Sand and Gravel** – This stratum generally consists of medium to compact, to very compact, brown and red-brown coarse to fine sand, and some trace gravel and trace silt. These deposits represent the sand facies of the Patuxent Formation of the Potomac Group, with a thickness up to 25 feet.
- **Residual Soil** – This stratum consists of medium compact to very compact brown and grey micaceous silty fine sand and trace rock fragments. This stratum has a thickness of up to 20 feet.
- **Bedrock** – This stratum comprises mostly quartz-mica schist to geneiss with occasional pegmatite veins belonging to the Jones Falls Schist Group.

Cut-and-cover structures are anticipated at both portals where cover is insufficient to support mined construction. Adjacent to each portal structure are transition zones comprised of fill, sand and gravel, and residual soil, through which a tunnel may be driven by any one of a variety of methods. Excavations through these materials are not stable for long periods of time and are less stable as the size of the excavation increases, unless some form of support is provided. Generally, tunneling through these materials involves making a series of smaller excavations adjacent to one another, which together, form the full-sized cross section. This is called the Sequential Excavation Method (SEM). Pre-excavation ground modification may include techniques such as dewatering, grouting, freezing, fore-poling, etc., or temporary support of the excavated face using compressed air, mechanical pressure, or pressurized face Tunnel Boring Machine (TBM).

Further from the portals, these transition zones will begin to encounter bed rock rising through the tunnel cross section as the tunneling proceeds. This condition, with soil or deteriorated rock that behaves in a soil-like manner, is labeled "mixed face" and requires the construction to maintain a stable arch overhead while excavating the bed rock in the lower portions of the cross section. Finally, the alignment will be excavated through full face bed rock, which can proceed at greater production rates due to the lower degree of initial ground support needed to be installed. Full face bed rock conditions constitute about 70 percent of the tunnel length.

The length of the passenger tunnel alignment lends itself to TBM construction. Acquiring a TBM, mobilizing it on site, and demobilizing it are expensive undertakings, but production rates are higher and tunneling cost per unit length is generally lower than more conventional or manual tunneling methods – generally drill-and-blast construction in hard rock ground. Consequently, longer tunnels are good candidates for TBM construction from an economic perspective.

For the purposes of this analysis, use of a hybrid TBM was assumed. This is a machine designed to excavate through soil or soil-like materials in a closed-face mode, where pressure is maintained in the cutting chamber to provide support to the tunnel face in front of the TBM shield. Then the machine is reconfigured for open-face production through a self-supporting rock face. As the tunneling approaches the other portal area, the machine is reconverted to closed-face mode for progress through the other mixed-face and transition zones. The entire bored tunnel is lined with a precast, segmental, one-pass liner.

The passenger tunnel must also satisfy the NFPA 130 Standards, which for tunnels of this length require provisions for emergency egress. Twin single-track tunnels require cross passage interconnection. Cross passages are generally sized for convenient construction, usually about 12 feet wide, to permit the use of wheeled or tracked excavation equipment. This is also wide enough to permit an unimpeded flow of evacuating passengers from an incident bore to the other bore. Cross passages are excavated after completing the track bores, and their structure is comprised of a cast-in-place concrete liner.

The single bore, double-track alternative can have either emergency exit shafts or a center wall dividing the tracks from each other. If exit shafts are used, they must be spaced no less than 2,500 feet apart. The exit shaft cross section must be sufficient to hold an emergency stair. Shaft construction may proceed from the surface down, or alternatively in the rock above the tunnel using raise boring methodology that allows shaft muck to be removed from the excavation in the same manner as tunnel muck is removed. Alternatively, all the muck from each shaft could be removed at the surface. Temporary support would be employed as the shaft is sunk, particularly in the looser soils, and a cast-in-place concrete permanent lining would be placed.

The center wall in the double-track tunnel alternative would also be cast-in-place concrete construction designed for resisting the air-pressure generated by the passing trains. This design creates more than sufficient separation to meet fire regulations.

COST COMPARISON

Table 14-3 presents a cost comparison of the various alternative cross sections considered herein. The cost comparison between the various passenger tunnel concepts does not identify a clear economic favorite at this level of analysis. The double-track passenger concept without the center wall is shown to be slightly more economical than the other concepts, but this concept includes the required four egress shafts, and the cost of the real estate acquisition is not included in the cost figures. This could cause the relative differences between the concepts to narrow further. In addition, the double-track tunnel options assume a similar length and profile as the two bore single-track option; in turn, this assumes that the smaller separation underneath the MTA Tunnel is acceptable from an engineering standpoint. Otherwise, the double-track tunnel would have to be longer and deeper, adding significantly to the construction cost.

Table 14-3. Tunnel Cross Section Cost Comparison (in millions)

		GREAT CIRCLE PASSENGER TUNNEL		
		TWIN, SINGLE-TRACK WITH X-PASSAGES	DOUBLE-TRACK WITHOUT WALL, WITH SHAFTS	DOUBLE-TRACK WITH WALL AND DOORS
Bid Cost	Portal Structures	$50.6	$49.8	$50.1
	Soft Ground Tunnel	$216.4	$212.9	$214.2
	Rock Tunnel	$193.3	$190.2	$191.4
	Total Bid Costs	$460.3	$452.9	$455.7

PROPERTY REQUIREMENTS

The land use settings and property impacts of the GCPT were further reviewed during the Phase Two study effort. The following paragraphs provide the findings of this additional effort. For reading convenience, the methodology is repeated, with some modifications, from the Phase One description.

COMMENTS ON PROPERTY REQUIREMENTS

APPROACH TO PROPERTY IDENTIFICATION

Property impacts were considered for a width of 50 feet on either side from the center line of the GCPT route. Minimal horizontal width was presumed to be 100 feet and depth from the surface to the top of the tunnel case 40-170 feet. With the exception of the portal approaches, the route runs below surface. Impact upon surface parcels was applied to portal locations and those required for potential vents and emergency shafts. Properties abutting cut and cover segments were included for the potential need to provide underpinnings and construction easements.

A physical inspection was made of the route. Available information was gathered for all parcels presumed to be affected. This included: property street address, property identifier number (assessment rolls), size, owner, type, zoning, current use, improvements, and age of improvements. If a parcel is improved with a multi-story structure or is zoned to permit such, a notation was made as the existing or potential depth of foundation could pose a problem. During this information search, no indication was found of sales of air rights. Sale of these rights can only be positively determined by doing a title search of each individual property; this is beyond the level of study possible herein. However, having inspected the route and observed the current use and zoning, there do not appear to be any locations with an issue except possibly where interstates pass overhead and passing adjacent to or under electric utility power lines.

All data used was presented to be current as of 2008/2010. Sources included: Maryland Department of Planning, City of Baltimore Department of Planning, City of Baltimore GIS Mapping Department, City of Baltimore Office of Assessment and Taxation, Greater Baltimore Board of Realtors Multiple Listing Service, Costar Systems Property Data Service, MRIS Property Sales Database, Google Maps, Maps Live, and consultation with local realtors and appraisers.

PROPERTY INTERESTS CONSIDERED

For all parcels potentially impacted, it was important to identify the current owner and type of owner, i.e., private, corporate, institutional, public, etc. Included in the bundle of rights inherent in fee ownership is subsurface ownership (in some instances those rights may have been excepted in prior conveyances of the property but this can only be ascertained by title research). The interests to be acquired include: full fee for the surface parcels; subsurface easement for tunneling; and temporary easement for construction staging and access. A subsurface easement represents a fractional interest in the property.

APPLICABLE STATUTES OR PROCEDURES

While no specific state statutes could be identified with regard to acquisition, Maryland Property Law applies as to the nature of property interests held and legal means of transfer for all or part of those rights, i.e., sale, lease, etc. For the purposes of this project, it is presumed that a portion of the funding will be from Federal sources, and this mandates that all requirements of the Uniform Federal Acquisition, Appraisal, and Relocation Act must be adhered to.

APPROACH TO VALUE

Utilizing market data developed from the above described research, a grid was made for the route, and a calculation of a range of values applicable to the affected parcels was made based upon comparable attributes.

The surface parcels impacted were given an estimated value based upon the comparable data from the marketplace. The GCPT was considered to have minimal impact upon the remainding interest in the properties, given the planned depth of the use. For subsurface easements, a range of value from $3,500 to $5,000 was applied depending upon the area of surface ownership and the percentage of the easement area to that amount. Factors considered included the angle at which the easement traverses the parcel and what is the current, planned, and/or permitted use of the parcel.

The most current project involving extensive tunneling in the U.S. is in northern New Jersey, where construction has commenced on a new passenger rail tunnel beneath the Hudson River to Manhattan. Extensive tunneling rights had to be obtained on both sides of the river. Persons familiar with the valuation and acquisitions for that project were consulted to gain insight into the process and procedures followed. The experience of the acquisitions for the L.A. Metro Rail system and the Baltimore Light Rail and Subway Project were also examined.

While the value of a subsurface easement may be nominal, the attendant required and imposed costs for appraisal, title, legal, and acquisition management generally result in a final cost greater than the value of the easement.

Table 14-4 lists the estimated number of parcels impacted by the GCPT route.

GENERAL COMMENTS

- Multiple Ownerships: Several of the easement parcels run beneath condominium ownerships of varying size. A liberal estimate of cost was applied as there was no experience or case history guidance.
- Public Ownership: The route traverses publicly-owned property, such as street, parks, maritime, and recreational. No cost was applied as it is presumed a policy and an agreement would be reached with the agency or authority involved.
- Ground Rents: There is a unique aspect to use and occupancy of land in Baltimore. Many parcels are occupied with surface structures, but the owners of those structures do not own the land. They pay ground rent to the fee owner of the land. In many cases, the rents have been in place for generations and are nominal. It is safe to assume that many parcels located in the path of the GCPT route have this condition. Depending upon the number of affected parcels, the acquisition costs would be tempered because the surface users do not have legal standing to object to the proposed subsurface use and the owners of the land may welcome receipt of payments offered for the easements as it will far exceed the amount of annual ground rent received (typically $100).

  Those parcels impacted by the proposed project and having ground rent status have not been identified in this analysis. There are an estimated 50,000 ground rent parcels in the City of Baltimore. There is no formal record of the current holders of such interests. In 2007, the city passed an ordinance that requires the holders of ground rent parcels to register them by October 2010. To date, a very large number remain unregistered. Upon expiration of the registration period, those unregistered will be considered extinguished and full fee rights will pass to the surface holder.

Table 14-4. Estimated Impacted Land Parcels

SECTION	# OF PARCELS	RESIDENCE	RESIDENCE (MULTI)	INDUSTRIAL	COMMERCIAL	PUBLIC
"Y" to Presstman/Payson	5	2	–	2	–	1 School
Presstman to Baker	12	12	–	–	–	–
Baker to Presbury	18	18	–	–	–	–
Presbury to Westwood	18	18	–	–	–	–
Westwood to North	13	13	–	–	–	–
North to Penn	8	6	–	1	1	–
Penn to Woodbrook	4	3	–	1	–	–
Woodbrook to Francis	12	12	–	–	–	–
Francis to Druid Hill	12	12	–	–	–	–
Druid Hill to McColloh	12	12	–	–	–	–
McColloh to Madison	9	5	4	–	–	–
Madison to Eutaw	5	2	3	–	–	–
Eutaw to Linden	10	5	5	–	–	–
Linden to Brookfield	10	4	6	–	–	–
Newington to Park Terrace	6	–	6	–	–	–
Park Terrace to Mt. Royal	5	–	4	–	1	–
Balance is MTA; MSHWD; NS	–	–	–	–	–	–
Total*	**159**	**124**	**28**	**4**	**2**	**1**

* Minimum width impact considered was 100 feet.

PRELIMINARY PROGRAM OF PROJECTS

The Northeast Corridor has been and continues to be the subject of various operational studies and planning by Amtrak, MDOT/MARC, and other agencies. The following is a partial listing:

- MARC Growth & Investment Plan (December 2007)
- An Interim Assessment of Achieving Improved Trip Time Goals on the Northeast Corridor (Amtrak October 2009 – prepared under Section 212(d) of the Passenger Rail Investment and Improvement Act of 2008)
- Northeast Corridor Infrastructure Master Plan (Prepared by the Master Plan Working Group for the NEC Policy Group, February 2008)
- Mid-Atlantic Rail Operations Phase II Study Final Report (I-95 Corridor Coalition, December 2009)
- Preliminary National Rail Plan (FRA, October 2009)

All of the above reports that address the Northeast Corridor have a common theme: the corridor needs significant capital improvements in order to maintain and grow passenger and freight movement capabilities. And, as noted in Section 14.1 of this report, a number of track improvements are needed to support year 2050 traffic levels.

The following paragraphs present a discussion of the more important improvements suggested in this and in the other various reports in a scheduled sequence. The discussion is limited to track configuration improvements and does not address items such as equipment acquisition, new stations (except those that could affect new GCPT alignment and approach trackage), station parking, service facility configuration, etc. The overall improvement schedule discussed herein takes into consideration that of MARC's *Growth and Investment Plan*, but there are significant modifications based on updated information. Maryland has a significant funding responsibility for NECIP facilities improvements within the state because of the MARC commuter services provided. The FRA and Amtrak are limited to funding improvements only associated with intercity passenger rail. MDOT/MARC and the Federal Transit Administration are funding sources for the improvements associated with commuter operations.

A major consideration when scheduling the construction of the GCPT is that it would be constructed off the existing railroad alignment; therefore, construction can progress using the most efficient construction methods and not be interrupted by railroad operations. Likewise for the railroads, their operations would not be subject to tunnel construction delays or interruptions. Naturally, comparatively minor delays to railroad operations would be incurred when the approach trackage is connected to the existing alignments.

Because of the by-pass character of the alignment, the construction of the GCPT can be scheduled principally on an as-needed basis.

SEQUENCE OF PRELIMINARY PROJECTS TO MEET 2050 GOALS

Figure 14-5 presents a schematic of the existing configuration of the Northeast Corridor segment between Washington Union Station and Perryville, a distance of approximately 75 miles. Note that presently there are only two continuous tracks between Washington Union Station and Perryville. Triple-track exists in three sections, totaling approximately 38 miles, and four tracks occur in two sections, totaling approximately 20 miles or just 27 % of the segment. A four-track configuration is generally considered necessary to enable combined high density commuter and high-speed rail operations: the outer two tracks for the slower trains (usually commuter) and the inner two tracks for high-speed trains.

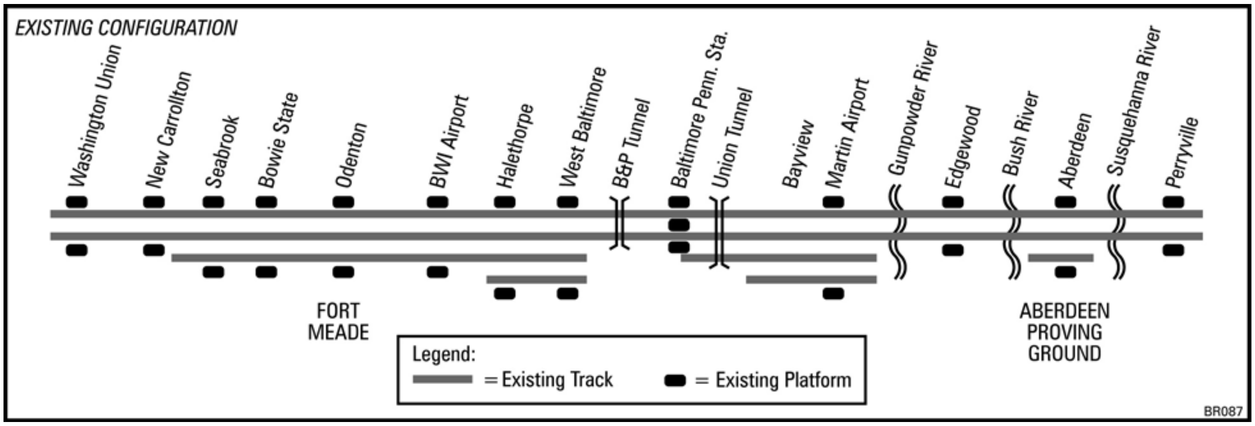


Figure 14-5. Existing Northeast Corridor Station and Track Configuration

Figure 14-6 presents a schematic of the 2020 configuration. The first extension of quadruple-track begins in a 2015 time frame. A fourth track is constructed between Halethorpe and Odenton, a distance of approximately nine miles. This extension is a component of the BWI Thurgood Airport station expansion, which includes the construction of a center platform. Further, the MARC *Growth and Investment Plan* envisions a new commuter station at Bayview. If the new freight tunnel is constructed, design of the Bayview Commuter Station could impact the NS connecting track between their Bayview Yard and the CSXT Belt Line. Connecting to the CSXT Belt Line is necessary for NS to access the new freight tunnel.

By 2020, the program for quadruple tracking is underway (see Figure 14-6). A track is added between Odenton and New Carrolton, which results in quadruple track all the way between New Carrolton and West Baltimore. Two additional tracks are constructed between the Gunpowder River and Edgewood, and the flyover at Edgewood is constructed. Also, an additional track is constructed between Edgewood and the Susquehanna River.

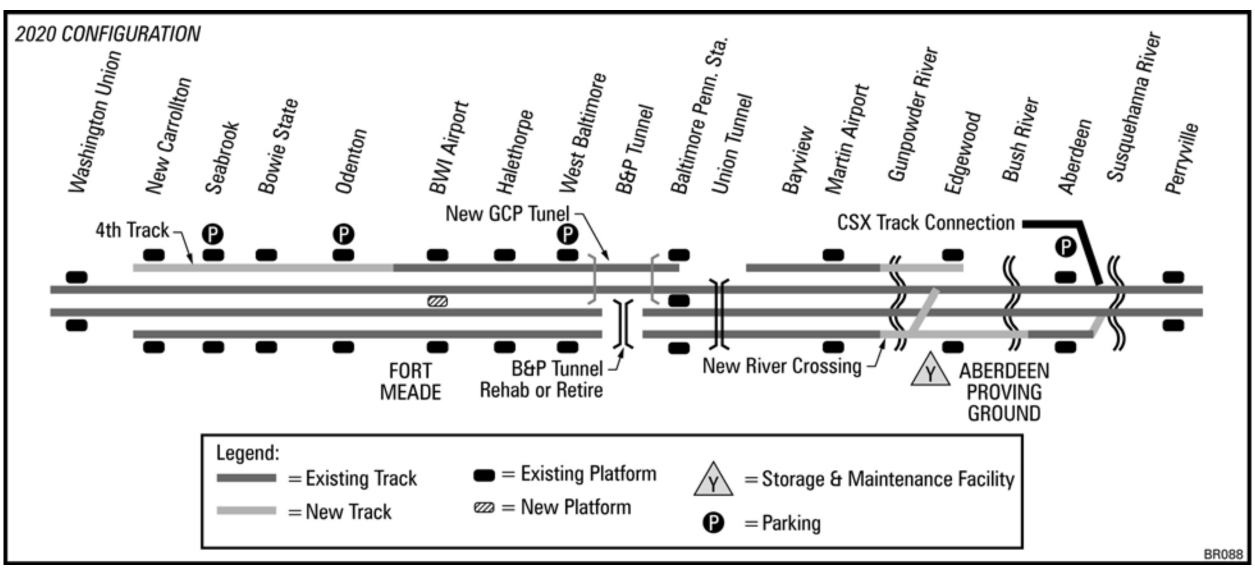


Figure 14-6. Year 2020 Northeast Corridor Station and Track Configuration

The construction of the new GCPT is included in the 2020 configuration. As noted earlier, the construction of the tunnel can proceed independently of the other Northeast Corridor track improvements; however, a ten-year time frame from the present is reasonable, considering the need to arrange for financing, complete the environmental process, and to procure long-lead construction items. Depending upon the physical deterioration of the B&P Tunnel, it could be necessary to construct the GCPT sooner.

It is noted that the MARC *Growth and Investment Plan* also includes the renovation of the B&P Tunnel. This renovation would result in a complete quadruple-track configuration between New Carrollton and Baltimore Penn Station. It should be noted that by shifting operations to the GCPT, the B&P Tunnel renovation could be carried out much more efficiently than under today's condition, particularly considering the need to keep one tunnel track in service at all times. Shifting operations to the new GCPT would allow rehabilitation activities to proceed without train interruption and delay. Further, by not having to limit rehabilitation activities to the space of one track, more efficient construction methods and machinery could be used. Finally, the actual rehabilitation of the B&P Tunnel need not be undertaken until evidence of potential demand becomes clear.

Figure 14-3 presents a schematic of the 2020 - 2050 configuration. The principal track configuration highlight is an additional track (making triple-track) between New Carrollton and Washington Union Station. Completion of the 2050 Plan would result in a three-track network between Washington Union Station and New Carrollton, and a four-track network from New Carrollton to West Baltimore and from Union Tunnel to Edgewood. Triple-track would extend between Edgewood and the Susquehanna River. In contrast, the MARC plan envisions a four-track network from New Carrollton to Perryville.

PROJECT COSTS

Table 14-5 presents the construction and associated costs for the GCPT route through Baltimore. The primary objective of this cost estimate is to document the methodologies and the practices that have been established for cost estimating efforts.

Specific considerations and data inputs utilized in developing this cost estimate include:

- All costs are presented in terms of Year 2010 dollars without escalation.
- A cost benchmark was established by using Eastern Class I data for track installation on existing roadbed.
- A cost benchmark was established by using MDOT for heavy civil earth work associated with roadway grading.
- Earthwork quantities are based on computer-aided design (CAD) Inroads-produced earth work volumes.
- Signals and communications are based on the installation of Positive Train Control (PTC) as would be required for the mainline freight and passenger operations considered herein.
- The geotechnical assessment was based on data available from numerous projects within the study area and three soil borings taken during the course of the project. The three soil borings were taken

Table 14-5. Project Costs (in millions)

CONSTRUCTION ITEM	CONSTRUCTION COST	COMPONENT COST
Tunnel (Twin Bore, Single-Track)		
Portal Structures	$50.6	
Soft Ground Tunnel	$202.5	
Rock Tunnel	$207.2	
Subtotal	**$460.3**	**$460.3**
Track / Civil		
Earthwork	$2.0	
Track, Interlockings	$32.5	
Subtotal	**$34.5**	**$34.5**
Structures	$30.7	
Signals	$7.5	
Property / Right of Way	$15.0	
Subtotal	**$53.2**	**$53.2**
Design Cost at 8%		$43.8
Construction Management Cost at 5%		$26.7
Contingency at 25%		$154.6
Total Estimated Cost		**$773.1**

along the route of the new freight tunnel; they also serve to reinforce the initial geotechnical evaluations of the GCPT.

- Tunnel excavation costs are inclusive and account for such items as construction crew size, boring production rates through the varying soil conditions, consumables, invert, sidewalks, cross passages, ventilation, etc.
- Track work unit costs were based on case histories from recent local projects. Track work includes ballast, ties, rail, other track materials, and turnouts.
- Bridges were identified by approximate overall length and span length. Unit bridge costs were determined based on experience with construction costs for similar types of bridges built by Class 1 railroads and recent experience on other projects.
- Property costs were calculated based upon an informed opinion of the market place, the circumstance of the affected properties, and the planned use of the interests to be acquired. An average cost per parcel was applied. The market data utilized covered the period 2006 to 2010. Consideration had to be given to the earlier sales to allow for the current skewed market due to volatile economic conditions.

  To reach a more realistic estimate of final cost, a deviation of 15% above or below the totals should be borne in mind when doing any comparison exercise without the benefit of appraised values for each. Also, the related acquisition costs referred to above can add an additional 50% to 200% or greater. As an example, if necessary to condemn an easement having an appraised value of $2,500, the related costs could well exceed $10,000.
- Electric traction costs (catenary and power) are included in the "Structures" cost item.
- The costs used herein emulate the offered prices of a contractor and include direct and indirect costs of general and administrative costs, overhead expenses, taxes, insurance, and profit. Costs reflect the physical conditions of the Baltimore region and include prices associated with materials delivery to the locations along the alignment.
- A contingency estimate allowance of 25% is added to the total cost of the project.

CONSTRUCTION/PHASING SCHEDULE

Construction of the GCPT is the central critical path duration in the overall project. Initial estimates indicate that the tunnel construction duration would be about two to three years, depending on tunnel cross section selected (i.e., single bore with two tracks or two single-track tunnels). Construction of the approach track network would be based on the tunnel construction duration. The overall scheduling strategy would be to begin the construction of the approach trackage so that completion is concurrent with that of the tunnel. At that point, the tunnel and the various track segments would be cut-in to the existing trackage and system tests would be completed. Track cut-in would mostly involve the installation of turnouts in interlockings; this would be accomplished in stages on weekends, nights, or other periods of low traffic levels.

Because the project is linear, surface construction activities can take place simultaneously at each end of the tunnel. **Figure 14-7** presents a concept level Construction and Phasing Schedule. The dotted line in the figure represents the time range of tunnel construction. The other activities would be adjusted to the actual estimated duration.

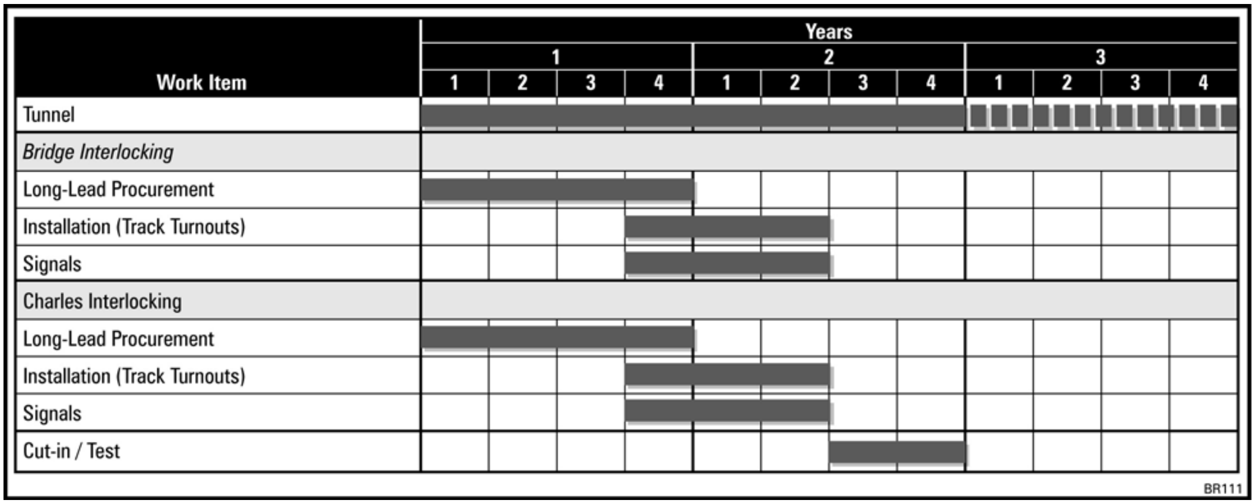


Figure 14-7. Concept Construction and Phasing Schedule

15 – GREAT CIRCLE FREIGHT TUNNEL, BELT-MODIFIED ALTERNATIVE

DISCUSSIONS WITH STAKEHOLDERS

During this phase of the project, additional discussions and meetings were conducted with the stakeholders. Site visits were made to the CSXT alignment in the areas of Herbert Run, Mt. Clare Yard, and the Hanover Subdivision leading up to the west portal area of the new freight tunnel. NS site visits included those to the throat area of Bayview Yard and the tunnel's east portal area at the Bulk Transfer Terminal yard. At Bayview, the vantage point at the throat area also provided the opportunity to observe CSXT's Sparrows Point Industrial Track overcrossing of Amtrak and the area where the Amtrak main line would potentially be depressed. Important issues were raised during the course of stakeholder conversations. NS noted that it has made significant investments in the current route via Harrisburg and did not express interest in the new Baltimore freight tunnel through route via Amtrak from the south. In addition to the new track connections needed at the north and south end of the new tunnel route, the catenary system for Amtrak may need to be raised to Plate H clearance at certain locations between Landover and Perryville, a distance of 70 miles. This improvement could involve a significant expense. Likewise, CSXT expressed satisfaction with their current route through the Howard Street Tunnel and did not convey an interest in the new freight tunnel route. Both railroads expressed major concerns for the high capital costs and the institutional issues involved.

Nonetheless, both railroads continued to cooperate with the engineering aspects of the project during Phase Two on the condition that their participation would not be interpreted as a commitment to the project. The insights gained from the site visits, comments, and personnel interviews have been incorporated, to the extent possible, into the track layouts and the train operation strategy supporting those layouts. These factors are discussed in the following paragraphs. **Figure 15-1** provides a general configuration of the Belt-Modified Freight Alternative.

PROCEDURES TO CONTROL RAIL CONGESTION

To test the performance of the new freight tunnel, CSXT and NS freight service, along with MARC Camden commuter service, were simulated. A number of features have been incorporated into the track layouts simulated to provide routing flexibility and to prevent rail congestion on the network. The overriding operating strategy is for the main line to be used for moving trains rather than for switching trains, train inspections, train maintenance, etc. To accomplish this objective, sufficient auxiliary tracks must be provided to clear trains from the main line in those cases where they are not able to keep moving. The following is a list of the facilities and operating principles that are provided in the proposed network to prevent congestion and keep the operation fluid:

- A double-track, bi-directionally signaled through main line on the complete Belt-Modified route;
- Double-track connections for NS to access the shared main line at both Halethorpe and Bayview;
- Staging tracks for NS trains to access and egress Amtrak track at Halethorpe; and
- Main line/staging tracks between Halethorpe and Curtis Bay Junction for the inspection and maintenance of CSXT coal trains.

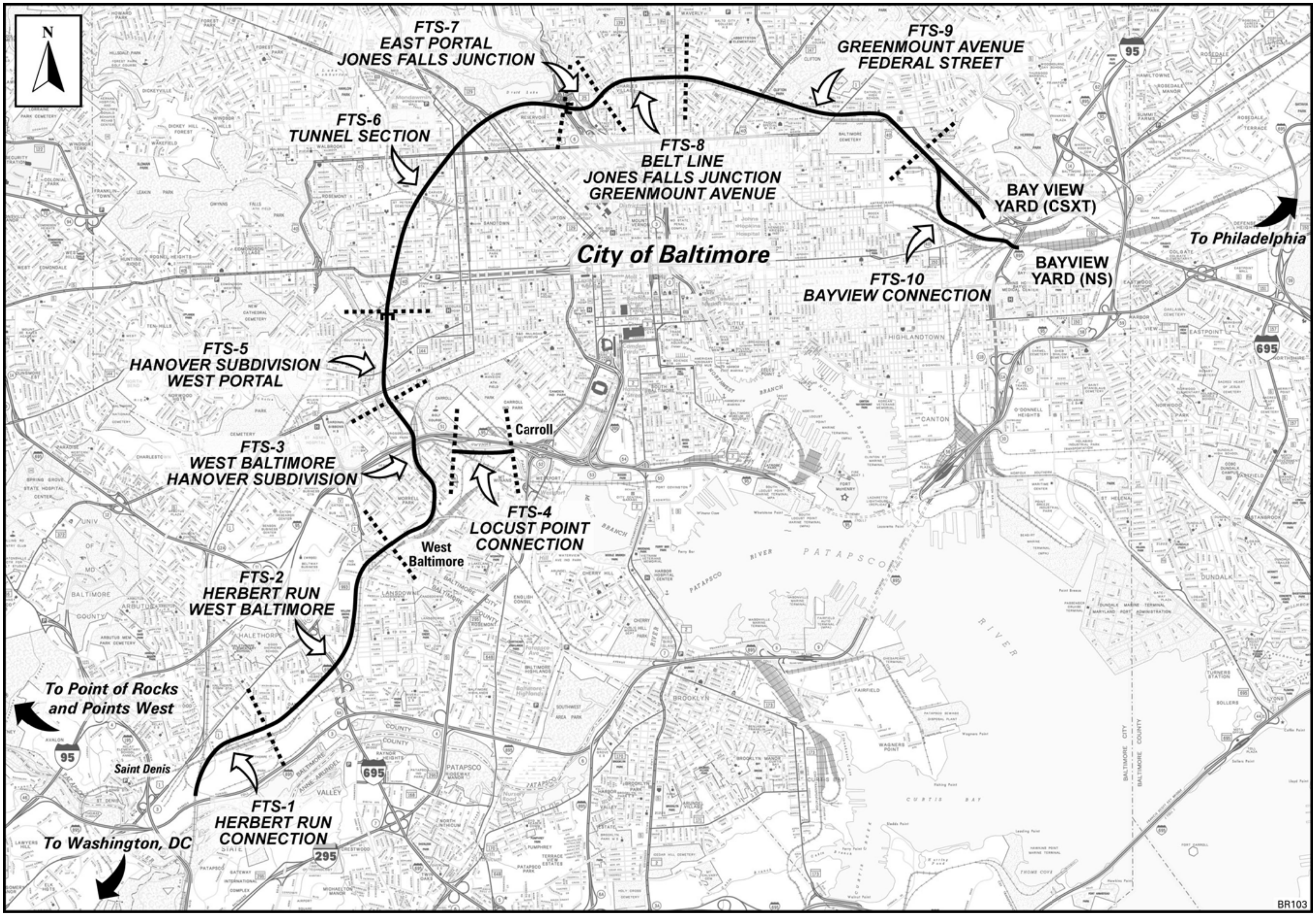


Figure 15-1. General Configuration of Belt-Modified Route

The northern limit of the Baltimore study is north of the crossing of the Susquehanna River, CP (Control Point) Aiken on CSXT. CSXT's southern limits are at JD (Hyattsville, MD), where trains from the south enter from the Anacostia Branch at "F Tower" – the connection point to Washington Union Station (MARC) and also the wye connection for westbound freight destined for Brunswick and beyond. Within the Baltimore terminal, CSXT yards at Canton, Locust Point, and Curtis Bay all provide entry and exit points for trains using the CSXT main lines through Baltimore.

At the southern limit, NS freight trains enter the NEC at Hanson, just south of New Carrollton. NS trains use the major terminal at Bayview Yard to enter or leave the NEC. **Figure 15-2** indicates the limits of the track network that was simulated herein.

15.1 OPERATIONS

MARC CAMDEN LINE

MARC Camden Line service operates on CSXT's freight main line between Washington ("F Tower") and a stub-end three track station at Camden Yards in Baltimore. Trains "turn" on the three platform tracks at Camden Yards Station. Overnight storage and servicing for MARC train sets is provided at Mt. Clare. Camden Line trains are a single 3,000 hp diesel-electric locomotive and a 4-car consist, operating in push-pull service. Maximum train speed is 70 mph.

MARC's 2050 Camden Line service operates 28 trains per weekday, 14 in each direction. Morning and afternoon peak periods would be operated on 30-minute headways. Five train sets would lay over at Baltimore, and two train sets would lay over at Washington overnight. This is an increase from the 2010 level of service of 18 weekday trains. Running times for 2050 are 65 minutes, Camden Station—Washington for all local stops.

NS FREIGHT IN THE NEC

Current 2010 NS freight service on the NEC is limited on the north end to the segment between Perryville and Bayview Yard. South of Bayview, NS only operates a weekday local turn from Bayview south to Landover and return, and a transfer from Bayview to the Bulk Terminal facility at Mount Vernon. Both of these movements operate at night, to avoid the heavy Amtrak daytime operations. North of Bayview, NS freight trains consist of coal trains for the Consol port operation in Canton and priority intermodal merchandise trains to Bayview Yard. Bayview Yard is a "safe haven" for Norfolk Southern freight operations, where trains can clear the NEC.

With the construction of the new freight tunnel, projections of NS freight operations over the entire NEC include the addition of priority intermodal and merchandise (municipal solid waste) trains operating between the Bennings Branch at CP Hanson (Landover) and north on the NEC past CP Bacon. These trains will leave the NEC right-of-way at the new freight connection at Herbert Run, operate via the freight tunnel, and return to the NEC via the Bayview Connection and Bayview Yard (see **Figure 15-3**). This adds an increasing number of slow-moving freight trains (limited to 50 mph by cab signal design based on train dynamics and braking considerations) to the high-speed Amtrak and MARC commuter trains operating south of Baltimore.

The 2050 forecast for NS freight on the NEC is for 12 freight trains to operate through the new freight tunnel. The forecasted trains will consist of three priority intermodal trains in each direction powered at 2.5 hp/ton to maintain their schedule over the NEC and two general freight trains in each direction, powered at 1.5 hp/ton. A late night weekday local freight would be operated as a Bayview-Bennings turn to switch local freight customers on the NEC and would operate with pull-pull power on both ends to facilitate switching.

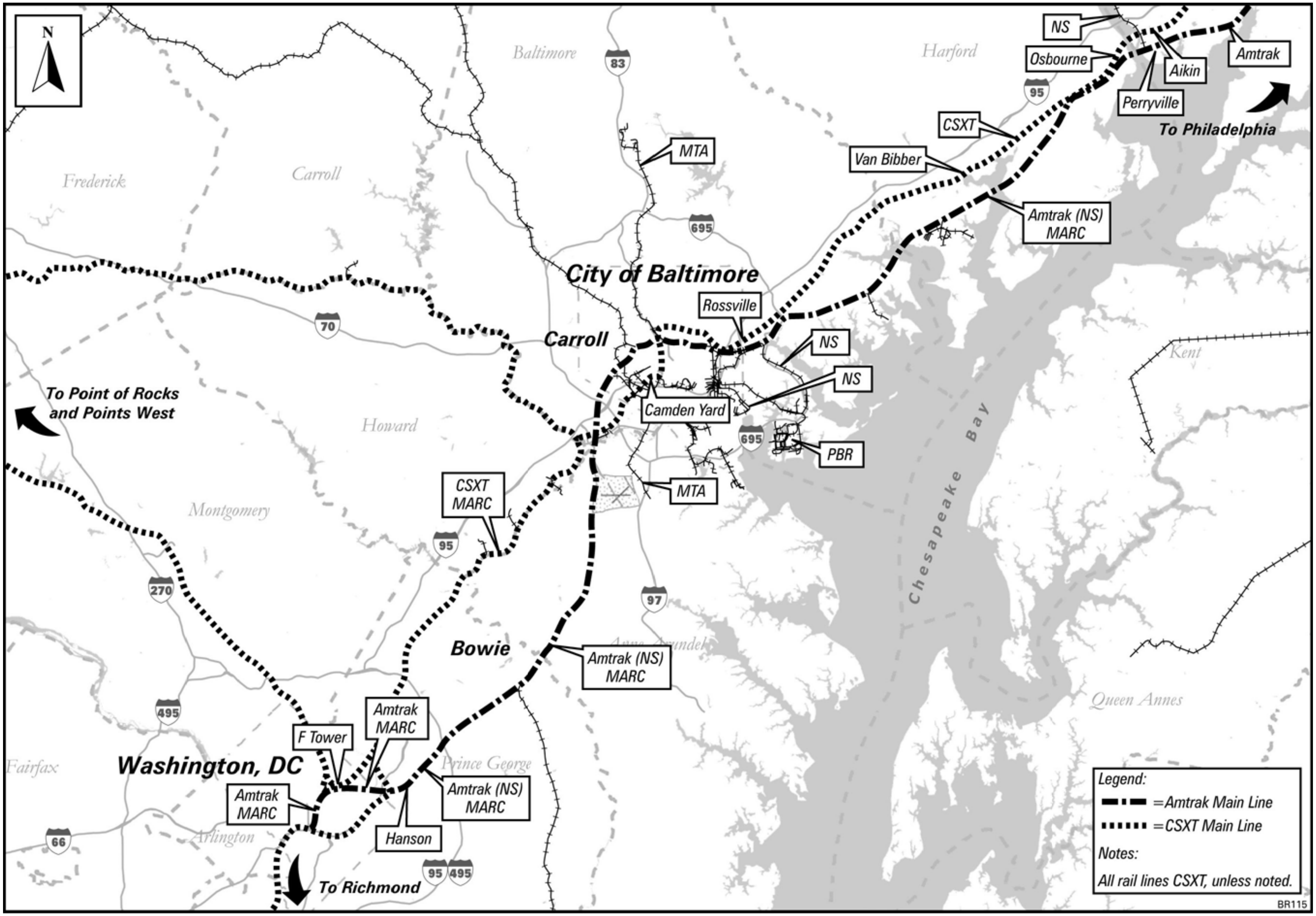


Figure 15-2. Limits of Freight Train Operational Study

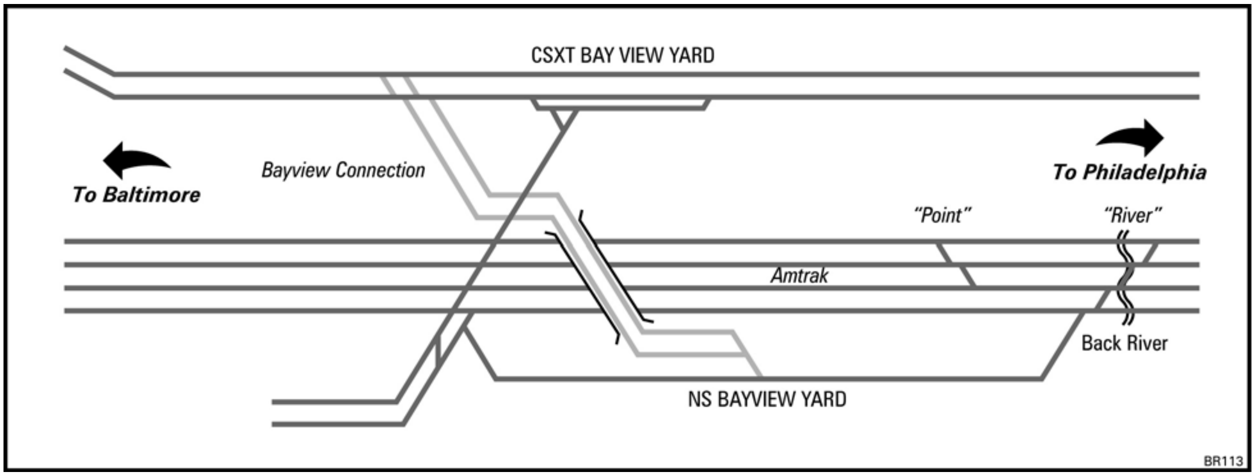


Figure 15-3. Bayview Connection

The trains would enter and exit the NEC at the CP Hanson connection to Bennings and the new freight connection at Herbert Run. Southbound trains will operate on the new Bayview Connection from NS's Bayview Yard to the CSXT main line, then through the new freight tunnel. Trains would exit CSXT at Herbert Run using the new connection to return to the NEC.

As previously noted in the Phase One report (Section 9.1), the new tunnel route saves about 3 hours runtime and 111 miles as compared to the existing route via Manassas Junction-Hagerstown-Harrisburg to North New Jersey and Philadelphia markets.

CSXT FREIGHT

CSXT continues to be the dominant freight operator in the Baltimore area. Freight trains operate to and from both the south and west from north of Baltimore, and also trains originate at a series of terminal locations within Baltimore. Coal trains and priority freight trains (the latter mainly automobile traffic) dominate the Curtis Bay terminal area on the south side of the city; these trains do not use the Howard Street Tunnel. Additional priority intermodal, automobile, and general freight trains operate to the north side of the harbor area via Bay View and Canton, where CSXT's intermodal terminal is currently located. Priority intermodal and automobile trains, general merchandise, and unit trains (municipal solid waste) operate from the south and west of Washington and north toward New York via the Susquehanna River crossing at Aiken. General merchandise trains stop and pick up or set off cars at CSXT's Bay View location, blocking one of the two main tracks there for 30+ minutes. There are daily local trains originating at Locust Point (Riverside locomotive serving facility) that work north to Aiken and return, and a second pair between Locust Point and Brunswick that provide local pick up and delivery service south of Baltimore.

CSXT's major capacity constraint through Baltimore is the 6.7-mile Howard Street Tunnel-Clifton Park segment of single-track connecting its north-south operations. Southbound trains must be held at Clifton Park or Bay View until they can operate through the tunnel and reach the double-track at CP Carroll. Northbound trains are held at CP Carroll if there is a southbound train coming through the tunnel; these northbound trains are stopped in the middle of the MARC Camden commuter service, which must operate around them to reach the Camden Yards Station. North-south trains operating to and from Richmond, VA have a five-minute stop at Halethorpe on the main line while crews are changed. East-west trains and trains originating or terminating in the Baltimore terminal do not require this crew change.

CSXT also operates PEPCO unit coal trains on the NEC. Loaded coal trains enter the NEC at CP Hanson, off the Bennings Branch, and run 8.5 miles to Bowie, where they use the Popes Creek Branch to reach the power plants. The returning empty train must operate against the current of traffic on the northbound track MT 1 back to Landover.

While NS was included within the study to determine the capacity and overall construction impacts of a new joint freight route tunnel operation, benefits would also accrue if CSXT was the only user of the new freight tunnel.

15.2 FREIGHT TUNNEL

Freight traffic is forecasted to increase significantly by the year 2050. Highway-to-rail diversions; growth in new commodities, like “trash trains”; development at the Port of Baltimore; and general economic growth all contribute to the increase. Growth occurs on both sides of the tunnel, and while trains from the south side of the tunnel (Curtis Bay, Locust Point) do not operate through the tunnel, they do contribute to the congestion that must be handled by the south end of the tunnel’s approaches—as do the increased number of MARC Camden Line trains (see **Table 15-1**).

Table 15-1. CSXT and NS Freight Train Projections 2010 – 2050

TUNNEL TRAINS		2010	2020	2030	2050
North Side Tunnel	CSXT	22	26	31	42
	NS	0	6	10	12
	Through Tunnel	22	32	41	54
South Side Tunnel	Curtis Bay, Locust Point	12	13	16	16
	Total through Halethorpe	**34**	**45**	**57**	**70**

In addition to the new tunnel’s construction, significant improvements would be required on both the north and south ends of the tunnel to handle the forecasted growth and the combining of CSXT and NS freight trains feeding the new tunnel. These improvements include:

- Double-track CSXT from Bay View Yard to the north tunnel portal (via Clifton Park);
- Interlocking and connection to NS Bayview Yard (Bayview Connection);
- Passing siding at “Osbourne” (south of single-track Susquehanna River Bridge) to improve line capacity north of Bayview;
- Running tracks at CSXT Bay View Yard to be sure that trains working there do not block main line movements;
- Connection from the Mt. Clare Branch to the Hanover Subdivision and then to the south tunnel approach so that trains and light engines from Riverside and Locust Point can operate to the tunnel;
- Rebuilt Halethorpe complex to provide three long tracks between West Baltimore and Saint Denis where trains can be held, re-crewed, do pick ups or set offs, and await their turn on the main line south to Washington or north through the tunnel; and
- Two-track Herbert Run Connection to take NS freight trains off the NEC and route them to the new tunnel (see **Figure 15-4**).

15.2.1 SIMULATION

Operations through the new freight tunnel were simulated using Parsons’ proprietary TrackMaster© simulation tool. The 2050 freight traffic levels were used to test how the new freight tunnel and approaches would handle the forecasted numbers of trains. An entire weekday’s schedule was simulated. A successful tunnel operation would allow all trains to operate without imposing delays or adding to the trains’ lateness. Performance measurements include: on-time arrival at each train’s destination, no additional delays to trains that are late entering the simulated operation, and limited signal delays at interlocking points on the NEC.

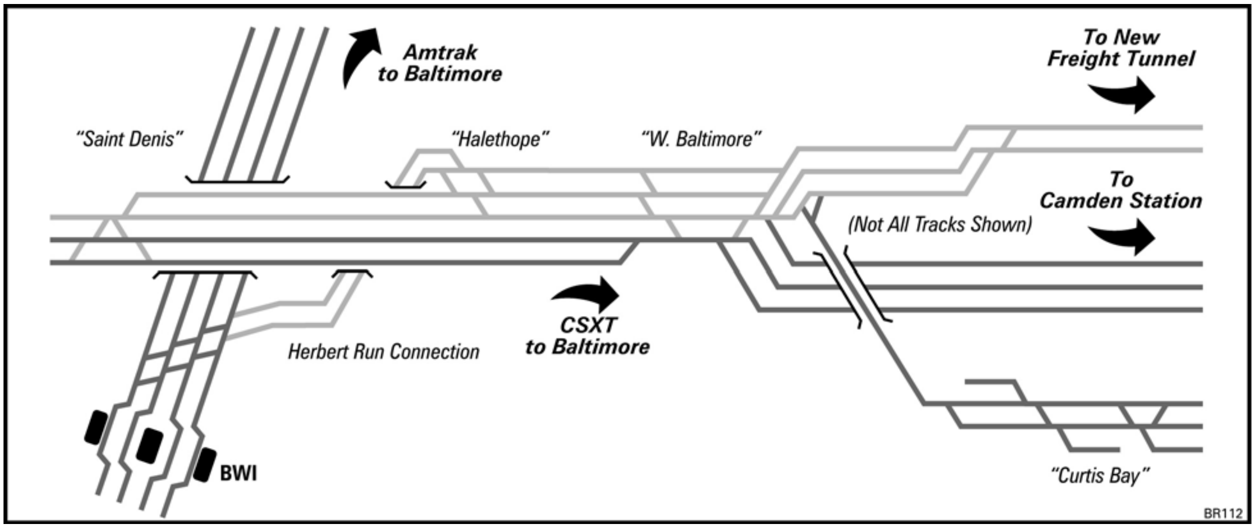


Figure 15-4. Track Configuration between Herbert Run Connection and West Baltimore

The tunnel itself is not a capacity problem even when limited to one train in each direction at a time. For simulation purposes, following trains were not permitted to enter the tunnel without space to clear the locomotives in open air at the other end. This is so crews are not held in the tunnel with their locomotives running. However, initial evaluations indicate that multiple trains can be moving in the tunnel at the same time.

Running times in the tunnel vary with freight train sizes and horsepower/ton assignments, but typically, five minutes southbound and five minutes and 45 seconds northbound is required to clear the head end of the tunnel—the difference is explained by the ascending grade northbound.

Critical to keeping trains moving freely through the new freight tunnel is adequate train capacity on either end of the tunnel. A clear northbound route through CSXT's Bay View Yard is required so that trains do not back up from there to the north tunnel portal. The capacity of the CSXT single-track main line north of Bay View is an issue for the railroad if the future forecasted train frequencies are to be handled. The simulation inserted sufficient added capacity through and north of Bay View so that the tunnel operations were not constrained.

Reconstruction between Herbert Run and West Baltimore provides multiple holding and staging tracks for north and southbound trains. MARC Camden Line trains hold the main tracks past the complex, and trains to and from Locust Pont or Curtis Bay can use the main tracks to bypass Mt. Winans Yard. Three long tracks provide flexibility for work trains, re-crews, and train inspections, and also bypass routes to the new tunnel for CSXT trains from the south and NS trains coming off the Herbert Run Connection. Two main tracks continue from Herbert Run through West Baltimore, along the Mt. Clare Branch to the Hanover Subdivision, and then run north to the new tunnel portal.

Although the "Old Main" remains a reliable route for limited numbers of freight trains to bypass the busy Metropolitan Subdivision to Washington, all CSXT freight trains were simulated using the Metropolitan subdivisions in order to "stress" the operation.

Signal delays indicate where congestion points occur on the tunnel and its approaches. The largest delays are at Rossville northbound and Van Bibber southbound, where operating the forecasted numbers of trains over the 12-mile single-track section between those two locations creates delays. Each freight train is "randomized" from its nominal schedule so that a precise schedule lineup, programmed to avoid all delays, is not operated through the tunnel (see **Table 15-2**).

MARC commuter operations create the delays at Carroll and points south of Saint Denis—Jessup, Savage, Ammendale, Greendale—as freight and passenger trains compete for track space. JD and "F" Tower are locations where freight movements from the south and west merge with each other and with MARC trains. Delays at Saint Denis are northbound trains waiting to enter the Herbert Run-West Baltimore track complex, and southbound are trains queuing into the Metropolitan Subdivision.

Delays at the tunnel portals are modest—one train (of 54 through the tunnel) is held for seven minutes clear of the North Portal, while trains ahead of it clear the Bay View Connection Interlocking and CSXT Bay View Yard.

Table 15-2. Signal Delay Report

			2050 CSXT		
DIR.	INTERLOCKING	SEG.	DELAY MINUTES	TRAINS	DELAY/TRAIN
S	W. Aiken	0056	8.26	2	4.31
S	Osbourne	0062	38.70	5	7.74
N	Van Bibber	0070	20.05	2	10.03
S	Van Bibber	0072	165.70	6	27.62
N	Rossville	0084	123.12	7	14.59
N	Bayview	0088	5.27	1	5.27
S	Bayview	0089	3.80	1	3.80
N	Armco	0090	23.98	4	6.00
S	Armco	0090	0.85	1	0.85
N	North Portal	0990	6.48	1	6.48
N	South Portal	0992	0.03	1	0.03
N	Carroll	1002	3.53	3	1.18
S	Carroll	1002	3.58	1	3.02
S	West Baltimore	1005	1.43	1	1.43
N	Halethorpe	1007	1.80	1	1.80
S	Halethorpe	1007	1.55	1	1.55
S	Saint Denis	1008	29.73	9	3.30
N	Saint Denis	1009	4.13	2	2.07
N	Dorsey	1013	17.23	8	2.15
N	Jessup	1015	1.20	3	0.40
S	Savage	1019	38.58	3	12.86
N	Ammendale	1025	6.25	5	1.25
S	Greendale	1029	0.75	1	0.75
S	JD	1032	10.12	3	3.37
N	JD	1033	52.37	4	13.09
S	"F"	1036	2.47	1	2.47
N	"F"	1037	15.55	3	5.18
		Totals	586.88	80	7.34

15.3 DESCRIPTION OF ROUTE AND CONSTRUCTION FEATURES

15.3.1 BACKGROUND

The total route length of the Belt-Modified Alternative is approximately 15 miles. To facilitate this discussion, the route has been divided into ten segments, designated Freight Tunnel Segment 1 through 10 (FTS-1 to FTS-10). The geographical limits of these sections are depicted on Figure 15-1**.** Each segment is discussed in terms of its route characteristics and construction methodology. In addition, a *Graphics Supplement* has been developed that provides route-of-line drawings, profiles, and signal diagrams for the Belt-Modified route.

FTS-1, HERBERT RUN CONNECTION

ROUTE DESCRIPTION

In order for NS to have access to the new tunnel route, a connection would have to be built between Amtrak's Northeast Corridor and CSXT. The logical place to site this is where the two alignments cross west of Halethorpe, MD. The area is unimproved and wooded, with a stream passing through it known as Herbert Run (referred to on Amtrak's track chart as Herbert's Run) (see **Figure 15-5**).

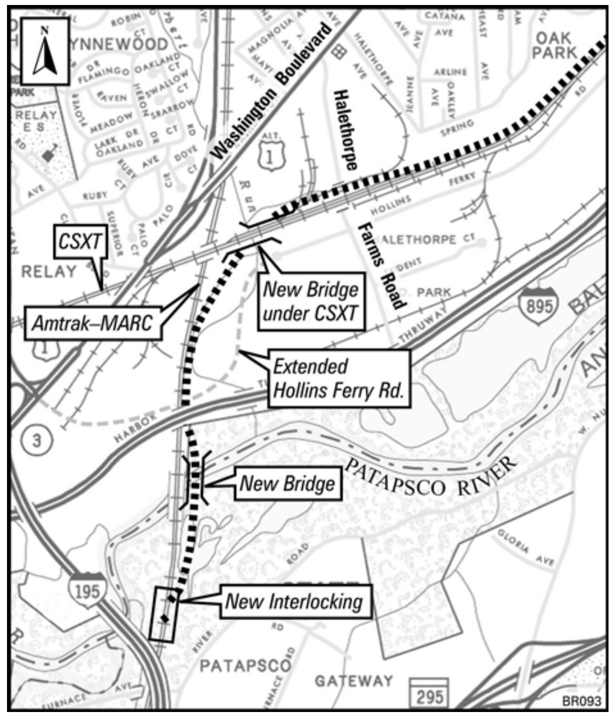


Figure 15-5. FTS-1 – Herbert Run Connection

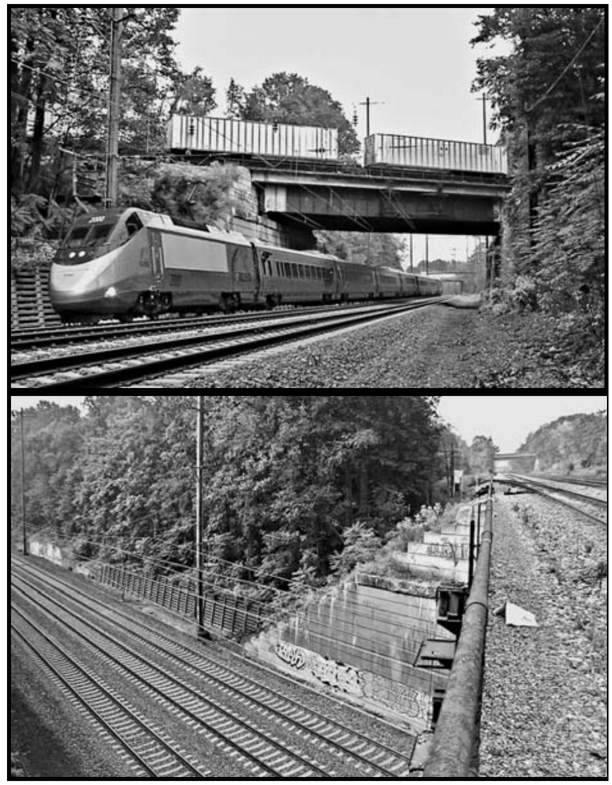
A two track connection is planned. It would diverge from the NEC at a point near the I-195 overhead bridge. A new interlocking is needed on Amtrak, which would provide for the simultaneous parallel movement of freight trains entering and leaving the Amtrak main line and moving across the three Amtrak tracks. This would be independent of an interlocking that is proposed for an expanded BWI Rail Station. The new Herbert Run Connection Interlocking would be located south of the Amtrak crossing of the Patapsco River. The existing bridge would have to be expanded or supplemented with an additional bridge.

Turning to the east, the connecting tracks would pass under the CSXT Baltimore Terminal Subdivision main tracks in a new overhead structure. Running the connection under CSXT and tying it in on the north side of the CSXT alignment reduces congestion by eliminating the need for NS trains to cross over the CSXT main line at grade. The grade separation also positions NS trains on the same side of the alignment as the divergence to the next route segment.

Because the NEC is situated approximately 35 feet below CSXT, the alignment would climb and intersect the CSXT between Halethorpe Farms Road and the Baltimore Beltway (I-695). The design profile maintains this grade at .98% or less, in accordance with the design criteria.

Because of the ascending grade of the Herbert Run connecting track in the vicinity of Halethorpe Farms Road, there is insufficient clearance for a highway-railroad grade separation and Halethorpe Farms Road would be closed. As a replacement, Hollins Ferry Road would be extended to the southwest, crossover Amtrak and connect at the intersection of Washington Boulevard and ramps to I-195. This new extension would cross wetlands and traverse an industrial site.

A fifth track would be added to the existing four CSXT tracks between Saint Denis and West Baltimore. A new interlocking would give NS trains access to the three northernmost tracks. For CSXT, the interlocking will supplement the existing Saint Denis Interlocking and give access to the four southernmost tracks. The CSXT tracks in this area also accommodate MARC Camden Line commuter service.



The crossing of Amtrak and CSXT, west of Halethorpe and north of BWI rail station.

CONSTRUCTION

In general, the new alignment would be constructed adjacent to existing railroad alignments, and consequently, would not materially interfere with railroad operations. Construction of the new interlocking on the Amtrak main line would require overnight track outages. The construction of the structure to carry CSXT over the connecting track could be accomplished in a number of ways that could involve track shifts, temporary bridges, temporary track outages, etc. Normal coordination with Amtrak and CSXT would be required throughout the construction period of this connecting track.

FTS-2, HERBERT RUN CONNECTION – WEST BALTIMORE

ROUTE DESCRIPTION

From the junction of the Herbert Run Connection, the track configuration would add a fifth track to the north side of the CSXT Baltimore Terminal Subdivision main line as far as Lansdowne Road, to the west of West Baltimore Interlocking. CSXT has expressed a need for two or three 10,000 foot holding tracks adjacent the main line, convenient to the Curtis Bay Car Shop. The aforementioned network of five tracks would provide the flexibility for CSXT to stage and inspect up to three trains and switch out cars for repair at Curtis Bay. The tracks would be signaled and equipped with power switches, in effect, giving any of those tracks the ability to be used for mainline movements or for holding trains. Crossovers would be arranged so that CSXT trains from any track could be routed to the new tunnel or to Curtis Bay Junction and beyond (see **Figure 15-6**).

Beyond Lansdowne Road, four tracks would be provided to West Baltimore. The alignment is limited in this area because of the close side clearance of the bridge piers for the Lansdowne and Hammonds Ferry Road overcrossings. Further, the CSXT tracks in this area also accommodate MARC Camden Line commuter service.

CONSTRUCTION

Construction activity in this area would consist of shifting track alignments and installing a number of turnouts. Track outages would be needed in order to place the turnouts and shift tracks.

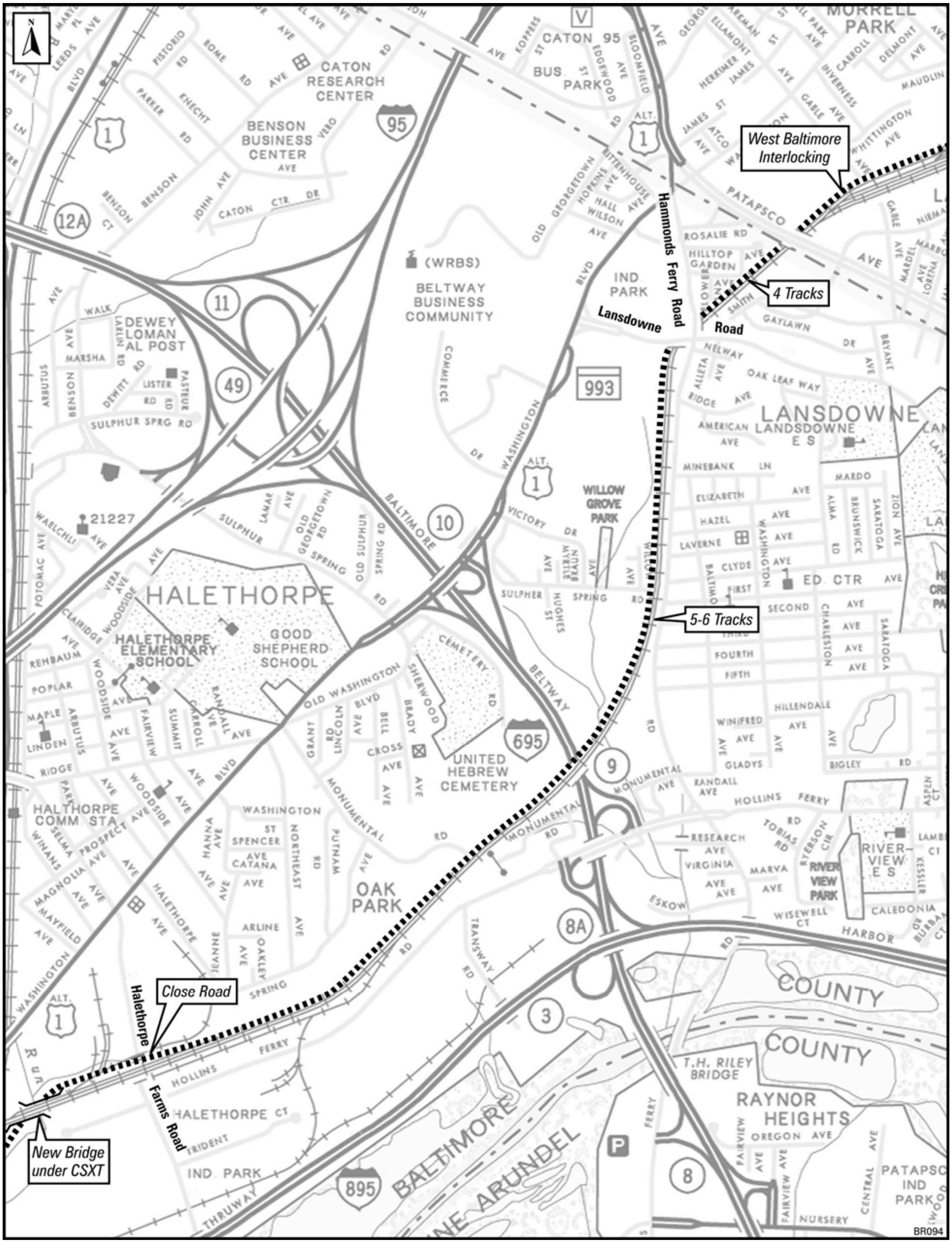


Figure 15-6. FTS-2 – Herbert Run Connection to West Baltimore

FTS-3, WEST BALTIMORE-HANOVER SUBDIVISION

ROUTE DESCRIPTION

At West Baltimore, the alignment continues on the Baltimore Terminal Subdivision, following Tracks 3 and 4 along the north side of Mt. Winans Yard to Curtis Bay Junction, then following the Mt. Clare Branch for a short distance. The alignment would pass through Mt. Clare Yard. In order to accommodate the curvature criteria of the new alignment, Mt. Clare Yard would be realigned and reconfigured. Sufficient tracks would be provided to continue the current level of operations (see **Figure 15-7**).

Mt. Clare Yard, under I-95 looking north where the proposed alignment would diverge to the left to meet the Hanover Subdivision.

At the north end of the yard, the alignment would turn to the northwest, away from the existing alignment and cut into a bluff on the west side of the yard, where it would begin to descend to meet the CSXT Hanover Subdivision. The alignment would pass between two existing buildings in a cut-and-continue under Wilmarco Avenue as it descends. It would cross over Gwynns Falls to meet the CSXT Hanover Subdivision just south of Wilkins Avenue.

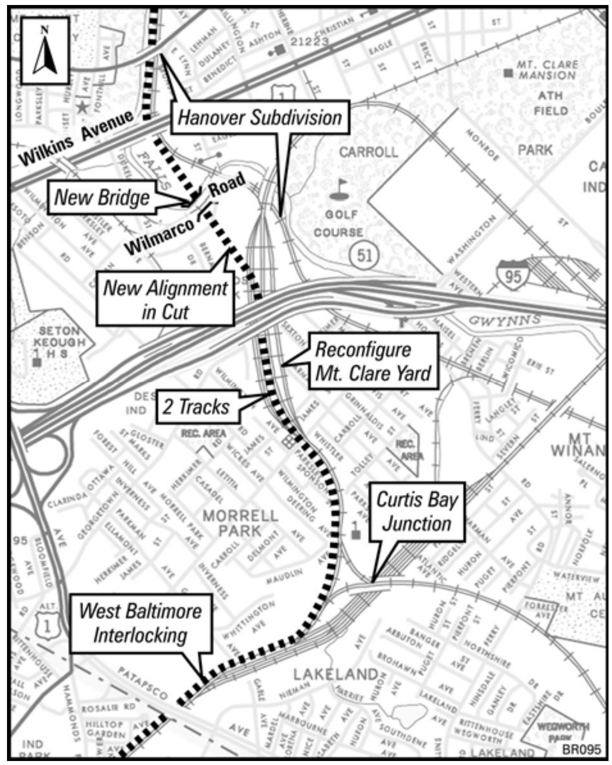


Figure 15-7. FTS-3 – West Baltimore to Hanover Subdivision

CONSTRUCTION

Maximum curvature criteria of the new alignment would require the reconfiguration and realignment of Mt. Clare Yard. The yard is lightly used, and space exists to phase construction without significant interference to existing operations.

The alignment between the yard and the Hanover Subdivision would be new. From the yard, the new alignment would be in a cut approximately 30 feet deep, which would probably require retaining walls and potential underpinning of adjacent buildings. It is anticipated that conventional braced excavation construction methods would be used (soldier piles, wales, lagging, and struts). Other methods include slurry walls and sheet piling.

The new alignment would also pass under Wilmarco Avenue, which would require a new bridge for the overcrossing. From there, the new alignment would cross the Gwynns Falls on a bridge about 300 feet long. Mt. Clare Yard could serve as a staging area for this construction.

FTS-4, LOCUST POINT CONNECTION, CARROLL INTERLOCKING – HANOVER SUBDIVISION

ROUTE DESCRIPTION

Discontinuing service through the Howard Street Tunnel would require that another way be found for trains to travel between Bay View and Locust Point without reversing. To maintain this access, a connection has been developed linking the Baltimore Terminal Subdivision main line to the Hanover Subdivision. It would begin at Carroll Interlocking, where it would diverge from the Mt. Clare Branch track just after that track diverges from main line Track 1. The connecting track would turn to the northwest and roughly parallel Gwynns Falls waterway until it merges into the Hanover Subdivision, just west of Washington Boulevard (see **Figure 15-8**).

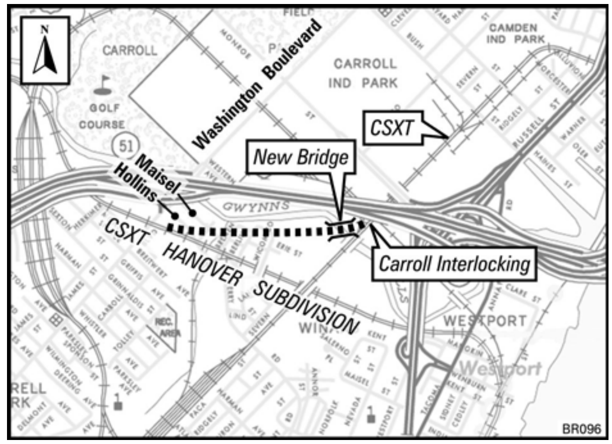


Figure 15-8. FTS-4 – Locust Point Connection

CONSTRUCTION

The Locust Point Connecting Track would be located entirely on a new right-of-way, approximately 5,000 feet long. Standard track construction methods would be used. A new bridge, approximately 300 feet in length, would be needed over the Gwynns Falls waterway at the north end of the alignment. The alignment is adjacent to the Gwynns Falls waterway bed for approximately 2,000 feet, and additional wetlands would be crossed. Standard construction environmental safeguards would be used. Light industry involving salvage, reclamation, and storage would be affected. Grade crossings at Maisel Street, Hollins Ferry Road, and Washington Boulevard would be required. These grade crossings would be equipped with warning devices, including flashing lights, gates, and constant time-warning circuitry.

FTS-5, HANNOVER SUBDIVISION AND WEST PORTAL

ROUTE DESCRIPTION

Gwynns Falls wanders through a deep valley in a generally southern direction, emptying into the Patapsco River. A segment of the CSXT Hanover Subdivision runs up the valley from South Baltimore. It was built in the early part of the 20th century by the former Western Maryland Railway to connect it to a then-new tidewater marine terminal – Port Covington. Today it sees limited use: a daily round trip conveying stone from quarries in Carroll County and an every-other-day local freight (see **Figure 15-9**).

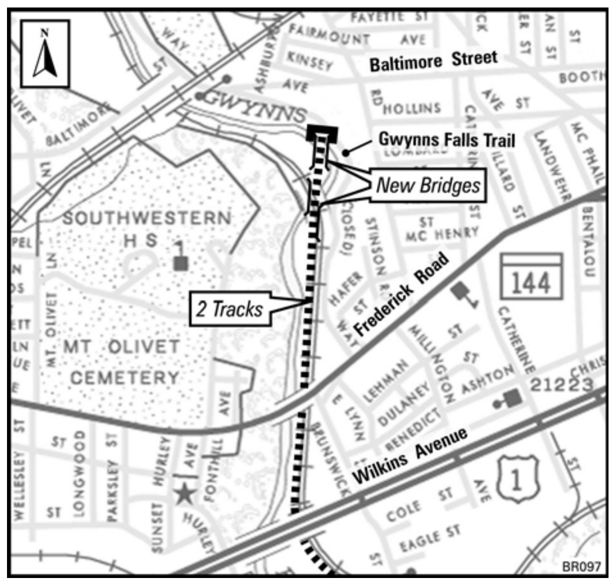


Figure 15-9. FTS-5 – Hanover Subdivision to West Portal

The floor of the valley is a wooded area of undeveloped park, a part of the Chesapeake Coastal Plain, populated with tree species such as sweet gum, red maple, and hickory. Running along the east ridge of the valley is Ellicott Driveway. Originally, this was a mill race serving the flour mills of the Ellicott Brothers. As water power became obsolete, it was abandoned. In 1917, it was rebuilt as Ellicott Driveway, as envisioned by the Olmstead Brothers in a 1904 park plan. Today it is part of the Gwynns Falls Trail.

The existing Hanover Subdivision alignment would be used for a short distance between a point just south of Wilkins Avenue, where the proposed alignment would connect from Mt. Clare Yard and a point south of Baltimore Street. Currently, a single-track runs along the east side of the Falls to a point about midway between Frederick Road and Baltimore Street. As it approaches the Falls from the south, it curves to the west, crossing the Falls and continuing along its west side. The proposed alignment would continue on tangent, crossing the Falls twice and heading directly into the outcropping below the Gwynns Falls Trail (formerly Ellicott Drive). The west portal would be located in this nearly vertical rise above Gwynns Falls and below the trail, immediately south of Baltimore Street. The new alignment would include two tracks, while the existing Hanover Subdivision has a single track. Right–of-way widening would have some effects on the park.

CONSTRUCTION

The new second track in this segment would be adjacent to the existing tangent alignment, thus construction is relatively straightforward. Construction best practices to minimize environmental effects to the Falls would have to be used. Where the Hanover Subdivision swings to the left and the new alignment continues straight on to the new tunnel portal, an approximately 1,000 foot bridge structure or a bridge-and-fill combination would be needed. A temporary materials lay-down area would also be needed to support the construction of the structure and the west end tunnel portal. Adding a second track could require the replacement of overhead bridge spans carrying Wilkins Avenue and Frederick Road. A new bridge would also be needed for Gwynns Falls Trail.

FTS-6, TUNNEL SECTION

ROUTE DESCRIPTION

The tunnel would be almost three miles long and curve in an arc northeasterly from its western portal to its eastern portal (see **Figure 15-10**). For most of its length, the tunnel will be deep enough to be bored or blasted and too deep for cut-and-cover. The exception would be the east end, where the need to support the Jones Falls Expressway (I-83) structure would necessitate excavation to underpin it as the tunnel is constructed. As presently envisioned, the tunnel would be a single bore with two tracks having an outside diameter of about 39′ 6″. It would pass under, and in the vicinity of, the following intersections:

- Calverton Heights Avenue and Warwick Avenue
- Franklin Street and Evergreen Avenue
- North Avenue and Felton Avenue
- Madison Avenue and Cloverdale Road

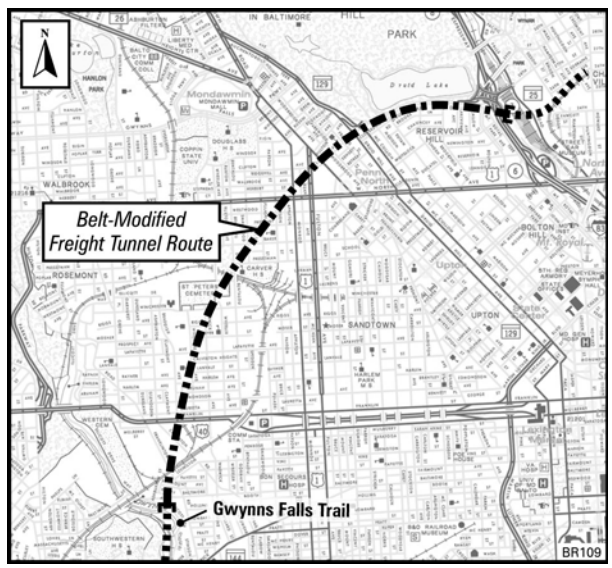


Figure 15-10. FTS-6 – Tunnel Section

CONSTRUCTION

A principle advantage of this tunnel route is that it is mostly deep and in hard rock, ideal conditions for using a Tunnel Boring Machine (TBM), which is a very cost-effective method of tunneling. Tunnel excavation and choice of tunnel cross section are discussed further in this section under “Tunnel Construction.”

FTS -7, EAST PORTAL – JONES FALLS JUNCTION

ROUTE DESCRIPTION

The east portal would be situated in the wall/slope below the Jones Falls Expressway, just south of the 28th Street Bridge and at the approximate elevation of the existing NS Bulk Terminal Yard. The alignment would emerge from the tunnel on an ascending grade, cross the area occupied by the yard while curving to the left, and cross a new 600-foot bridge. The bridge passes over the MTA light rail line and the Jones Falls valley to meet the CSXT Belt Line before it passes under Sisson Street. This location is referred to herein as Jones Falls Junction (see **Figure 15-11**).

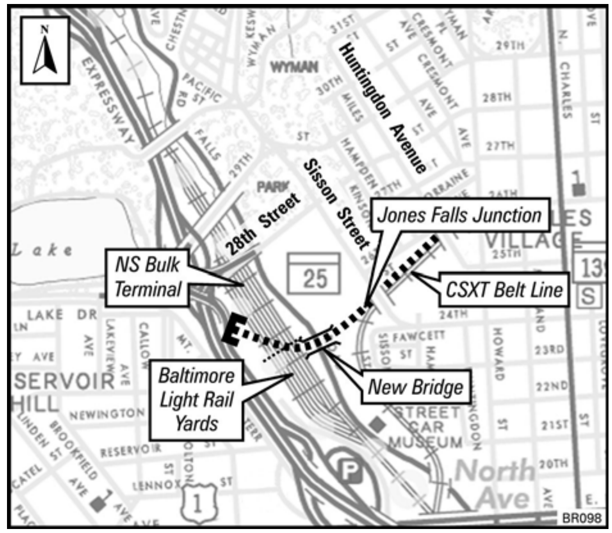


Figure 15-11. FTS-7 – East Portal to Jones Falls Junction

In crossing the valley, the alignment would pass over the Baltimore light rail tracks, Jones Falls, Falls Road, and the Baltimore Streetcar Museum tracks. The top-of -ail would be approximately 40 feet above the surface of Falls Road. The alignment would pass over the southern end of the former Maryland & Pennsylvania Railroad roundhouse (which now is used by the City of Baltimore Department of Transportation) to reach the east slope of the valley. There, it would cut into the bluff to reach the existing Belt Line alignment, also in a cut, which is curving from a north/south to an east/west orientation.

Where the alignment emerges from the tunnel, it would be in conflict with the north end of the light rail yard tail track, situated between the expressway ramp and the NS yard. The light rail track would need to be shortened. It presently accommodates a three-vehicle train; it would be shortened to accommodate a two-vehicle train. The light rail main tracks would also have to be lowered to accommodate the freight route overcrossing.

The NS Bulk Terminal Yard is level, with nine tracks, eight of which are situated in pairs. Most of the area surrounding the pairs of tracks is paved for the use of trucks. The track pairs are spaced far enough apart for trucks to circulate between them so that bulk commodities can be transferred from rail to truck. Because the proposed alignment passes diagonally across the yard, it would preclude continuing NS yard operations, and they must be moved to another location. In project meetings, NS has indicated an interest in moving from this facility.

CONSTRUCTION

Removal of the NS Bulk Terminal Yard would make the site available for a laydown area supporting the construction of the tunnel and the Jones Falls Bridge.

Bridge construction should not affect Jones Falls, Falls Road, or the Streetcar Museum's track, except by the potential location of bridge piers. The Jones Falls waterway is channeled between stone walls erected in the early 20th century. Falls Road is a lightly traveled road of two lanes. The museum trackage is normally used only on Sunday afternoons. The Maryland & Pennsylvania Railroad roundhouse was built around 1905 but is not on the National Register of Historic Places. The freight alignment barely avoids this building. The bluff east of the valley is occupied by a small industrial building, used as an office for a bus operator. The remaining area is used to stage the buses and for employee parking.

FTS-8, THE BELT LINE, JONES FALLS JUNCTION – GREENMOUNT AVENUE

ROUTE DESCRIPTION

East of the Jones Falls Junction, the existing CSXT Belt Line alignment would be used. The alignment runs northeast at the junction, adjacent to the Remington residential community. It turns to an easterly direction as it passes under Howard Street, passing south of the Charles Village and Harwood residential communities. The line continues in an easterly direction, paralleling 26th Street to Greenmount Avenue (see **Figure 15-12**).

The multiple street crossings in FTS-8.

Figure 15-12.FTS-8 – Jones Falls Junction to Greenmount Avenue

The B&O Railroad built the "Baltimore Belt Line" in the 1890s as a means to circumvent Baltimore and avoid a ferry crossing of the harbor. It was, in effect, the 19th century equivalent of the proposed Belt-Modified Alternative. The problem with the Belt Line is that it is still constrained by 19th century infrastructure and clearances. Over the years, CSXT and its predecessors have taken steps to maintain traffic with larger freight cars, but they are limited to what can be accomplished with the existing infrastructure. The track is situated in a depression (also referred to as a cut), between retaining walls set for smaller 19th century rail cars and closer track spacing. It is crossed by a collection of structures carrying major streets across the alignment, the newest of which dates to the early 20th century. Some of them are tunnel-like, of arched masonry construction, which serves to further limit vertical clearances. The individual highway crossings are:

- Sisson Street
- Huntingdon Avenue
- Gilford Avenue
- Barclay Street
- Greenmont Avenue

Six intermediate blocks are "roofed over" for parking lots and recreational areas. These blocks are included in the segment:

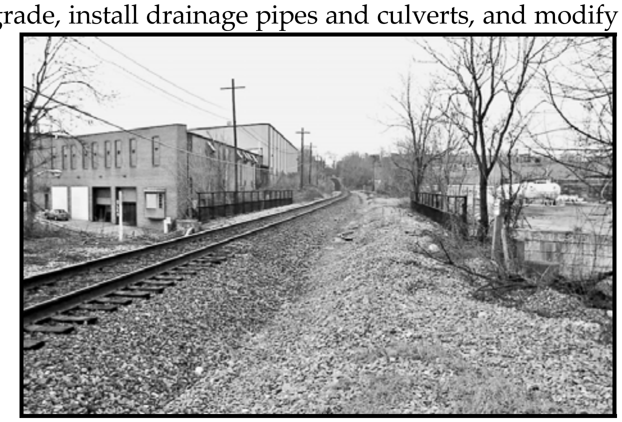
- Howard Street to Charles Street (approximately 800 feet)
- St. Paul Street to Calvert Street (approximately 400 feet)

When opened for service in 1895, the Belt Line had double-track. Later, to attain the highest possible vertical clearance through the existing structures, the original double-track was replaced with a single-track that has been located in the center to maximize vertical clearances under the arches. While increasing vertical clearance, the offsetting effect is a single-track railroad of reduced throughput capacity. In a further attempt to increase vertical clearance, the track also has been lowered, causing problems with drainage. Even with these measures in place, the clearances are still inadequate for Plate H.

The existing Belt Line through this area would have to be rebuilt in order to fully realize the benefits of the Belt-Modified tunnel route. When completed, it is envisioned that a two-track railroad, offering full clearance for the movement of Plate H cars, would be operating under a series of bridges/platforms, providing surface area for cross streets, parking, and various community uses.

CONSTRUCTION

Reconstructing the bridge structures in this segment would require that the cut be widened to provide a space for the second track. Also, the railroad must be kept operating during the reconstruction, although short periods of railroad shut-down may be possible. The general reconstruction strategy would be to first demolish and rebuild the street overcrossings to accommodate the wider width of the cut. This would be sequenced so that all cross streets are not closed simultaneously in order to minimize the adverse effects on traffic and neighborhoods. Second, once the new overcrossings are constructed, grading would commence for the site work in the cut area (widen and level the grade, install drainage pipes and culverts, and modify any utilities). Maintaining traffic on the parallel 26th Street can probably be accomplished by using temporary shoring. The third step would be to lay the new track, which includes placing ballast, shifting the existing track to a new alignment, and constructing the new second track.

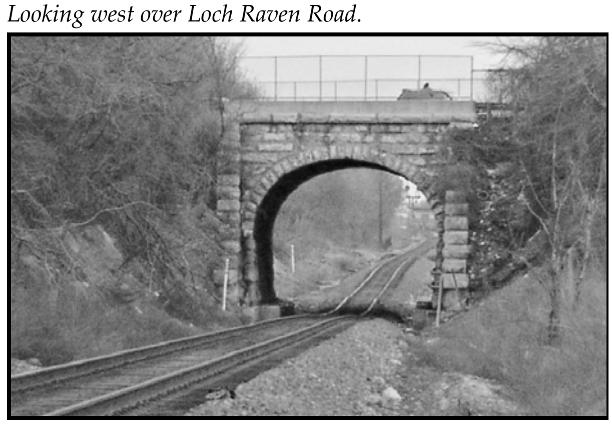


Looking west over Loch Raven Road.

FTS-9, BELT LINE, GREENMOUNT AVENUE – BAYVIEW

ROUTE DESCRIPTION

To the east of Greenmount Avenue, the land use becomes commercial and remains so, for the most part, as far as Bay View. **Figure 15-13** presents a schematic of the FTS-9 route. At Loch Raven Road, the line turns to the east southeast continuing to Belair Road, where it turns east again. Through this area it passes over four bridges, Loch Raven Road, Kirk Avenue, Garrett Avenue, and Asquith Street, all of which previously held double-track. It next passes under Harford Road, where a significant vertical curve, commonly known as a sag, has been introduced to drop the track level under the overhead bridge to gain additional vertical clearance.



The sag under Harford Road.

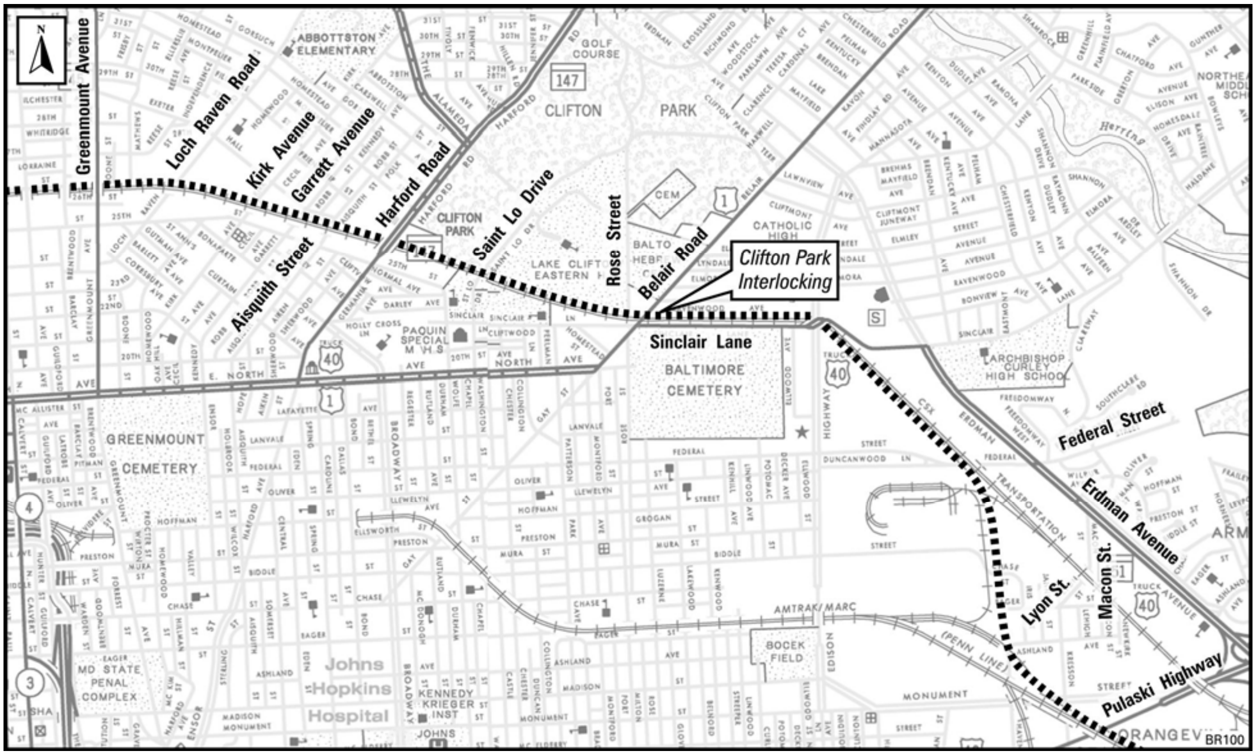


Figure 15-13. FTS-9 – Greenmount Avenue to Federal Street

The Belt Line continues through the southwest corner of Clifton Park, over Saint Lo Drive, another double-track structure, and then turns eastward as it passes over Rose Street and Belair Road. A second track begins at Clifton Park Interlocking (BAK 91.5) and continues eastward to Bay View.

From Clifton Park Interlocking, the alignment again turns southeast as it passes under Sinclair Lane and Erdman Avenue, which cross each other on a bridge over the alignment. The line continues to the southeast, passing over Federal Street, Lyon Street, Macon Street, and Pulaski Highway (US 40), where it turns to the east northeast, passing under the Harbor Tunnel Throughway (I-895) bridge to parallel Bay View Yard. Before reaching Macon Street, the alignment widens for a third track, which has been removed, and an industrial siding takes off on the south side, eventually diverging to the west. West of Pulaski Highway, a third track emerges from Bay View Interlocking. This track leads into Bay View Yard, and another track diverges from it, to the south, as the west leg of a wye track that continues southward to Canton and eventually to Sparrows Point.

CONSTRUCTION

Construction in this segment would consist of reinstalling a second main line between Clifton Park Interlocking and Greenmount Avenue and the reconstruction of the Harford Road overhead bridge. This would be relatively easily accomplished because the segment previously had a second track. Coordination with adjacent train operations would be required.

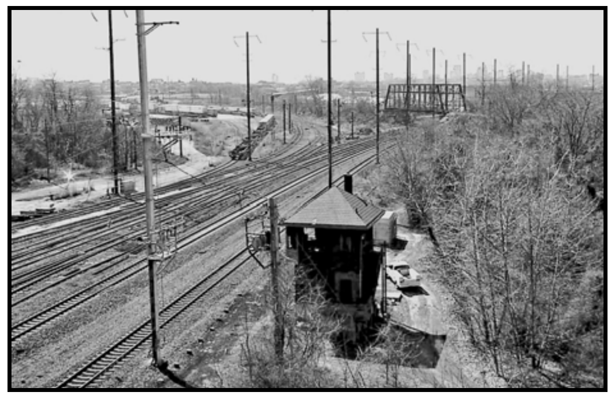
FTS-10, BAYVIEW CONNECTION

ROUTE DESCRIPTION

An alignment connecting the Belt Line to the NS Bayview Yard is needed for NS to access the new freight tunnel route. The connection alignment would diverge from the Belt Line near Federal Street and turn to the south. It would pass over an industrial siding and six highways, and roughly parallel a set of transmission lines situated between the old Armco (later, Republic) steel plant and the Orangeville residential community. This segment would be on a fill approximately 4,000 feet long and generally between 10–30 feet high. The six highways crossed are Federal Street, Chase Street, Haven Street, Monument Street, Kresson Street, and Pulaski Highway.

Looking east over NS Bayview Yard.

The connection alignment would then pass through the Baltimore City maintenance facility, where it would turn to the southeast and parallel the Amtrak alignment, continuing eastward on the north side of the tracks.



Looking west to the CSXT Railroad Bridge.

The connection track alignment would then cut into the embankment that supports the CSXT Sparrows Point Branch and lead tracks, which go to a potentially historic bridge over Amtrak. In the same location, the Amtrak alignment would be depressed and realigned to reduce curvature. This would result in a slight increase in Amtrak's passenger train speed. A segment of the CSXT bridge fill would be replaced with a bridge that would carry two tracks for CSXT and span six tracks: two for NS and four for Amtrak. As configured, the new alignment would not affect the potentially historic CSXT bridge.

As the connection alignment approaches the CSXT undercrossing, it would begin to rise to a bridge that would span four Amtrak tracks. Because of the desire to limit gradient for freight trains, the freight alignment rises only a few feet. Concurrently, the Amtrak alignment would be depressed 30 feet in order to provide the necessary clearance under the NS overcrossing.

Following this, the connection alignment would descend to assume the location of the northernmost tracks of Bayview Yard. These tracks would continue eastward to the North Point Boulevard underpass, where they would fold in to the adjacent yard track. There also would be a connection to the yard near the end of the overcrossing (see **Figure 15-14**).

CONSTRUCTION

The construction in this segment is principally on a new alignment. Conventional track construction methods would be used. Where the new alignment would pass under the CSXT Sparrows Point Industrial Track, a bridge structure would need to be constructed. This could be accomplished using a number of methods, including building a temporary bridge and bracing and undercutting. It is probable that some CSXT track outage would be required. However, this being an industrial switching track, track outages could possibly be longer and more easily tolerated than for those on a main line.

Construction of the NS bridge over Amtrak would have the advantage of not having to maintain existing freight service, thus construction would be more conventional without the need for temporary tracks or bridges. However, coordination would be required for the construction of the depressed Amtrak main line through the area. The need to work under the overhead electrification system, modify it for the

Amtrak realignment, and construct the NS overcrossing above it would require careful coordination and would be subject to limitations on power outages.

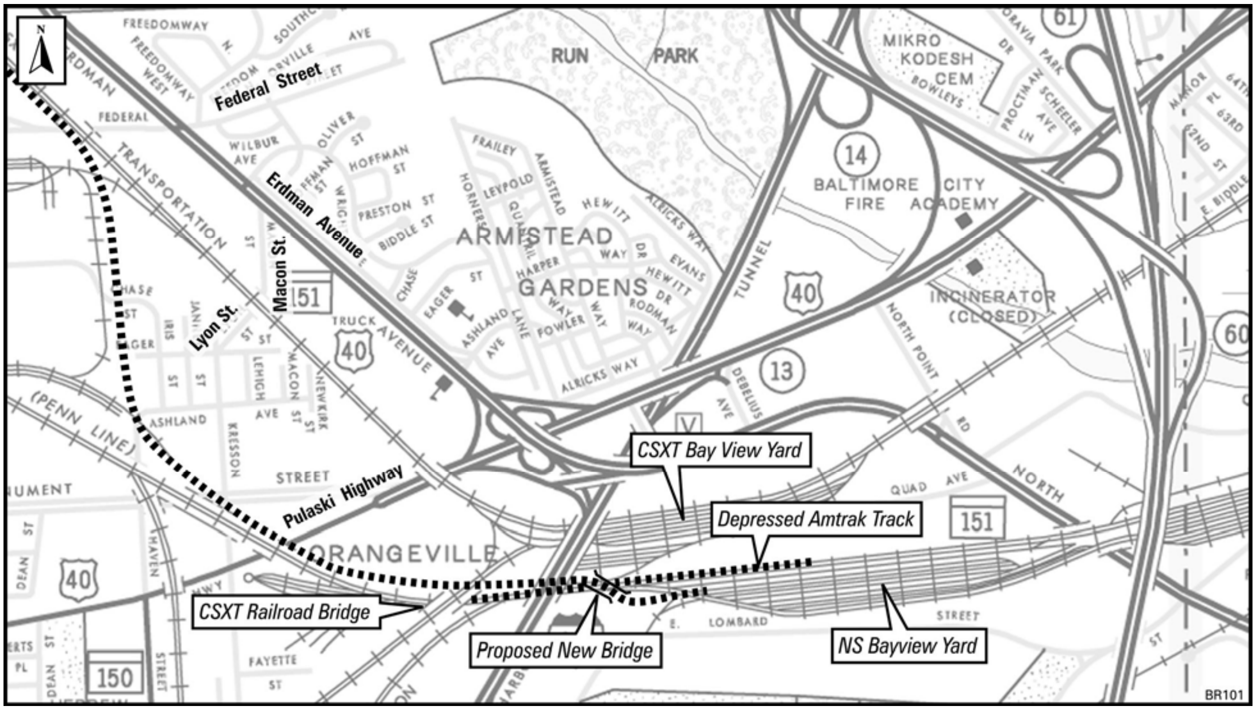


Figure 15-14. FST-10 – Bayview Connection

In order for the NS connecting tracks to cross over the Amtrak four-track main line, the Amtrak alignment in the Bayview area would have to be depressed. The depressed track would be approximately 4,800 feet long, with a maximum gradient of 2.0% and a maximum depth of approximately 30 feet. The profile as developed within this report meets all Amtrak design standards. Amtrak has noted that this area has been identified as a potential location for train speed improvement. The alignment indicated herein does provide a slight speed improvement; however, significant speed improvement would require track shifts and bridge alterations west of the depressed track segment.

As the construction for the Amtrak depressed track section is mostly off the existing alignment, the excavation can be accomplished with relatively little interference to Amtrak operations. Construction coordination would be required for the tie in points and some overnight track outages may be needed.

Although the most realistic route, neither Amtrak nor MTA are satisfied with the layout of the connecting track as presented herein and further discussions would be required regarding this issue.

COMMUTER STATION AT BAYVIEW

The Maryland MTA is in the planning stages of the Red Line, a Light Rail Transit (LRT) system that lies in a east-west orientation connecting the West Baltimore and Bayview areas through the Baltimore CBD. A Red Line MARC station stop is planned for the Bayview area along Lombard Street immediately north of the Johns Hopkins Bayview Medical Center and adjacent to the NS railroad near the I-895 interstate. The Red Line MARC station would serve both the Red Line and MARC. An overhead pedestrian way would connect the Red Line station with the MARC station platforms, which would be located on the Amtrak main line. As presently planned, the MARC station platforms would be located in the area of the NS connecting track overcrossing and depressed Amtrak tracks. This area would make the construction and use of passenger platforms very awkward, if not completely impractical. Coordination meetings between MARC, MTA, and Amtrak have taken place regarding this issue, but it remains unresolved.

TUNNEL CONSTRUCTION

Approximately 2.9 miles of the 15-mile Belt-Modified route would be in a tunnel. Potential cross sections for the tunnel segment are twin, single-track tunnels or a single bore, double-track tunnel. Both would be sized to accommodate Plate H clearances. NFPA 130 Guidelines are not applicable to a tunnel used only by freight trains.

Concerning the two tunnel single-track option, each single-track freight tunnel would require an inside diameter (ID) of about 26′-0″and a final outer lining 15 inches thick. This results in an excavated overall diameter (OD) of about 28′-6″ that has a cross sectional area of 638 sq.ft. To maintain a minimum pillar width of one tunnel diameter between the two bores, a tunnel spacing of 60 feet is assumed.

A double-track freight tunnel would require an ID of about 36′-4″ with a final outer lining 19″ thick. This results in an OD of about 39′-6″ that has a cross sectional area of 1,225 sq.ft.

Given the grade to be climbed by eastbound trains and the assumption that diesel powered locomotives would be employed, tunnel ventilation is required. Initial estimates indicate that ventilation requirements can be accomplished using wall-mounted jet fans that fit within the cross sections and that no intermediate ventilation shafts are needed. Purging would occur after the passage of a train or trains. Concerning the twin bore single-track option, it is postulated that no cross passages are needed to connect the tunnels together.

Figure 15-15 presents the typical cross sections for the tunnel options discussed above.

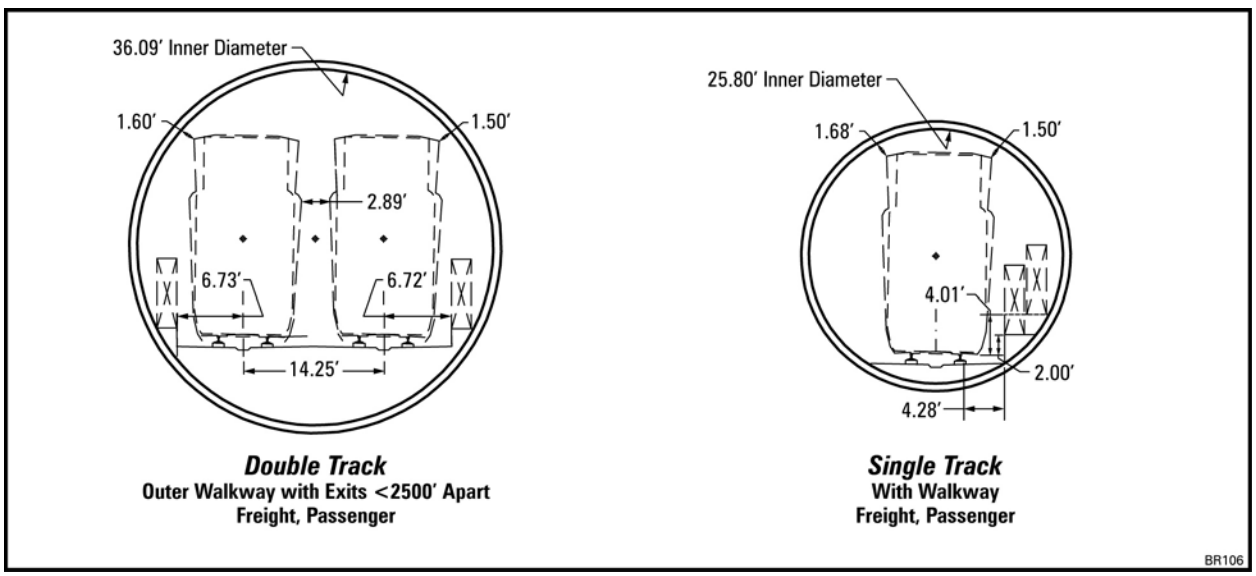


Figure 15-15. Freight Tunnel Cross Section Options

GEOLOGY/CONSTRUCTION METHODS

The Belt-Modified tunnel profile transitions from at-grade sections at both ends, where the tunnel penetrates existing slopes, and descends to its completely underground alignment, reaching a depth of 190 feet (bottom of tunnel). The general subsurface conditions encountered along the GCPT route consist of four general strata:

- **Fill** – This stratum generally consists of loose to medium compact light brown and brown micaceous silty fine sand or clayey fine sand with traces of medium to coarse sand and gravel. This stratum is generally less than 20 feet thick.
- **Sand and Gravel** – This stratum generally consists of medium to compact, to very compact, brown and red-brown coarse to fine sand, and some trace gravel and trace silt. These deposits represent the sand facies of the Patuxent Formation of the Potomac Group, with a thickness up to 25 feet.
- **Residual Soil** – This stratum consists of medium compact to very compact brown and grey micaceous silty fine sand and trace rock fragments. This stratum has a a thickness of up to 20 feet.
- **Bedrock** – Bedrock encountered along the alignment comprises mostly quartz-mica schist to geneiss, with occasional pegmatite veins belonging to the Jones Falls Schist Group.

Cut-and-cover structures are anticipated at both portals where cover is insufficient to support mined construction. Adjacent to each portal structure are transition zones, comprised of fill, sand and gravel, and residual soil, through which a tunnel may be driven by any one of a variety of methods. Excavations through these materials are not stable for long periods of time and are less stable as the size of the excavation increases, unless some form of support is performed. Generally, tunneling through these materials involves making a series of smaller excavations adjacent to one another, which together form the full-sized cross section. This is called the Sequential Excavation Method (SEM). Pre-excavation ground modification may include techniques such as dewatering, grouting, freezing, fore-poling, etc., or temporary support of the excavated face using compressed air, mechanical pressure, or pressurized face TBM.

Further from the portals, these transition zones will begin to encounter bed rock rising through the tunnel cross section as the tunneling proceeds. This condition, with soil or deteriorated rock that behaves in a soil-like manner, is labeled "mixed face" and requires the construction to maintain a stable arch overhead while excavating the bed rock in the lower portions of the cross section. Finally, the alignment will be excavated through full face bed rock which can proceed at greater production rates due to the lower degree of initial ground support needed to be installed. Full face bed rock conditions constitute about 90 percent of the tunnel length.

The length of the freight tunnel alignment lends itself to Tunnel Boring Machine (TBM) construction. Acquiring a TBM, mobilizing it on site, and demobilizing it are expensive, but production rates are higher and tunneling cost per unit length is generally lower than more conventional or manual tunneling methods, generally drill-and-blast construction in hard rock ground. Consequently, longer tunnels are good candidates for TBM construction from an economic perspective.

For the purposes of this analysis, use of a hybrid TBM was assumed. This is a machine designed to excavate through soil or soil-like materials in a closed-face mode, where pressure is maintained in the cutting chamber to provide support to the tunnel face in front of the TBM shield. Then the machine is reconfigured for open-face production through a self-supporting rock face. As the tunneling approaches the other portal area, the machine is reconverted to closed-face mode for progress through the other mixed-face and transition zones. The entire bored tunnel is lined with a precast, segmental, one-pass liner.

TUNNEL CONSTRUCTION COST COMPARISON

Table 15-3 presents a cost comparison between the two tunnel cross sections considered herein. The table indicates that the double-track single bore tunnel is the least costly option.

Table 15-3. Tunnel Cross Section Cost Comparison (in millions)

		BELT-MODIFIED FREIGHT	
		TWIN, SINGLE-TRACK	SINGLE BORE, DOUBLE-TRACK
Bid Cost	Portal Structures	$50.8	$48.0
	Soft Ground Tunnel	$186.3	$174.6
	Rock Tunnel	$327.4	$307.4
	Total Bid Costs	$564.5	$530.0

PROPERTY REQUIREMENTS

COMMENTS ON PROPERTY REQUIREMENTS

APPROACH TO PROPERTY IDENTIFICATION

Property impacts were considered for a width of 50 feet on either side from the center line of the Belt-Modified Freight route. Minimal horizontal width was presumed to 100 feet and depth from the surface to the top of the tunnel case 40-140 feet. Impact upon surface parcels was applied to portal locations and those along the route. Properties abutting cut-and-cover segments were included for the potential need to provide underpinnings and construction easements.

A physical inspection was made of the route. Available information was gathered for all parcels presumed to be affected. This included: property street address, property identifier number (assessment rolls), size, owner, type, zoning, current use, improvements, and age of improvements. If a parcel is improved with a multi-story structure or is zoned to permit such, a notation was made as the existing or potential depth of foundation could pose a problem. During this information search, no indication was found of sales of air rights. Sale of these rights can only be positively determined by doing a title search of each individual property; this is beyond the level of study possible herein. However, having inspected the route and observed the current use and zoning, there do not appear to be any locations with an air rights issue except possibly where interstates pass overhead and passing adjacent to or under electric utility power lines.

All data used was presented to be current as of 2008/2010. Sources included Maryland Department of Planning, City of Baltimore Department of Planning, City of Baltimore GIS Mapping Department, City of Baltimore Office of Assessment and Taxation, Greater Baltimore Board of Realtors Multiple Listing Service, Costar Systems Property Data Service, MRIS Property Sales Database, Google Maps, Maps Live, and consultation with local realtors and appraisers.

PROPERTY INTERESTS CONSIDERED

For all parcels potentially impacted, it was important to identify the current owner and type of owner, i.e., private, corporate, institutional, public, etc. Included in the bundle of rights inherent in fee ownership is subsurface ownership (in some instances those rights may have been excepted in prior conveyances of the property, but this can only be ascertained by title research). The interests to be acquired include: full fee for the surface parcels; subsurface easement for tunneling; and temporary easement for construction staging and access. A subsurface easement represents a fractional interest in the property.

APPLICABLE STATUTES OR PROCEDURES

While no specific state statutes could be identified with regard to acquisition, Maryland Property Law applies as to the nature of property interests held and legal means of transfer for all or part of those rights, i.e., sale, lease, etc. For the purposes of the project it is presumed that a portion of the funding will be from Federal sources, and this mandates that all requirements of the Uniform Federal Acquisition, Appraisal, and Relocation Act must be adhered to.

APPROACH TO VALUE

Utilizing market data developed from the above described research, a grid was made of the route and a calculation of a range of values applicable to the affected parcels was made based upon comparable attributes.

The surface parcels impacted were given an estimated value based upon the comparable data from the marketplace. The tunnel was considered to have minimal impact upon the remaining interest in the properties, given the planned depth of the use. For subsurface easements, a range of value from $3,500 to $5,000 was applied depending upon the area of surface ownership and the percentage of the easement area to that amount. Factors considered included the angle at which the easement traverses the parcel and what the current, planned, and/or permitted use of the parcel is.

The most current project involving extensive tunneling in the U.S. is in northern New Jersey, where construction has commenced on a new passenger rail tunnel beneath the Hudson River to Manhattan. Extensive tunneling rights had to be obtained on both sides of the river. Persons familiar with the valuation and acquisitions for that project were consulted to gain insight into the process and procedures followed. The experience of the acquisitions for the L.A. Metro Rail system and the Baltimore Light Rail and Subway Project were also examined.

While the value of a subsurface easement may be nominal, the attendant required and imposed costs for appraisal, title, legal, and acquisition management generally result in a final cost greater than the value of the easement.

Table 15-4 lists the estimated number of parcels impacted by the Belt-Modified route.

Table 15-4. Estimated Impacted Land Parcels

SECTION	# OF PARCELS	RESIDENCE	RESIDENCE (MULTI)	INDUSTRIAL	COMMERCIAL	PUBLIC
Herbert Run Connection						
Herbert Run Connection	3			2		1
Herbert Run – West Portal	3			2		1
West Portal	1	–	–	1	–	–
West Baltimore to Franklin	22	–	14	6	–	2
W. Franklin to Edmondson	25	22	–	1	2	–
Edmondson to Arnum	8	8	–	–	–	–
Arnum to Presstman	100	97	–	2	1	–
Presstman to Presbury	30	30	–	–	–	–
Presbury to North	66	63	–	–	3	–
North to Penn	10	10	–	–	–	–
Penn to Druid	48	32	8	2	5	1
Druid to Brookfield	13	7	3	–	–	3
Brookfield to East Portal (all public)						
East Portal - Bayview	2	–	–	2	–	–
Total*	**331**	**269**	**25**	**18**	**11**	**8**

* Minimum width impact considered was 100 feet.

GENERAL COMMENTS

- Multiple Ownerships: Several of the easement parcels run beneath condominium ownerships of varying size. A liberal estimate of cost was applied as there was no experience or case history guidance.

- Public Ownership: All of the routes traverse publicly-owned property such as street, parks, maritime, and recreational. No cost was applied as it is presumed a policy and an agreement would be reached with the agency or authority involved.
- Ground Rents: There is a unique aspect to the use and occupancy of land in Baltimore. Many parcels are occupied with surface structures where the owners of the structures do not own the land. They pay ground rent to the fee owner of the land. In many cases, the rents have been in place for generations and are nominal. It is safe to assume that many parcels located in the proposed path of the Belt-Modified route have this condition. Depending upon the number of affected parcels, the acquisition costs will be tempered because the surface users do not have legal standing to object to the proposed subsurface use. However, the owners of the land may welcome receipt of payments offered for the easements as it will far exceed the amount of annual ground rent received (typically $100).

  Those parcels impacted by the proposed project and having ground rent status have not been identified in this analysis. There are an estimated 50,000 ground rent parcels in the City of Baltimore. There is no formal record of the current holders of such interests. In 2007, the city passed an ordinance that requires the holders of ground rent parcels to register them by October 2010. To date, a very large number remain unregistered. Upon expiration of the registration period, those unregistered will be considered extinguished and full fee rights will pass to the surface holder.

ENVIRONMENTAL ASPECTS

The Belt-Modified tunnel route, in conjunction with the Virginia Avenue Tunnel in Washington, DC, would be the last components of a high-dimension railroad freight route that would serve the I-95 corridor from Florida to Philadelphia. This project would have a ***multi-state impact***. The added capability of the new tunnel route would make rail transportation more efficient and competitive with the resultant benefits of diverting freight from trucks and the subsequent reduction in fuel consumption, pollution, and wear and tear on the highway network. Considering overall traffic growth projections for the next fifty years, this could be considered a project of ***national significance.***

The vast majority of the project uses existing in-service railroad routes; therefore, environmental effects are minimal compared to a project involving a comparable length of new right-of-way. This is even more evident considering the route is 15 miles long and must traverse a fully developed and industrialized area, the City of Baltimore. For this project, above-ground construction on new alignments is limited to connecting tracks and the crossings of the Gwynns Falls waterway and Jones Falls Valley. There are, however, some potential impacts that are noteworthy from an environmental standpoint. These are listed below by FTS. They would be subject to full analysis and quantification in documentation required by the NEPA process, which would take place subsequent to this report.

FTS-1	Wetlands in the southeast quadrant
	New highway bridge
FTS-2	A potential historic interlocking tower
FTS-3	A new alignment in a deep cut between two buildings
	New highway bridge
	A crossing of Gwynns Falls waterway and Gwynns Falls Park
FTS-4	A crossing of Gwynns Falls waterway
	The alignment is adjacent to Gwynns Falls waterway
	A crossing of wetlands
	Alignment adjacent to small businesses
FTS-5	Alignment adjacent to Gwynns Falls waterway
	A crossing of Gwynns Falls waterways

	Replacement of bridge spans on two highway bridges
FTS-7	A crossing of Jones Falls waterway and Jones Falls Park
	Alignment adjacent to businesses
FTS-8	Replacement of seven bridges, adjacent to urban development
FTS-9	New highway bridge
FTS-10	A new alignment on a high fill bypassing a potentially historic railroad bridge

SEQUENCE OF PRELIMINARY PROJECTS TO MEET 2050 GOALS

Other than the connections for NS at Herbert Run and Bayview and the track modifications between Saint Denis and West Baltimore, other network track configuration changes are minimal. The changes to the CSXT track configuration needed to route freight traffic to the new freight tunnel also have to provide capacity to accommodate MARC Camden Line commuter service without interference to freight trains. MARC's Camden Line service operates over the CSXT Capital Subdivision between Washington, DC and Camden Station in Baltimore. It serves ten intermediate stations. Commuter ridership on the Camden Line is considerably lower that that on the Northeast Corridor; therefore, track improvements are smaller.

Figure 15-16 presents a schematic of the current and 2020 line configurations between Washington, DC and Baltimore. For illustrative purposes, improvements indicated by the MARC *Growth and Investment Plan* are also shown. By 2015, it is anticipated that one track is added through Ft. Meade between Savage and Jessup, resulting in a four-track configuration. This improvement accommodates the expected increase in commutation to Ft. Meade resulting from the Base Closure and Realignment (BRAC) Program. Also, by 2020, a third track would be extended from Greenbelt into Washington, DC.

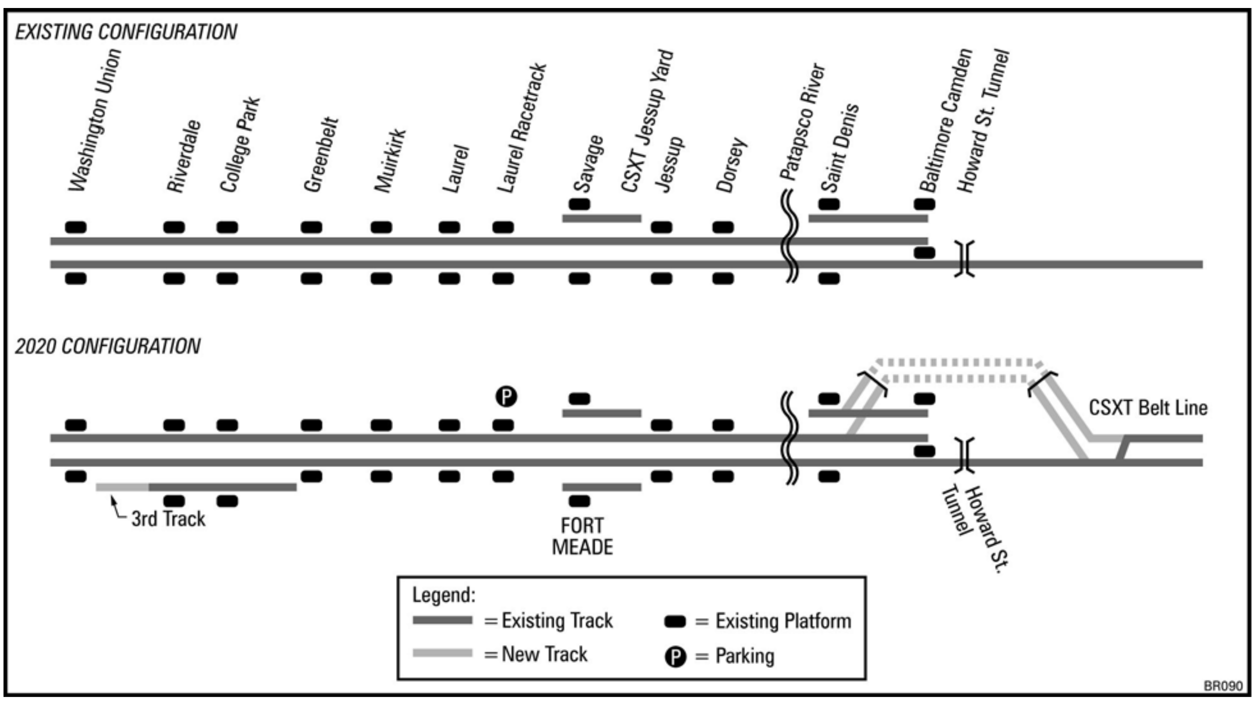


Figure 15-16. Existing and 2020 Configuration

It is probable that the construction of the new freight tunnel would begin during the 2015 - 2020 time period. This scheduling takes into consideration the need to develop a financing plan, complete environmental documentation, negotiate institutional issues (tunnel ownership, dispatching control, liability, NS shared use of CSXT tracks, etc.), and procurement of long-lead construction items. However, the timing of the new freight tunnel is flexible and ultimately dependent upon financing, traffic demand influences, and the generally perceived importance of removing the CSXT tracks from the Howard Street Tunnel.

The implementation of freight service through the new tunnel would eliminate the use of Howard Street Tunnel for CSXT freight service. However, the Howard Street Tunnel could remain in a dormant condition while awaiting other potential uses. It is noted that the Howard Street Tunnel is on the National Register of Historic Places.

Also, the MARC long range plan (beyond 2020) indicates an extension of commuter service from Camden Station through the Howard Street Tunnel to Bayview, possibly serving intermediate stations at Mt. Royal, Charles Village, and Clifton Park. This new extended commuter service would require the use of the CSXT Belt Line, which is also a segment of the Belt-Modified freight route. Although the Belt Line would have double-track, the addition of commuter service would need to be carefully evaluated, considering the potential number of freight trains that could be using the route. It is noted that the Belt-Modified route combines the operation of two major Class 1 railroads onto the only through-freight route crossing Baltimore; as such, freight movements should have absolute priority on its use. CSXT has commented that "The Belt-Modified freight route should maintain 'Freight Only Status' and CSXT is not agreeable to allowing passenger or commuter service onto the already congested freight line."

In addition, the MARC long range build-out for the Camden Line would see expansion from the present double-track configuration to triple-track between Washington, DC and Camden Station. Increased freight traffic would also require additional siding capacity on the CSXT north of Baltimore at Van Bibber and Osbourne. These sidings can be constructed by CSXT as the traffic warrants.

PROJECT COSTS

Table 15-5 presents the construction and associated costs for the Belt-Modified freight route through Baltimore. The primary objective of this cost estimate is to document the methodologies and the practices that have been established for the cost estimating efforts.

COST ESTIMATE

Specific considerations and data inputs utilized in developing this cost estimate include:

- All costs are presented in terms of Year 2010 dollars without escalation.
- A cost benchmark was established by using Eastern Class I railroad data for track installation on existing roadbed.
- A cost benchmark was established by using MDOT for heavy civil earth work associated with roadway grading.
- Earthwork quantities are based on computer-aided design (CAD) Inroads-produced earth work volumes.
- Signals and communications costs are based on the installation of Positive Train Control (PTC) as would be required for the main line freight operations considered herein.
- The geotechnical assessment was based on data available from numerous projects within the study area and three soil borings taken during the course of the project. The three soil borings were taken along the route of the new freight tunnel; although not conclusive, they served to reinforce the initial geotechnical evaluations.
- Tunnel excavation costs are inclusive and account for such items as construction crew size, boring production rates through the varying soils conditions, consumables, invert, sidewalks, cross passages, ventilation, etc.
- Track work unit costs are based on case histories from recent local projects. Track work includes ballast, ties, rail, other track materials, and turnouts.

- Bridges were identified by approximate overall length and span length. Unit bridge costs were determined based on experience with construction costs for similar types of bridges built by Class 1 railroads and recent experience on other projects.
- Property costs were not arrived at by formal appraisal of each property but were calculated based upon an informed opinion of the market place, the circumstance of the affected properties, and the planned use of the interests to be acquired. An average cost per parcel was applied. The market data utilized covered the period 2006 to 2010. Consideration had to be given to the earlier sales to allow for the current skewed market due to volatile economic conditions.

  To reach a more realistic estimate of the final cost, a deviation of 15% above or below the totals should be borne in mind when doing any comparison exercise without the benefit of appraised values for each. Also, the related acquisition costs referred to above can add an additional 50% to 200% or greater. For example, if necessary to condemn an easement having an appraised value of $2,500, the related costs could well exceed $10,000.
- Electric traction costs (catenary and power) are included in the "Structures" cost item.
- The costs used herein emulate the offered prices of a contractor and include direct and indirect costs of general, administrative, overhead, taxes, insurance, and profit. The costs reflect the physical conditions of the Baltimore region and include costs associated with materials delivery to the locations along the alignment.
- A contingency estimate allowance of 25% is added to the total cost of the project.

Table 15-5. Project Costs (in millions)

CONSTRUCTION ITEM	CONSTRUCTION COST	COMPONENT COST
Tunnel (Single Bore, Double-Track)		
Portal Structures	$48.0	
Soft Ground Tunnel	$174.6	
Rock Tunnel	$307.4	
Subtotal	**$530.0**	**$530.0**
Track / Civil		
Earthwork	$6.5	
Track, Interlockings	$84.7	
Subtotal	**$91.2**	**$91.2**
Structures	$156.0	
Signals	$20.0	
Property / Right of Way	$19.1	
Subtotal	**$195.1**	**$195.1**
Design Cost at 8%		$65.3
Construction Management Cost at 5%		$39.8
Contingency at 25%		$230.2
	Total Estimated Cost	**$1,151.6**

CONSTRUCTION/PHASING SCHEDULE

Construction of the tunnel is the central critical path duration in the overall project schedule. Initial estimates indicate that the tunnel construction duration would be about 2.0 to 2.5 years. Construction of the approach tracks and structures would be based on that duration. The overall scheduling strategy would be to begin the construction of the approach trackage so that completion is concurrent with that of the tunnel. At that point, the tunnel and the various track segments would be cut-in to the existing trackage and system tests would be completed.

Because the project is linear, construction can take place simultaneously at many locations. There are a number of major bridge structures in which the construction duration is somewhat less than that of the tunnel. As such, their construction starts almost simultaneously with the tunnel. It is advantageous for the bridges to be completed before the tunnel so that track may be emplaced on them. Interestingly, it is possible that the infrastructure leading to the tunnel could take longer to construct than the tunnel itself.

The magnitude of constructing five major bridge structures simultaneously is challenging. Also, the phasing of the replacement of the seven bridges in FTS-8 within a two-year time frame could be problematic because of the limits placed on the simultaneous closing of streets.

Figure 15-17 presents a concept level Construction and Phasing Schedule and indicates the simultaneous nature of the project. Also indicated in dotted lines are more conservative durations. Above ground construction activities would be adjusted to the actual tunnel construction duration once determined.

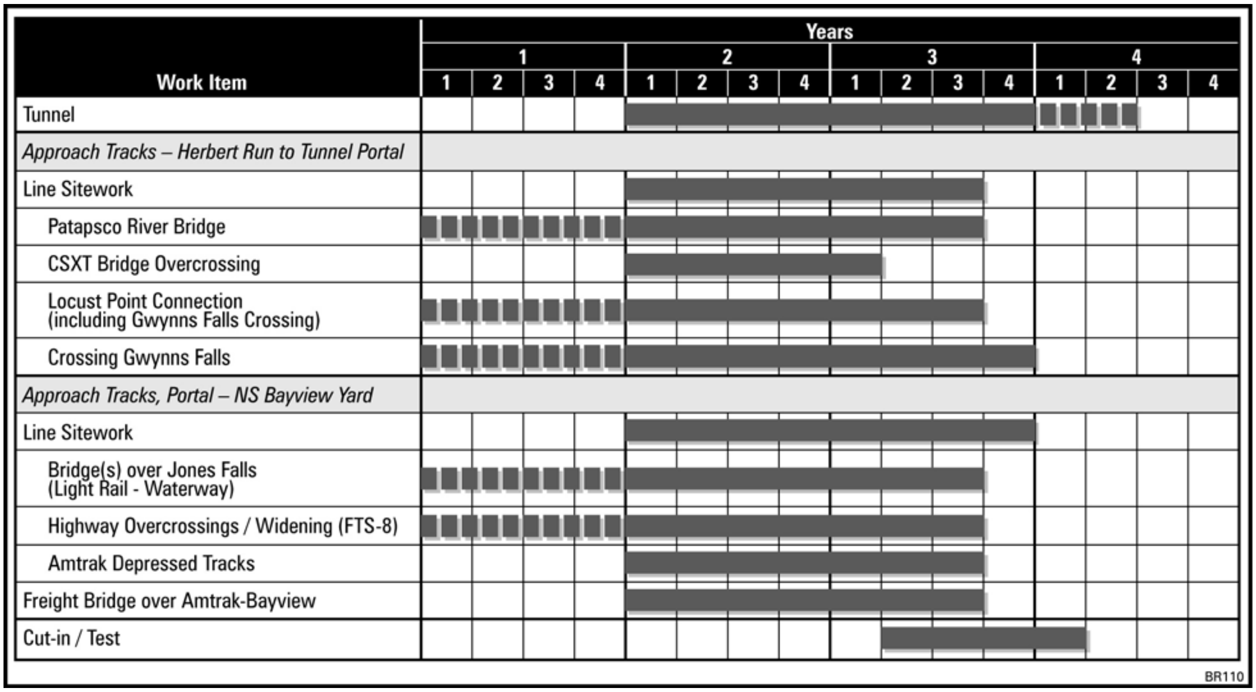


Figure 15-17. Concept Construction and Phasing Schedule

16 – CONCLUSIONS AND PROJECT IMPLEMENTATION ISSUES

INTRODUCTION

The principal goal of this study effort was to develop the alignment and cost of construction for a freight and passenger route through the Baltimore region. The new freight tunnel was to eliminate the use of the Howard Street Tunnel as a freight route through Baltimore. The passenger route, among other objectives, was to replace the B&P Tunnel because of its deteriorating conditions. This goal of this study has been achieved, and the resultant conclusions are presented herewith.

However, before these two projects can proceed to construction, there are institutional issues that need to be resolved, particularly in the case of the freight tunnel. Also presented herewith is a brief discussion of some of the more important issues. Any solutions proffered in the discussion are for illustrative purposes only; they should not be considered a formal recommendation.

CONCLUSIONS

The study team arrived at the following principal conclusions as a result of its investigations:

1. As detailed throughout this report, the Great Circle Passenger Tunnel and the Belt-Modified Freight Alternatives were selected by the stakeholders for the additional engineering and analysis that was undertaken in Phase Two.
2. Baltimore's railway network is so antiquated and underdeveloped, and so important to the Nation's transportation system, as to fully justify the Congressional request for this analysis. For example, the B&P Tunnel was completed eight years after the Civil War ended.
3. Both the passenger and freight alternatives have beneficial impacts beyond state lines. The potential for high-dimension freight and improved passenger service could divert significant passenger and freight traffic off the I-95 Corridor with the associated reduction in energy use, air pollution, highway wear and tear, and congestion.
4. In the environment of Baltimore's topography and development patterns, the needs of freight and passenger service differ so greatly as to mandate separate freight and passenger facilities. To attempt to meet the challenge with a single facility would likely result in compromises that would undermine the justification for any restructuring plan so designed. Indeed, analogous compromises made in the nineteenth century by two separate railroads, each developing a multipurpose facility on limited funds, produced the two inadequate facilities inherited by the railways of today.
5. Further incremental repairs to existing facilities, other than for purposes of safety and operational continuity, will not address any of the inherent geometric problems that plague the transit of Baltimore by rail.
6. Baltimore City, with its heavy existing development, pre-existing facilities, and difficult topography, presents severe engineering challenges to the design of new tunnel crossings, whether for freight or passenger service.
7. If and when the concerned parties wish to progress a restructuring of the railway network in the Baltimore region, significant further analytical work will be unavoidable—and essential to ensure that any possible future investment is wisely and optimally spent.

ISSUES COMMON TO BOTH THE FREIGHT AND PASSENGER TUNNEL PROJECTS

ENVIRONMENTAL PROCESS

The findings presented herein do not represent the final decision as to which passenger and freight route will be ultimately pursued. However, these findings should be used to further the required follow-on National Environmental Policy Act (NEPA) and preliminary engineering work. A final determination of the passenger and freights routes will require further alternatives analysis and evaluation under the NEPA process. Because of the differences in funding avenues between the passenger and freight tunnels, it is almost certain that the projects will proceed independently of one another.

This Report to Congress can be included in future environmental documentation by Formal Reference.

REGIONAL SERVICE AREA (COSTS, BENEFITS, FUNDING)

These two tunnel projects involve regional and national impacts — not just those of local and Maryland impacts. The passenger tunnel would serve the Northeast Corridor (Washington, DC – Boston) and intercity services beyond, while the freight tunnel would serve CSXT and NS north-south services along the I-95 Corridor from Florida to Philadelphia. Also, there are national environmental goals that these projects can help to achieve. Given these factors, the out-of-state benefits should be represented in the funding allocation method adopted for these projects. For the passenger tunnel, Amtrak funding traditionally comes from the Federal Government through the DOT/FRA, and possibly local participation to recognize the commuter use by MARC. For the freight tunnel, participation could include a combination of funds from Federal, local, other beneficiary States, and freight railroad sources.

OWNERSHIP

In usual practice, ownership of property rests with the party who provides the most funds. For the passenger tunnel, ownership would probably follow existing practice in that most of the funding would come from Federal sources with Amtrak (through various agreements with the Federal government) having ownership and maintenance responsibilities.

The freight tunnel is a different matter. It is probable that the majority of the funding would come from the Federal government. The other contributors could consist of State and private sources. A clear line of ownership becomes clouded in this case. A potential solution could be to create a "holding" type company, made up of the joint funding participants, to own the tunnel. Maintenance could be sub contracted to a participating freight railroad or other qualified firm. Ownership of the approach trackage on CSXT property would probably rest with CSXT.

Another option would be for CSXT to own the tunnel and approach trackage outright. Some type of obligation between the funding participants and CSXT would have to be negotiated for the transfer of property. In all funding ownership scenarios, the possibility of charging tolls for tunnel usage may be considered wherein a per car or per train toll is charged, the revenue being used to offset the project's construction costs. A similar arrangement was used to rehabilitate the Shell Pot Bridge in Delaware. However, the toll cost will be recovered in some way by the users; most likely included in transportation rates. Consequently, this will have a negative competitive effect on the applicable rail rates.

GREAT CIRCLE PASSENGER TUNNEL ISSUES

FUNDING

On January 3, 2008, Congress enacted the *Passenger Rail Investment and Improvement Act of 2008.* Section 304, entitled Tunnel Project, provided that a new rail tunnel alignment in Baltimore be developed…"that will permit an increase in train speed and service reliability; and ensure completion of the related environmental review process." An authorization of appropriations of $60 million was provided to carry out this section.

As of this writing, Amtrak and MDOT are progressing the procurement of a contractor to execute the NEPA process. It is anticipated that further design and construction funding will be provided through FRA/Amtrak and possibly MDOT/FTA funding avenues.

FREIGHT TUNNEL ISSUES, BELT-MODIFIED ROUTE

VACANCY AND RELOCATION OF THE NS BULK TERMINAL

The relocation of the NS Bulk Terminal Yard is an absolute and critical component of the Belt-Modified freight route. Throughout the Phase One and Phase Two activities, NS has continually expressed its willingness to discuss relocating from the existing Bulk Terminal Yard site. Because of the critical nature of this property, immediate steps should be taken to obligate this property to the state of MD or other appropriate entity in some manner. Potential options include:

- Purchase and relocate the facility;
- Negotiate to obtain a Right of First Refusal; or
- Develop a binding Memorandum of Understanding (MOU).

OPERATIONAL CONTROL

Once the alignment is agreed to, designed, and constructed, it will need to be operated. In developing a freight alignment available to both NS and CSXT, the issue of control of the operation must be carefully considered. There are several variations on how this can be accomplished.

- One railroad could own and control the line, permitting the other to move trains over it, either by:
  - Trackage rights, where a tenant railroad operates its trains with its own locomotives and crews over the owning railroad's line, or
  - Haulage rights, where the tenant railroad's cars are moved in the owning railroad's trains.
- The line could be jointly operated, with representatives from each railroad working collectively.
- The line could be independently owned and operated, with management having no allegiance to either railroad.

CSXT currently owns a significant portion of the proposed alignment. The tunnel essentially will connect CSXT lines on the east and west sides of the city. It is envisioned that NS will deviate from its current rights and use the proposed alignment between two connections from Amtrak to CSXT.

CSXT has stated that they must dispatch the new route and will not cede control of any segment on the I-95 corridor. It is assumed that NS will maintain that it cannot accept being forced to rely on a route that is controlled by its major competitor. While railroads have coexisted with trackage rights and other similar arrangements at various locations for years, the record is not always good. The difficulty in trackage or haulage rights is that the "tenant" carrier is dependent upon the owner to permit the movement of the tenant's trains. Inevitably, this raises concerns when the limit of line capacity is approached. Ideally, all trains are dispatched without favoritism, but in the real world, that is not always the case and it is difficult to monitor and enforce.

Developing a jointly available facility of this cost and magnitude will require that the two parties be treated fairly and given equal access to its utilization. Although the improvements would largely correspond to existing CSXT alignments, they would be vastly superior in terms of speed, gradient, and capacity to what either freight railroad enjoys currently. Giving both railroads equal access and fairly administrated control would be essential. Each must be convinced that they will be treated fairly.

Furthermore, the potential level of participation must be considered, not in terms of today's levels of traffic, but in terms of what could be generated through the improvements. NS currently handles a limited level of north-south traffic but might be able to attract considerably more if it enjoyed a route of unrestricted clearances that would be free of the current constraints imposed by operation on a high-speed passenger route of restricted line capacity. CSXT would enjoy enhanced operating efficiencies through higher speeds, reduced grades, and reduced congestion. Combining this with unrestricted clearances would serve to build their level of traffic as well.

A potential model for a balanced operation, equally favorable to both parties, already exists, and it was implemented jointly by NS and CSXT. Conrail Shared Assets (CRSA) was created at the time of the Conrail acquisition to operate facilities where it was decided that the Conrail operations could not reasonably be separated. It currently operates in these areas, successfully performing the service as intended while moving the trains of its parent carriers.

AMTRAK CATENARY CLEARANCE FOR PLATE H, WASHINGTON DC – PERRYVILLE, MD

Amtrak has a concern regarding what they see as a fundamental issue with the operation of Plate H equipment under catenary. It is felt that to do so would require that the trolley wire be so high that it may have an adverse impact on operation at very high speeds. The concern is that pantograph oscillation and subsequent wear and tear on pantograph components becomes an issue. There also is a higher potential for dewirement.

It is necessary to determine that the concern expressed about high clearance catenary is, in fact, real and justified. The future installation of Constant Tension Catenary System could potentially alleviate the concern. Although very expensive, such a system is required for higher speed train operations (i.e., + 150 mph) on the NEC.

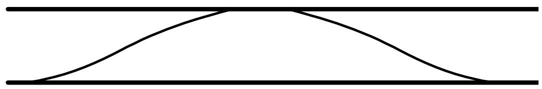
The experience is limited or nonexistent regarding this issue. A detailed analysis is required if a determination is to be made.

THROUGH NORTH-SOUTH ROUTE CLEARANCE - WASHINGTON DC, VIRGINIA AVENUE TUNNEL

There is interdependence between the Baltimore, MD and the Washington, DC rail networks with regard to development of a north-south high-dimension freight route. Such a route would not only require clearance improvements to the Baltimore network but also the Virginia Avenue Tunnel in Washington DC (refer to Section 11 of the Phase One Report). There have been recent efforts to fund this project. Further, there may be clearance improvements needed to overhead structures on the CSXT route between Baltimore and Washington. A cursory review of the alignment conducted in Phase One identified two questionable structures, but this finding must be further verified by field measurements.

GLOSSARY AND LIST OF ACRONYMS

ACRONYM/TERM	MEANING
AAR	Association of American Railroads (headquartered in Washington, DC; represents the Class I railroads)
ADA	Americans with Disabilities Act
AREMA	American Railway Engineering and Maintenance-of-Way Association
Automatic Train Control (ATC)	A track-side system working in conjunction with equipment installed on the locomotive, so arranged that its operation will automatically result in the application of the brakes to stop or control a train's speed at designated restrictions, should the engineer not respond. ATC usually works in conjunction with cab signals.
B&O	Baltimore and Ohio Railroad
B&P	Baltimore and Potomac (relating to the B&P tunnel)
C&O	Chesapeake & Ohio Railway
Catenary	Overhead support wires that supply power to a train, light rail vehicle, or trolley bus.
CBD	A city's Central Business District
CETC	Centralized Electrification and Traffic Control
CFS	FRA's Commercial Feasibility Study of high-speed ground transportation, summarized in the 1997 report *High-Speed Ground Transportation for America,* available on-line at: http://www.fra.dot.gov/Content3.asp?P=515
CLRL	Central Light Rail Line – The Baltimore Light Rail Line between Timonium (at the north end) and BWI Thurgood Marshall Airport, and Cromwell/Glen Bernie (at the south ends) operated by the Mass Transit Administration.
CP	Control Point—a term designating an interlocking, where trains can switch tracks. CP-Virginia is the current designation for the former "Virginia Interlocking."
CPRR	Canadian Pacific Railroad
CSXT	CSX Transportation, Inc.
CTP	Corridor Transportation Plan
Current of Traffic	The movement of trains on a main track, in one direction, specified by the rules.
D&H	Delaware and Hudson Railroad
Dead Head	An operating term used to describe off-duty or non revenue movement of a train crew or train equipment.
Duckunder	A railway structure in which the branch line, separating from the main, gradually ramps down and, on attaining sufficient vertical distance from the main line grade, smoothly bears away from the principal right-of-way beneath a bridge carrying the main line tracks.
FRA	Federal Railroad Administration
GCFT	Great Circle Freight Tunnel—the main component (with variations possible) in a freight solution in the "Near North Sector" as defined in the report.
GCPT	Great Circle Passenger Tunnel—the main component in a passenger solution in the "Near North Sector" as defined in the report.
GIS	Geographical Information System
Home Signal	A fixed signal at the entrance of a route or block to govern trains or engines entering and using that route or block (Standard Code of Rules).
HP	High-level platform (at passenger stations)
HSR	High Speed Rail

ACRONYM/TERM	MEANING
Interlocking	 Schematic of a universal, two-track interlocking (each track is represented by a single line). A location where carefully laid-out turnouts ("switches") allow trains to move from one track to another. The trackwork and accompanying signals are all controlled by a mechanical apparatus and/or electric circuitry that is "interlocked" to prevent conflicting paths from being established for simultaneously passing trains. A universal interlocking on a multiple-track railroad allows trains to move from any track to any other track.
JFX	John F. Kennedy Expressway, otherwise known as I-83
Ladder Track	A track connecting successively the body tracks of a yard.
LP	Low-level platform (at passenger stations)
MARC	The commuter rail operation of the State of Maryland, managed by the State's Mass Transit Administration.
MAROps	Mid-Atlantic Rail Operations Study, prepared for the I-95 Corridor Coalition
MAS	Maximum Authorized Speed
MP	Milepost
MTA	Mass Transit Administration, a component of the Maryland Department of Transportation
NEC	Northeast Corridor – Amtrak route between Washington, DC and Boston, MA.
NECIP	Northeast Corridor Improvement Project (sometimes: Program), a large Federal investment in the NEC main line, most of which occurred between 1976 and 1984.
NEC South	The portion of the NEC main line between New York, Philadelphia (30th Street), Baltimore, and Washington.
NFPA	National Fire Protection Association
NS	Norfolk Southern Corporation
P&BR	Patapsco and Blacks Rivers Railroad
Pickup	A term descriptive of a car or cars added to a train enroute between the departure yard and terminal yard.
PRR	Pennsylvania Railroad
Set-out	A term descriptive of a car or cars detached from a train enroute between yards or terminals.
SHA	State Highway Administration 9in this report refers to Maryland
Slip Switch	 Where two tracks cross at grade at an acute angle, a special piece of trackwork that allows for trains to either go straight or diverge to the other track. A very simple schematic of a slip switch appears to the left. Because slip switches are complex and labor-intensive to maintain, modern railway engineering practice is to avoid them where possible.
STB	Surface Transportation Board, successor to the Interstate Commerce Commission
Stub End	A track or tracks connected to a running track at only one end.
TBM	Tunnel Boring Machine
TEA-21	Transportation Equity Act for the 21st Century, enacted June 9, 1998 as Public Law 105-178.
TPC	Train Performance Calculator

ACRONYM/TERM	MEANING
Track Chart	A scroll-like line diagram of a particular section of railroad, showing (among other items) each track, the degree of curvature and location of each curve, grades, stations, interlockings (“control points”—places where trains can switch from one track to another). and other details of the road’s facilities and geometry.
Washington	All references to “Washington” are to “Washington, DC”.
WM	Western Maryland Railroad

APPENDIX – STAKEHOLDERS' COMMENTS

This appendix contains comments from the stakeholders received upon their review of the final draft of the report. To the extent practical, these comments have been incorporated into the text of the final printed report.

This report was developed over a time span of three years. During the course of this effort, the most up-to-date information was requested from the various sources. Naturally, information changes over time and there are differences between the information used herein and that currently available. In particular, this applies the train operations analysis aspect. Differences arise in the assumptions used for train movements including those for freight, intercity and commuter.

In the future, as operations are further refined, the location of particular facilities may be different from those assumed herein. However, the numbers of trains, locations and configuration of interlockings used in the capacity simulation of this report are representative of those necessary to handle future conditions and serve as a constructive indicator of future requirements.

NATIONAL RAILROAD PASSENGER CORPORATION
30th Street Station, 30th & Market Streets, Philadelphia, PA 19104

AMTRAK

Andrew J. Galloway
Assistant Vice President
Policy & Development - East

November 8, 2010

Richard U. Cogswell
Staff Engineer
Office of Railroad Development, W38-145
Federal Railroad Administration
1200 New Jersey Avenue SE
Washington, DC 20590

Dear Mr. Cogswell:

This is in response to your request to provide comments on the Baltimore Tunnel Phase II study, issued September 2010. In general, we do not disagree with the general principles of the study and the alternatives recommended. Amtrak supports advancing the Great Circle Route Passenger alignment as the preferred alternative which will be the primary facility for future intercity and commuter passenger service. However, we do have comments pertaining to specific aspects of the study / report as follows:

1. The freight connection just north of BWI station is projected to inject significant new freight volumes over the NEC between BWI and Landover, MD. Amtrak did not evaluate substantial movements of freight service as part of the NEC Master Plan for this segment nor can we recall being given the opportunity to have reviewed any study simulations modeling data for it. Given this situation, we can not endorse the report's recommendations for accommodating the projected freight service volumes south of Baltimore.
2. Similarly, Amtrak did not evaluate the substantial projected freight volumes north of Baltimore along the NEC as found in the study. Until we are able to review any detailed modeling data developed by the study team, we can not endorse the projected uses.
3. Of greater importance, we are very concerned the planned design of the proposed grade separation at Bayview Yard to permit NS trains to cross over NEC passenger trains will prevent a planned realignment of the Northeast Corridor tracks to double operating speeds through the area. Given the long-standing mandate by Congress to reduce travel times, and given the opportunity this location provides to make substantive improvements, we can not accept the proposed track configuration for the Bayview area. We believe other configurations can achieve the desired operating conditions without prohibiting important NEC alignment improvements.
4. The MARC train movements, number of stations and ridership growth projections assumed by the study appears to deviate from levels MARC provided Amtrak. We are concerned this difference could negatively affect capacity assumptions of use through the new tunnels and other main line locations.
5. The study recommends retirement and in-filling of the current B&P tunnels. Amtrak believes there likely is merit to making long-term repairs to the B&P, after the new Great Circle tunnels are in service, to retain the use of at least one track for freight, commuter and intercity services when tunnel maintenance or traffic conditions warrant its use. Amtrak proposes to undertake a more detailed engineering feasibility analysis of this option and requests the Phase II report include this concept as part of the future activities.

AMTRAK

Thank you for the opportunity to provide comments. Amtrak is committed to working with FRA and Maryland DOT to advance PE/NEPA for studying passenger rail alternatives including the Great Circle Passenger Route as expeditiously as possible. We look forward to progressing this program in accordance with the agreed-upon schedule. If you have any questions, please feel free to contact me directly at (215) 349-1373.

Sincerely,

Andrew J. Galloway /gr

Andrew J. Galloway
Assistant Vice President, Policy & Development – East

cc: S. Gardner, Amtrak
F. Vacca, Amtrak
C. Rayman-Hughes, Maryland DOT

Frank, Winn B

From: richard.cogswell@dot.gov
Sent: Monday, November 08, 2010 2:31 PM
To: Frank, Winn B
Subject: FW: Baltimore Rail Tunnel Report Comments

From: Hunter, Jake [mailto:Jake_Hunter@csx.com]
Sent: Wednesday, September 15, 2010 5:07 PM
To: nkatsikides@mdot.state.md.us; Cogswell, Richard (FRA)
Cc: Daboin, Sharon; Bell, Evan
Subject: Baltimore Rail Tunnel Report Comments

CSX has received and reviewed the final draft of the Baltimore Rail Tunnel Report. To remain consistent, we would like to provide and reiterate the following comments:

Control

CSXT must dispatch the new route. CSXT will not cede control of any segment on the I-95 corridor, and our participation is dependent on our dispatch authority.

Operation

The belt-modified freight route should maintain "freight-only status" and CSXT is not agreeable to allowing passenger or commuter service onto the already congested freight line.

Contribution

CSXT's participation in this tunnel study is not intended to be a commitment to any level of financial involvement for this project.

Foreign Traffic

By agreement, NS trains are restricted to handling only traffic originating or terminating on the former Richmond, Fredericksburg and Potomac RR Co. or routed via lines of CSXT to or from Richmond, VA

NS COFC/TOFC/GM trains may not exceed 9,000 tons, 125 cars, or 7,500 ft. in length

NS can only operate a total of five (5) trains daily, two (2) of which are Westbound and three (3) of which are Eastbound

We appreciate being involved in this study and the diligence of everyone involved.

Thank you,

Jake Hunter

CSX Transportation

MARYLAND TRANSIT ADMINISTRATION, MARYLAND DEPARTMENT OF TRANSPORTATION TUNNEL COMMENTS

9/15/2010

- The executive summary is very important because that's what will be read by most people.
- There is a lot of confusion between the two tunnels by those not involved in the study.
- The report must explain that although the study was precipitated by the fire, there are no structural issues associated with the Howard St. Tunnel. A new freight tunnel's economic benefits are from better clearances and congestion relief on the only rail freight route in the I-95 corridor.
- While inclusion of an NS option is OK, the report must clarify that the project makes sense even for CSX only.
- The report also does not indicate that CSX has said they are content with the present tunnel. This is the result of their unwillingness to incur substantial capital costs for what they perceive to be a low return.
- It needs to be clear that there is presently no NS through freight south of the tunnel (only local Maryland business).
- It must explain how NS handles north south freight via Front Royal, the investments they have made in that route and that NS has said they <u>will not use</u> a new freight tunnel and why.
- It must also be clear that neither Amtrak nor MTA are satisfied with the proposed NS connection at Bayview and it should not be represented as a done deal.
- For the passenger tunnel it must be made clear that there is not a true "no build option" because something will have to be done to the tunnel if a new tunnel is built.
- It must explicitly explain the cost and operational consequences of trying to rehab the tunnel under traffic at what cost and over what time period.
- Table ES-3 seems to indicate that the present tunnel has fewer delays than any of the passenger tunnel options. It would seem to warrant at least one sentence explaining why that is. Table ES-6 summarizes passenger train delays but does not show MARC.
- On page ES-14 wouldn't it be appropriate to explain why you need four tracks on the NEC except in the tunnel?
- The report needs to be extremely clear throughout the report that it is a feasibility study not to preempt NEPA and that no agreements have been made by any of the stakeholders. The agreements to study the selected alternatives in Phase II should not mean that we all are held to those alternatives as what the stakeholders want to see happen in the future. We had to only pick two alternatives and those seemed to be what most stakeholders except the Port of Baltimore wanted to study. In other words, in next steps, our work in this study does not bind us in any way to the selected alternatives.

NORFOLK SOUTHERN™

Norfolk Southern Corporation
Three Commercial Place
Norfolk, VA 23510-2191

John H. Friedman
Vice President
Strategic Planning
757-533-4948
John.Friedman@nscorp.com

September 14, 2010

Richard Cogswell
Staff Engineer
Federal Railroad Administration
Office of Policy and Planning, West Building
Mail Stop 20, W38-145
1200 New Jersey Avenue, SE,
Washington, DC 20590

RE: Report to Congress: Baltimore's Rail Network

Dear Mr. Cogswell:

First let me thank you for the opportunity to review the draft Baltimore Rail Tunnel report. As you know Norfolk Southern has participated on the team of stakeholders to develop a plan for passenger and freight rail through the City of Baltimore.

After reviewing the Draft Baltimore Rail Tunnel report to Congress, we would like to reiterate some general comments that we feel were not addressed in the report, but can be as the process moves forward.

1. We currently have rights to use Amtrak's Northeast Corridor (NEC) to provide our freight service from Perryville through Baltimore.

2. While our use of the NEC for freight purposes is not perfect, it is adequate for our service today and into the foreseeable future.

3. We believe improvements from Perryville to Baltimore Bayview for intermodal growth is the prudent route.

4. We do not have any rights to use the CSX route through Baltimore.

5. The draft plan includes a proposed connection from the CSX Freight route (CSX) to our Bayview Yard. This could severely restrict our movements and capacity.

6. While we understand that the new passenger tunnel and freight tunnel are on different timelines, we need to maintain our freight service south of Baltimore.

We will continue to work with all the Stakeholders to improve passenger and freight rail service through the City of Baltimore.

Sincerely,

John H. Friedman