Chapter III

Alternatives Development

U.S. Department of Transportation
Federal Railroad Administration

Maryland Department
of Transportation

III. ALTERNATIVES DEVELOPMENT

This FEIS includes a detailed evaluation of the Preferred Alternative for the B&P Tunnel Project in **Chapter VI**. The alternative was advanced through a comprehensive alternatives development and evaluation process that incorporated input from the public as well as federal, state, and local government agencies. FRA has identified Alternative 3B as the Preferred Alternative based on the information provided.

This chapter summarizes the process by which an initial set of sixteen preliminary alternatives were developed and narrowed down based on design criteria, the Project Purpose and Need, evaluation of environmental impacts, and agency and public coordination. The alternatives development process has been documented in the *Preliminary Alternatives Screening Report*, *Alternatives Report*, *and Draft Environmental Impact Statement* (DEIS) documents. Refer to these reports for more detailed information on each phase of the alternatives development process leading up to this FEIS.

The DEIS evaluated four alternatives: Alternative 1: No-Build, Alternative 3A, Alternative 3B, and Alternative 3C. Since the publication of the DEIS, Alternative 3A, Alternative 3B, and Alternative 3C have undergone engineering refinements to reduce impacts and respond to public comments. This chapter includes descriptions of these refinements to Alternative 3A, Alternative 3B, and Alternative 3C.

This chapter also explains the rationale for the identification of Alternative 3B as the Preferred Alternative, which is based on information presented in the FEIS, and public and agency input on the Project alternatives.

A. Alternative Design Elements

1. Alternatives Design Goals

Design development and environmental evaluation were based on design goals that considered existing and future NEC operations, the Baltimore Penn Station Master Plan, and input from agencies and the public.

a. NEC Operations

In the Project Area, NEC operations consist of shared rail service through the B&P Tunnel by Amtrak Northeast Regional and Acela Express passenger trains; the MARC commuter train service between the West Baltimore MARC Station and Baltimore Penn Station; and NS freight. Amtrak NEC service and some MARC Penn Line trains are powered by overhead electric wires (catenary), while other MARC and freight trains are powered by diesel-electric locomotives. MTA plans to increase the number of MARC diesel locomotives by 2019 (MTA, 2013).

A total of 145 daily trains traverse the B&P Tunnel with a maximum of 35 trains during the four-hour afternoon peak period. The majority of trains using the B&P Tunnel are Amtrak trains (61 percent), 38 percent are MARC trains, and less than 1 percent are NS freight trains. In 2014, an estimated 21,600 people passed through the tunnel daily, of which 79 percent are Amtrak passengers and 21 percent MARC passengers.

The NEC is included in multiple national efforts including the HSIPR Program (implemented by the 2009 *High Speed Rail Strategic Plan* (USDOT, 2009)), 2008 Congressional Mandate for Amtrak to Reduce Travel Time along the NEC (Public Law 110-432), *Amtrak NEC Master Plan* (Amtrak, 2010a), and the NEC FUTURE program (USDOT, Accessed September 8, 2014). The B&P Tunnel Project is a "related project" to the NEC FUTURE program and has been coordinated to be consistent with the NEC FUTURE program.

b. Baltimore Penn Station Master Plan

Amtrak's Baltimore Penn Station Master Plan is in its early planning stages that include consideration of both short- and long-term improvements. In the short term, general station improvements would include modifying existing low-level platforms to high-level platforms on certain tracks to provide level boarding. These changes would have only minimal effects to where B&P Tunnel tracks would tie into station tracks, and would impact the configuration of the proposed "Charles" Interlocking. Long-term improvements, such as a streetscape and bike lanes, would not affect or need to be incorporated into the B&P Tunnel Project.

c. West Baltimore MARC Station Improvements

MTA, in coordination with FTA, has been making incremental improvements to the existing West Baltimore MARC Station over the last several years. These improvements consist of upgrades to the facilities including addressing some ADA compliance requirements. It is not feasible to construct a fully accessible station with high level platforms and level boarding that is in compliance with ADA at the current station because it is located along a curved portion of the track. Since the existing Station cannot be completely upgraded to be ADA compliant given the existing track geometry, MTA has been reviewing options to relocate the Station to the south along a straight portion of the track; however, there has been concern from the public and MTA regarding the distance of the potential new station in relation to the existing parking lots and MTA bus lines. Amtrak and MTA have been coordinating the need to maintain service and operations for MARC passengers and the potential to straighten the curve and provide a fully accessible station at the existing location.

d. Overall Design Goals

Several goals for the B&P Tunnel Project guide the design process. The overall design for the B&P Tunnel Project will provide:

- Optimal safety;
- Minimum travel times (maximum speeds);
- Maximum passenger comfort;
- Optimum constructability; and
- Minimum long-term maintenance costs.

The alternatives must meet the Purpose and Need for the Project, as well as preserve as much existing infrastructure as possible. The alternatives should:

- Include four tracks optimized for Amtrak and MARC commuter services, with freight able to provide service on either set of tracks;
- Reduce travel time by enabling higher train speeds;
- Offer greater capacity by increasing the number of tracks and supporting double-stack container freight cars;
- Provide universal interlockings with the NEC mainline;
- Minimize substantial track modifications south of, and over, the Amtrak Gwynns Falls Bridge and through, and north of, Baltimore Penn Station;
- Serve the West Baltimore MARC Station and Baltimore Penn Station;
- Have no impact on the MTA Metro Subway tunnels and underground Penn-North or Upton Avenue/Market stations;
- Preserve the CSX track under Howard Street, Amtrak Jones Falls Bridge, Jones Falls Expressway and the Howard Street Bridge;
- Accommodate freight movement at current levels; and
- Continue operation of the two tracks through the existing tunnel during construction, with temporary outages taken as permitted by rail schedules weekday nights and on weekends during construction.

The B&P Tunnel design should not preclude implementing the alternatives of the NEC FUTURE Tier 1 DEIS (USDOT and FRA, 2015) and FEIS, which is scheduled for publication in fall 2016. The following describes applicable NEC FUTURE constraints:

- Build alternatives include four tracks through the B&P Tunnel.
- Ensure that conflicts do not occur between express through-rail traffic at Baltimore Penn Station and MARC commuter trains turning at the station. The NEC FUTURE program assumes NEC intercity operations would typically be on the railroad's west side of Baltimore Penn Station (geographical north) with MARC operations on the railroad's east side (geographical south). Two mainline tracks would feed each line on either side of the station, which is consistent with the current operating pattern. To provide operational redundancy and resiliency, either service should be able to use alternate station tracks when conditions warrant.

2. Alternative Design Criteria

Design criteria establish the standards and guidance needed to complete the engineering and design work for the proposed B&P Tunnel modernization or replacement. These criteria, standards and guidance are described in the B&P Tunnel Project *Draft Final Design Criteria Report* and form the basis for design updates during the Preliminary Engineering phase of the Project.

Table III-1 summarizes the design criteria and assumptions most relevant to the development and evaluation of B&P Tunnel alternatives. Many design criteria stipulate the components, size, clearance, and placement of design features. These criteria originate from regulations, oversight agency guidance, and knowledge of safety standards, constructability, operational parameters and maintenance needs.

Table III-1: Design Criteria and Assumptions

Design Criterion/Assumption	Description
Design Speed	Intercity Passenger Trains: Maximum 110 mph or greater Commuter Passenger Trains: Maximum 70 mph Freight Trains: Maximum 50 mph
Horizontal Geometry	Curvature should support desired maximum speeds. When a horizontal curve is located on the grade, the maximum allowed grade on the curve is reduced by 0.04 percent for each degree of horizontal curve.
Slope/Grade	Grades measured as the change in elevation in feet per 100 feet of horizontal distance shall not exceed 2 feet (or 2.000 percent grade). Avoid frequent changes in gradient.
Geotechnical	Maximize tunnel placement in bedrock to minimize the amount of soft ground and mixed-face mining required.
Mining Tunnel Portal	Minimum 50-foot depth from ground surface to top of rail for underground construction.
Tunnel Clearance	One set of tracks per bore. Design to Plate H clearances suitable for double-stack container freight operations with an operating envelope, generally, of 10 feet 8 inches wide by 20 feet 3 inches tall.
Internal Tunnel Dimensions	Approximately 30 feet diameter to allow safe passage of trains, operation and maintenance of tunnel, and meet applicable regulatory code.

Design Criterion/Assumption	Description
Fire Life/Safety	Ensure emergency ventilation and exits. Emergency ventilation provided by jet fans in the tunnel and/or ventilation facilities housing fans and other equipment. With multiple tunnels, place cross passageways connecting separate track tunnels at no more than 800 foot intervals between adjacent tunnels or use fire-resistant enclosed stairways/passageways to surface, per National Fire Protection Association (NFPA) 130. The maximum distance between emergency exits cannot exceed 2,500 feet. Provide evacuation walkways per NFPA 130.
Signals	Design based on universal interlockings at the "Charles" Interlocking on the north and the "Bridge" Interlocking on the south.
Utilities	Consider railroad alignment changes to avoid or minimize difficult or costly utility relocations.
Right-of-Way	Safety and security of the public, as well as the neighborhoods that house the railroad, require a physically separate right-of-way with a well-protected perimeter. The Project must, by location and design, prevent unauthorized intrusion into or upon the operating railroad environment, and discourage vandalism, loitering, or dumping on the right-of-way or adjacent to facilities.

3. Four Tracks

Consistent with NEC long-range planning needs identified in the NEC FUTURE program, the B&P Tunnel Alternatives propose a total of four tracks through Baltimore. The increased number of tracks will eliminate a chokepoint and expand capacity to accommodate future high-frequency, high-speed passenger train service anticipated on the NEC by 2040. Four tracks provide the resiliency/redundancy needed to maintain rail traffic between the West Baltimore MARC Station and Baltimore Penn Station, and NEC connectivity in the event of interruptions to service on any of the tracks. Four tracks also provide the ability for conflict-free operation and separation of traffic types (intercity vs. commuter) which further improves operations, reduces travel time, and accommodates over-takes of slower trains by faster trains.

To accommodate the train volumes identified in the NEC FUTURE Tier 1 EIS ridership forecasts, all of the NEC FUTURE Action Alternatives propose four tracks through the Study Area, as well as north and south of the tunnel. To include less than four tracks would create a chokepoint in conflict with the Tier 1 NEC FUTURE Alternatives. The volumes of trains forecast for each of the NEC FUTURE Action Alternatives would not be accommodated without this increased throughput in Baltimore, including a four-track alignment through the B&P Tunnel Study Area (FRA, 2015).

4. Plate H Clearance

Two freight railroad operators, NS and CSX, currently have trackage rights to route freight along the NEC, as described in Chapter II. Amtrak practices followed for all new infrastructure projects along the entire NEC, and in accordance with national rail policy, recognize the value of designing new tunnels to allow additional and larger freight trains. Because of the long lifespan of the proposed tunnels, precluding future double-stack freight use is considered undesirable even though the proposed tunnels could not immediately be used by double-stack freight trains. Smaller dimension would govern the maximum clearance through Baltimore on the NEC for the 150-year life of the new tunnels. The build alternatives would therefore have tunnel clearances to accommodate double-stack container freight cars, known as AAR (Association of American Railroads) Plate H. The current tunnel does not accommodate Plate H equipment and could not accommodate Plate H equipment without reconstruction.

5. Four Separate Tunnel Bores

Single sets of tracks in four separate, equally-sized tunnel bores are proposed. The single track design instead of two double-track tunnels is based on several criteria: conflict-free operations, physical constraints, and constructability. FRA, in consultation with Amtrak, has determined that four tunnel bores with one track each, as opposed to two bores with two tracks each, would better meet the Project's operational and safety needs.

a. Operational and Safety Needs

Alternatives were developed and designed with the goal of conflict-free operations and service flexibility, so that the number of conflicting moves at railroad interlockings and places where two or more sets of tracks would cross (junctions) are minimized. These movements can be controlled by at-grade signaling or grade-separated crossings. A subterranean grade-separated track crossing or "duck under" is proposed as the most efficient method for preventing conflicts, and maintaining operational goals, for the new four-track B&P Tunnel. This could not be achieved if two sets of tracks were together in a single tunnel. Four separate tunnel bores also allows for service to continue if one or more tracks is out of service.

Four separate tunnel bores allows for the use of cross-passages between the tunnel bores to facilitate emergency egress through some portions of the tunnels. In the case of an emergency, passengers can exit one tunnel bore into an adjacent tunnel through cross-passages in order to safely evacuate.

b. Physical Constraints

The separation of four sets of tracks into individual tunnel bores is driven by physical constraints that include passing beneath the existing MTA Metro Subway tunnel and its Penn-North or Upton/Avenue Market stations. The depth of the subway and geotechnical ground conditions require approximately one-half tunnel diameter of separation, which would result in a railroad grade just under the design criterion of 2.000 percent. Two percent is the maximum design grade allowable to connect to the existing NEC near the West Baltimore MARC Station. A single bore with two sets of tracks would be wider and taller, resulting in an increased vertical separation between the new tunnel and the MTA Metro Subway. Lowering the tunnel to provide the additional clearance would increase the steepness of the grade and exceed the maximum for connection to the NEC at the West Baltimore MARC Station. To avoid an increase in profile grade, the connection between a new B&P Tunnel with double tracks and the existing NEC would have to be made further south of the West Baltimore MARC Station. This would increase surface impacts by requiring a longer trench excavation for the approach to the new tunnel, require modifications to the West Baltimore MARC Station, and cause more extensive impacts to adjacent communities.

c. Constructability

Another issue in the decision to construct four sets of tracks in four separate tunnel bores is constructability of the tunnel portal, where the surface transitions to the underground tunnel bore. A conservative criterion used to select the location of a tunnel portal is where ground cover above the tunnel is a minimum of 75 percent of the proposed tunnel diameter. Single tracks in a single bore would be a minimum of 50 feet below the overlying ground surface to the top of rail elevation. Two tracks per bore would be a minimum of 62 feet from top of rail elevation to the overlying ground surface. The latter would not work at the north portal because the grade would be too steep for connecting to the existing "Charles" Interlocking, which is a relatively short distance to the railroad north (geographical southeast).

The available space for the "Charles" Interlocking between the north portal and Baltimore Penn Station is a limiting factor. The limited space would also incur more surface impacts at the south portal from a longer trenched approach, which would connect to the existing NEC alignment further south. The north and south portals could be shifted further away from the existing alignment, but this would encroach further into neighborhoods and greatly increase environmental impacts to communities.

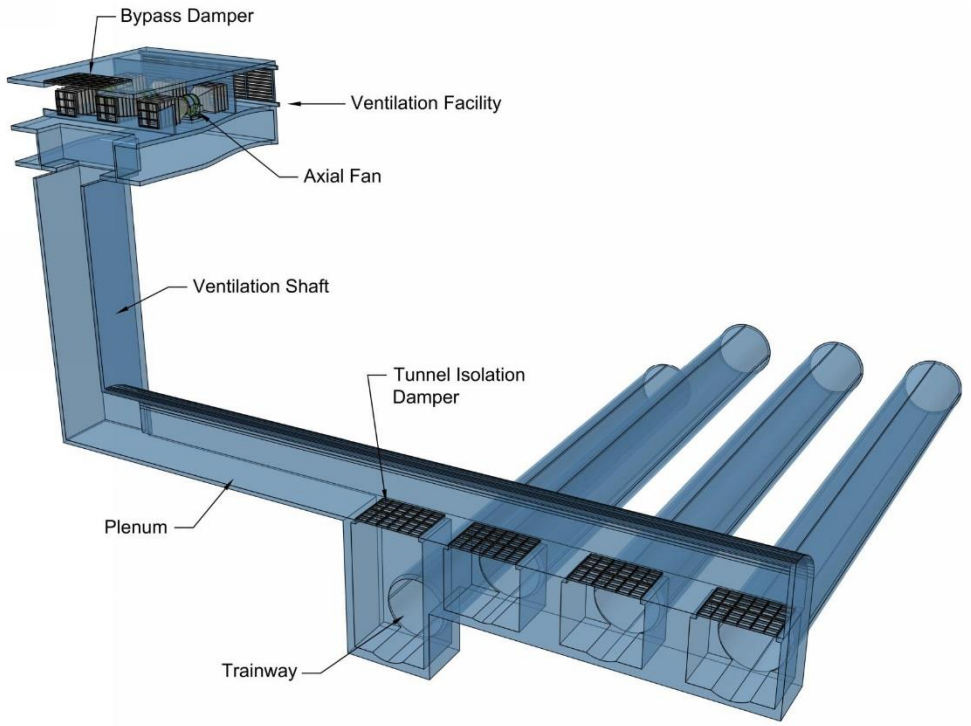
6. Ventilation Facilities

Each build alternative evaluated for the B&P Tunnel Project would require a ventilation system with three above ground ventilation facilities in order to meet current safety industry standards, particularly NFPA 130 for projected NEC FUTURE train demand and assumed two-minute minimum headway.

Ventilation facilities are an essential Life/Safety component of the B&P Tunnel Project. As shown in **Figure III-1**, the facilities are above ground structures, housing facilities essential to safely and securely perform necessary tunnel ventilation, which includes fans, operation and control equipment, fire protection equipment, and emergency exits. The purpose of the ventilation facility is to pull fresh air into the tunnel and ventilate the tunnel air to the outside; this is done through both passive (from train movement) and active (from fans) ventilation. Passive or active ventilation occurs depending on the following tunnel operations:

- Normal operation: trains run at their scheduled speed, providing sufficient ventilation through the piston effect, or "push-pull" movement. A longer ventilation plenum reduces the effectiveness of passive ventilation.
- Congested operation: trains run at slower speeds and do not provide sufficient passive ventilation, necessitating active mechanical ventilation.
- Maintenance operation: while work is being performed in the tunnel, trains would not provide sufficient passive ventilation, requiring active mechanical ventilation to provide a safe atmosphere for workers. Ventilation facilities maintain safe air quality by automatically turning on fans when sensors indicate air is nearing air quality standards for nitrogen dioxides, an indicator pollutant, regulated by the Occupational Safety and Health Administration (OSHA). The air discharged from the fan plants will meet national ambient air quality standards (NAAQS). The ventilation facilities will also remove heat generated by train operations from inside the tunnel, thereby maintaining appropriate temperatures in the tunnel for passenger trains, work crews, and emergency responders.
- Emergency operation: in a potential emergency situation, active mechanical ventilation is necessitated to control heat and smoke to provide a tenable environment for first responders and emergency egress.

Figure III-1: Ventilation Facility Schematic



The number and placement of ventilation facilities are determined by tunnel length and the necessary number of ventilation zones. Three ventilation facilities—one near the north portal, one at an intermediate location along the tunnel alignment, and one at the south portal—are needed to divide each build alternative into two ventilation zones.

The NEC FUTURE program calls for service headways of three minutes between trains through the Project corridor. Service headways are the practical average headways between trains that can be routinely achieved in the operation of the railroad. Design headways, in contrast, are the theoretical minimum headway that is permitted while achieving safe braking distance between trains. The design headway for the Project is based upon the industry practice of using approximately 67 percent of the service headway; therefore, the design headway is two minutes for the build alternatives.

The tunnels proposed under each build alternative would be approximately two miles long, and projected NEC FUTURE train demand and headway could not be met with a single ventilation zone tunnel. Current industry safety standards dictate that only one train can be permitted in a ventilation zone at a time. Train performance models show that the NEC FUTURE demand and headway requirements require two ventilation zones for the build alternatives. The interface between the two ventilation zones must be located at the point that balances travel time in each ventilation zone (considering both directions). The ventilation zone interface is not in the geographic center of the tunnel for Alternatives 3A, 3B, and 3C due to asymmetrical curvature and grades, trains entering the tunnel at differing speeds depending on their direction of travel, and braking distances.

The ventilation zones are created by installing tunnel isolation dampers in the tunnel ceiling at the interface location (**Figure III-1**). The dampers are connected to the Intermediate Ventilation Facility at the surface by a horizontal connecting tunnel (plenum) and vertical shaft. To meet practical air velocities and pressures, this conduit must have a cross-sectional area larger than 30 feet in diameter.

Preliminary engineering determined that a building sized approximately 100 feet by 200 feet and 55 to 70 feet tall would be needed for each ventilation facility. This size is provided as a rough order of magnitude; however, the dimensions of each ventilation facility will vary based on site-specific design. Since publication of the DEIS, the original height estimate of 55 feet has been increased to ensure adequate emission dispersion in compliance with air quality standards. More detailed information on current ventilation facility designs and air quality analysis is included in **Chapters IV and VI**. The facility is sized to address emergency ventilation requirements in one tunnel at a time; this emergency capacity provides sufficient capability for normal, congested, and maintenance operations in all four tunnels simultaneously.

The size of the ventilation facilities is determined by the equipment that is located within them, which is largely dictated by the size of fire that is to be controlled by the ventilation facility. The ventilation facilities must be large enough to house the required number of fans and ancillary equipment, such as silencers and dampers, as well as associated ductwork to connect to the tunnel, and space to conduct deliveries and maintenance. The ventilation facilities contain electrical equipment, such as transformers and motor starters, and provide emergency and maintenance access to the tunnels. To the greatest extent practical, the ventilation facilities would conform to local building codes and the exterior façade would complement/blend in with the built environment.

B. Preliminary Alternatives Development and Screening

The initial range of alternatives was identified based on previous studies, including the two phases of the *Baltimore's Railroad Network Study* (FRA, 2005; FRA and MDOT, 2011) and during the preliminary alternatives development phase of the Project. A total of 16 preliminary alternatives were identified, including Alternative 1: No-Build, Alternative 2: Restore/Rehabilitate Existing B&P Tunnel, and 14 new location alternatives. The 14 new location alternatives included five alternatives based on previous studies (Alternatives 3 through 7), and

nine additional alternatives identified by this Project (Alternatives 8 through 16). Alternative 16 was based on public comments received at the October 29, 2014 public open house.

FRA considered the following preliminary alternatives:

- Alternative 1: No-Build
- Alternative 2: Restore/Rehabilitate Existing B&P Tunnel
- Alternative 3: Great Circle Passenger Tunnel
- Alternative 4: Presstman Street
- Alternative 5: Route 40
- Alternative 6: Locust Point
- Alternative 7: Sports Complex
- Alternative 8: Wilson Street—Existing Tunnel
- Alternative 9: Mosher Street North
- Alternative 10: Mosher Street South
- Alternative 11: Robert Street South
- Alternative 12: Robert Street North
- Alternative 13: Wilson Street—Under Existing Tunnel
- Alternative 14: North Avenue Bridge
- Alternative 15: Gilmor Street—Existing Tunnel
- Alternative 16: North Avenue Tunnel (Alternative from Public Input)

The preliminary alternatives screening process was applied to all of the 16 preliminary alternatives with the exception of Alternative 1: No-Build and Alternative 2: Restore/Rehabilitate Existing B&P Tunnel. In accordance with Council on Environmental Quality guidance (40 CFR § 1502.14(d)), Alternative 1: No-Build was not screened, as it is the baseline against which the impacts of the build alternatives are assessed. Alternative 2 was not fully evaluated because there was insufficient information at the time on the most appropriate manner of tunnel restoration and rehabilitation, future uses of the existing tunnel, and whether reconstruction of the tunnel could reasonably accommodate train operations.

Alternatives 3 through 16 were first screened for fatal flaws that clearly rendered the alternative not feasible or unreasonable. An alternative was considered to have a fatal flaw if it did not meet Purpose and Need, did not utilize existing infrastructure at Baltimore Penn Station and the Gwynns Falls Bridge, or would result in an unacceptable engineering issue that could not be reasonably avoided or solved during the early stages of alternatives development. Alternative 5: Route 40, Alternative 6: Locust Point, Alternative 7: Sports Complex, Alternative 14: North Avenue Bridge, Alternative 15: Gilmor Street, and Alternative 16: North Avenue Tunnel, were all found to have fatal flaws as summarized in **Table III-2**.

The eight remaining preliminary alternatives that did not have fatal flaws were then evaluated using criteria derived from the Project Purpose and Need, as well as functional needs identified by FRA, MDOT, and Amtrak. A total of 19 screening criteria within three categories were identified: Engineering, Operational, and Environmental. These criteria are summarized below.

1. Engineering

- Tunnel Separation: the minimum separation between existing underground structures (especially the MTA Metro Subway tunnel) and the proposed tunnel should be 30 to 40 feet.
- Tunnel Clearance: alternatives should be able to accommodate Plate H (double-stack) clearance for either twin single-track tunnels or a single double-track tunnel.
- Horizontal Curvature: alternatives should allow for design speed of 40 miles per hour or greater.
- Vertical Grade: the maximum vertical compensated grade should not exceed two percent.
- West Baltimore MARC Station Service: the alternative should be capable of serving the West Baltimore MARC Station.

- Track Grade at Baltimore Penn Station: alternatives should not alter existing track alignments at Baltimore Penn Station.
- Physical Constraints: the alternatives should not impact physical constraints, including MTA Light Rail, MTA Metro Subway, the CSX track under Howard Street, the Jones Falls Bridge, the Jones Falls Expressway, and the Howard Street Bridge.
- Separated Right-of-Way: tunnels should be on physically separate right-of-way within a well-protected perimeter.

2. Operational

- Amtrak and MARC Operations: Amtrak and MARC should be able to maintain the volume and frequency of trains through Baltimore Penn Station with no significant interruptions.
- Number of Tracks and Throughput Capacity: tunnels should include at least two tracks and a practical throughput capacity of at least 24 trains per hour per direction during and after construction. This is equivalent to a theoretical throughput capacity of 30 trains per hour or two-minute headways between trains.
- Travel Time: tunnels should reduce travel time between the northern and southern Project limits.
- NEC Operational Reliability: each track should be bi-directional and the tunnel should have universal interlocking with the NEC mainline (the ability for a train on any track to reach any other track within the limits of the interlocking).
- Movement of Freight: alternative should accommodate movement of freight at current (2015) levels.

3. Environmental

- Primary Construction Method: tunnels should be primarily bored, and should require limited cut-and-cover construction.
- Parks: impacts to parks located within the surface disturbance footprint should be avoided or minimized.
- Residential Land Uses: impacts to residential land use areas within the surface footprint should be avoided or minimized.
- Existing Bridge over Jones Falls: alternatives should utilize the existing bridge over Jones Falls.
- Minority and Low-income Communities: alternatives should avoid or minimize impacts to low-income and minority populations.
- Historic Districts and Structures: effects to historic districts and structures within the surface footprint should be avoided or minimized.

As a result of this initial screening process, twelve alternatives were eliminated from further study, and four alternatives, including Alternative 1 and Alternative 2, were retained for further engineering development and environmental evaluation. This information was presented to the public in December 2014 in the *Preliminary Alternatives Screening Report*. The results of this evaluation are shown in **Table III-2.**

Table III-2: Preliminary Alternatives Screening Results

	Alternative	Basis for Elimination or Retention
Eliminated from Study	Alternative 4: Presstman Street	• Does not meet tunnel separation requirement. • Amount of cut-and-cover construction would likely result in more severe environmental impacts relative to the other alternatives.
	Alternative 5: Route 40	• Fatal flaw: Does not utilize existing infrastructure at Baltimore Penn Station.
	Alternative 6: Locust Point	• Fatal flaw: Does not utilize existing infrastructure at Baltimore Penn Station.
	Alternative 7: Sports Complex	• Fatal flaw: Does not utilize existing infrastructure at Baltimore Penn Station.
	Alternative 8: Wilson Street—Existing Tunnel	• Requires closing the existing tunnel during construction. • Fails to avoid a key physical constraint (CSX mainline). • Likely to have substantial environmental impacts.
	Alternative 9: Mosher Street North	• Conflicts with multiple rail lines at Baltimore Penn Station. • Fails to meet NEC reliability criterion that requires two-track operation and universal interlocking with the existing NEC mainline.
	Alternative 10: Mosher Street South	• Conflicts with multiple rail lines at Baltimore Penn Station. • Fails to meet NEC reliability criterion that requires two-track operation and universal interlocking with the existing NEC mainline. • Fails to avoid a key physical constraint (CSX mainline). • Likely to have substantial environmental impacts.
	Alternative 12: Robert Street North	• Fails to avoid a key physical constraint (MTA Metro Subway rail line). • Fails to maintain existing passenger operations during construction. • May have substantial environmental impacts.
	Alternative 13: Wilson Street-Under Existing Tunnel	• Fails to avoid a key physical constraint (CSX mainline). • Fails to maintain existing passenger operations during construction. • May have substantial environmental impacts.
	Alternative 14: North Avenue Bridge	• Fails to meet profile grade requirements. • May have substantial environmental impacts.
	Alternative 15: Gilmor Street—Existing Tunnel	• Proposed geometry impossible to design or construct.
	Alternative 16: North Avenue Tunnel	• Fails to meet profile grade requirements.

	Alternative	Basis for Elimination or Retention
Retained for Further Study	Alternative 1: No-Build	• Serves as baseline for comparison to other alternatives.
	Alternative 2: Restore/Rehabilitate Existing B&P Tunnel	• Additional information needed to determine the viability of alternative; in particular, the most appropriate method of tunnel restoration or rehabilitation, and whether construction could reasonably accommodate train operations.
	Alternative 3: Great Circle Passenger Tunnel	• Does not contain a fatal flaw and meets engineering, operational and environmental criteria.
	Alternative 11: Robert Street South	• Does not contain a fatal flaw and meets engineering, operational and environmental criteria.

Based on the *Preliminary Alternatives Screening Report* screening criteria, Alternatives 3 and 11 met tunnel separation goals; had less conflict with physical constraints; maintained existing Amtrak, MARC and freight operations; maintained at least two tracks and throughput capacity of at least 24 trains per hour in each direction; supported NEC reliability; and required a potentially less-invasive primary construction method (boring instead of cut-and-cover). The remaining four alternatives (Alternative 1: No-Build, Alternative 2: Restore/Rehabilitate Existing B&P Tunnel, Alternative 3: Great Circle Passenger Tunnel, and Alternative 11: Robert Street South) were retained for further design development and environmental evaluation.

C. Alternatives Development and Screening in the Alternatives Report

Alternatives 1, 2, 3, and 11 were carried forward from the *Preliminary Alternatives Screening Report* and underwent an additional, more detailed preliminary engineering review based on refined design goals, criteria, future rail demands, required operational services, and safety. As a result of the refined goals and more detailed engineering, described in the *Alternatives Report*, Alternatives 3 and 11 were each expanded to include several Options. These Options consisted of potential alignment shifts and other adjustments possible under the general concepts of Alternatives 3 and 11. Alternative 3 included Options A, B, and C. Alternative 11 included Options A and B. Construction methods and potential community impacts were also taken into consideration during the development of the alternatives, and included public and agency input**.**

The *Alternatives Report* evaluated and compared the alternatives in much greater detail than the *Preliminary Alternatives Screening Report*. The preliminary screening criteria were replaced with a new set of 52 evaluation criteria, which were developed to more fully evaluate the key potential impacts and benefits of each Alternative and Option summarized above. These criteria include design criteria, design goals, and environmental impacts. The overall categories are Operations, Engineering, Transportation, Cost, Construction, Right-of-Way, Community Resources, Cultural Resources, Natural Resources, and Other Environmental. (The same 52 criteria were used in the DEIS and in this FEIS, as shown in **Table III-5,** below.) The *Alternatives Repor*t documented the conclusion that Alternative 1: No-Build, Alternative 3 Option A (Alternative 3A), Alternative 3 Option B (Alternative 3B), and Alternative 3 Option C (Alternative 3C) were still under consideration. Alternative 2, Alternative 11 Option A, and Alternative 11 Option B were eliminated from further consideration. The reasons for elimination are described below.

1. Alternative 2: Reconstruct/Modernize Existing Tunnel

Alternative 2 would reconstruct and modernize the existing tunnel, but would not meet the Project's Purpose and Need.

Specific reasons for the elimination of Alternative 2:

- Construction would require the complete cessation of rail service along the NEC corridor, including all Amtrak service, MARC service north of the West Baltimore MARC Station, and freight service using the B&P Tunnel during construction. Service would be interrupted for an extended period of time, as long as several years.
- Design speeds would be the same as the current tunnel; horizontal geometry would remain effectively unchanged. Design speed would be as low as 30 mph, significantly lower than the other build alternatives.
- No travel time savings over existing conditions.
- Can only accommodate two tracks, which does not allow for future growth in rail service along the NEC.
- An option to build four new tracks could be accommodated by more significant widening of the existing alignment. This option was not analyzed because there is no available right-of-way and widening would require significant residential takes for the entire length of the alignment.
- An option to build four new tracks under the existing tunnel (in a two-by-two arrangement) is not feasible due to the clearance needed from the MTA Metro Subway line and geometry needed to bring the tracks together in a four-track arrangement transitioning from the tunnel portals.
- Due to the shallow depth of the existing tunnel, the only viable construction approach is open excavation along the entire tunnel length. This excavation would have significant impacts on the community, including the following:
    - Full or partial closure of Wilson Street, Winchester Street, and numerous cross streets throughout construction;
    - No parking along Wilson Street or Winchester Street during construction;
    - Limitations for residential and commercial access along Wilson and Winchester Streets during construction;
    - Minor impacts to four parks—Eutaw Place Median Park, Park Avenue Median Park, Mount Royal Median Park, and Fitzgerald Park;
    - Substantial residential property impacts; and
    - Severe impacts to North Avenue, central MTA Light Rail line, and CSX Main Line operations due to open-cut construction through North Avenue, the light rail, and CSX track beds.

2. Alternative 11 Option A

Alternative 11 Option A would meet the Project Purpose and Need. However, the overall impacts would not result in commensurate benefits compared to the alternatives still under consideration.

Specific reasons for the elimination of Alternative 11 Option A:

- Extensive excavation in a residential area, with the following resulting impacts:
    - 140 historic buildings impacted, more than any other Build Alternative;
    - 160 parcels impacted, more than any other Build Alternative;
    - 140 residential displacements, more than any other Build Alternative;
    - 20 business displacements, more than any other Build Alternative;
    - Loss of 120 on-street parking spaces;
    - High-level of community impacts during construction;
    - Potential environmental justice considerations—impacts within minority communities and partially within low-income communities;
    - 210 buildings with potential noise impacts, more than any other Build Alternative; and
    - Permanent closure of some sections of local streets.

- West Baltimore MARC Station shifted further south, which is a less desirable location for the station and would reduce access to parking lots and bus lines.
- Demolition of the American Ice Company building, a locally-important, community historic resource.
- Potentially severe impact to redevelopment efforts envisioned in the West Baltimore MARC Station Master Plan due to relocation of the station away from planned redevelopment properties and demolition of the American Ice Company building, a centerpiece of the plan.
- Impacts to Winterling Elementary School.

3. Alternative 11 Option B

Alternative 11 Option B would meet the Project Purpose and Need. However, the overall impacts, less operational flexibility, and high construction cost would not result in commensurate benefits compared to the alternatives still under consideration.

Specific reasons for the elimination of Alternative 11 Option B:

- Requires demolition of the entire block bounded by Edmondson Avenue, Franklin Street, Pulaski Street, and the NEC. Due to the construction, the entire block is lost to excavation and the needs of the B&P Project. There is no opportunity to use cut-and-cover construction and gain back any of the property for other uses.
- Potential environmental justice considerations: all residences and businesses taken are within minority and low income communities.
- Potentially severe impacts to the redevelopment efforts envisioned in the West Baltimore MARC Station Master Plan, including demolition of nearby properties proposed for redevelopment.
- Historic resources impacts including demolition of the American Ice Company building and other historic resources in the Midtown-Edmondson Historic District.
- Minor impacts to Mary Ann Winterling Elementary School recreational facilities.
- Reconstruction of Franklin and Mulberry Streets at a higher elevation to accommodate Alternative 11 Option B passing underneath. The higher elevation would raise Franklin and Mulberry Streets to between 10 and 20 feet, with resultant impacts including visual effects.
- Highest capital cost among build alternatives, estimated at the time of screening at $4.2 billion.
- Requires a MARC Station to be constructed below surface grade, in a cut section.
- Requires taking of a portion of the existing West Baltimore MARC Station parking lots.
- Less operational flexibility compared with other build options:
    - During construction, most work would be performed without affecting NEC operations once temporary runaround tracks and temporary viaduct are in place. However, the runaround tracks require a lower operating speed, thereby affecting train movement during the Project.
    - Alternative does not accommodate a replacement for the existing “Fulton” (partial) Interlocking. If one of the two tracks that serve the side platforms at the West Baltimore MARC Station was out-of-service, one MARC platform would not be accessible.

D. Alternatives Considered in the DEIS

Four alternatives were evaluated in the DEIS: Alternative 1: No-Build, Alternative 3A, Alternative 3B, and Alternative 3C. The build alternatives evaluated in the DEIS are described below.

1. Alternatives 3A, 3B, and 3C

Alternatives 3A, 3B, and 3C would extend on a new location along a wide arc north of the existing B&P Tunnel. The wide, continuous arc of each proposed alignment allows trains to travel at higher speeds. Alternatives 3A, 3B, and 3C were developed, in part, as a way to bypass the tight curves that slow train traffic through the existing B&P Tunnel while still maintaining platforms at Baltimore Penn Station.

Tracks in four separate tunnel bores extend between the north and south portals. The alignments would remain below ground until exiting through the tunnel portals, where the tracks would transition back to the surface. Alternatives 3A, 3B, and 3C would each involve open-cut and cut-and-cover sections to bring the tracks to the surface after exiting the tunnel portals on each end. Tracks would pass through the portals, through a cut-and-cover section, followed by an open-cut (trench) section prior to connecting with the existing NEC alignment.

There are several design elements that would apply to each of the Alternatives, as described below:

- All three Alternatives include a four-track alignment in four individual tunnel bores.
- Each Alternative would provide universal interlockings to the NEC mainline and would avoid the MTA Metro Subway while servicing the West Baltimore MARC Station.
- Each includes a “duck under” tunnel to facilitate conflict-free operations. To properly align the tracks, the southbound MARC commuter train track would duck under the two Amtrak tracks to align as the west track on the southbound platform of the West Baltimore MARC Station.
- All three Alternatives would relocate a pier of CSX (formerly B&O) Bridge Number 3.
- NEC service would continue through the existing tunnel during construction of a new alignment.
- Each Alternative would involve surface track work between the existing Baltimore Penn Station platforms and an existing retaining wall adjacent to the MTA North Avenue Light Rail transit (LRT) station. Each alignment would pierce the retaining wall to pass below the LRT tracks and station before entering into bored tunnels at the north portal.
- Each Alternative would have a maximum design speed of 100 mph. The lowest design speed along each alignment would be 50 mph.
- Each Alternative would have a maximum vertical grade of 2.0 percent. Three ventilation facilities for Alternatives 3A, 3B, and 3C would be required to ensure proper ventilation of the proposed tunnels. For each alternative, a North Ventilation Facility would be located near the north portal and a South Ventilation Facility would be located near the south portal. A third Intermediate Ventilation Facility would be connected to the bored portion of the tunnels (see **Chapter IV** for more detail).

E. Alternatives Descriptions and Refinement after the DEIS

Alternative 1: No-Build, Alternative 3A, Alternative 3B, and Alternative 3C were carried forward from the DEIS for further analysis. In response to public and agency input subsequent to the publication of the DEIS, Alternatives 3A, 3B, and 3C were refined to reduce potential social, cultural, and environmental impacts and address community concerns. Descriptions of these alternatives, including their refinement since the DEIS, are provided in this section. Potential impacts associated with the Preferred Alternative are located in **Chapter VI**.

In addition to alignment changes, refined limits-of-disturbance (LODs) were generated for each build alternative based on a narrower offset from the tracks. The LODs presented in the DEIS were developed conservatively to include additional area in order to account for potential alignment shifts. Since the engineering has been refined, the amount of area included in the LODs was reduced to provide a more accurate footprint. Reduced environmental impacts were determined as a result of the narrower LODs.

Preliminary cost estimates provided in this chapter were developed for Alternatives 3A, 3B, and 3C for comparative purposes. These preliminary estimates do not account for the preferred Intermediate Ventilation Facility site or mitigation costs. The cost estimate for Alternative 3B has been updated in **Chapter IV** to reflect a higher level of engineering detail, the preferred Intermediate Ventilation Facility site, and Project mitigation actions associated with the Preferred Alternative. More information is available for Alternative 3B than Alternatives 3A and 3C because the engineering was advanced to a greater level of detail. However, FRA assumes that the increase in cost estimates for Alternatives 3A and 3C would likely be proportionate to the increase for Alternative 3B. Therefore, the preliminary estimates are included in this chapter to provide a comparison between the build alternatives.

1. Alternative 3A

Alternative 3A would result in a total travel distance of 3.67 miles between Baltimore Penn Station and Gwynns Falls Bridge (average of the four tracks). The tunnel segment of the alignment comprises 1.92 miles of the total length. Alternative 3A, including the horizontal alignment and vertical profile, is shown in **Figure III-2**. Minor refinements were made to the alignment of Alternative 3A subsequent to publication of the DEIS. The alignment modification consisted of narrowing the track spacing near the south portal approach, which entailed only slight adjustments to the alignment presented in the DEIS. The alignment did not change through the tunnel or north portal segments. Because the alignment for Alternative 3A uses primarily existing Amtrak right-of-way for the south portal approach, further adjustment of the alignment would not have resulted in substantial reduction of impacts relative to the DEIS alignment. Accordingly, the Project Team did not pursue further refinements to the alignment.

a. North Portal

Alternative 3A would follow the existing mainline tracks in the Jones Falls Valley under the Howard Street Bridge to just before North Avenue, where the alternative diverges from the existing track alignment. The alignment continues above ground until the north portal located at the retaining wall next to the MTA North Avenue LRT Station. The alignment would travel through an existing retaining wall, adjacent to the LRT station, to begin its descent below ground. The north portal would require specialized tunnel construction techniques, such as ground improvement (reinforcement or stabilization), in advance of tunneling to allow the four tracks to pass below the LRT facilities. A North Ventilation Facility would be located approximately 300-600 feet from the north portal.

b. Tunnel Segment

Alternative 3A continues below ground in a gradual arc for 1.92 miles, traversing below primarily residential city blocks in the neighborhoods of Reservoir Hill, Penn North, Sandtown-Winchester, Bridgeview/Greenlawn, Midtown-Edmondson, and Penrose/Fayette. From the north portal, the alignment crosses under I-83 (Jones Falls Expressway), north of the intersection of Reservoir Street and Mount Royal Terrace. The alignment continues in a gradual curve north of Reservoir and Ducatel Streets, and south of the east-west portion of Whitelock Street. The alignment continues to curve southwest, crossing Whitelock Street and the intersection of North and Pennsylvania Avenues. The alignment begins to curve to the south, as the western side of the alignment runs near the east side of the Carver Vocational-Technical High School athletic field boundary. Through the tunnel segment, the depth of the alignment would reach 180 feet, with an average depth of 120 feet (from ground level to top of tunnel). An Intermediate Ventilation Facility would be located at surface level, connected to the tunnel segment by a plenum.

c. South Portal

Alternative 3A would include a south portal located within the existing P. Flanigan & Sons asphalt plant, roughly a third of a mile west of the existing B&P Tunnel south portal. The cut-and-cover and open-cut sections would be located between the P. Flanigan & Sons property and Lafayette Avenue, with some additional at-grade track work located between Lafayette and Edmondson Avenues. Further at-grade track work within Amtrak right-of-way would be located between Mulberry Street and Gwynns Falls Bridge. A new "Edmond" Interlocking, in place of the existing "Fulton" Interlocking, would be constructed south of the south portal. No modifications to the West Baltimore MARC Station would be required; consequently, no high-level platform for level boarding at the Station would be provided. The south portal would include a South Ventilation Facility.

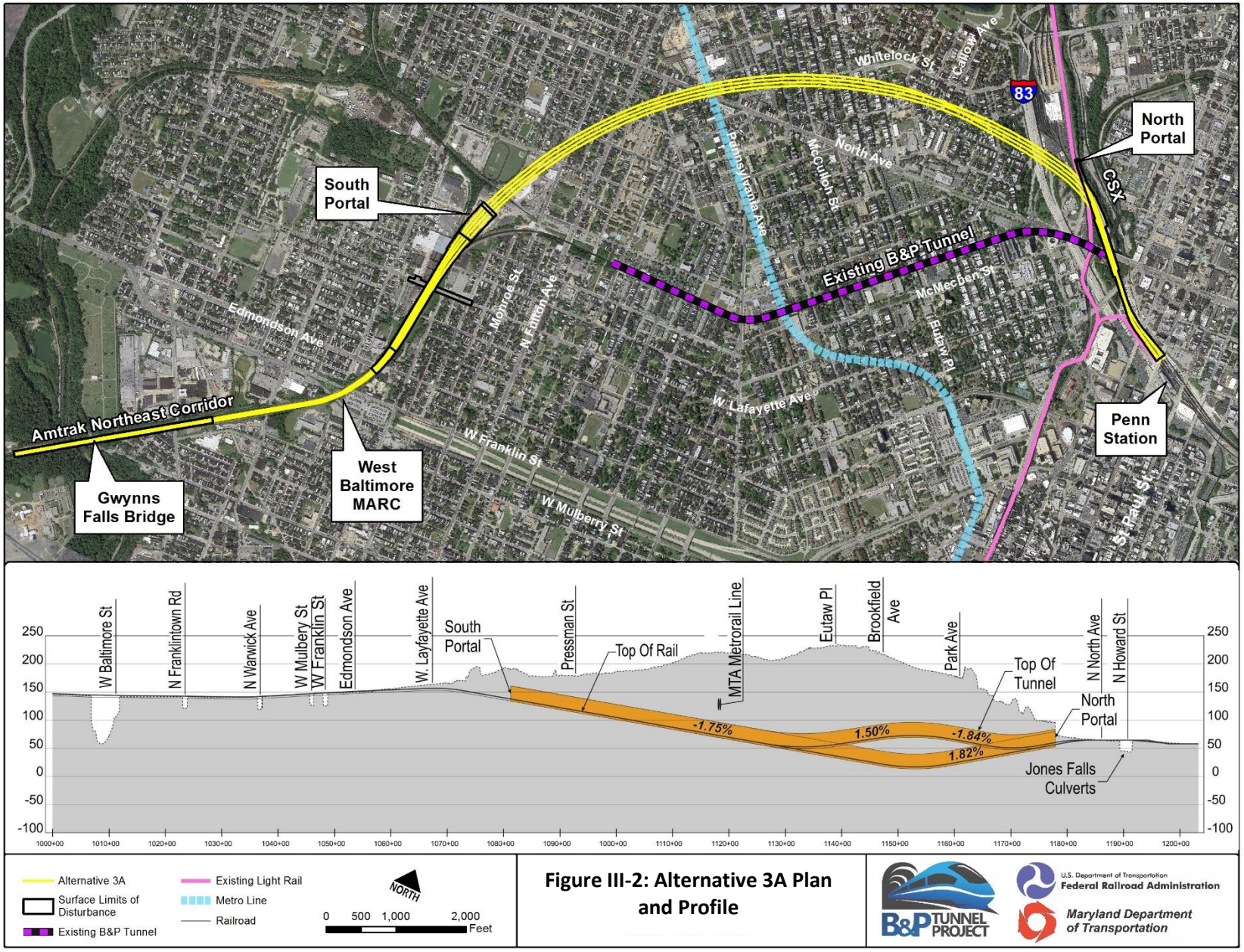


Figure III-2: Alternative 3A Plan and Profile

2. Alternative 3B

Alternative 3B was initially developed to retain the basic conceptual alignment of Alternative 3A while improving travel speeds near the south portal. The Project Team determined during preliminary engineering that travel speeds under Alternative 3A would be permanently limited to 55 mph by the existing speed-restricted curve (Curve 381) along which the West Baltimore MARC Station is currently located. Alternative 3B would address this speed restriction along Curve 381 by shifting the alignment to partially flatten the curve, thus improving operational speeds to as much as 100 mph on the inner tracks. Alternative 3B differs from 3A primarily in the location of the south portal and the southern tie-in with the existing tracks. The proposed south portal is shifted southeast by roughly 600 feet relative to Alternative 3A.

Alternative 3B would result in a total travel distance of 3.67 miles between Baltimore Penn Station and Gwynns Falls Bridge (average of the four tracks). The tunnel segment of the alignment comprises 2.00 miles of the total length. An overview of Alternative 3B, including the horizontal alignment and vertical profile, is shown in **Figure III-3**.

Since publication of the DEIS, the Project Team has refined the Alternative 3B alignment. These refinements were made to reduce environmental impacts from the alternative while still retaining the benefits of improvement to Curve 381. The horizontal and vertical alignment of the tunnel and south portal approach tracks shifted as a result of these alignment changes. The south portal approach track spacing is narrowed substantially, and the alignment shifted west in the vicinity of Franklin and Mulberry Streets. These shifts result in an alignment that stays closer to the existing right-of-way. The alignment was refined to minimize impacts to historic resources in the portal area, particularly the buildings associated with American Ice Company, the Ward Baking Company, the Atlas Safe Deposit and Storage Company Warehouse Complex, and Fire Department Engine House No. 36.

Alignment shifts in the south portal vicinity required further refinement of the tunnel alignment to meet design standards. As a result, the proposed tunnel alignment is shifted roughly 200 feet northwest of the DEIS Alternative 3B in the vicinity of where the tunnels would pass below Pennsylvania Avenue and North Avenue. The proposed tunnel alignment is also shifted south by roughly 200 feet underneath Reservoir Hill in the vicinity of Callow Avenue.

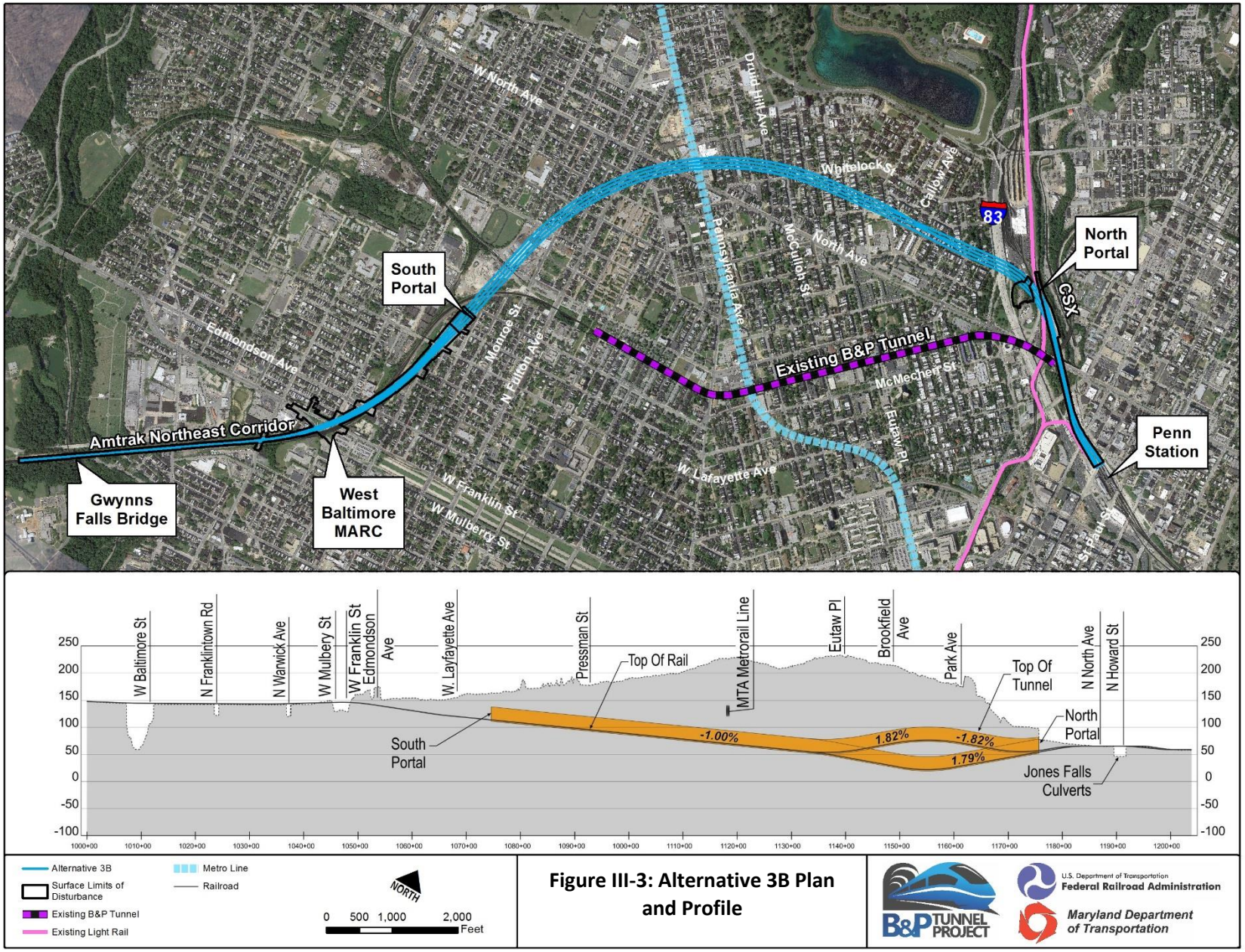


Figure III-3: Alternative 3B Plan and Profile

U.S. Department of Transportation
Federal Railroad Administration
Maryland Department of Transportation

a. North Portal

Alternative 3B follows the existing railroad mainline track in the Jones Falls Valley under the Howard Street Bridge to just before North Avenue, where the alternative leaves the existing track alignment to begin its gradual arc. The alignment continues above ground until it reaches its north portal located at the retaining wall next to the MTA North Avenue LRT Station. The alignment would travel through an existing retaining wall adjacent to the LRT rail station to begin its descent below ground. The north portal would require specialized tunnel construction techniques, such as ground improvement, in advance of tunneling to allow the four tracks to pass below the LRT facilities. A North Ventilation Facility would be located approximately 300-600 feet from the north portal.

b. Tunnel Segment

Alternative 3B continues below ground in a gradual arc for 2.00 miles, traversing below primarily residential city blocks in the neighborhoods of Reservoir Hill, Penn North, Sandtown-Winchester, Bridgeview/Greenlawn, Midtown-Edmondson, and Penrose/Fayette. From the north portal, the alignment crosses under I-83 (Jones Falls Expressway), north of the intersection of Reservoir Street and Mount Royal Terrace. The alignment continues in a gradual curve north of Reservoir Street and Ducatel Street, and south of the east-west portion of Whitelock Street. The alignment continues to curve southwest, crossing the northeast-southwest portion of Whitelock Street and the intersection of North and Pennsylvania Avenues. The alignment continues to curve southwest, under the center of an industrial property at 1320 North Monroe Street. Through the bored tunnel segment, the depth of the alignment reaches 180 feet, with an average depth of 115 feet (from ground level to top of tunnel). An Intermediate Ventilation Facility would be located at surface level, connected to the tunnel segment by a plenum.

c. South Portal

Alternative 3B would include a south portal located southeast of the P. Flanigan & Sons asphalt plant, and southeast of the existing NEC tracks, approximately 200 feet east of the 3A south portal. The cut-and-cover and open-cut sections would be located adjacent to the existing NEC, between the proposed south portal and Lafayette Avenue. The alignment would continue on a new aerial structure over Franklin and Mulberry Streets, then return to the existing NEC right-of-way near Warwick Avenue. At-grade track work within Amtrak right-of-way would occur from near Edmondson Avenue to just south of the Gwynns Falls Bridge. A new “Edmond” Interlocking, in place of the existing “Fulton” Interlocking, would be constructed south of the permanent south portal. The West Baltimore MARC Station would be relocated slightly west of its current location to align with the new tracks, and the reduced curvature would allow for reconstructing with ADA accessible high-level platforms. Some neighborhood streets near the new portal would be closed at the new rail right-of-way and others re-established after construction. The south portal would include a South Ventilation Facility.

3. Alternative 3C

Alternative 3C was also developed to retain the basic conceptual alignment of Alternative 3A, while eliminating speed restrictions imposed by Curve 381. The Project Team determined during preliminary engineering that travel speeds under Alternative 3A would be permanently limited to 55 mph by the existing speed-restricted curve (Curve 381) along which the West Baltimore MARC Station is currently located. Alternative 3C would address this speed restriction along Curve 381 by shifting the alignment to partially flatten the curve, thus improving operational speeds to as much as 100 mph for the inner tracks. Alternative 3C differs from 3A and 3B primarily in the location of the south portal and the southern tie-in with existing tracks. The proposed south portal is shifted northwest by roughly 300 feet relative to Alternative 3A.

Alternative 3C would result in a total travel distance of 3.83 miles between Baltimore Penn Station and Gwynns Falls Bridge (average of the four tracks). The tunnel segment of the alignment comprises 2.23 miles of the total length. An overview of Alternative 3C, including the horizontal alignment and vertical profile, is shown in **Figure III-4**. Alternative 3C differs from 3A and 3B in the location of the south portal, and tie-in and alignment of the underground tunnels.

Minor refinements were made to the alignment of Alternative 3C since publication of the DEIS. Specifically, a narrowed LODs was generated, which resulted in a reduction of impacts relative to the DEIS version.

a. North Portal

Alternative 3C follows the existing railroad mainline tracks in the Jones Falls Valley under the Howard Street Bridge to just before North Avenue, where the alternative diverges from the existing alignment. The alignment continues above ground until it reaches its north portal located at the retaining wall next to the MTA North Avenue LRT Station. The alignment would travel through an existing retaining wall adjacent to the LRT station and begin its descent below ground. The north portal would include tunnel construction techniques that allow the four tracks to pass below the LRT facilities. The segment of the alignment below the MTA North Avenue LRT Station would require specialized construction, such as ground improvement, in advance of tunneling. A North Ventilation Facility would be located approximately 300-600 feet from the north portal.

b. Tunnel Segment

Alternative 3C continues below ground in a gradual arc for 2.23 miles. The alignment traverses below primarily residential city blocks in the neighborhoods of Reservoir Hill, Penn North, Easterwood, Bridgeview/Greenlawn, Midtown-Edmondson, and Penrose/Fayette. From the north portal, the alignment crosses under I-83 (Jones Falls Expressway), north of the intersection of Reservoir Street and Mount Royal Terrace. The alignment crosses under I-83 farther north than either 3A or 3B. The alignment continues in a gradual curve south of Chauncey Avenue and north of Newington Avenue and Whitelock Street. At the intersection of Madison Avenue and Brooks Lane, the alignment begins to arc to the southwest, running roughly in between Clifton Avenue and Retreat Street. The alignment curves to the south, traveling below the intersection of Payson and Baker Streets. Before entering the south portal, Alternative 3C runs fully under the center of the Carver Vocational-Technical High School athletic field. Through the tunnel segment, the depth of the alignment reaches 200 feet, with an average depth of 140 feet. An Intermediate Ventilation Facility would be located at surface level, connected to the tunnel segment by a plenum.

c. South Portal

Alternative 3C would include a south portal located within the P. Flanigan & Sons asphalt plant, just south of the athletic fields at Carver Vocational-Technical High School, and roughly a third of a mile west of the existing B&P Tunnel south portal. The cut-and-cover and open-cut sections would be located along the western edge of the P. Flanigan & Sons property, and travel south in a cut-and-cover section, parallel to the existing Amtrak right-of-way near Lafayette Avenue. The alignment would continue in an open-cut section shifted west of the NEC, south of Lafayette Avenue. The alignment would continue on a new aerial structure over Franklin and Mulberry Streets, then return to the existing NEC right-of-way near Warwick Avenue. At-grade track work within Amtrak right-of-way would occur from near Edmondson Avenue to just south of Gwynns Falls Bridge. A new “Edmond” Interlocking, in place of the existing “Fulton” Interlocking, would be constructed south of the permanent south portal. The West Baltimore MARC Station platforms would be relocated west to align with the new tracks. Some neighborhood streets near the new portal would be closed at the new rail right-of-way and others re-established after construction. The south portal would include a South Ventilation Facility.

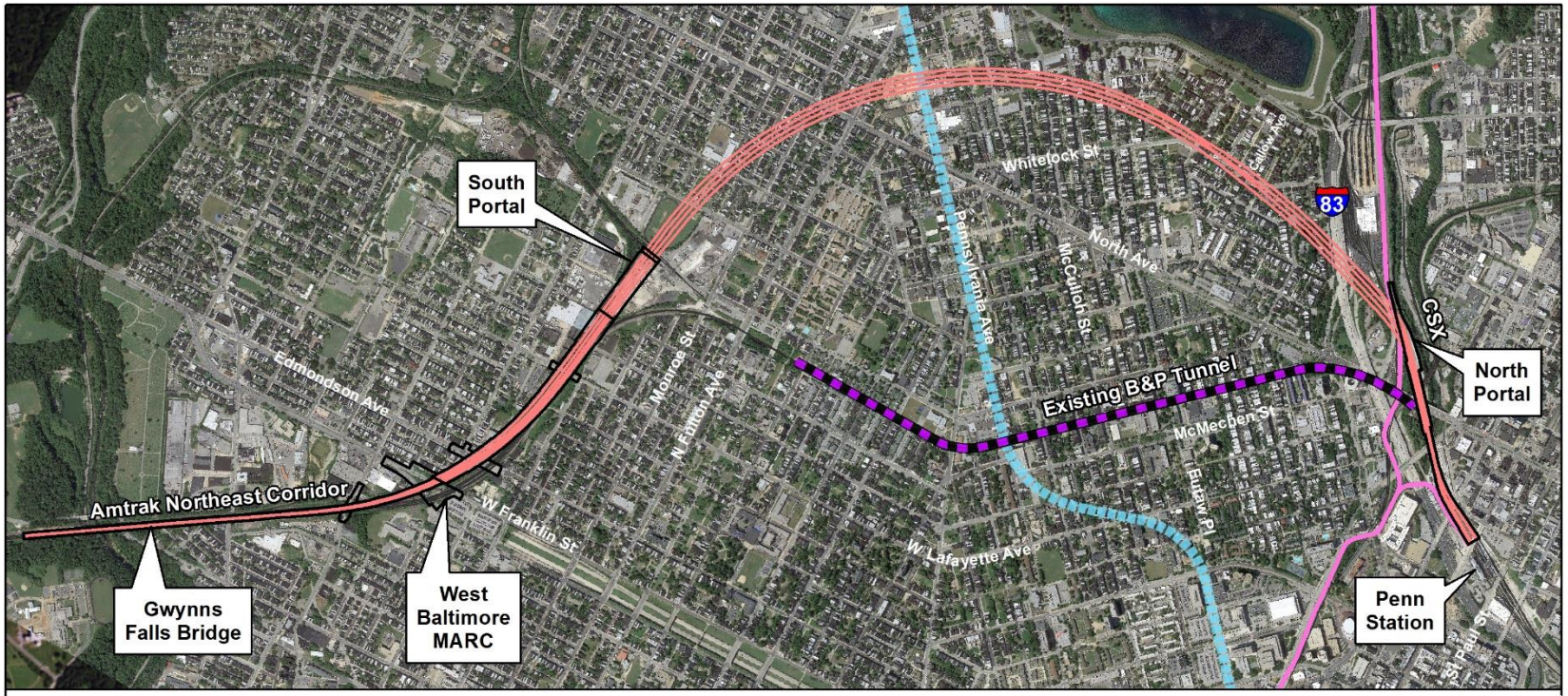


Figure III-4: Alternative 3C Plan and Profile

F. Ventilation Facilities

Each of the build alternatives would require three ventilation facilities to ensure proper ventilation of the proposed tunnels. A North Ventilation Facility would be located approximately 300-600 feet from the north portal, and a South Ventilation Facility would be at the south portal. A third Intermediate Ventilation Facility would be located at street level, connected to the bored portion of the tunnels by a vertical shaft and connecting tunnel (plenum), splitting the proposed tunnel into two unequal lengths. More detail is provided in **Section III.A.6**, and in **Chapter IV** of this FEIS.

1. Intermediate Ventilation Facility

FRA has identified a preferred site for location of an Intermediate Ventilation Facility as part of the build alternatives presented in this FEIS. This section describes the process by which Intermediate Ventilation Facility sites were identified, analyzed, and refined based on public input. The preferred Intermediate Ventilation Facility site is located at 900-940 West North Avenue in the Reservoir Hill neighborhood. The site previously proposed in the DEIS, located at Whitelock Street at Brookfield Avenue, is not currently recommended as part of the build alternatives. The 900-940 West North Avenue site is identified as preferred in this FEIS because it reduces community and historic resource impacts, and is responsive to community input.

An initial Area of Consideration for the Intermediate Ventilation Facility of each build alternative was identified as part of the preliminary engineering, based on engineering considerations. The three overlapping Areas of Consideration (corresponding with DEIS Alternatives 3A, 3B, and 3C) included an area within the Reservoir Hill neighborhood. The area was roughly bounded by Whitelock Street to the north, Ducatel Street to the south, Brookfield Avenue to the east, and Morris Street to the west. This area was developed to assist with identifying the ideal Intermediate Ventilation Facility location, from an engineering standpoint, while allowing for flexibility in the specific site proposed to minimize community impacts.

Open properties of suitable size, with no buildings within the Area of Consideration, were initially considered for the Intermediate Ventilation Facility. A suitable site was identified within this area, located at the corner of Whitelock Street and Brookfield Avenue (See **Figure III-5**). However, further analysis of the potential community, land use, and historic property impacts resulting from use of the site suggested that the Intermediate Ventilation Facility would be incompatible with the surrounding land uses and prompted evaluation of additional sites in the DEIS. Substantial community concerns related to the Whitelock Street site were received before and during the DEIS public hearings and comment period. Community members opposed the site on the grounds that it was displacing an important use (a portion of the Whitelock Community Farm), precluding future development at a central site in the neighborhood, placing an incompatible use in a primarily residential area, and would be visually incompatible with surrounding historic properties in the Reservoir Hill Historic District. In order to reduce environmental impacts and respond to community input on the Intermediate Ventilation Facility, alternate sites were developed and analyzed in addition to the Whitelock Street site.

Alternate sites located inside and outside of the original Area of Consideration were identified in the DEIS. The following sites were considered (see **Figure III-5** for site locations):

- Site 1: Druid Park Lake Drive between Brookfield Avenue and Linden Avenue
- Site 2: Druid Park Lake Drive between Brookfield Avenue and Lakeview Avenue
- Site 3: Druid Hill Avenue between Cloverdale Road and Retreat Street
- Site 4: Whitelock Street at Linden Avenue
- Site 5: Druid Hill Avenue between Whitelock Street and Clendenin Street
- Site 6: West North Avenue between Madison Avenue and McCulloh Street
- Site 7: West North Avenue between Morris Street and Madison Avenue
- Site 8: West North Avenue between Linden Avenue and Eutaw Place

- Site 9: West North Avenue between Linden Avenue and Park Avenue

A total of nine alternate sites were identified in the DEIS. Sites 1, 2, 3 and 5 were not considered further due to their distance from the optimal location for a ventilation facility near the tunnel alignment. Site 4 was potentially considered as an additional area for the site at Whitelock Street and Brookfield Avenue, but was determined not to be large enough to serve as a standalone site. Sites 1-5 would all be in close proximity to residences in Reservoir Hill, particularly Site 4 which is in the interior of the neighborhood.

Sites 6, 7, 8, and 9 were analyzed in greater detail. As a result of this stage of the analysis, Sites 6 and 7 were not considered further because the route required for the ventilation tunnels would pass diagonally through the street grid and underneath numerous homes resulting in greater disruption during construction. Site 8 (900-940 West North Avenue and 1000 Linden Avenue; hereafter referred to as "900-940 West North Avenue") and Site 9 (850 West North Avenue) were advanced for further analysis.

The two West North Avenue sites were identified as having no active residential uses. Furthermore, public feedback indicated that sites along the periphery of the Reservoir Hill neighborhood, rather than in its interior, were considered less invasive than the Whitelock Street site. The West North Avenue corridor is also less residential in character, generally, though some residential uses do exist in the vicinity.

In general, the West North Avenue sites are much farther from the ventilation zone interface. A longer connection results in substantially higher cost and changes to the ventilation system such as increased ventilation plenum cross-section size, a greater number of ventilation fans, increased ventilation fan horsepower and associated electrical power, and reduced effectiveness of piston-action ventilation requiring the fans to run in normal operations more frequently. Furthermore, a greater amount of drill-and-blast construction leading to more severe construction-related impacts would result from a site with a longer connecting plenum with a larger cross-section.

Project engineers examined each of the two West North Avenue sites and determined that either would be feasible for use as an Intermediate Ventilation Facility site. An initial assessment of duct-tunneling options was used to help determine cost differences between the various alternatives. **Table III-3** below presents the estimated cost of each potential site with Alternative 3B, including Whitelock Street at Brookfield Avenue as a point of comparison. The cost estimates for the West North Avenue sites are based on preliminary air plenum designs shown in **Figure III-6**, below. These cost estimates were prepared during preliminary engineering based on initial estimates and are subject to revision as Project engineering advances. Cost differences between the three sites for Alternatives 3A, 3B and 3C would be of similar magnitude.

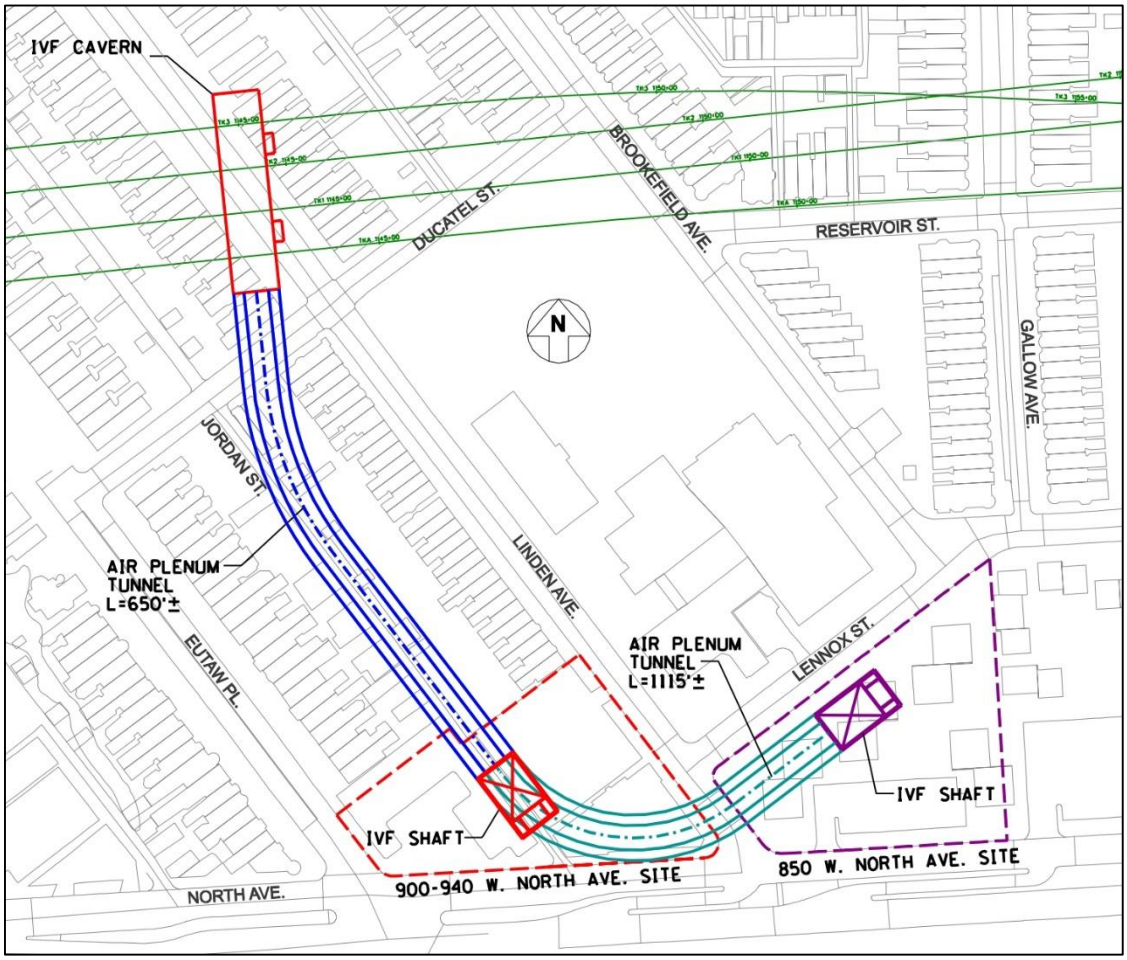
Table III-3: Estimated Cost of Intermediate Ventilation Facility Sites by Location

Location	Cost
Whitelock Street and Brookfield Avenue (DEIS Proposed Site)	$325 Million
900-940 West North Avenue (Site 8)	$590 Million
850 West North Avenue (Site 9)	$820 Million

The 900-940 North Avenue location is identified in this FEIS as the preferred site due to the greater impact of constructing a larger plenum and the subsequent substantial greater cost ($230 million) associated with 850 West North Avenue. The 900-940 West North Avenue site is therefore included in the evaluation of environmental impacts of the build alternatives in this FEIS. For a comparison of environmental impacts between 900-940 West North Avenue, 850 West North Avenue, and Whitelock Street at Brookfield Avenue Intermediate Ventilation Facility sites, see **Section VI.P**. The 900-940 West North Avenue site would require an estimated seven business displacements and demolition of one historic element that contributes to the Reservoir Hill Historic District, as assessed in the Section 4(f) Evaluation (**Chapter VI**).


Druid Park Lake Dr
Chauncey Ave
Brooks Ln
Eutaw Pl
Lakeview Ave
Callow Ave
Linden Ave
Whitelock St
Morris St
Madison Ave
McCulloh St
Cleveland Rd
Flora St
Francis St
Druid Hill Ave
Retreat St
Salem St
Tracton St
Clendenin St
Ducatel St
Brookfield Ave
Newington Ave
Reservoir St
Park Ave
W North Ave
Cumberland St
N Stockton St
DEIS Proposed Site
Whitelock Street
1
2
3
4
5
6
7
8
9
Alternate Vent Plant Sites
DEIS Proposed Vent Plant Site
Alternative 3B - Preferred Track Centerlines
NORTH
0 125 250 500 Feet
Figure III-5: Intermediate Ventilation Facility Sites Considered
B&P TUNNEL PROJECT
U.S. Department of Transportation
Federal Railroad Administration
Maryland Department of Transportation

Figure III-6: Alternative 3B Ventilation Plenum Concepts



2. North and South Ventilation Facilities

Each of the alternatives analyzed would need one North Ventilation Facility located at or near the north portal and one South Ventilation Facility located near the south portal. For each of the alternatives, the North Ventilation Facility would be located at a site approximately 300-600 feet from the proposed north portal, at what is currently a Baltimore City Department of Transportation (BCDOT) maintenance facility. The South Ventilation Facility would be located atop the south portal cut-and-cover section, which varies for each alternative depending on the south portal location.

G. Comparison of DEIS and Refined Alternatives

Refinements to the designs of Alternatives 3A, 3B, and 3C, completed subsequent to the DEIS versions, were undertaken with the primary aim of reducing environmental impacts associated with each build alternative and responding to public comment. In particular, project engineers sought to reduce the residential, business, community facility, and historic resource impacts that would occur near the proposed south portals associated with each build alternative. For Alternative 3A, only slight refinements were made because the minimal impacts that would have occurred under the DEIS alternative could not be substantially reduced further. For Alternative 3B, refinements in the alignment resulted in sizeable reductions in impacts – particularly to residences and historic resources. These alignment shifts were designed to reduce impacts while still retaining the travel-time benefits from flattening Curve 381. Alignment shifts for Alternative 3C were unable to be designed in a way that reduced impacts to a similar level as 3B, so only minor refinements were undertaken for Alternative 3C.

Table III-4 below provides a comparison of the alternatives presented in the DEIS and the current, refined versions of Alternatives 3A, 3B, and 3C to illustrate the impacts associated with refinements to the alternatives since the DEIS. The table displays 13 of the key impact criteria, selected from the 52 total, that helped to distinguish between the various alternatives, including environmental and operational factors.

Table III-4: Comparison of DEIS and Refined Versions of Alternatives 3A, 3B, and 3C

Criterion	Alternative 3A (DEIS)	Alternative 3A (Refined)	Alternative 3B (DEIS)	Alternative 3B (Refined)	Alternative 3C (DEIS)	Alternative 3C (Refined)
Travel Time Savings over No-Build (Min:Sec)	Acela: 1:56 Regional: 1:46 MARC: 1:26	Acela: 2:00 Regional: 1:55 MARC: 1:38	Acela: 2:32 Regional: 2:26 MARC: 1:53	Acela: 2:31 Regional: 2:32 MARC: 1:49	Acela: 2:30 Regional: 2:23 MARC: 1:44	Acela: 2:30 Regional: 2:23 MARC: 1:44
Capital Cost Estimate (YOE $)[1]	$3.7 billion	$3.8 billion	$4.0 billion	$4.0 billion	$4.2 billion	$4.2 billion
Surface Right-of-Way Acreage Required	7.8 Acres	9.4 Acres	17.1 Acres	13.2 Acres	15.9 Acres	15.1 Acres
Number of Surface Parcels Impacted[2]	19	12	107	87	93	78
Section 4(f) Properties Impacted	5 (+1 De Minimis)	6 (+1 De Minimis)	8 (+4 De Minimis)	9 (+3 De Minimis)	9 (+2 De Minimis)	10 (+2 De Minimis)
Likely Adverse Effects for Historic Properties[3]	6 (8 contributing elements impacted, including 2 building demolitions)	6 (8 contributing elements impacted, including 2 building demolitions)	8 (84 contributing historic elements impacted, including 53 building demolitions)	9 (64 contributing historic elements impacted, including 31 building demolitions)	10 (76 contributing historic elements impacted, including 31 building demolitions)	10 (66 contributing historic elements impacted, including 19 building demolitions)
Residential Displacements	0	0	46	22	24	12
Business Displacements	2	9	9	13	10	16
Community Facility Displacements	0	0	5	4	1	1
Average Depth of Tunnel	130 feet	120 feet	130 feet	115 Feet	140 Feet	140 Feet

[1] Preliminary cost estimates for comparative purposes. Does not include mitigation or Intermediate Ventilation Facility. For updated cost estimate of the Preferred Alternative, see **Chapter IV.**

[2] Includes Intermediate Ventilation Facility. Does not include existing Amtrak right-of-way. Parcel numbers presented in the DEIS did not include ventilation facilities.

[3] Resources contributing to multiple districts are counted only once here.

Criterion	Alternative 3A (DEIS)	Alternative 3A (Refined)	Alternative 3B (DEIS)	Alternative 3B (Refined)	Alternative 3C (DEIS)	Alternative 3C (Refined)
Permanent On-Street Parking Spaces Lost	0	0	150	85	40	40
Requires Reconstruction of West Baltimore MARC Station and Facilitates High-Level Platforms at Existing Station Location	No; does not facilitate high-level platforms between Franklin and Mulberry	No; does not facilitate high-level platforms between Franklin and Mulberry	Yes; facilitates high-level platforms between Franklin and Mulberry	Yes; facilitates high-level platforms between Franklin and Mulberry	Yes; facilitates high-level platforms between Franklin and Mulberry	Yes; facilitates high-level platforms between Franklin and Mulberry
Right-of-way Impacts within Minority and Low Income Areas[4]	Minority: 5.8 Acres Low Income: 0.9 Acres	Minority: 5.8 Acres Low Income: 0.9 Acres	Minority: 15.1 Acres Low Income: 2.4 Acres	Minority: 10.8 Acres Low Income: 2.0 Acres	Minority: 13.9 Acres Low Income: 5.0 Acres	Minority: 12.5 Acres Low Income: 3.6 Acres

Note: Some of the impact values associated with DEIS alternatives have been updated from those published in the DEIS in order to provide a more complete "apples-to-apples" comparison; however, they are still based on the alignments and LODs described in the DEIS. DEIS alternatives assume the Whitelock Street IVF location, and refined alternatives include the 900-940 West North Avenue Intermediate Ventilation Facility location.

[4] Not including roadway improvements right-of-way.

H. Evaluation and Identification of Preferred Alternative

The current build alternatives, as described above and included in **Table III-4** as the refined Alternatives 3A, 3B and 3C, will hereafter be referred to as Alternative 3A, Alternative 3B, and Alternative 3C, respectively. **Table III-5** provides a comparison of Alternative 1: No-Build, Alternative 3A, Alternative 3B, and Alternative 3C based on 52 engineering and environmental evaluation criteria developed for this Project. The potential impact data presented in this table includes the engineering refinements that Alternatives 3A, 3B, and 3C have undergone since the publication of the DEIS. **Chapters IV and VI** present more detailed information about the Preferred Alternative and the potential environmental impacts.

Subsequent to the publication of the DEIS, the three public hearings, and the end of the comment period for the DEIS, FRA, in coordination with MDOT and Amtrak, have identified a Preferred Alternative for the B&P Tunnel Project. The identification of the Preferred Alternative is based on the following: an assessment of how the alternatives meet the Purpose and Need; an assessment of rail operations, engineering, transportation, cost, and construction; an assessment of all environmental impacts; and consideration of all public and agency comments received.

The Preferred Alternative for the B&P Tunnel Project is Alternative 3B. **Chapter IV** provides a detailed description of the alternative including details such as the alignment, ventilation facilities, egress facilities, construction methods, and other details.

Alternative 3B is the Preferred Alternative because of its superior ability to meet the Project's Purpose and Need while minimizing environmental impacts to the extent possible. When compared to each of the other alternatives evaluated in this FEIS, Alternative 3B provides a superior balance of benefits and impacts. This section will summarize how Alternative 3B compares to Alternative 1: No-Build, Alternative 3A, and Alternative 3C relative to the Project Purpose and Need, environmental impacts, rail operations and engineering, and other important considerations such as cost.

1. Comparison of Preferred Alternative to Alternative 1: No-Build

Alternative 3B is superior to the No-Build because it effectively meets the Project's Purpose and Need. While there would be no environmental impacts resulting from the No-Build scenario, the alternative would not address pressing infrastructure issues on Amtrak's NEC laid out in the Purpose and Need. Alternative 3B would address every component of the Project Purpose and Need, as described in **Chapter II**. The No-Build Alternative is therefore not selected as the Preferred Alternative.

2. Comparison of Preferred Alternative to Alternative 3A

While Alternative 3A would generally result in fewer environmental impacts relative to Alternative 3B, its key disadvantages stem from its inability to improve Curve 381. Because Alternative 3A would not improve Curve 381, it would not improve travel times to the same degree as Alternative 3B. Alternative 3A would result in an average travel time savings of 2:00 (minutes: seconds) over the No-Build for Amtrak Acela service, compared to 2:31 for Alternative 3B. Additionally, an alignment retaining the existing Curve 381 would not allow for provision of high-level platforms at the West Baltimore MARC Station at its current location, due to the existing degree of curvature. Alternative 3B, on the other hand, would allow for a high-level West Baltimore MARC Station platform to be constructed at the Station's current location between Franklin and Mulberry Streets by modifying the curve. Furthermore, the improvements under Alternative 3A would effectively preclude any future improvements to the curve, limiting travel speeds and precluding ADA accessible high-level platforms through the curve for the life of the tunnel. Thus, Alternative 3B would more effectively meet the Project's stated purpose of eliminating impediments to existing and projected operations along the NEC, and reducing travel time through the B&P Tunnel and along the NEC.

Table III-5: Full FEIS Evaluation Matrix

	Criterion	Measure	Alternative 1: No-Build	Alternative 3A	Alternative 3B	Alternative 3C
Operations	**1. Travel Time Between Baltimore Penn Station and Gwynns Falls Bridge (southbound/northbound)**	Minutes: Seconds	Amtrak Acela 5:43/6:10 Amtrak Regional 5:50/6:19 MARC 5:50/6:14	Amtrak Acela 3:58/3:55 Amtrak Regional 4:15/4:05 MARC 4:32/4:17	Amtrak Acela 3:24/3:27 Amtrak Regional 3:36/3:30 MARC 4:25/4:02	Amtrak Acela 3:27/3:27 Amtrak Regional 3:46/3:37 MARC 4:33/4:04
	2. Travel Time Savings over Alternative 1 (southbound/northbound)	Minutes: Seconds	Not Applicable	Amtrak Acela 2:00 Amtrak Regional 1:55 MARC 1:38	Amtrak Acela 2:31 Amtrak Regional 2:32 MARC 1:49	Amtrak Acela 2:30 Amtrak Regional 2:23 MARC 1:44
	3. Value of Time Savings for All Passengers[5]	Dollars per year	Not Applicable	$33.8 Million per Year	$43.0 Million per Year	$42.3 Million per Year
	4. Lowest Design Speed within the Alignment	MPH	30 mph	50 mph	50 mph	50 mph
	5. Maximum Design Speed along the Alignment	MPH	75 mph	100 mph	100 mph	100 mph
	6. Average Operating Speed (southbound/northbound)	MPH	Amtrak Acela 35/34 mph Amtrak Regional 34/34 mph MARC 34/34 mph	Amtrak Acela 54/56 mph Amtrak Regional 50/52 mph MARC 44/52 mph	Amtrak Acela 65/67 mph Amtrak Regional 61/66 mph MARC 50/57 mph	Amtrak Acela 65/68 mph Amtrak Regional 59/65 mph MARC 49/57 mph

[5] 2040 Projected ridership, 2015 dollars.

	Criterion	Measure	Alternative 1: No-Build	Alternative 3A	Alternative 3B	Alternative 3C
	7. Operational Flexibility and Reliability	High Medium Low	Low – only two tracks in common bore	High – four tracks in individual bores and the ability to platform at West Baltimore from two different tunnel tracks	High – four tracks in individual bores and the ability to platform at West Baltimore from two different tunnel tracks	High – four tracks in individual bores and the ability to platform at West Baltimore from two different tunnel tracks
	8. Meets Projected Year 2040 Level of Service for Amtrak/ MARC/ Freight	Yes/No	No – two tracks do not accommodate projected level of service; does not accommodate double-stack freight	Yes	Yes	Yes
Engineering	**9. Length of Alignment between Baltimore Penn Station and Gwynns Falls Bridge**	Miles	3.5 Miles	3.67 Miles	3.67 Miles	3.83 Miles
	10. Length of Tunnel	Miles	1.42 Miles	1.92 Miles	2.00 Miles	2.23 Miles
	11. Steepest Vertical Grade	% Grade	1.3%	2.0%	2.0%	2.0%
	12. Ability to Meet Current Project Design Criteria: Passenger (P) and Freight (F)	High Medium Low	Low (P) Low (F) Two tracks in a single bore; does not accommodate double-stack freight	High (P) Medium (F) Four tracks in individual bores; accommodates double-stack freight, steep grades for freight	High (P) Medium (F) Four tracks in individual bores; accommodates double-stack freight, steep grades for freight	High (P) Medium (F) Four tracks in individual bores; accommodates double-stack freight, steep grades for freight
	13. Depth of Tunnel	Average Depth in Feet	15-foot average depth	120-foot average depth	115-foot average depth	140-foot average depth
	14. Extent of Major Utility Relocations	Minor Moderate Major Severe	None	Major – Relocations in the general vicinity of tunnel portals	Severe – Relocations extend significant distances outside of tunnel portal areas	Major - Relocations in the general vicinity of tunnel portals

	Criterion	Measure	Alternative 1: No-Build	Alternative 3A	Alternative 3B	Alternative 3C
Transportation	**15. Estimated Number of On-Street Parking Spaces Lost**	# Spaces	0	0	85	35
	16. Requires Reconstruction of West Baltimore MARC Station	Yes/No	No	No	Yes	Yes
	17. West Baltimore MARC Station in proximity to Existing MARC Parking	Yes/No	Yes	Yes	Yes	Yes
	18. Allows for High-Level Platforms for West Baltimore MARC Station between Franklin and Mulberry Streets	Yes/No	No	No	Yes	Yes
Cost	**19. Capital Cost Estimate[6]**	YOE $	$0	$ 3.8 Billion	$4.0 billion	$ 4.2 Billion
Construction	**20. Impacts to Existing Amtrak Operations during Construction/ Rehabilitation**	Minor Moderate Major Severe	Minor – Scheduled maintenance would continue during off-peak; emergency repairs could cause significant delays. Frequency and magnitude of repairs expected to increase with time.	Minor – Most work would be performed without affecting NEC operations; only final cutover would cause minor impacts.	Moderate – Most work would be performed without affecting NEC operations; numerous track shifts and temporary cutovers would cause moderate impacts.	Moderate – Most work would be performed without affecting NEC operations; numerous track shifts and temporary cutovers would cause moderate impacts.

[6] Preliminary estimate for comparative purposes. Does not include preferred Intermediate Ventilation Facility site or mitigation. For more detailed cost estimate of the Preferred Alternative, see **Chapter IV**.

	Criterion	Measure	Alternative 1: No-Build	Alternative 3A	Alternative 3B	Alternative 3C
	21. Impacts to Existing MARC Operations During Construction/ Rehabilitation	Minor Moderate Severe	Minor – Scheduled maintenance would continue during off-peak; emergency repairs could cause significant delays. Frequency and magnitude of repairs expected to increase with time.	Minor – Most work would be performed without affecting NEC operations; only final cutover would cause minor impacts.	Moderate – Most work would be performed without affecting NEC operations; numerous track shifts and temporary cutovers would cause moderate impacts.	Moderate – Most work would be performed without affecting NEC operations; numerous track shifts and temporary cutovers would cause moderate impacts.
	22. Impacts to Existing LRT Operations During Construction/ Rehabilitation	Minor Moderate Severe	None – Construction would be contained within existing tunnel.	Minor – Adequate ground cover between proposed tunnel and LRT track for minimally disruptive tunneling.	Minor – Adequate ground cover between proposed tunnel and LRT track for minimally disruptive tunneling.	Minor – Adequate ground cover between proposed tunnel and LRT track for minimally disruptive tunneling.
	23. Impacts to Existing NEC Freight Rail Operations During Construction/ Rehabilitation	Minor Moderate Severe	Minor – Scheduled maintenance would continue during off peak; emergency repairs could cause significant delays. Frequency and magnitude of repairs expected to increase with time.	Minor – Most work would be performed without affecting freight operations; only final cutover would cause minor impacts.	Minor – Most work would be performed without affecting freight operations; freight trains could be scheduled around the numerous track shifts and temporary cutovers.	Minor – Most work would be performed without affecting freight operations; freight trains could be scheduled around the numerous track shifts and temporary cutovers.
	24. Temporary Community Impacts During Construction	High Medium Low	None	Low – The portal construction area is mostly located in either existing Amtrak ROW or industrial property. Predicted construction vibrations are not expected to damage buildings.	Medium – Portal construction would impact residential and industrial areas east of the existing NEC. Predicted construction vibrations are not expected to damage buildings.	Medium – Portal construction would impact residential and industrial areas west of the existing NEC. Predicted construction vibrations are not expected to damage buildings.

	Criterion	Measure	Alternative 1: No-Build	Alternative 3A	Alternative 3B	Alternative 3C
Right-of-Way (ROW)	**25. Surface Right-of-Way Acreage Required, by land use type[7]**	Acres	Residential: 0 Acres Commercial: 0 Acres Industrial: 0 Acres Other: 0 Acres **Total: 0 Acres**	Residential: 0 Acres Commercial: 1.4 Acres Industrial: 2.4 Acres Other: 5.6 Acres **Total: 9.4 Acres**	Residential: 0.5 Acres Commercial: 3.4 Acres Industrial: 2.6 Acres Other: 6.7 Acres **Total: 13.2 Acres**	Residential: 0.3 Acres Commercial: 2.1 Acres Industrial: 6.1 Acres Other: 6.6 Acres **Total: 15.1 Acres**
	26. Surface Acreage of Roadway LODs	Acres	0 Acres	1.4 Acres	5.3 Acres	6.0 Acres
	27. Estimated Surface Parcels Impacted	# of Parcels	0	12	87	78
	28. Area of Excavation (including open-cut)	Acres	0 Acres	10.0 Acres	9.4 Acres	15.3 Acres
	29. Area of Permanent Open Cut	Acres	0 Acres	6.9 Acres	7.8 Acres	11.1 Acres
Community Resources	**30. Estimated Residential Building Displacements**	# Displaced	0	0	22 (5 vacant)	12 (3 vacant)
	31. Estimated Business Displacements	# Displaced	0	9	13	16
	32. Estimated Community Facility Displacements[8]	# Displaced	0	0	4 places of worship	1 fire station

[7] Does not include existing Amtrak ROW or city street ROW. Includes temporary and permanent, and ventilation facilities.
[8] Includes schools, churches, community centers, libraries, hospitals, police and fire stations.

	Criterion	Measure	Alternative 1: No-Build	Alternative 3A	Alternative 3B	Alternative 3C
	33. Estimated Residential Properties Impacted, but Residence Not Displaced[9]	# of Parcels	0	0	29	35
	34. Estimated Non-Residential Properties Impacted with No Displacement[3]	# of Parcels	0	5	15	18
	35. Right-of-Way Impacts within Minority Population Areas[10]	Acres	0 Acres	9.2 Acres	13.1 Acres	15.0 Acres
	36. Right-of-Way Impacts within Low Income Population Areas	Acres	0 Acres	0.2 Acres	2.2 Acres	2.8 Acres
	37. Impacts to Baltimore City's *West Baltimore MARC Station Master Plan*	Minor Moderate Severe	None – Compatible with West Baltimore MARC Station Master Plan	None – Compatible with West Baltimore MARC Station Master Plan	Moderate – Excavation would impact portions of industrial land proposed for redevelopment. MARC Station could remain between Franklin and Mulberry Streets.	Moderate – Excavation would impact portions of industrial land proposed for redevelopment. MARC Station could remain between Franklin and Mulberry Streets.

[9] Permanent or temporary impacts to property.

[10] Calculation methodology changed since DEIS, and does not include existing Amtrak right-of-way or city streets right-of-way. Includes temporary and permanent, and ventilation facilities.

	Criterion	Measure	Alternative 1: No-Build	Alternative 3A	Alternative 3B	Alternative 3C
	38. Parks Potentially Impacted	# of Parks	0	0	0	0
	39. Estimated Area of Parkland Impacted	Acres	0 Acres	0 Acres	0 Acres	0 Acres
Cultural	**40. Adverse Effects for Historic Properties[11]**	Number of Properties (Number of Contributing Elements)	0	6 (10 contributing historic elements)	9 (82 contributing historic elements)	10 (120 contributing historic elements)
	41. Area of Surface Disturbance within Historic District	Acres	0 Acres	15.6 Acres –, Greater Rosemont, Baltimore & Potomac Railroad, Reservoir Hill and Midtown-Edmondson Historic Districts	21.2 Acres – Baltimore & Potomac Railroad, Edmondson Avenue, Greater Rosemont, Reservoir Hill and Midtown-Edmondson Historic Districts	21.0 Acres – Baltimore & Potomac Railroad, Edmondson Avenue, Greater Rosemont, Reservoir Hill and Midtown-Edmondson Districts
	42. Known Archaeological Resource Sites Impacted	# of Sites	0	0	0	0
Natural Resources	**43. Stream Impacts**	Linear Feet	0 Feet	0 Feet	0 Feet	0 Feet
	44. Wetland Impacts	Acres	0 Acres	0 Acres	0 Acres	0 Acres
	45. Estimated Street Trees Impacted	# of Trees	0	1	74	35

[11] Contributing historic elements are counted once per district

	Criterion	Measure	Alternative 1: No-Build	Alternative 3A	Alternative 3B	Alternative 3C
	46. Forested Land Impacted	Acres	0 Acres	1.5 Acres	2.4 Acres	1.9 Acres
	47. 100-Year Floodplain Impact	Acres	0 Acres	3.4 Acres	3.4 Acres	3.4 Acres
Other Environmental	**48. Use of Section 4(f) Properties**	Number of Properties	0	6 (+1 De Minimis)	9 (+ 3 De Minimis)	10 (+2 De Minimis)
	49. Hazardous Materials Sites Identified	# of Low, Medium, and High Priority Sites (and Total #)	N/A	57 Low, 29 Med, 6 High (92 Total)	67 Low, 38 Medium, 7 High (112 Total)	92 Low, 52 Medium, 9 High (153 Total)
	50. Estimated Number of Buildings with Potential Noise Impacts	# of Buildings, Moderate or Severe	0 Severe 0 Moderate	0 Severe 254 Moderate	141 Severe 297 Moderate	111 Severe 979 Moderate
	51. Estimated Number of Sites with Potential Vibration Impacts	# of Sites	0 Vibration 12 Ground-Borne Noise	0 Vibration 156 Ground-Borne Noise	0 Vibration 449 Ground-Borne Noise	0 Vibration 168 Ground-Borne Noise
	52. Permanent Negative Visual Impacts	Low Medium High	None	Medium – would construct new south tunnel portal and South Ventilation Facility in primarily industrial area and construct an Intermediate Ventilation Facility in Reservoir Hill residential area	High – would construct new south tunnel portal, South Ventilation Facility, and new tracks in residential area and construct a new Intermediate Ventilation Facility in Reservoir Hill residential area	High – would construct new south tunnel portal, South Ventilation Facility, and new tracks in residential area and construct a new Intermediate Ventilation Facility in Reservoir Hill residential area

Alternative 3A would not result in any residential or community facility displacements, but it would require nine business displacements, including substantial impact to the P. Flanigan & Sons asphalt plant, a major local employer. Alternative 3B, in contrast, would impact an estimated 13 businesses, but would avoid the P. Flanigan & Sons property. Alternative 3A, at an estimated capital cost of $3.8 billion, would also be somewhat less expensive than Alternative 3B, which is estimated at $4.0 billion[12] and would require somewhat less surface right-of-way, at 9.4 acres relative to the Alternative 3B estimate of 13.2 acres.

Alternative 3A would less effectively meet the overall Purpose and Need of the Project compared to Alternative 3B. Alternative 3B would more effectively reduce travel time through the B&P Tunnel and along the NEC, better accommodate existing and projected travel demand for intercity and commuter passenger services, and would eliminate an impediment to existing and projected operations along the NEC in accordance with the Purpose and Need. Therefore, Alternative 3A has not been identified as the Preferred Alternative.

3. Comparison of Preferred Alternative to Alternative 3C

Unlike Alternative 3A, Alternative 3C includes some of the key advantages of Alternative 3B in meeting the Project Purpose and Need. It would improve Curve 381, thus improving travel times and allowing for accessible high-level platforms at the West Baltimore MARC Station.

However, Alternative 3C would result in more detrimental overall environmental impacts compared to Alternative 3B – particularly in regards to historic resources – even though Alternative 3B would result in more impacts with respect to certain resources than Alternative 3C. Alternative 3C would require demolition of buildings at Ward Baking Company building and Fire Department Engine Company No. 36, two important historic properties located in the south portal vicinity. The Section 106 consulting parties, in consultation with FRA, have expressed a strong preference towards prioritizing the preservation of these historic properties. Alternative 3B, in contrast, would avoid impacts to the Ward Baking Company and Fire Department Engine Co. 36 buildings.

Alternative 3C would impact an estimated 12 residences; which is fewer than the estimated 22 residential impacts for Alternative 3B. Alternative 3C would require 16 business impacts, including major impacts to the P. Flanigan & Sons asphalt plant. Alternative 3B, in contrast, would impact 13 businesses and avoid major impacts to the P. Flanigan & Sons property. Alternative 3C would require somewhat higher surface right-of-way, an estimated 15.1 acres compared to approximately 13.2 acres for Alternative 3B.

Alternative 3C would be somewhat more expensive than Alternative 3B, with an estimated capital cost of $4.2 billion compared to $4.0 billion for Alternative 3B.

In summary, Alternative 3C would meet the stated Project Purpose and Need to a similar degree as Alternative 3B. When all of the impacts described above and in **Chapter VI** are taken into account, despite the advantage of having fewer residential impacts, the overall environmental impacts from Alternative 3C are more severe than Alternative 3B. The impacts to individually eligible historic properties that would occur under Alternative 3C are particularly severe. Alternative 3C is also the most expensive of the three build alternatives considered. Thus, Alternative 3C has not been selected as the Preferred Alternative.

[12] Based on preliminary estimate for comparative purposes, not including the preferred Intermediate Ventilation Facility site and mitigation. See **Chapter IV** for more detailed cost estimate of the Preferred Alternative.

4. Selection of Alternative 3B as the Preferred Alternative

Based on the considerations described above, FRA has selected Alternative 3B as the Preferred Alternative for the B&P Tunnel Project. Alternative 3B meets the Project Purpose and Need better than Alternative 1: No-Build and Alternative 3A by allowing for superior travel times along the NEC though the Study Area, better accommodating existing and projected travel demand for intercity and commuter passenger services, and more effectively eliminating impediments to existing and projected operations along the NEC. Although Alternative 3B and Alternative 3C would similarly meet the Project Purpose and Need, Alternative 3B has less severe overall environmental impacts compared to Alternative 3C.

Alternative 3B may be subject to further engineering refinement through the remainder of the preliminary design process and, ultimately, final design and implementation. Ongoing mitigation efforts and coordination with agencies and the public will proceed based on the Alternative 3B alignment, and mitigation measures will be designed to address the potential impacts resulting from Alternative 3B.

Table III-6 below highlights several of the primary disadvantages of Alternative 3A and Alternative 3C which informed the selection of Alternative 3B as the Preferred Alternative. While all of the impacts and engineering considerations described in this FEIS were considered in the identification of the Preferred Alternative, the factors included in **Table III-6** help to illustrate the important distinctions between the three build alternatives that played a key role in the decision-making process. **Table III-6** illustrates these key factors that led to the identification of Alternative 3B as the Preferred Alternative.

Table III-6: **Comparison of Key Criteria for Alternatives 3A, 3B (Preferred) and 3C**

	Alternative 3A	**Preferred Alternative (Alternative 3B)**	**Alternative 3C**
Travel Time Savings over No-Build (Min:Sec average of northbound and southbound)	Acela: 2:00 Regional: 1:55 MARC: 1:38	Acela: 2:31 Regional: 2:32 MARC: 1:49	Acela: 2:30 Regional: 2:23 MARC: 1:44
Allows for high-level platforms for West Baltimore MARC Station between Franklin and Mulberry Streets	No	Yes	Yes
Capital Cost (YOE $)*	$3.8 billion	$4.0 billion	$4.2 billion
Ward Baking Company (historic property)	Preserved	Preserved	Demolished
Fire Department Engine Company No. 36 (historic property)	Preserved	Preserved	Demolished
P. Flanigan & Sons, Inc. business and jobs	Substantial Impact	Minimal Impact	Substantial Impact
Surface right-of-way required	9.4 acres	13.2 acres	15.1 acres

* Preliminary estimate for comparative purposes. Does not include preferred Intermediate Ventilation Facility site or mitigation. For more detailed cost estimate of the Preferred Alternative, see **Chapter IV**.