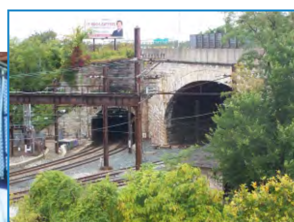
B&P TUNNEL PROJECT

B&P Tunnel Project
Baltimore, Maryland

NOISE TECHNICAL REPORT

August 2015



U.S. Department of Transportation
Federal Railroad Administration

Maryland Department of Transportation

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I. INTRODUCTION

This technical report presents a detailed analysis of the noise impacts potentially generated by the alternatives being studied for the Baltimore and Potomac (B&P) Tunnel Project. This technical report has been prepared in support of the Environmental Impact Statement (EIS)[2] being prepared by the Federal Railroad Administration (FRA)[3], in coordination with the Maryland Department of Transportation (MDOT)[4].

The project Study Area surrounds the existing 1.4-mile B&P Tunnel in the west-central portion of Baltimore City and includes Amtrak's Northeast Corridor (NEC) between Penn Station to the north and the Gwynns Falls Bridge to the south, as illustrated in **Figure 1**.

The operational noise effects were evaluated using the guidelines set forth by the Federal Transit Administration (FTA) *Transit Noise and Vibration Assessment*[5]. The temporary construction effects were also evaluated using both the FTA guidelines and the Noise Control Policy from the Maryland Department of the Environment (MDE). Please note that all environmental evaluation in this technical report is current through August 2015.

II. PROJECT BACKGROUND

As shown in **Figure 1**, the B&P Tunnel is located beneath several West Baltimore neighborhoods, including Bolton Hill, Madison Park, and Upton. The tunnel is currently used by Amtrak[6], MARC[7], and Norfolk Southern Railway (NS)[6], and is owned by Amtrak. Built in 1873, the tunnel is one of the oldest structures on the NEC. It is approximately 7,500 feet (1.4 miles) long and is comprised of three shorter tunnels: the John Street Tunnel, the Wilson Street Tunnel, and the Gilmor Street Tunnel. The B&P Tunnel is a centerpiece of the Baltimore rail network that contributes to the economic vitality of the Northeast region. The B&P Tunnel is important not only for Baltimore, but also the NEC (NEC MPWG, 2010). The NEC is the nation's most congested rail corridor and one of the highest volume corridors in the world (Amtrak, 2010).

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[2] The EIS and associated technical reports are being conducted in compliance with the National Environmental Policy Act of 1969 (42 United States Code [USC] 4321 et seq.), the Council of Environmental Quality NEPA Regulations (40 CFR 1500-1508), the FRA Procedures for Considering Environmental Impacts (64 FR 28545, May 26, 1999), and FRA's Update to NEPA Implementing Procedures (78 FR 2713, January 14, 2013).

[3] FRA is serving as the lead Federal agency for the B&P Tunnel Project.

[4] MDOT is the funding grantee for the B&P Tunnel Project. MDOT oversees six modal state agencies, including the Maryland Transit Administration (MTA).

[5] Federal Transit Administration, *Transit Noise and Vibration Impact Assessment*, Washington, DC, May 2006

[6] Amtrak is the nation's high-speed rail operator and owns the existing B&P Tunnel.

[7] MARC (Maryland Area Regional Commuter) is administered by MTA. MARC is a commuter rail system comprised of three rail lines of service. One of the lines (the MARC Penn Line) operates along the NEC and through the B&P Tunnel, providing service between Washington, D.C. and Perryville, Maryland.

[6] NS is a freight transportation provider that manages a nearly 20,000-mile rail network across the United States, including freight service through the existing B&P Tunnel (NS, 2014a).

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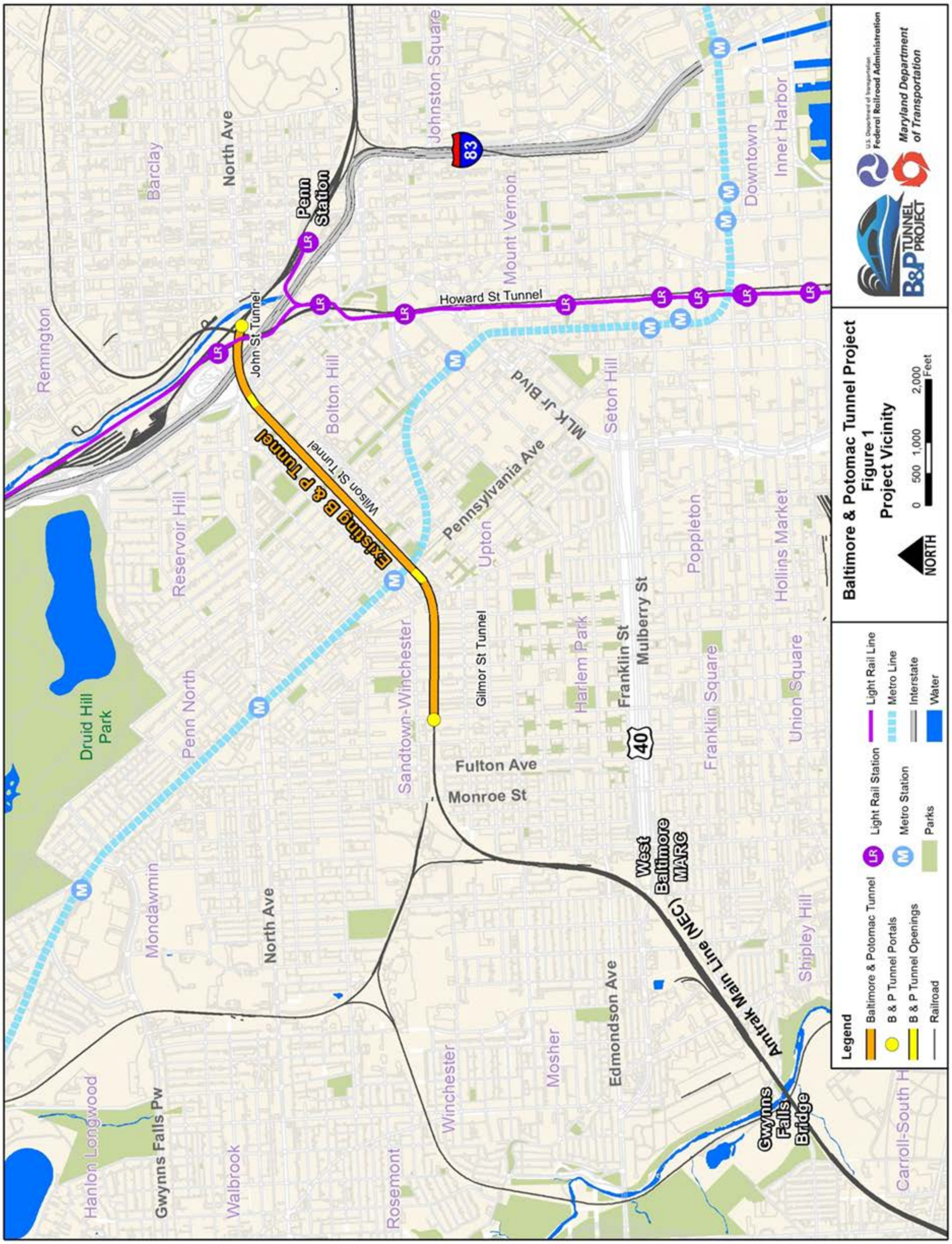
Baltimore & Potomac Tunnel Project
Figure 1
Project Vicinity
NORTH
0 500 1,000 2,000 Feet
Legend
Baltimore & Potomac Tunnel
B & P Tunnel Portals
B & P Tunnel Openings
Railroad
Light Rail Station
Metro Station
Parks
Light Rail Line
Metro Line
Interstate
Water
U.S. Department of Transportation Federal Railroad Administration
Maryland Department of Transportation
Existing B & P Tunnel
Wilson St Tunnel
John St Tunnel
Howard St Tunnel
Gilmor St Tunnel
Penn Station
West Baltimore MARC
Amtrak Main Line (NEC)
Gwynns Falls Bridge
Druid Hill Park
North Ave
Pennsylvania Ave
MLK Jr Blvd
Franklin St
Mulberry St
Fulton Ave
Monroe St
Edmondson Ave
Gwynns Falls Pw
40
83
Remington
Barclay
Johnston Square
Mount Vernon
Downtown
Inner Harbor
Bolton Hill
Seton Hill
Reservoir Hill
Upton
Poppleton
Hollins Market
Penn North
Sandtown-Winchester
Harlem Park
Franklin Square
Union Square
Mondawmin
Shipley Hill
Walbrook
Rosemont
Winchester
Mosher
Hanlon Longwood
Carroll-South H

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III. PROJECT PURPOSE AND NEED

A. Purpose of the Project

The primary purpose of the project is to address the structural and operational deficiencies of the B&P Tunnel. In addition, the project would: improve travel time, accommodate existing and projected travel demand for passenger services (regional and commuter), eliminate impediments to existing and projected operations along the NEC, provide operational reliability, and take into account the value of the existing tunnel as an important element of Baltimore's rail infrastructure.

B. Need for the Project

The purpose of the project was derived from the following needs:

- The existing B&P Tunnel is more than 140 years old and is approaching the end of its useful life with regard to its physical condition. While the tunnel currently remains safe for rail transportation, it requires substantial maintenance and repairs, and it does not meet current design standards. The tunnel is considered to be structurally deficient due to the horizontal radius of the original design, its age, and wear and tear.
- The tunnel is also functionally obsolete, meaning that it is not able to meet current and future rail demands due to its vertical and horizontal track alignment. The low-speed tunnel creates a bottleneck at a critical point in the NEC, affecting operations of the most heavily-traveled rail line in the United States.
- The existing double-track tunnel does not provide enough capacity to support existing and projected demands for regional and commuter passenger service.
- The existing tunnel is not suited for modern high-speed usage due to the current horizontal and vertical track alignment, which limits passenger train speeds through the tunnel to 30 MPH.
- The existing tunnel is a valuable resource. The disposition of the existing tunnel needs to be considered in the project.

IV. ALTERNATIVES

Sixteen preliminary alternatives were identified, evaluated using a two-level progressive screening approach, and narrowed to four alternatives in the *B&P Tunnel Project – Preliminary Alternatives Screening Report* (FRA/MDOT, December 2014). The four preliminary alternatives retained for further design development and environmental study include Alternative 1: No-Build, Alternative 2: Restore/Rehabilitate Existing B&P Tunnel, Alternative 3: Great Circle Passenger Tunnel, and Alternative 11: Robert Street South.

These conceptual alternatives have evolved as the preliminary designs advanced. It was determined upon more detailed study of Alternatives 3 and 11 that several options could be accommodated within the general corridors of each, and that each of the options should be considered as part of the Project. This technical report considers Alternative 3 Options A, B, and C as well as Alternative 11 Options A and B (**Figure 2**). Alternative 2 is hereafter referred to as "Reconstruction and Modernization of the Existing Tunnel" to more accurately reflect the components of the alternative.

A. Alternative 1: No Build

Alternative 1 would entail continued use with no significant improvements to the existing B&P Tunnel. Routine maintenance of the tunnel would continue. The tunnel's basic geometry and structure would not be improved; the existing tunnel and tracks would be left in place. This alternative would not modernize the tunnel or bring it into a "state of good repair," but would rather maintain the existing service and ongoing maintenance as currently practiced with minimal disruption.

Necessary maintenance required to continue using the existing tunnel may include replacing damaged track slabs, repairing leaking utility lines above the tunnel, rebuilding deteriorated manholes, repairing brick and mortar, replacing catenary supports, and repairing the Gilmor Street portal.

B. Alternative 2

Alternative 2 includes the complete reconstruction of the existing B&P Tunnel in its current location. This alternative would address the existing B&P Tunnel's deteriorating conditions and eliminate restrictions on the size of railcar traffic over the NEC through Baltimore. This alternative would completely replace the existing tunnel liner, lower the tunnel invert for greater vertical clearance, and widen the tunnel for greater horizontal clearance. The geometry of the existing tunnel, such as curves and grades, would not be altered. The resulting tunnel would accommodate a two-track alignment through the Study Area.

C. Alternative 3

Alternative 3 consists of three options (A, B, and C), all of which would extend in a wide arc north of the existing B&P Tunnel. Each option would include a north portal located in the vicinity of the MTA North Avenue Light Rail station, north of where I-83 crosses North Avenue. The south portal for each option would be constructed at one of two sites located south of Presstman Street, between Bentalou and Payson Streets. Each option would result in a four-track alignment through the Study Area, and would involve construction of four separate tunnel bores. Each option would require three ventilation plants – one at each portal and one mid-tunnel plant. All of the alternatives have similar north portal locations but differ in their south portal locations and underground alignment.

Alternative 3 Option A would include a south portal located at the existing P. Flanigan Asphalt plant, just south of the athletic fields at Carver Vocational-Technical High School, roughly a third of a mile west of the existing B&P Tunnel south portal. The alignment would rejoin the existing NEC corridor at the curve located south of the asphalt plant. Option A would result in a total travel distance of approximately 3.7 miles between Penn Station and the Amtrak Gwynns Falls Bridge. The tunnel segment of the alignment comprises 1.9 miles of this total length.

Alternative 3 Option B would include a south portal located southeast of the P. Flanigan Asphalt plant, adjacent to the existing NEC between Mosher Street and Riggs Avenue, roughly a third of a mile southwest of the existing B&P Tunnel south portal. Much of the underground portion of the alignment is identical to Option A. However, the alignment south of the south portal would be located east of the existing NEC. Alternative 3 Option B would result in a total travel distance of approximately 3.7 miles between Penn Station and the Amtrak Gwynns Falls Bridge. The tunnel segment of the alignment comprises 2.0 miles of this total length.

Alternative 3 Option C would include a south portal located at the P. Flanigan Asphalt plant, just south of the athletic fields at Carver Vocational-Technical High School, roughly a third of a mile west of the existing B&P Tunnel south portal. The underground portion of the tunnel would parallel the alignments identified under Options A and B; however, the alignment would be shifted further north. The alignment south of the south portal would be located west of the existing NEC. Option C would result in a total travel distance of approximately 3.8 miles between Penn Station and the Amtrak Gwynns Falls Bridge. The tunnel segment of the alignment comprises 2.2 miles of this total length.

D. Alternative 11

Alternative 11 includes two options (A and B) that provide for relatively straight alignments between Penn Station and the West Baltimore MARC Station, crossing diagonally underneath the existing B&P Tunnel. Each option would include a north portal in the vicinity of the MTA North Avenue Light Rail station, north of where I-83 crosses North Avenue. The south portal for each option would be located in the general vicinity of the West Baltimore MARC Station in the Midtown-Edmondson neighborhood. Each option would result in a four-track alignment through the Study Area, and would involve construction of four separate tunnel bores. Each option would require three ventilation plants – one at each portal and one mid-tunnel plant. Options A and B differ primarily in the south portal location and underground alignments.

Alternative 11 Option A would include a south portal located just west of the intersection of Harlem Avenue and Appleton Street, northeast of the West Baltimore MARC Station. The alignment would cross over Franklin and Mulberry Streets. Option A would result in a total travel distance of approximately 3.3 miles between Penn Station and the Amtrak Gwynns Falls Bridge. The tunnel segment of the alignment comprises 1.9 miles of this total length.

Alternative 11 Option B would exit the bored tunnel portion at a south portal located just southwest of the intersection of Edmondson Avenue and Pulaski Street, adjacent to the existing West Baltimore MARC Station. The underground portion of the alignment would run parallel to Option A, but would be shifted slightly north for the length of the tunnel alignment. The alignment would cross under Franklin and Mulberry Streets. Alternative 11 Option B would result in a total travel distance of approximately 3.3 miles between Penn Station and the Amtrak Gwynns Falls Bridge. The tunnel segment of the alignment comprises 2.2 miles of this total length.

V. AFFECTED ENVIRONMENT

A. Human Perception of Noise

According to the FTA, noise is generally considered unwanted sound[8]. Three factors generally affect the level of sound as perceived by the human ear: amplitude (quiet or loud), frequency (low or high pitch), and time pattern (variability). First, the loudness of sound is measured in decibels (dB) that can range from 0 dB (the threshold of hearing) to about 120 dB. Second, the number of times sound waves occur in one second is frequency, expressed in Hertz (Hz). Humans can typically detect noises ranging from 20 Hz to 20,000 Hz. The frequency of a noise will impact how it sounds. For example, a low-frequency noise is a rumble, and a high-frequency noise is a whistle. Third, the time pattern of noise sources can be characterized as: continuous, such as with a ventilation fan; intermittent, such as for trains passing by; or impulsive, such as pile-driving activities during construction.

The amplitude and frequency of sound are affected by the distance between the source and receiver. That is, the observed sound level decreases as the distance between source and receiver increases. This reduction is due to several factors: divergence (spreading) of sound energy over a greater area; absorption

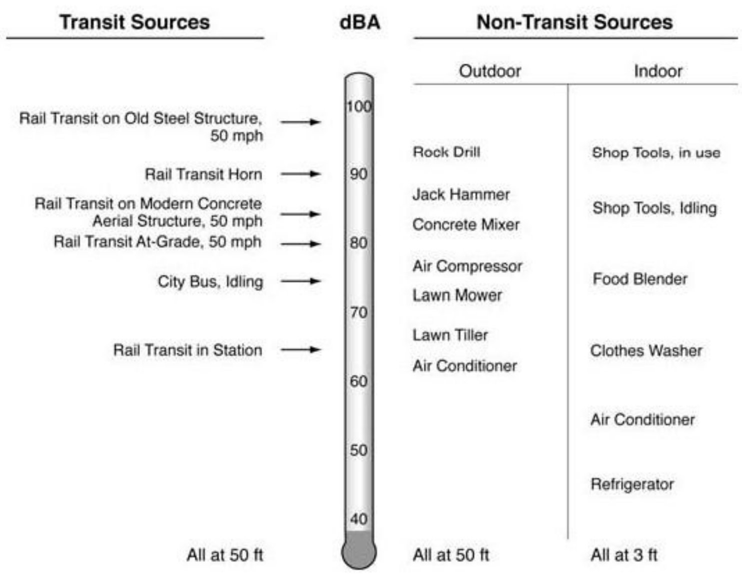
[8] Federal Transit Administration, *Transit Noise and Vibration Impact Assessment*, Washington, DC, May 2006

of sound as it travels over sound-absorbing surfaces such as grass; and, shielding from building rows, noise barriers, or vegetation.

Various sound metrics are used to quantify noise from transit sources. The A-weighted decibel (abbreviated "dBA") is used to describe the overall noise level and closely matches the human ear's response to audible frequencies. Typical A-weighted sound levels from transit and other common sources are shown in **Figure 3**. The following A-weighted noise metrics are used to describe impacts from transit related sources:

- L_{max} – The maximum noise level that occurs during an event (such as a train passby);
- L_{eq} – The equivalent sound level, which is the level of constant noise with the same acoustical energy as the fluctuating noise levels observed during a given time interval (such as one hour); and
- L_{dn} – The 24-hour day-night average sound level, an average sound level which includes a 10-decibel penalty added between 10:00 pm and 7:00 am to account for greater nighttime sensitivity to noise.
- SEL – The sound exposure level that converts the cumulative noise energy of an event into one second.

Figure 3: Typical A-Weighted Sound Levels



Source: *Transit Noise and Vibration Impact Assessment*, Federal Transit Administration, Washington, DC, May 2006.

Figure 2: B&P Tunnel Project Alternatives

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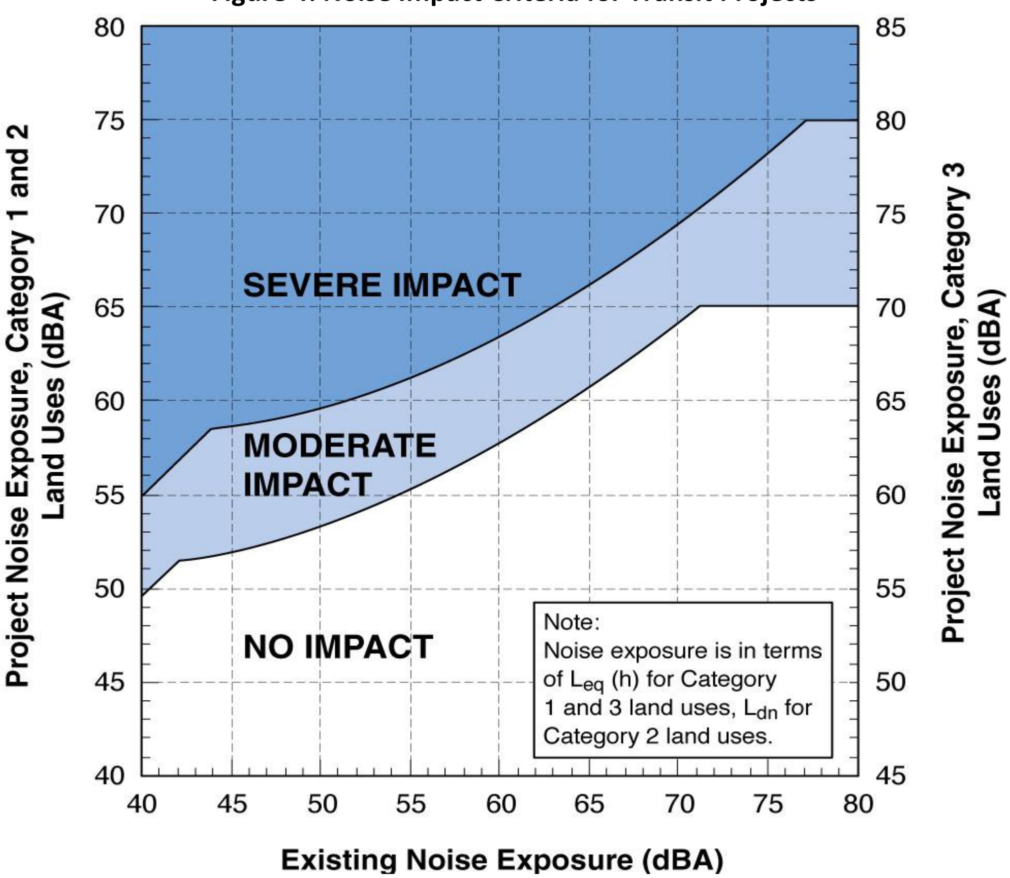
B. Regulatory Framework/Evaluation Criteria

1. Operational Noise Criteria

The FTA's guidance manual, *Transit Noise and Vibration Impact Assessment*, presents the basic concepts, methods and procedures for evaluating the extent and severity of noise impacts from transit projects. Transit noise impacts are assessed based on land use categories and sensitivity to noise from transit sources under the FTA guidelines. As shown in **Figure 4**, the FTA noise impact criteria are defined by two curves. The FTA land use categories and required noise metrics are shown in **Table 1**.

The FTA noise criteria are delineated into two categories: *moderate* and *severe* impact. The *moderate* impact threshold defines areas where the change in noise is noticeable but may not be sufficient to cause a strong, adverse community reaction. The *severe* impact threshold defines the noise limits above which a significant percentage of the population would be highly annoyed by new noise. The level of impact at any specific site is established by comparing the predicted future Project noise level at the site to the existing noise level at the site. The FTA noise impact criteria for all three land use categories are shown in **Figure 4**.

Figure 4: Noise Impact Criteria for Transit Projects



Source: *Transit Noise and Vibration Impact Assessment*, Federal Transit Administration, Washington, DC, May 2006.

Table 1: FTA Land Use Categories and Noise Metrics

Land-Use Category	Noise Metric	Description
1	$L_{eq}(h)$	Tracts of land set aside for serenity and quiet, such as outdoor amphitheaters, concert pavilions, and historic landmarks.
2	L_{dn}	Buildings used for sleeping such as residences, hospitals, hotels, and other areas where nighttime sensitivity to noise is of utmost importance.
3	$L_{eq}(h)$	Institutional land uses with primarily daytime and evening uses including schools, libraries, churches, museums, cemeteries, historic sites, and parks, and certain recreational facilities used for study or meditation.

Source: *Transit Noise and Vibration Impact Assessment*, Federal Transit Administration, Washington, DC, May 2006.

The L_{dn} is used to characterize noise exposure for residential areas (FTA Category 2). The L_{dn} metric describes a receiver's cumulative noise exposure from all events over 24 hours. For other noise sensitive land uses, such as schools and libraries (FTA Category 3) and outdoor amphitheaters (FTA Category 1), the average hourly equivalent sound level $L_{eq}(h)$ is used to represent the peak operating hour.

2. Construction Criteria

During the EIS development phase of a project, construction details are limited. Therefore, the FTA guidelines suggest evaluating prototypical construction scenarios against local ordinances (if applicable criteria are available). The FTA design guidelines, for example, are evaluated against noise levels from the two loudest pieces of equipment that, under worst case conditions, are assumed to operate continuously for one hour during both the daytime (7 am to 10 pm) and nighttime (10 pm to 7 am) periods.

In Baltimore City, the local noise ordinance identified for the project study corridor exempts construction activities.[9] Since the local noise ordinance does not provide quantitative noise limits on construction activities, the noise policy from the MDE was reviewed to assess temporary construction activities.

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The MDE has established the following noise guidelines for construction activities. These maximum allowable sound pressure levels, although not specified, are assumed to be L_{max} levels:

- Construction activities are regulated by MDE 26.02.03 Control of Noise Pollution:
- 90 dBA – daytime (7 am to 10 pm) – residences,
- 55 dBA – nighttime (10 pm to 7 am) – residences,
- Blasting during construction is exempt from the MDE noise ordinance during the daytime (7 am to 10 pm),

[9] Health Code of Baltimore City, § 9-103.b Noise Regulation

- Pile driving during construction is exempt from the MDE noise ordinance from 8 am to 5 pm, and
- Construction activities on public property are exempt (MDE 26.02.03.02.C.2.l).

C. Area of Potential Effect

In accordance with the FTA *Transit Noise and Vibration Impact Assessment* guidelines, a screening assessment was conducted to identify locations where the project may cause noise impact. The FTA screening distances for operations are based on typical commuter rail systems. A screening distance of 750 feet was computed and used to determine if noise-sensitive land uses are present within a defined area of project noise influence. This distance represents the unobstructed distance from a commuter rail line to where the project noise reaches an L_{dn} of 50 dBA.

The screening distance was applied from the centerline of the proposed Build alternatives to determine the area of potential effect (APE). Since noise-sensitive land uses were within the screening distance, further analysis was needed. Therefore, a General Assessment was conducted for the project.

The APE for construction activities varies, depending on factors such as types and numbers of construction equipment operating in an area at the same time, and the specific location and distance between the construction activity and the sensitive receptor. As mentioned, the specific types and locations of equipment in any one location are difficult to predict at this early stage of project development. Therefore, the same APE used to assess operational impacts was also used to assess the potential for construction impacts. For construction noise, the discussion in **Section IX** provides strategies to reduce noise effects.

D. Analysis Methodology and Assumptions

Noise impacts were evaluated using the FTA's "General Noise Assessment" guidelines as discussed below.

1. Noise Operating Assumptions

The reference noise levels for each of the proposed noise sources and related operating characteristics are summarized in **Table 2**. These data are based on default FTA data.

Table 2: Summary of Noise Source Reference Data

Source Type	Specific Source	Reference Conditions	Reference SEL (dBA)
Fixed Guideway	Locomotive	Diesel-electric, 3000 hp, throttle 5	92
	Rail Cars	Ballast, welded rail	82

Note: SEL noise levels are reported in decibels at a reference distance of 50 feet and a reference speed of 50 mph.
Source: *Transit Noise and Vibration Impact Assessment*, Federal Transit Administration, Washington, DC, May 2006.

The tunnel operations data are summarized in **Table 3** for the Build alternatives (2, 3, and 11). Existing train operating speeds at the portals are approximately 30 miles per hour (mph). For the Build alternatives

(2, 3, and 11), train operating speeds at the east portals are also 30 mph. The speed at the west portals is projected to be a maximum of 70 mph.[10]

Table 3: Tunnel Operating Characteristics in the Build Year (2040)

Train Service	Total Bi-directional Frequencies		Consist Data		Speed N/S* (mph)
	Daily	Peak Hour	# of Locos	# of Cars	
MARC (Regional)	164	15	1	8	30/70
Acela (Intercity Express)	82	8	N/A	14	30/70
NE Regional (Intercity Corridor)	48	4	1	8	30/70
Freight	2	0	1	30	30/70
Metropolitan	92	8	N/A	14	30/70

*Note: Average train speed entering and exiting the north portal (N) and south portal (S).

Source: Federal Railroad Administration, *NEC FUTURE Project*, February 2015.

VI. EXISTING CONDITIONS

To establish existing noise levels in vicinity of the project, a noise monitoring program was conducted to document existing conditions at sensitive receptors within the Study Area.

A. Noise

Existing background noise levels at sensitive receptors in the vicinity of the north portal were estimated using tabulated values from the FTA's "General Noise Assessment" guidelines. Existing noise levels were estimated based on proximity to major roads, such as Interstate 83, and existing railroad lines. Due to the higher density of noise sensitive receptors in the vicinity of the south portals, existing noise levels were based on a noise-monitoring programconducted on May 14th and May 28th, 2015. The existing noise levels are shown in **Table 4**.

The noise monitoring was conducted at three sites in vicinity of the south portals including North Mount Street, West Lanvale Street, and at the Mary Ann Winterling Elementary School, as shown in **Figure 5**. The measured noise levels at these sites can be used to estimate noise levels at other nearby sites because of similar proximity to the rail line, similar proximity to motor vehicle noise, and similar land use and housing density.

The noise measurements documented existing noise sources within the Study Area, such as existing rail traffic and motor vehicle traffic along surface streets. The L_{dn} is used to describe existing noise at residences and other FTA Category 2 land uses. Similarly, $L_{eq}(h)$ is reported for non-residential or

[10] Federal Railroad Administration, *NEC FUTURE Project*, February 2015

institutional receptors such as schools, libraries, or churches. All noise levels are reported in dBA for comparison with the FTA criteria.

As summarized in **Table 4**, measured peak-hour noise levels in vicinity of the south portals range from 64.3 dBA to 70.3 dBA, and the measured day-night noise levels range from 63.2 dBA to 64.7 dBA. The estimated noise levels in vicinity of the north portals are 60.0 dBA for both the peak-hour and day-night noise levels.

Table 4: Existing Noise Levels

Receptor Location	FTA Land Use Category	FTA Description	Peak Hour L_{eq}(h) (dB)	24-Hour L_{dn} (dB)
In Vicinity of the South Portals *(Measured)*				
N Mount Street	2	Residential	N/A	64.7
W Lanvale Street	2	Residential	N/A	63.4
Mary Ann Winterling Elementary School	3	Institutional	64.3	N/A
In Vicinity of the North Portals *(Estimated)*				
Residential and Institutional receptors in vicinity of the project	2 and 3	Residential and Institutional	60.0	60.0

Source: RK&K noise measurements conducted on May 14th and May 28th, 2015; and *Transit Noise and Vibration Impact Assessment*, Federal Transit Administration, Washington, DC, May 2006.

VII. FUTURE NO BUILD CONDITIONS

Future ambient noise levels under the Alternative 1: No-Build are anticipated to be similar to those under existing conditions. The Study Area is characterized by urban communities that include major highways (such as I-83) and arterials (such as N Fulton Avenue and W North Avenue). Irrespective of other projects in the Long Range Transportation Plan, ambient noise under the Alternative 1: No-Build is anticipated to be similar to under existing condition without any of the proposed build alternatives (2, 3, and 11).

VIII. FUTURE BUILD CONDITIONS

A. Operational Effects and Mitigation

1. Operational Noise

To determine the number of potentially affected receptors associated with each Build alternative (2, 3A,

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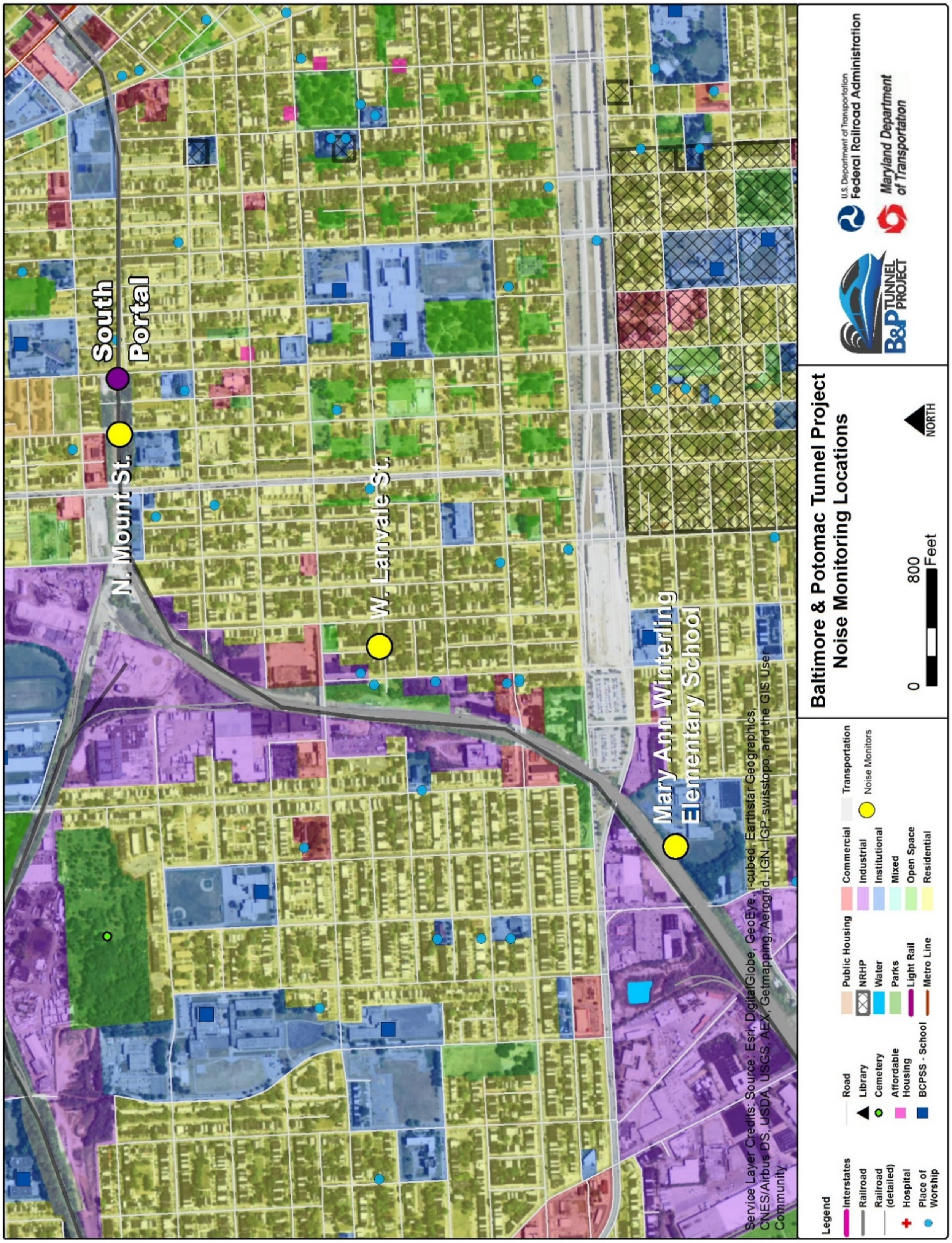
Figure 5. Noise Monitoring Locations



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3B, 3C, 11A, and 11B), the predicted *moderate* and *severe* impact contour distances were developed and are summarized below in **Table 5**. These contour distances define the outer limit of an impact area from the track centerline. Following FTA General Noise Assessment guidelines, these contours are based on the estimated noise levels associated with the tunnel operating characteristics and the existing noise levels.

Table 5: Distance from Track Centerline to Impact Contours for All Build Alternatives

Description	FTA Land Use Category	South Portals (feet)		North Portals (feet)	
		Moderate	Severe	Moderate	Severe
Residential	2	675	292	572	242
Institutional	3	191	85	239	101

Source: KB Environmental Sciences, June 2015.

Based on the contour distances from **Table 5**, the number of potential *moderate* and *severe* noise impacts along each Build alternative (2, 3, and 11) were estimated using noise contour maps and land use information. The numbers of potentially affected buildings for each Build alternative are summarized in **Table 6** and are shown graphically on the noise contour maps (see **Appendix**).

Table 6: Number of Buildings Potentially Affected by Noise

Alternative	Number of Affected Residential Buildings		Number of Affected Institutional Buildings	
	Moderate	Severe	Moderate	Severe
2	1,288	254	7	3
3A	254	0	0	0
3B	1,077	175	1	0
3C	975	111	4	0
11A	696	207	2	1
11B	233	32	2	0

Source: KB Environmental Sciences, June 2015.

2. Mitigation Measures

FTA's guidance states that noise mitigation should be considered for areas of *severe* impact, unless the project's location or alignment can be modified to eliminate the impact. FRA's guidance stongly recommends mitigation for areas of *severe* impact. Noise impacts designated as *moderate* also require consideration for mitigation, but additional project factors should first be considered when assessing mitigation (such as: the increase in noise as a result of the project; the cost of the mitigation relative to the amount of noise reduction; and, the number of affected receptors).

Since noise impacts are predicted for all of the proposed Build alternatives (2, 3A, 3B, 3C, 11A, and 11B), a range of mitigation measures were investigated for addressing *moderate* and *severe* noise impacts from tunnel operations. Specific mitigation measures will be examined once a Preferred Alternative is selected. The following are examples of the types of mitigation measures that could reduce impacts within the Study Area:

- Operational restrictions, based on time of day;
- Utilizing approved control measures (such as spring frogs) to eliminate rail gaps at crossovers;
- Track-side low-profile noise barriers or parapets to shield residents from wayside train passbys;
- Acquisition of buffer zones; and
- Building noise insulation.

IX. CONSTRUCTION NOISE MITIGATION

Noise impacts may occur during construction of the B&P Tunnel at residences and other sensitive receptors along the proposed build alternatives (2, 3, and 11). To reduce temporary construction noise impacts that may occur, the following noise control measures could be incorporated into the construction process:

- Where practical, erect temporary noise barriers between noisy activities and noise- sensitive receptors.
- Locate construction equipment and material staging areas away from sensitive receptors. Route construction traffic and haul routes along roads in non-noise-sensitive areas where possible.
- Whenever possible, conduct all construction activities during the daytime and during weekdays in accordance with the MDE noise policy.
- Require contractors to use best available control technologies to limit excessive noise and vibration when working near residences.
- Adequately notify the public of construction operations and schedules. Methods such as construction-alert publications or a Noise Complaint Hotline could be used to handle complaints quickly.
- Where possible, consideration should be given to early construction of permanent noise barriers to shield receptors from some construction generated noise.

All mitigation measures would be confirmed during the Final Design phase of the project when the details of the Preferred Alternative and the construction scenarios have been finalized.

X. REFERENCES

US Department of Transportation, Federal Transit Administration (FTA), 2006, FTA-VA-90-1003-06, *Transit Noise and Vibration Impact Assessment,* Office of Planning and Environment. Washington, DC.

Baltimore City Department of Legislative Reference, Health Code of Baltimore City, Title 9. Noise Regulation, § 9-103. Exemptions.

Maryland Department of the Environment (MDE), Code of Maryland, Title 26 Department of Environment; Subtitle 02 Occupational, Industrial, and Residential Hazards; Control of Noise Pollution (Ch. 26.02.03).

Federal Railroad Administration (FRA), NEC FUTURE Project, B&P Tunnel Replacement Project Preliminary Engineering, Input Requested from the NEC FUTURE Project 2/25/15.

RK&K, Noise measurements conducted on May 14th and May 28th, 2015.

US Department of Transportation, Federal Railroad Administration (FRA), 2012, DOT/FRA/ORD-12/15, *High-Speed Ground Transportation Noise and Vibration Impact Assessment,* Office of Railroad Policy and Development. Washington, DC.

KB Environmental Sciences, Results from the Federal Transit Administration (FTA) Noise Impact Assessment Spreadsheet, June 2015.

XI. ACRONYMS

APE - Area of Potential Effect

B&P - Baltimore & Potomac

dB - Decibel

dBA - A-weighted Decibel

DEIS - Draft Environmental Impact Statement

EIS - Environmental Impact Statement

FRA - Federal Railroad Administration

FTA - Federal Transit Administration

Hz - Hertz

Leq - Equivalent Sound Level

Leq(h) - Average Hourly Equivalent Sound Level

Ldn - 24-Hour Day-Night Average Sound Level

Lmax - Maximum Sound Level

MARC - Maryland Area Regional Commuter

MDE - Maryland Department of the Environment

mph - Miles Per Hour

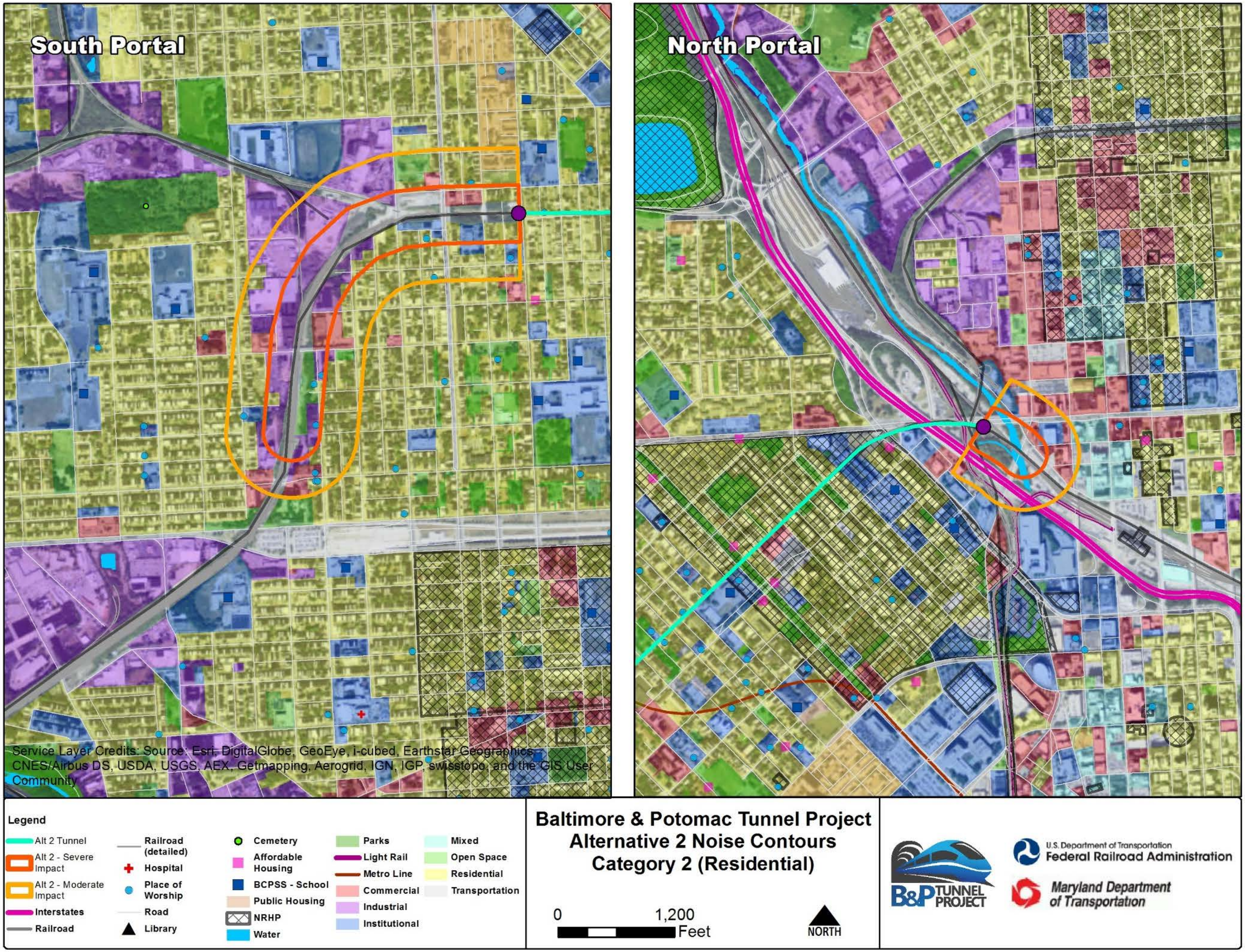
NEC - Northeast Corridor

NEPA - National Environmental Policy Act

SEL - Sound Exposure Level

XII. APPENDIX

Noise Contour Maps


South Portal
North Portal
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Legend
Alt 2 Tunnel
Alt 2 - Severe Impact
Alt 2 - Moderate Impact
Interstates
Railroad
Railroad (detailed)
Hospital
Place of Worship
Road
Library
Cemetery
Affordable Housing
BCPSS - School
Public Housing
NRHP
Water
Parks
Light Rail
Metro Line
Commercial
Industrial
Institutional
Mixed
Open Space
Residential
Transportation
Baltimore & Potomac Tunnel Project
Alternative 2 Noise Contours
Category 2 (Residential)
0
1,200
Feet
NORTH
B&P TUNNEL PROJECT
U.S. Department of Transportation
Federal Railroad Administration
Maryland Department of Transportation

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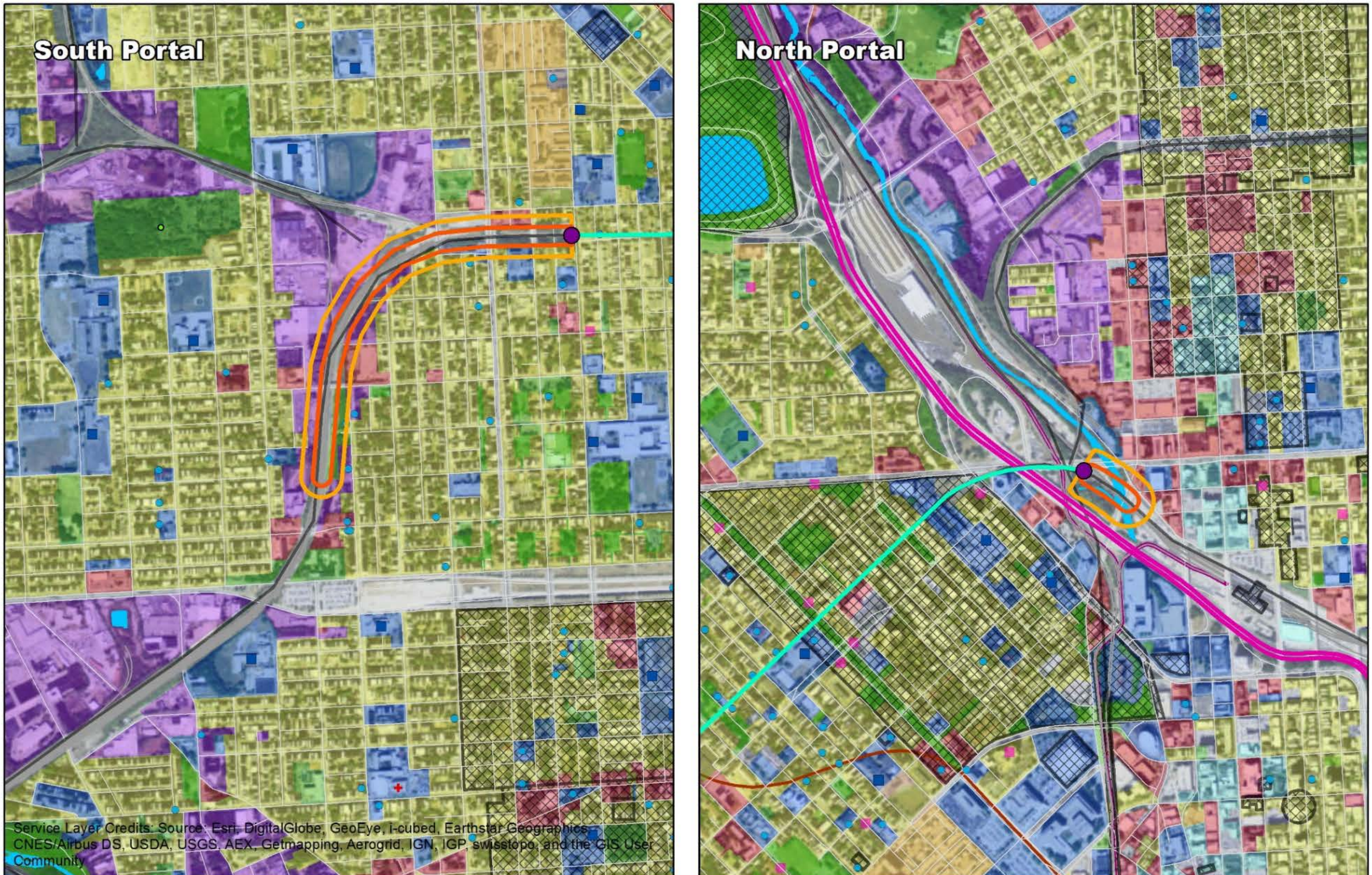

Baltimore & Potomac Tunnel Project
Alternative 2 Noise Contours
Category 3 (Institutional)

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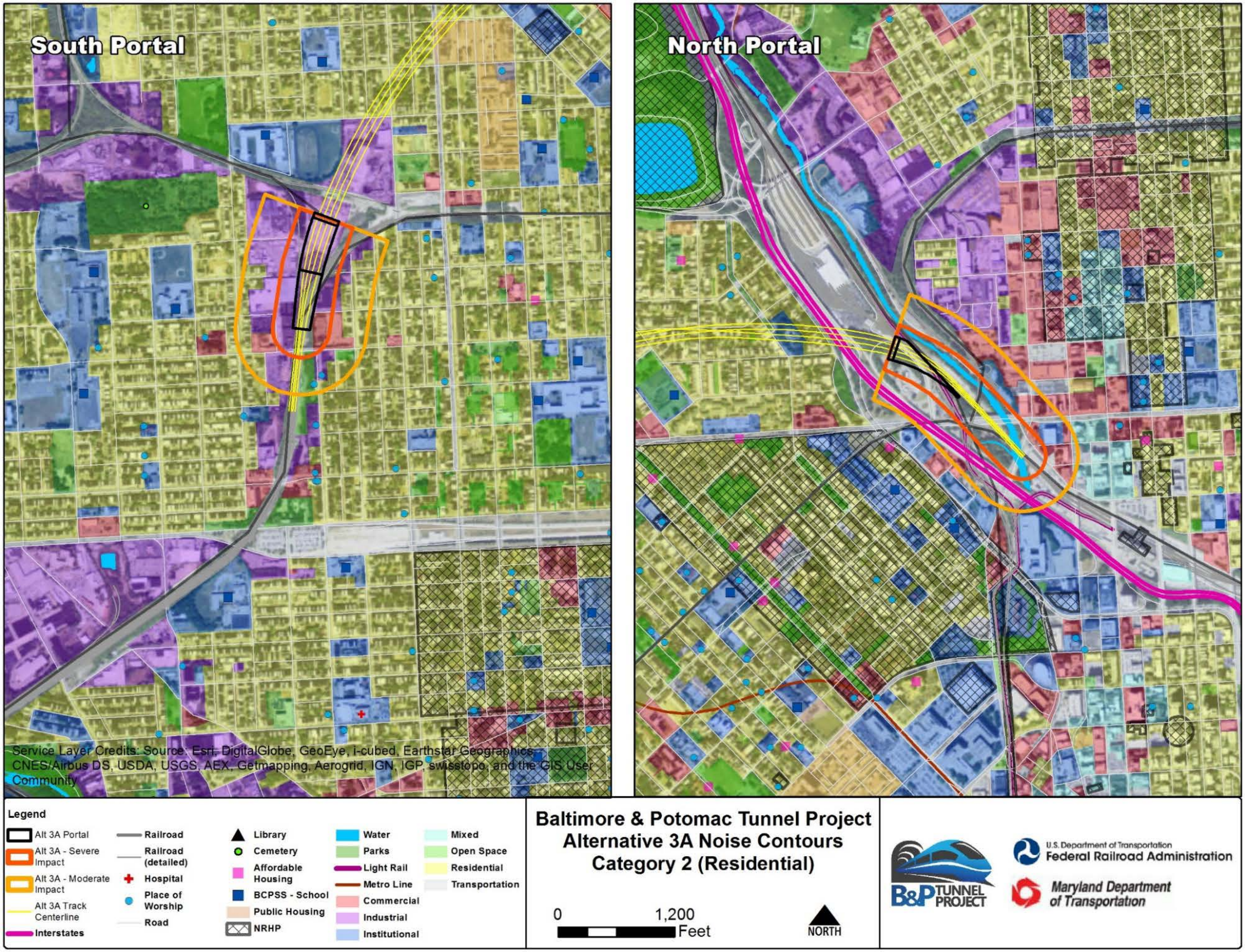
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Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Legend
Alt 3A Portal
Alt 3A - Severe Impact
Alt 3A - Moderate Impact
Alt 3A Track Centerline
Interstates
Railroad
Railroad (detailed)
Hospital
Place of Worship
Road
Library
Cemetery
Affordable Housing
BCPSS - School
Public Housing
NRHP
Water
Parks
Light Rail
Metro Line
Commercial
Industrial
Institutional
Mixed
Open Space
Residential
Transportation
Baltimore & Potomac Tunnel Project
Alternative 3A Noise Contours
Category 2 (Residential)
0
1,200
Feet
NORTH
B&P TUNNEL PROJECT
U.S. Department of Transportation
Federal Railroad Administration
Maryland Department of Transportation

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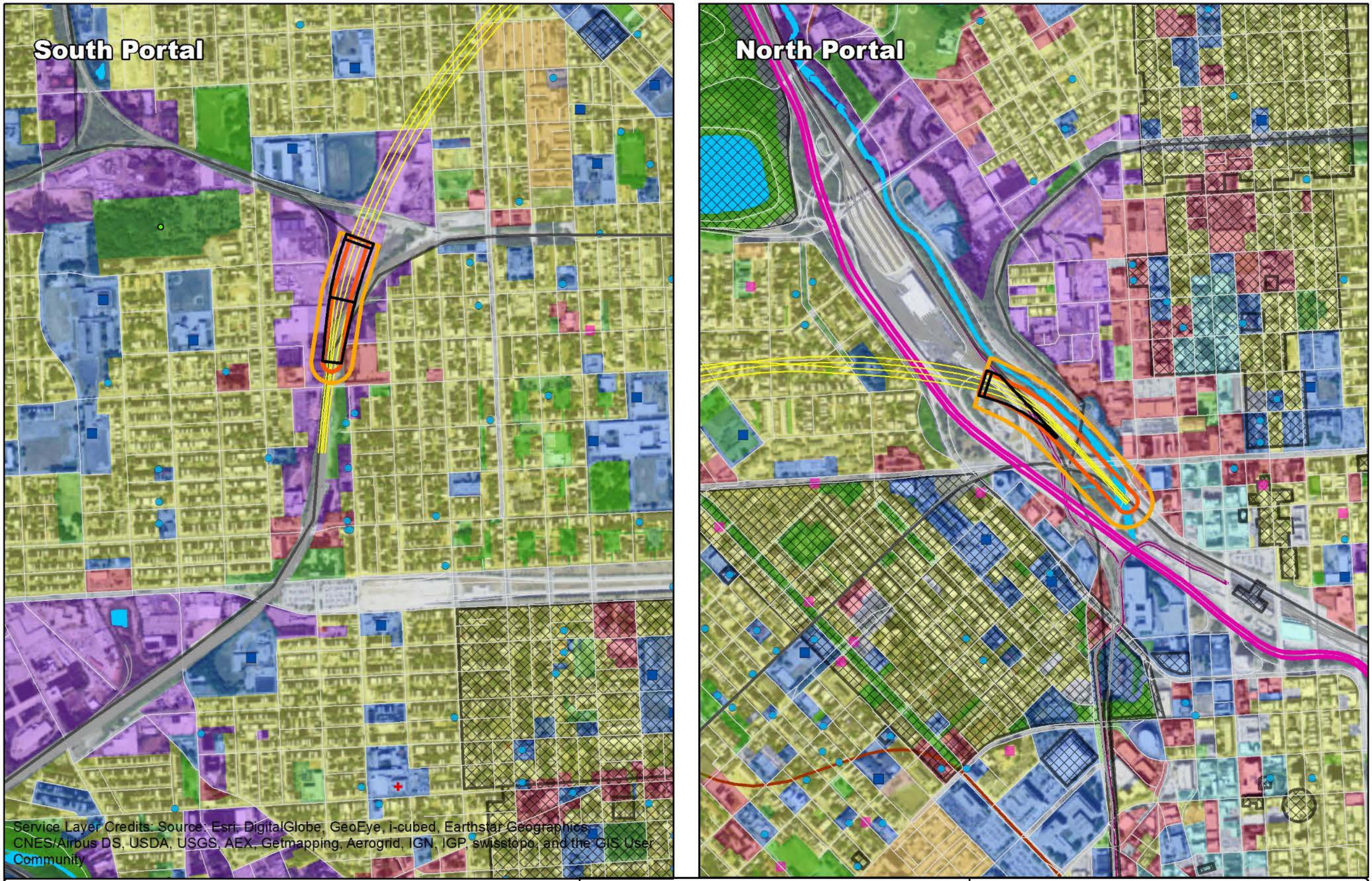

Legend

- Alt 3A Portal
- Alt 3A - Severe Impact
- Alt 3A - Moderate Impact
- Alt 3A Track Centerline
- Interstates
- Railroad
- Railroad (detailed)
- Hospital
- Place of Worship
- Road
- Library
- Cemetery
- Affordable Housing
- BCPSS - School
- Public Housing
- NRHP
- Water
- Parks
- Light Rail
- Metro Line
- Commercial
- Industrial
- Institutional
- Mixed
- Open Space
- Residential
- Transportation

Baltimore & Potomac Tunnel Project
Alternative 3A Noise Contours
Category 3 (Institutional)

0 1,200 Feet

NORTH

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Federal Railroad Administration

Maryland Department of Transportation

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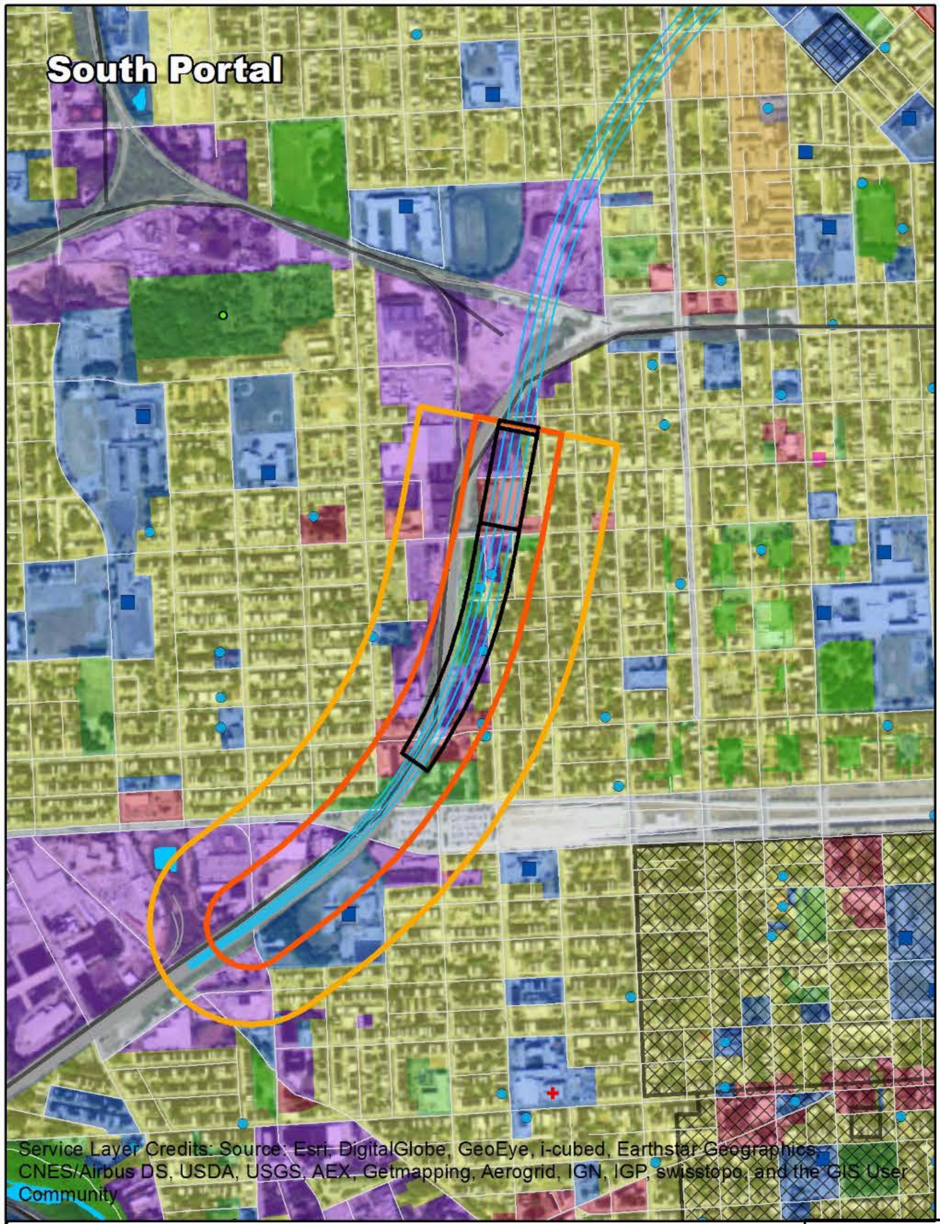

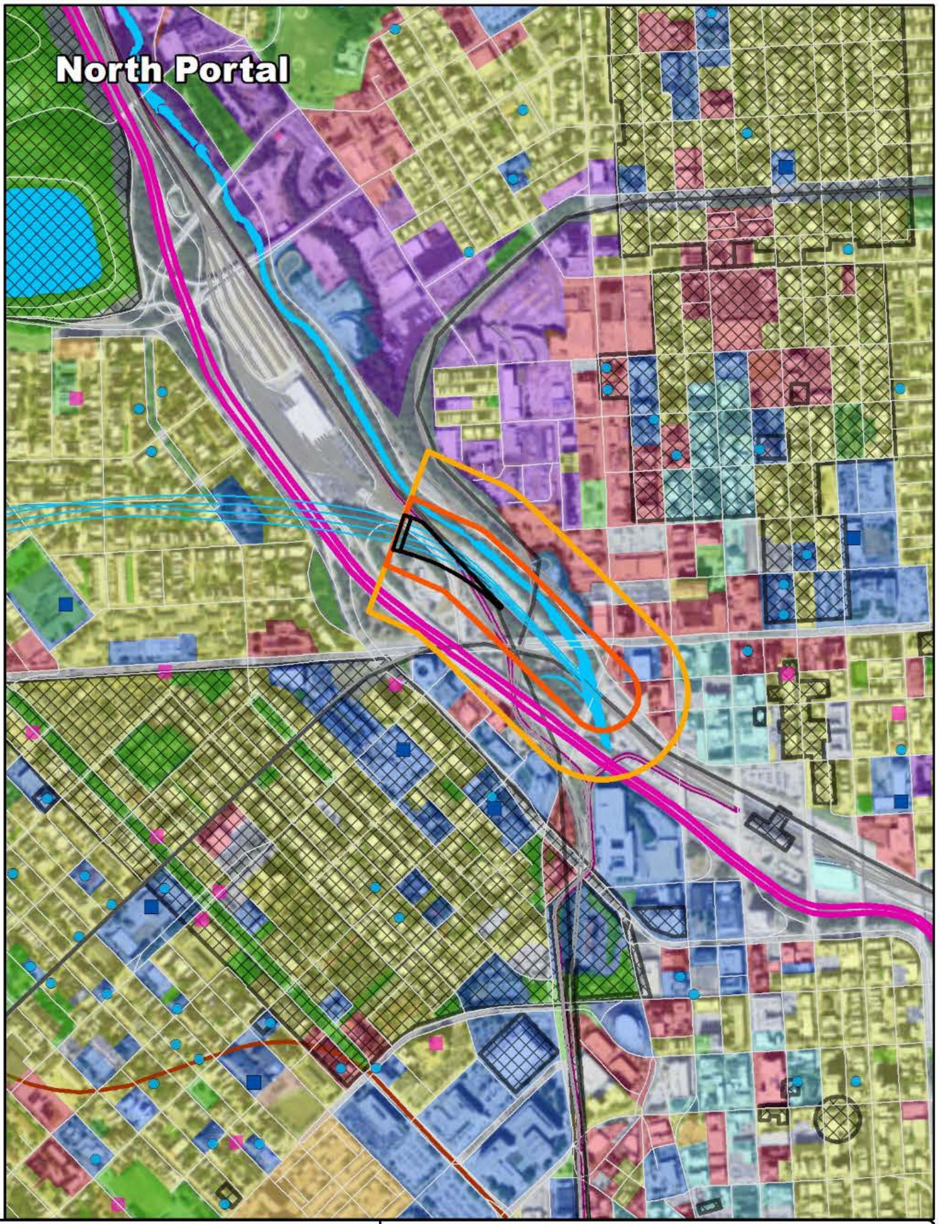

Legend

- Alt 3B Portal
- Alt 3B - Severe Impact
- Alt 3B - Moderate Impact
- Alt 3B Track Centerline
- Interstates
- Railroad
- Railroad (detailed)
- Hospital
- Place of Worship
- Road
- Library
- Cemetery
- Affordable Housing
- BCPSS - School
- Public Housing
- NRHP
- Water
- Parks
- Light Rail
- Metro Line
- Commercial
- Industrial
- Institutional
- Mixed
- Open Space
- Residential
- Transportation

Baltimore & Potomac Tunnel Project
Alternative 3B Noise Contours
Category 2 (Residential)

0 1,200
Feet

NORTH

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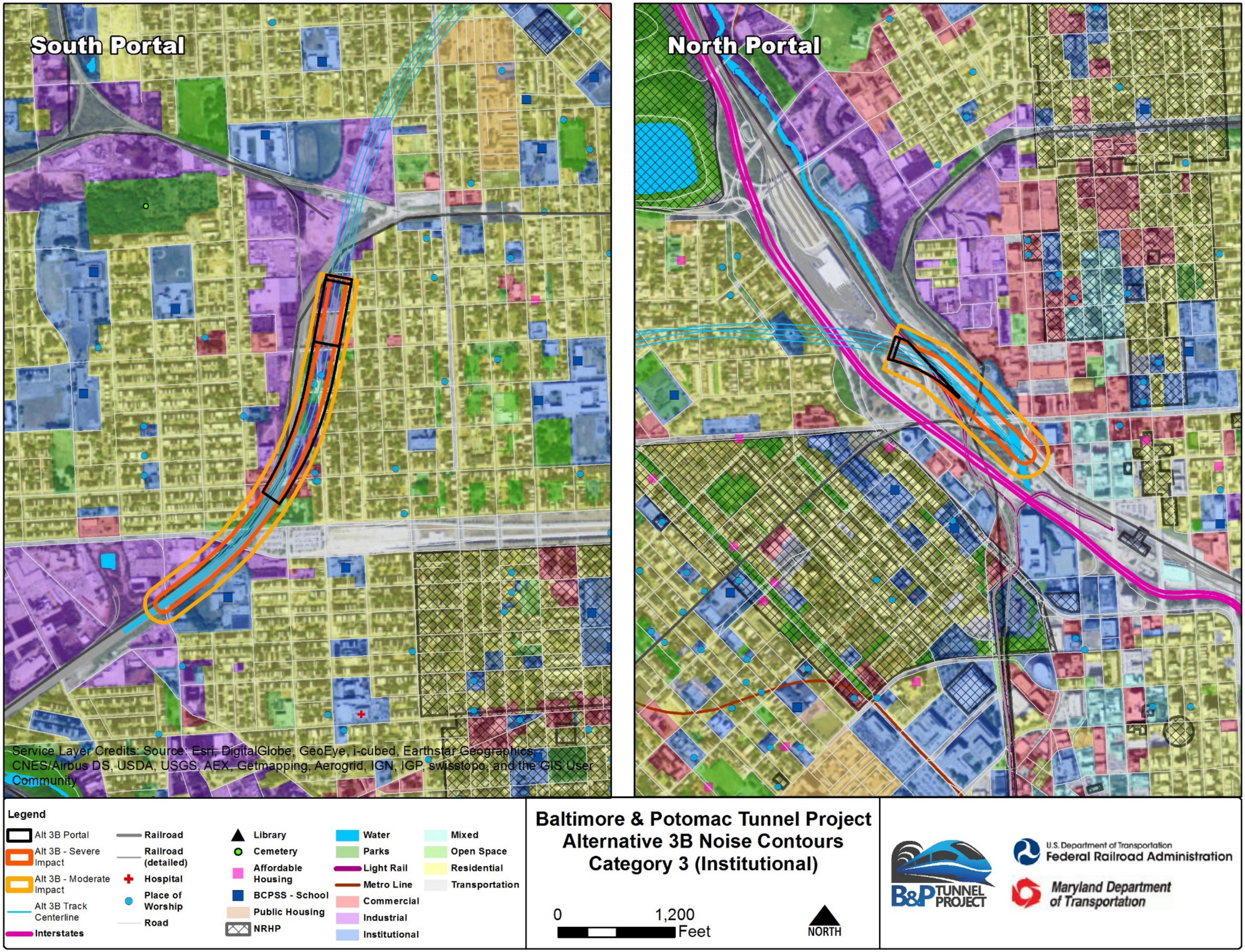

South Portal
North Portal
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Legend
Alt 3B Portal
Alt 3B - Severe Impact
Alt 3B - Moderate Impact
Alt 3B Track Centerline
Interstates
Railroad
Railroad (detailed)
Hospital
Place of Worship
Road
Library
Cemetery
Affordable Housing
BCPSS - School
Public Housing
NRHP
Water
Parks
Light Rail
Metro Line
Commercial
Industrial
Institutional
Mixed
Open Space
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Baltimore & Potomac Tunnel Project
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1,200
Feet
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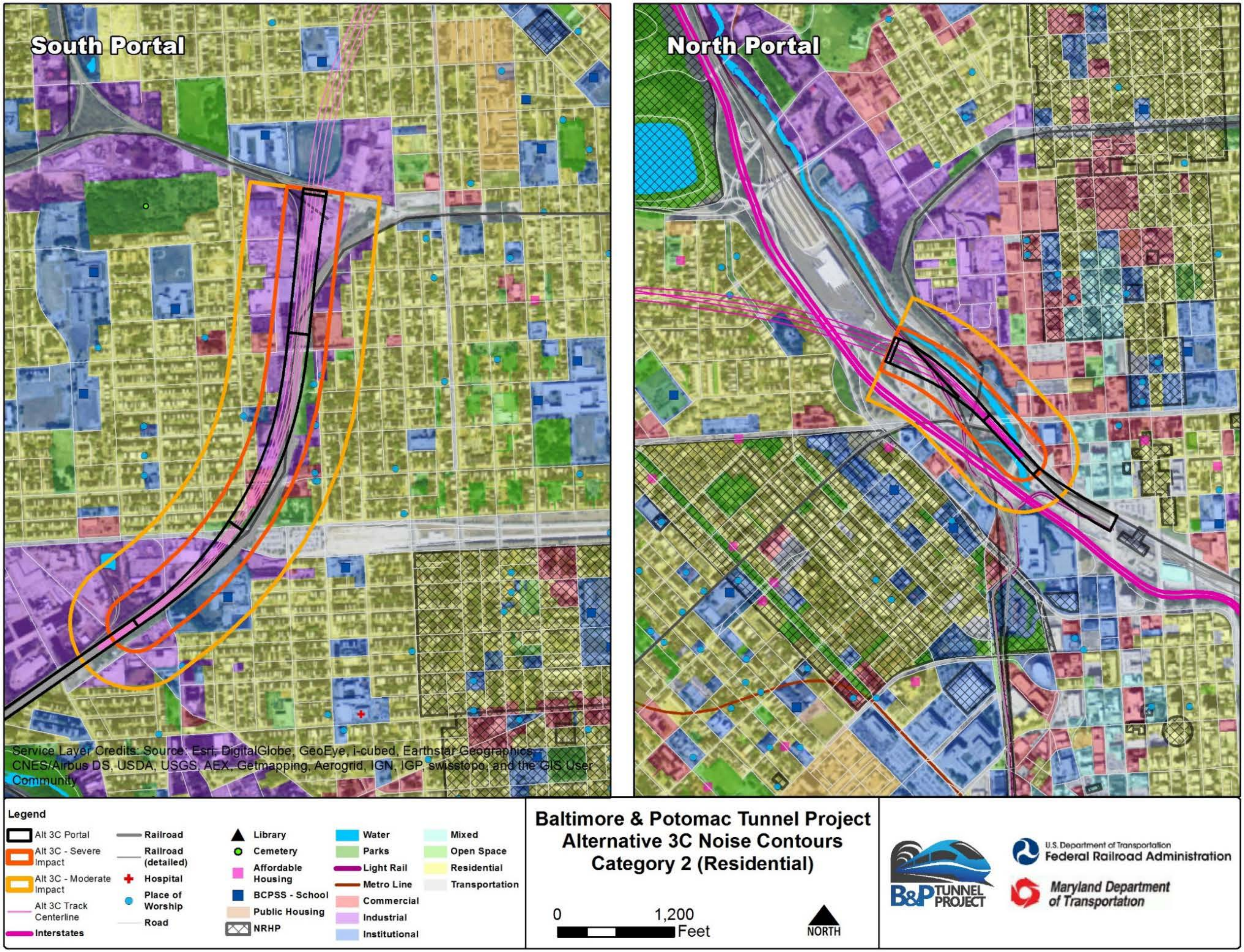

Baltimore & Potomac Tunnel Project
Alternative 3C Noise Contours
Category 2 (Residential)

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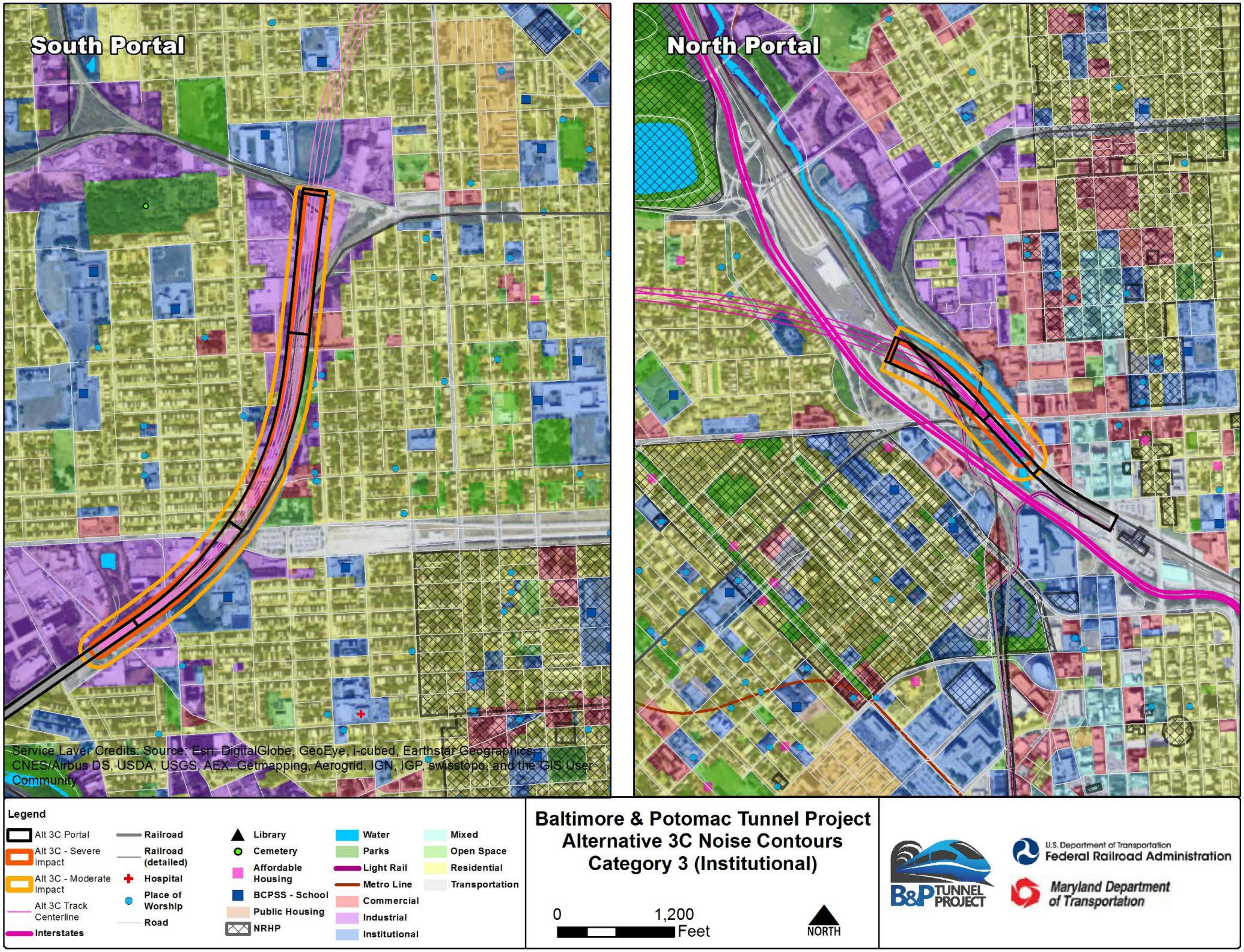

Baltimore & Potomac Tunnel Project
Alternative 3C Noise Contours
Category 3 (Institutional)

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Federal Railroad Administration

Maryland Department of Transportation

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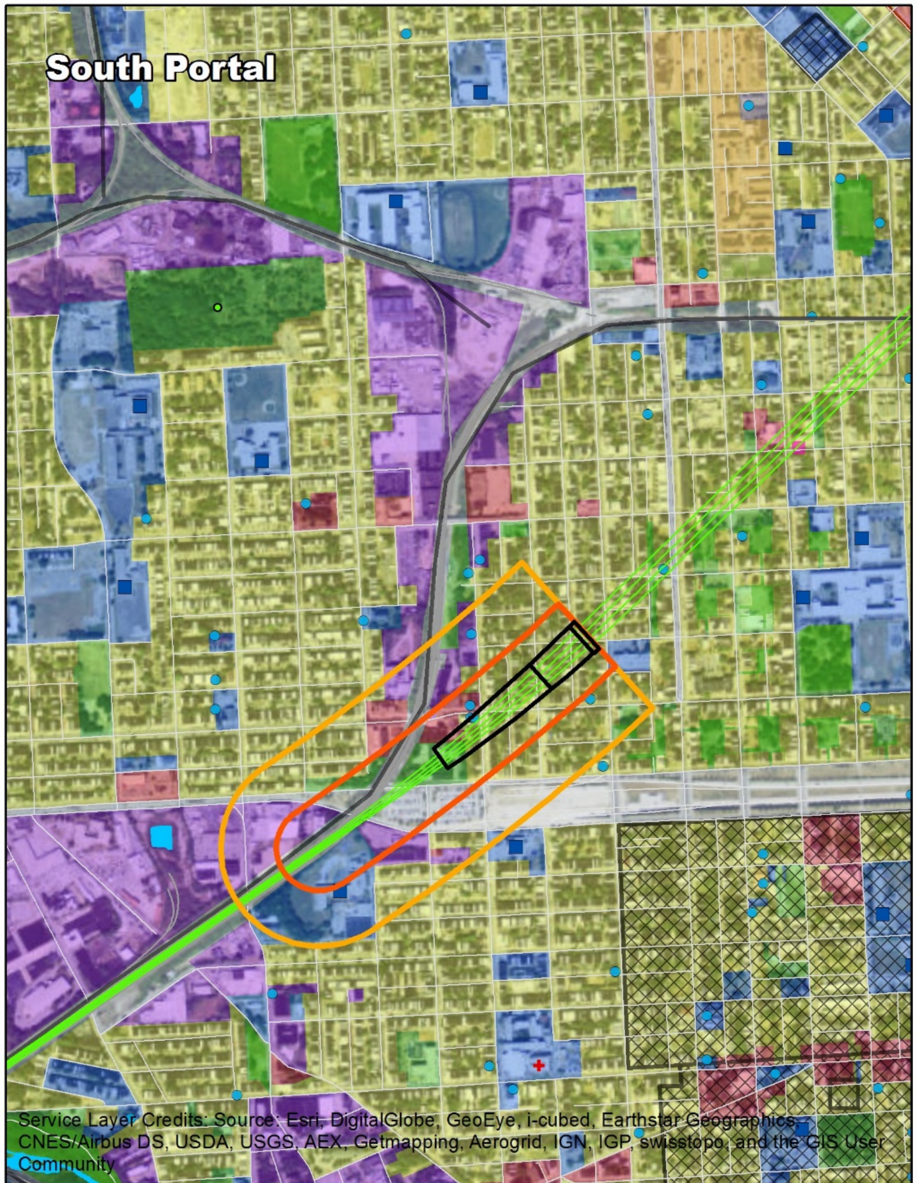

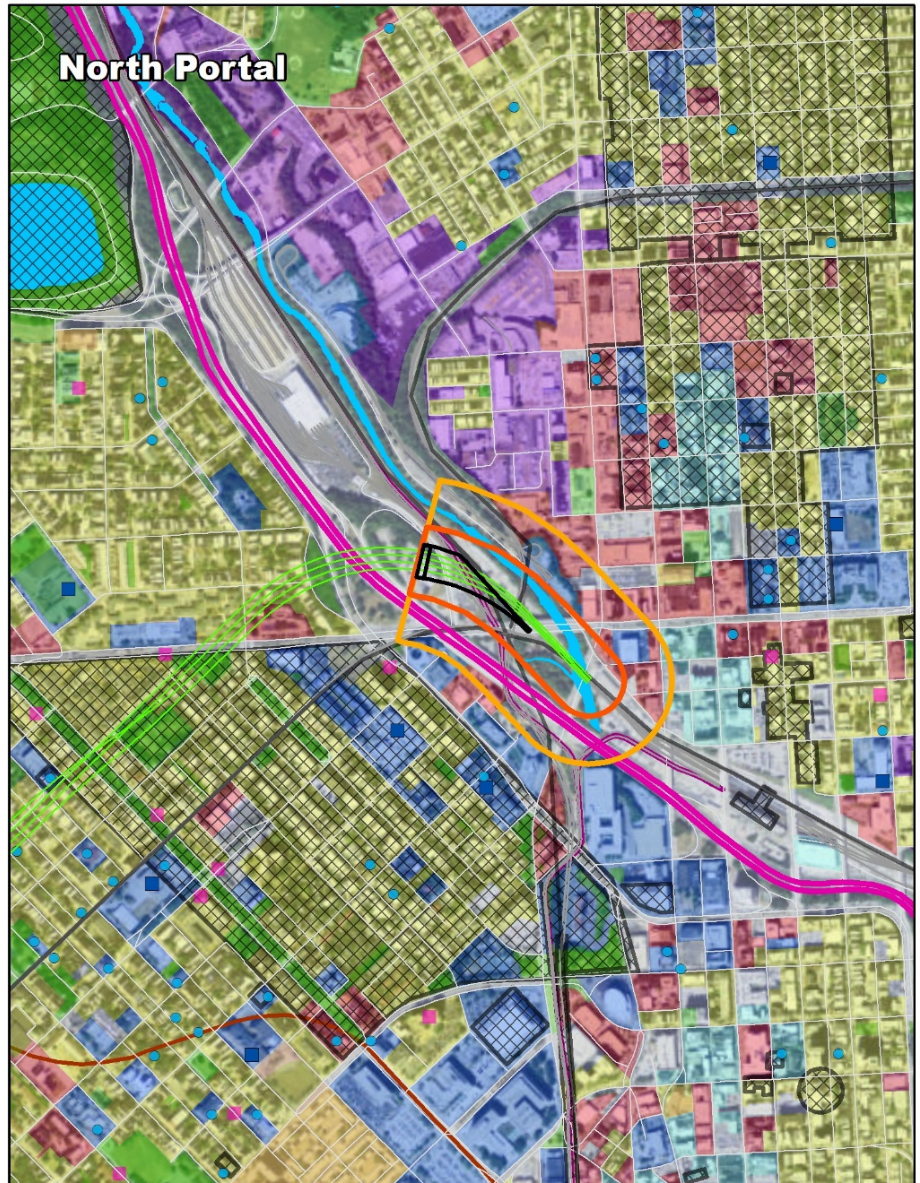

Legend

- Alt 11A Portal
- Alt 11A - Severe Impact
- Alt 11A - Moderate Impact
- Alt 11 A Track Centerline
- Interstates
- Railroad
- Railroad (detailed)
- Hospital
- Place of Worship
- Road
- Library
- Cemetery
- Affordable Housing
- BCPSS - School
- Public Housing
- NRHP
- Water
- Parks
- Light Rail
- Metro Line
- Commercial
- Industrial
- Institutional
- Mixed
- Open Space
- Residential
- Transportation

Baltimore & Potomac Tunnel Project
Alternative 11A Noise Contours
Category 2 (Residential)

0 1,200 Feet

NORTH

B&P TUNNEL PROJECT

U.S. Department of Transportation Federal Railroad Administration

Maryland Department of Transportation

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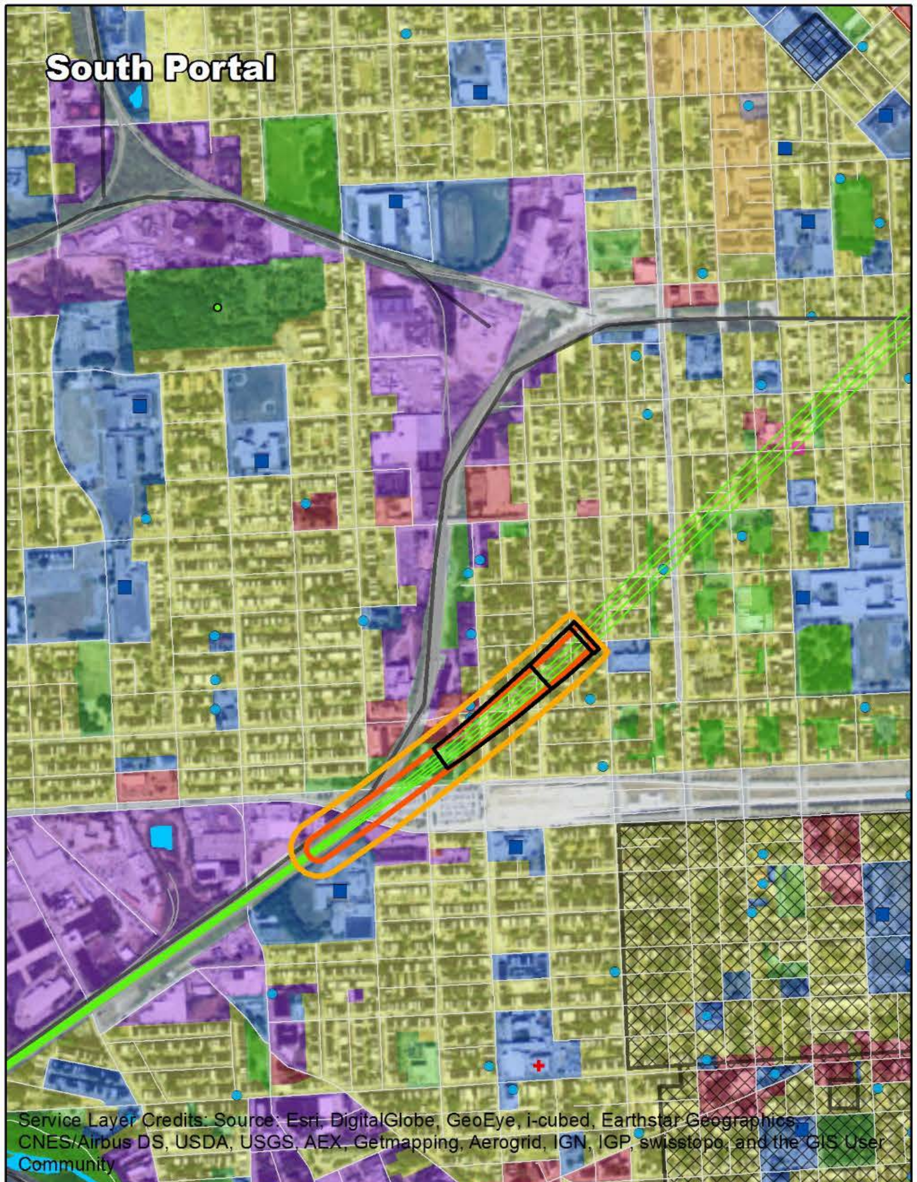

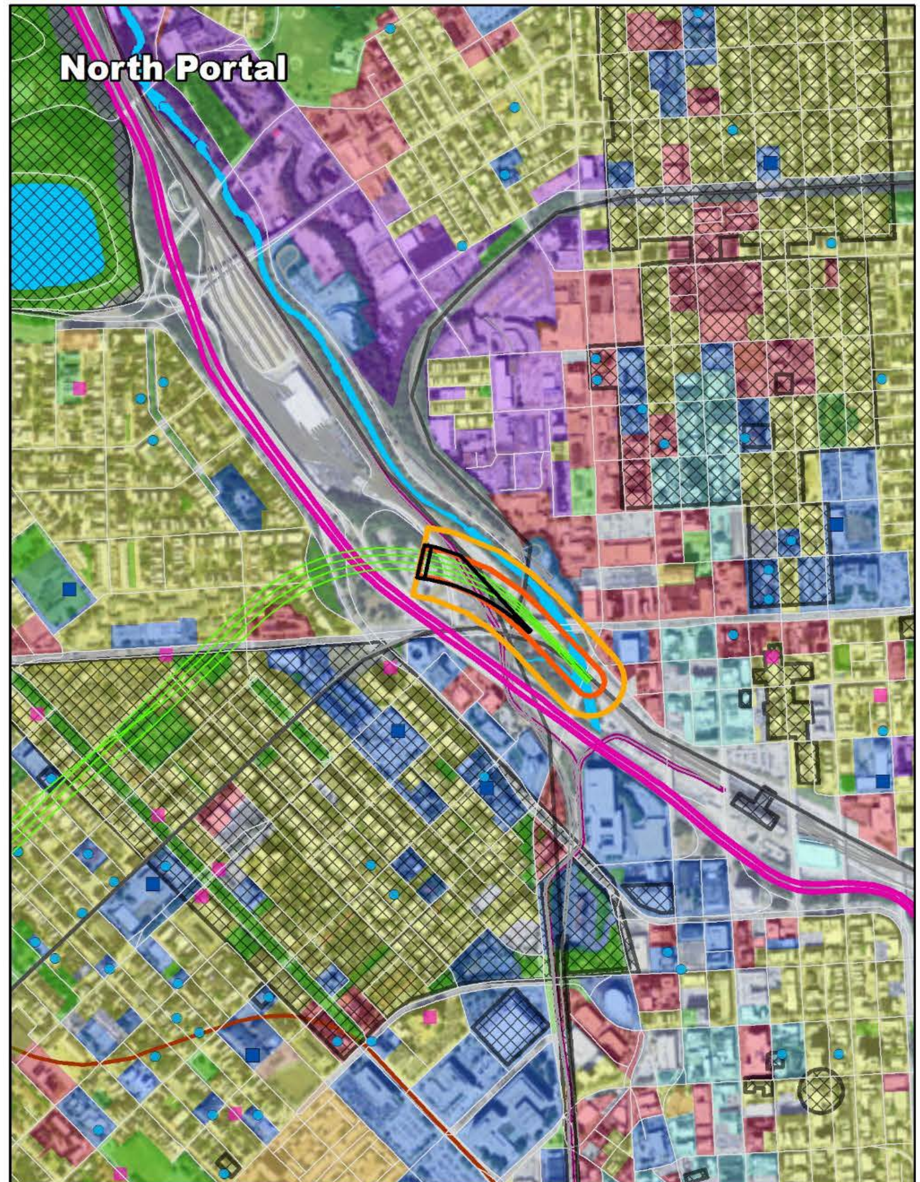

Legend

Alt 11A Portal	Railroad	Library	Water	Mixed
Alt 11A - Severe Impact	Railroad (detailed)	Cemetery	Parks	Open Space
Alt 11A - Moderate Impact	Hospital	Affordable Housing	Light Rail	Residential
Alt 11 A Track Centerline	Place of Worship	BCPSS - School	Metro Line	Transportation
Interstates	Road	Public Housing	Commercial	
		NRHP	Industrial	
			Institutional	

Baltimore & Potomac Tunnel Project
Alternative 11A Noise Contours
Category 3 (Institutional)

0 1,200 Feet

NORTH

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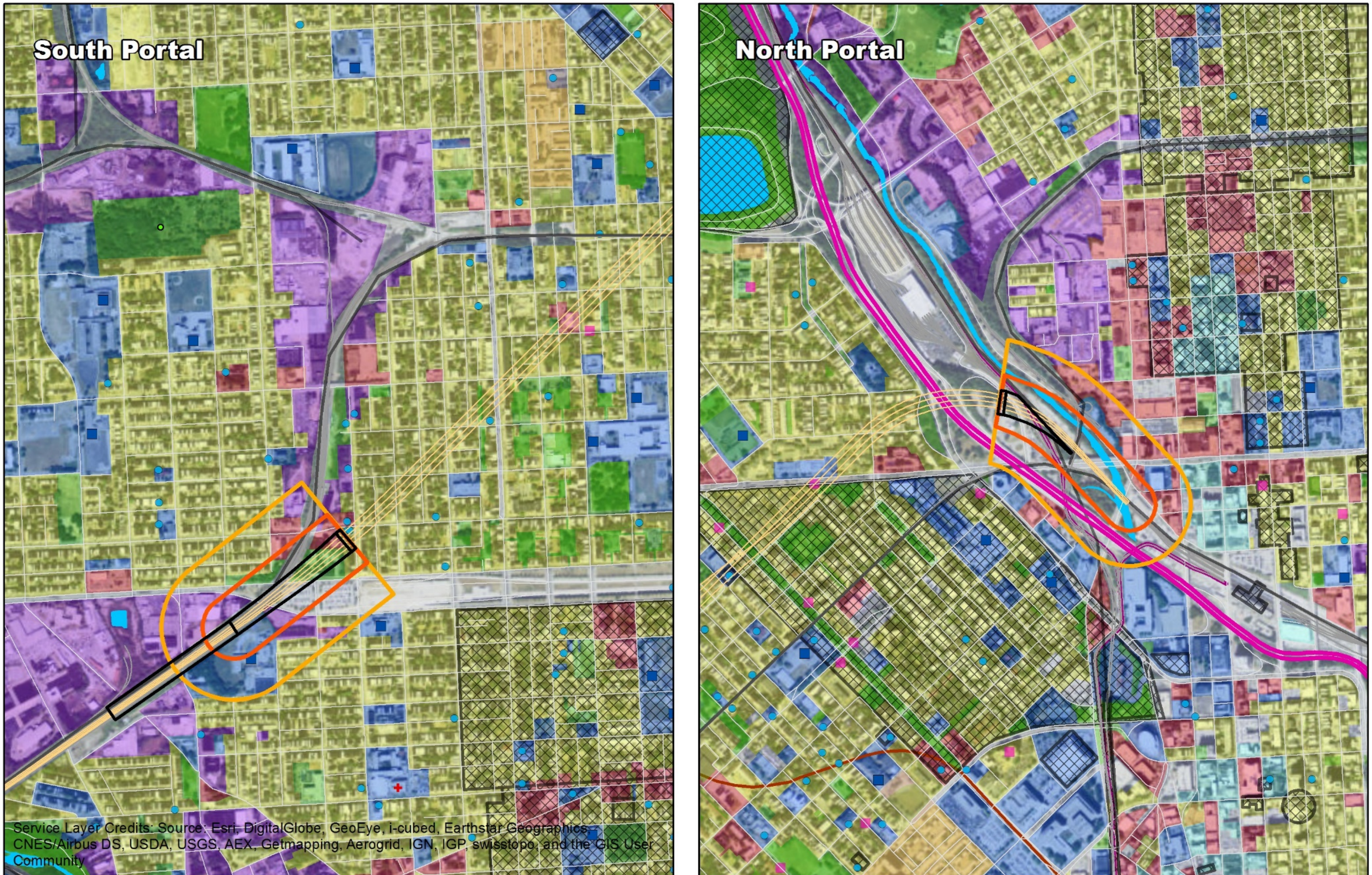

Legend

- Alt 11B Portal
- Alt 11B - Severe Impact
- Alt 11B - Moderate Impact
- Alt 11B Track Centerline
- Interstates
- Railroad
- Railroad (detailed)
- Hospital
- Place of Worship
- Road
- Library
- Cemetery
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Baltimore & Potomac Tunnel Project
Alternative 11B Noise Contours
Category 2 (Residential)

0 1,200 Feet

NORTH

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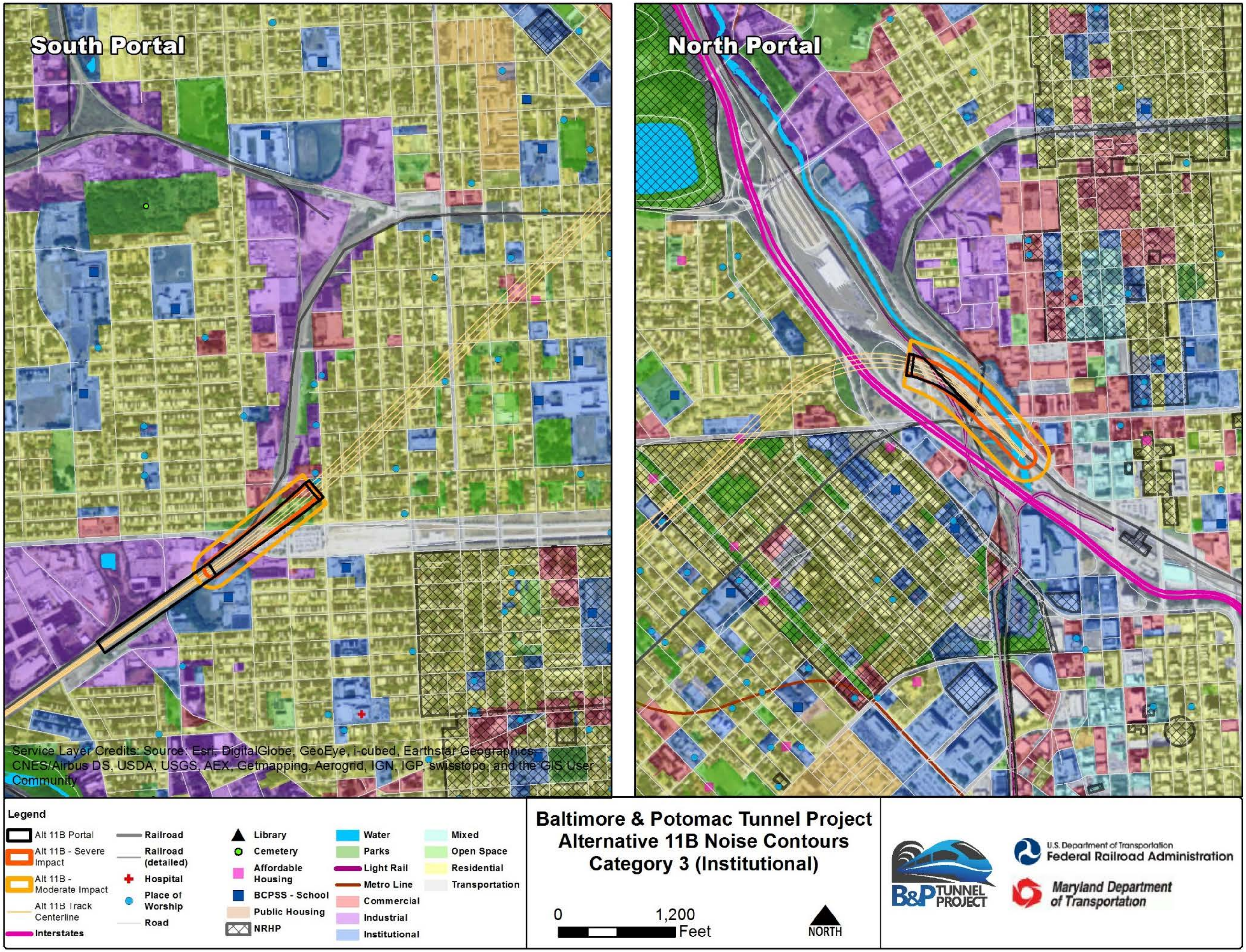

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