



Appendix 1.5 Tunnels & Overbuild Segments: Metropolitan Avenue and All Faiths Cemetery Tunnel

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2 Metropolitan Avenue & All Faiths Cemetery Tunnel

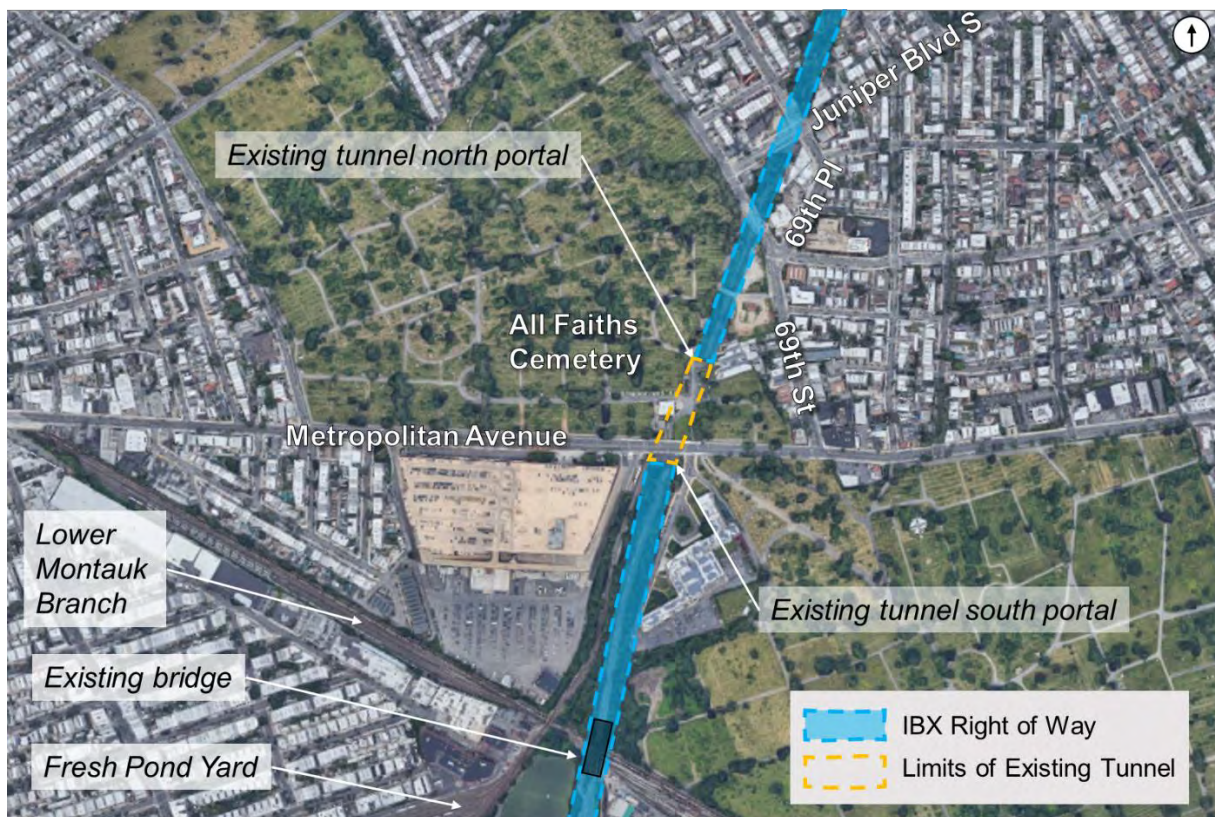
2.1 Introduction

Each of the three alternatives under consideration (conventional rail [CR], light rail transit [LRT] and bus rapid transit [BRT]) must traverse Metropolitan Avenue and All Faiths Cemetery in Queens. While LRT and BRT would exit the existing right of way and travel along streets to circumnavigate the cemetery, CR would travel underground in a new tunnel and rejoin the ROW upon resurfacing. Although a cut-and-cover structure currently exists along the ROW (discussed in more detail in subsequent sections), this tunnel currently contains two active freight tracks and is not wide enough to add trackage to accommodate IBX service. This technical memorandum investigates the feasibility of, and performs an alternatives analysis for, underground solutions for the CR alternative at Metropolitan Avenue and All Faiths Cemetery.

2.2 Existing Structures

This section describes the existing structures and features in the vicinity of Metropolitan Avenue and All Faiths Cemetery, which are illustrated in **Figure 1**.

Figure 1: Metropolitan Avenue and All Faiths Cemetery Existing Conditions



2.2.1 Fresh Pond Yard

Fresh Pond Yard is located about 1,500 feet south of Metropolitan Avenue. There is an existing bridge over Fresh Pond Yard with two tracks, which are used daily by the New York & Atlantic Railway (NY&A) to traverse Fresh Pond Yard. There are embankments on both ends of the bridge abutment. There is also a spur track which connects freight line services from the Bay Ridge Branch to Fresh Pond Yard and the Lower Montauk Branch.

2.2.2 Existing Freight Tunnel

Freight service extends from the bridge over Fresh Pond Yard toward Metropolitan Avenue. This segment of the existing freight line is on embankment. There is a cut-and-cover box under Metropolitan Avenue and the All Faiths Cemetery entrance, buildings and structures. Two side-by-side tracks are present within this tunnel, which is approximately 30 feet wide, and approximately 520 feet long. The existing northern portal connects to the open cut of the CSX Fremont Secondary.

2.2.3 Existing Bridge Crossings

After the ROW emerges from the tunnel and proceeds north into the open cut, it passes underneath bridge crossings at Cemetery Road, 69th Street, and the intersection of 69th Place and Juniper Boulevard South.

2.3 Tunnel Alternatives

Two options are considered for the CR tunnel under Metropolitan Avenue and All Faiths Cemetery, including a short, shallow concept tunnel, and a long, deep concept tunnel.

2.3.1 Short, Shallow Concept

The short, shallow concept tunnel would have an underground length of approximately 515 feet, at a depth of at least 18 feet under Metropolitan Avenue and All Faiths Cemetery, with 0.5% grade toward the north portal. The proposed tracks would go down with 2.5% grade about 50 feet north of Fresh Pond Yard bridge crossing. A new bridge running parallel to the existing bridge above Fresh Pond Yard and the LIRR Lower Montauk Branch is needed in this alternative to accommodate two new tracks. The southern approach structure would be approximately 700 feet in length. The proposed tunnel runs parallel with the existing cut-and-cover box under Metropolitan Avenue and All Faiths Cemetery, and would minimize construction impacts on All Faiths Cemetery. The tracks would rise with 2.5% grade after the north portal and would return to the existing grade after approximately 470 feet.

The tunnel plan and profile for the short, shallow concept tunnel is shown in **Appendix A**.

Under this option, the proposed Metropolitan Avenue Station would be an open cut station where the Top of Rail (TOR) is about 10 feet below the existing grade. The station's side platforms would be 540 feet long and on 0.5% grade toward the tunnel south portal. Connection to the M Line would be achieved by exiting IBX service onto Metropolitan Avenue and re-entering the system at the Metropolitan Avenue M Line station via a free transfer.

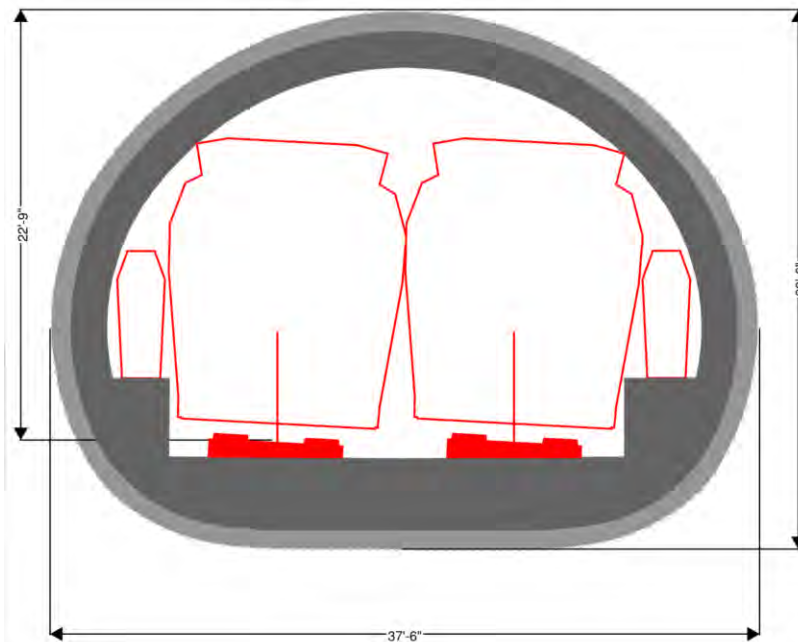
The lengths of all components for this concept are shown in **Table 1**.

Table 1: Length of underground elements for Short, Shallow Concept Tunnel

Underground Element	Approximate Length (in feet)
South approach structure	700
Metropolitan Avenue Station	540
SEM tunnel	515
North approach structure	470
Total	2,225

The tunnel would be about 37.5 feet wide and 28.5 feet tall, accommodating side-by-side tracks with safety walkways on each side of the tunnel. The tunnel section is shown in **Figure 2**.

Figure 2: Short, shallow concept under Metropolitan Avenue and All Faiths Cemetery - SEM tunnel



The tunnel would be constructed using the Sequential Excavation Method (SEM). Also known as the New Austrian Tunneling Method (NATM), SEM is used for the construction of shallow, mined tunnels. The principle behind the SEM is the integration of ground behavior under loading and the continuous monitoring of the underground construction. Therefore, optimized support depends on the observed site conditions and the prevailing rock/soil strength. The proposed tunnel is divided into multiple segments. Each segment is mined using an excavator in a sequential manner. As soil from each segment is removed, sprayed concrete known as shotcrete is applied around the excavation. Additional excavation support is provided by installing lattice girders. Considering the minimal amount of cover above the SEM tunnel under Metropolitan Avenue and All Faiths Cemetery, pre-excavation support measurements such as pipe roofing or forepoling is also needed. The SEM tunnel in this case would be temporarily supported by layers of shotcrete and lattice girders. A permanent concrete liner would be installed thereafter.



2.3.2 Long, Deep Concept

The long, deep concept tunnel has a total bored length of 4,400 feet, more than 8 times the underground length of the short, shallow concept tunnel. The south open-cut section would start after Cypress Hills Street, with trackage going down at a 2.0% grade until there is sufficient cover for a cut-and-cover structure. The existing spur track connecting the Bay Ridge Branch to Fresh Pond Yard should be relocated in this alternative to accommodate space for the south open-cut and south cut-and-cover structures. The combined length of the south cut-and-cover and south open-cut sections would be approximately 1,300 feet. The track grade after Fresh Pond Yard crossing would be reduced to 0.25% and would continue with this grade under the Metropolitan Avenue and All Faiths Cemetery. The maximum grade considered for the bored tunnel is 2.0%. The tunnel would run more than 60 feet below Metropolitan Avenue and All Faiths Cemetery, and almost parallel with the existing cut-and-cover box. Therefore, construction impacts on the existing tunnel and All Faiths Cemetery buildings and structures would be significantly minimized.

The proposed IBX Metropolitan Avenue Station would be fully underground in mezzanine and platform levels. Its side platforms would be 540 feet in length and have a grade of 0.25%. The TOR at this station would be about 60 feet below the existing grade. As per NFPA 130 standards, no additional emergency egress is needed in this tunnel concept, as the distances of the station entrances to the north and south open cut sections are less than 2,500 feet away from the station. An “in-system” (free) transfer for passengers between this station and the existing M Line station would be provided by an underground connection between the IBX station mezzanine and M Line service. Access to the M Line platform will be via elevator, and escalators.

The track would rise again with 2.0% grade after 69th Street bridge crossing. The overall length of the north cut-and-cover and north open-cut sections would be about 1,500 feet. The track would return to existing grade before the bridge crossing at Eliot Avenue. The existing CSX freight track would require relocation between 69th Place/Juniper Boulevard South and the Eliot Avenue crossings to accommodate the north approach structures.

The tunnel plan and profile for the long and deep bored tunnel concept is shown in **Appendix B**.

The lengths of all components for this concept are shown in **Table 2**.

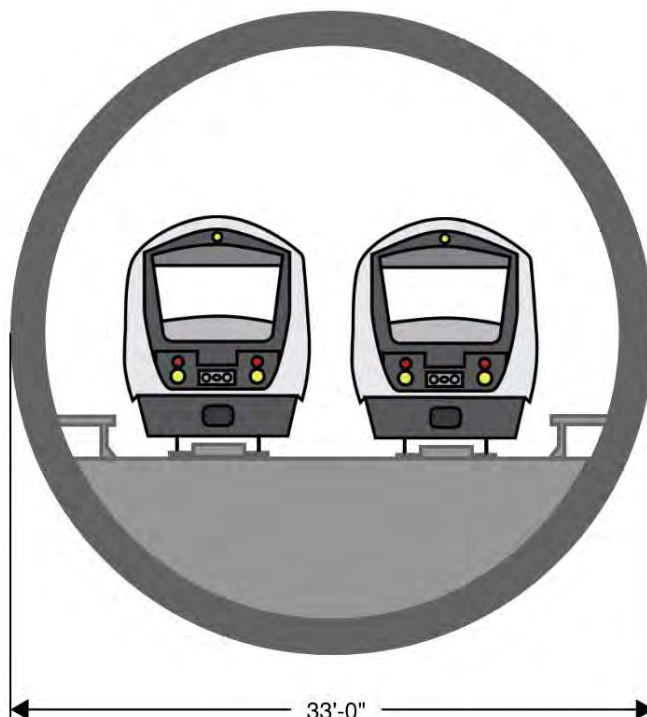
Table 2: Length of components for Long, Deep Concept Tunnel

Underground Element	Approximate Length (in feet)
South open cut	890
South cut and cover	400
Bored tunnel	4,400
Metropolitan Avenue Station	540
North cut and cover	330
North open cut	1,170
Total	7,730

A single-tube bored tunnel with side-by-side tracks would be constructed using a Tunnel Boring Machine (TBM). The tunnel diameter would be 33 feet and accommodate safety walkways on each side of the tunnel. The TBM launch shaft would be located at the north end of the south cut-

and-cover structure, between Otto Road and the existing tracks, with a retrieval location north of the 69th Place and Juniper Boulevard South intersection. A minimum curve radius of 1,000 feet is considered all along the bored tunnel section. The bored tunnel would go under the existing Fresh Pond Yard by maintaining at least half of a TBM diameter. The bored tunnel section is shown in **Figure 3**.

Figure 3: Long, deep concept under Metropolitan Avenue and All Faiths Cemetery - bored tunnel



A pressurized shielded TBM would be needed considering the soft ground conditions expected in this part of Queens. There are generally two types of pressurized machines: Earth Pressure Balance (EPB) Shield Machine and Slurry Shield Machines.

The face of an EPB Shield Machines is pressurized by making use of the excavated ground. Soil is excavated by the cutting wheel and enters the excavation chamber. The volume flow of entering soil can be regulated through the excavation speed of the shield machine. Support pressure is regulated by the extraction flow of the screw conveyor and by the injection of foam for soil conditioning when the excavation is performed through coarser ground. The primary application range of EPB Shields is in fine-grained soil, where soil may be conditioned only by water.

In Slurry Shield Machines, the excavation chamber (front chamber) and working chamber (back chamber) are filled with a slurry, i.e., a suspension of water and bentonite particles, which consists mostly of montmorillonite clay minerals. The excavation chamber is separated from the working chamber by a submerged wall. The flow between the two chambers is ensured by an opening at the bottom of the submerged wall. The support pressure in the excavation chamber is controlled by regulating the pressure of the compressed-air reservoir in the pressure chamber. The excavated soil is mixed with the suspension and pumped through the suction inlet and slurry discharge pipe to a separation plant at ground level. Fresh or regenerated slurry is continuously



supplied into the excavation chamber by a slurry feed pipe. Additionally, the machine is equipped with a sieve grill and stone crusher before the suction inlet to reduce the size of cobbles for hydraulic transport by the slurry discharge pipe. The primary application range of slurry shields is in coarse-grained soils. However, anti-clogging measures can be taken if finer grain soils are encountered.

2.3.3 Comparative Analysis

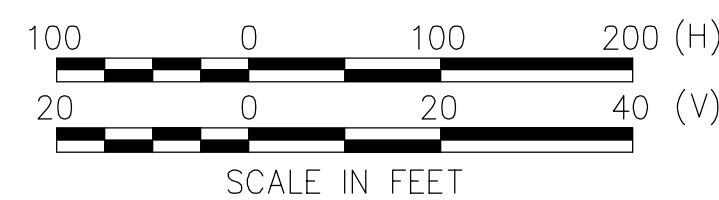
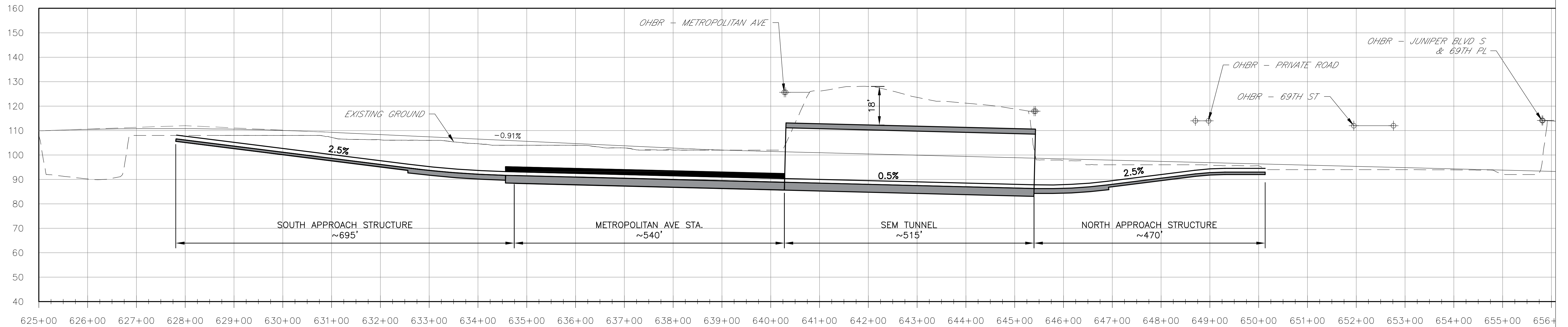
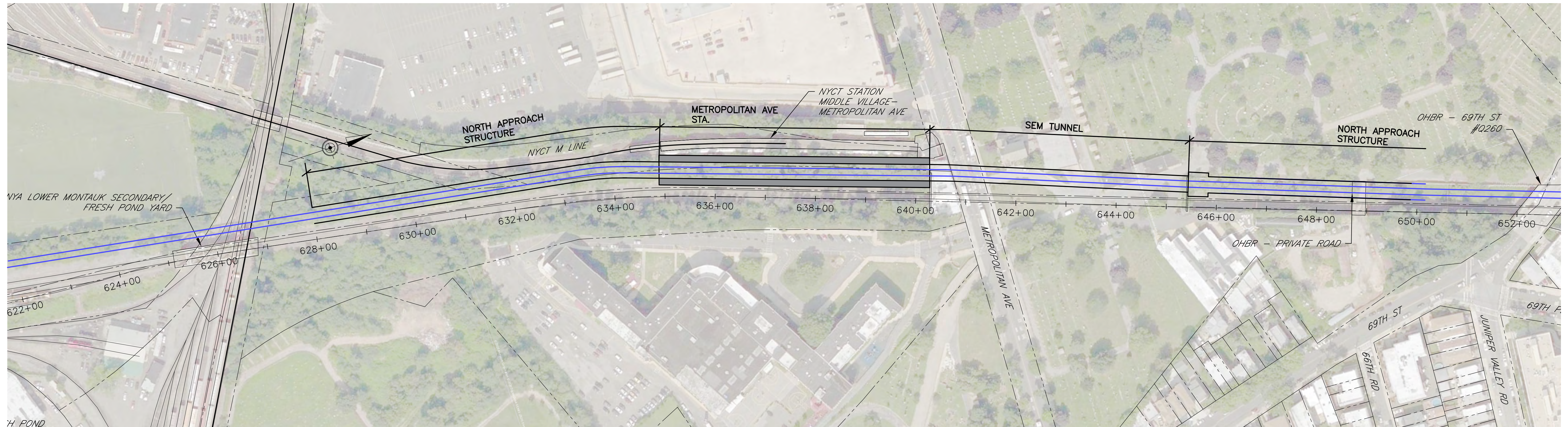
The pros and cons of each tunnel concept under Metropolitan Avenue and All Faiths Cemetery are listed in **Table 3**.

Table 3: Pros and cons of tunnel concepts under Metropolitan Avenue and All Faiths Cemetery

Short, Shallow Tunnel (SEM)		Long, Deep Tunnel (TBM)	
Pros	Cons	Pros	Cons
Construction		Construction	
<ul style="list-style-type: none"> • Lower capital cost • Shorter overall construction schedule 	<ul style="list-style-type: none"> • Only 18 ft below All Faiths Cemetery • High risk of surface impacts to cemetery • Construction of Fresh Pond Junction / Lower Montauk Branch overpass required 	<ul style="list-style-type: none"> • Sufficient distance (60 ft) below All Faiths Cemetery • Minimum risk of surface impacts to cemetery 	<ul style="list-style-type: none"> • Higher capital cost • Longer overall construction schedule
Freight operations		Freight operations	
	<ul style="list-style-type: none"> • Subject to increased rail freight activity at Fresh Pond Junction 	<ul style="list-style-type: none"> • Bypass Fresh Pond Junction / Lower Montauk Branch and freight activity 	
Metropolitan Station		Metropolitan Station	
<ul style="list-style-type: none"> • Less complicated Fire Life Safety requirements • Faster access to street level 	<ul style="list-style-type: none"> • Passengers subject to weather conditions 	<ul style="list-style-type: none"> • Improved direct passenger transfer to M Line • Climate controlled station 	<ul style="list-style-type: none"> • More complicated Fire Life Safety requirements • Increased number of elevators and escalators



Appendix A: Short, Shallow Tunnel Concept (SEM)



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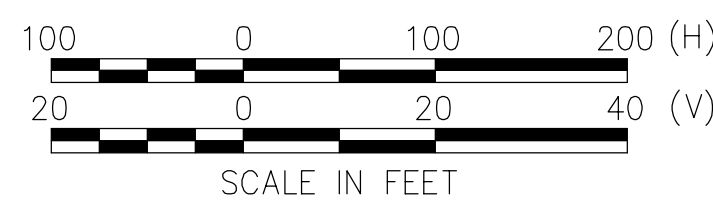
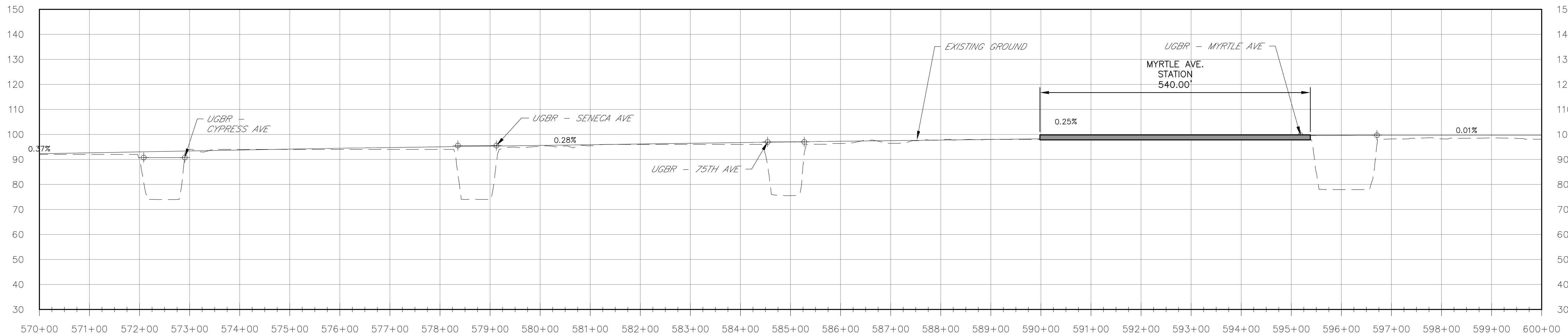


MTA BAY RIDGE CONNECTOR
TRACK PLAN AND PROFILE
SHORT, SHALLOW CONCEPT

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Appendix B: Long, Deep Tunnel Concept (TBM)



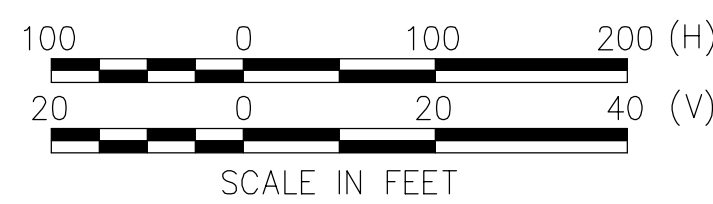
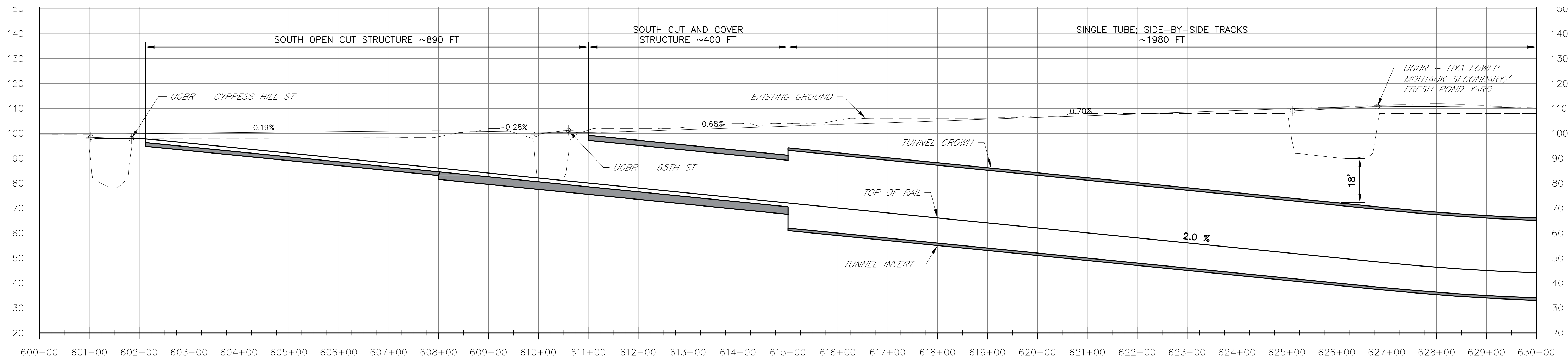
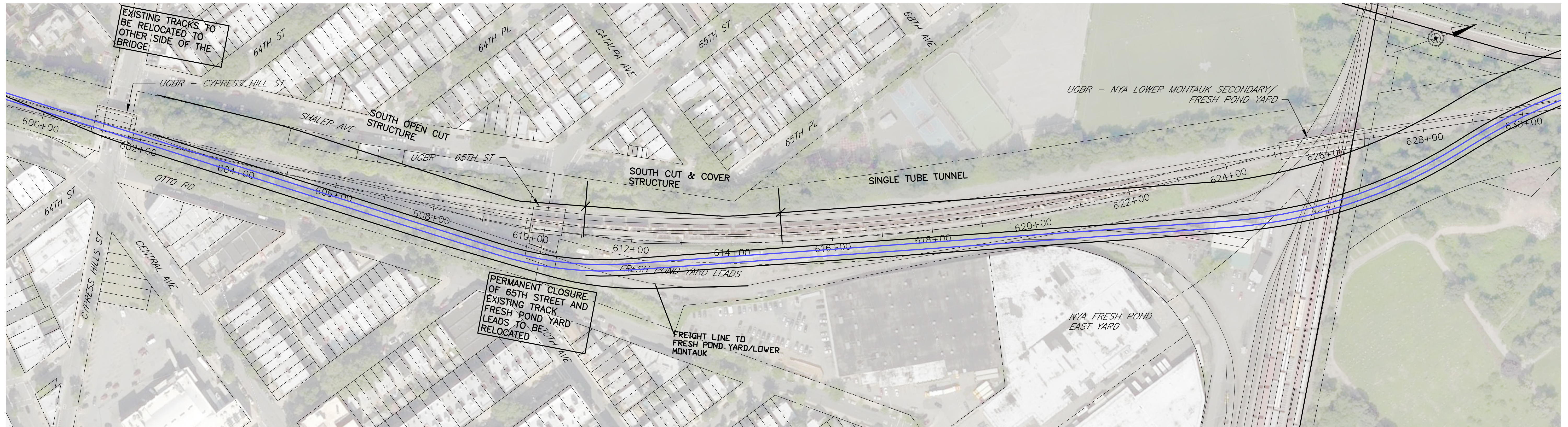
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AECOM
 1700 MARKET STREET
 PHILADELPHIA, PA 19103

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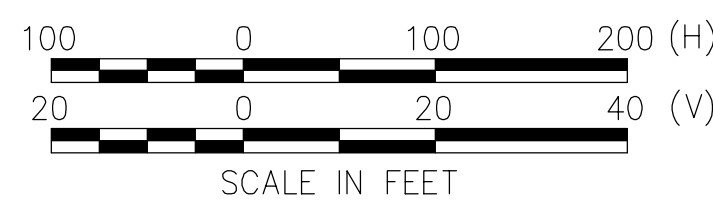
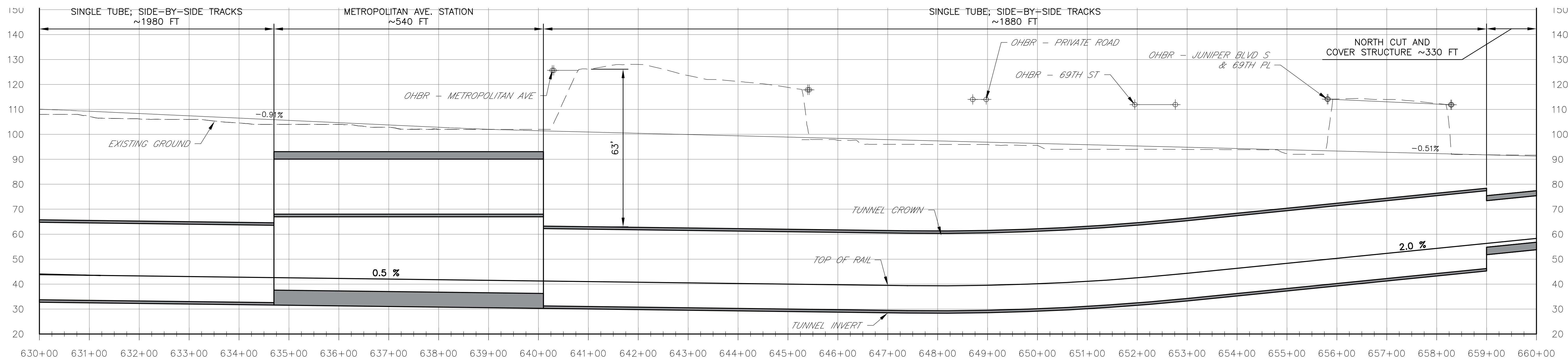
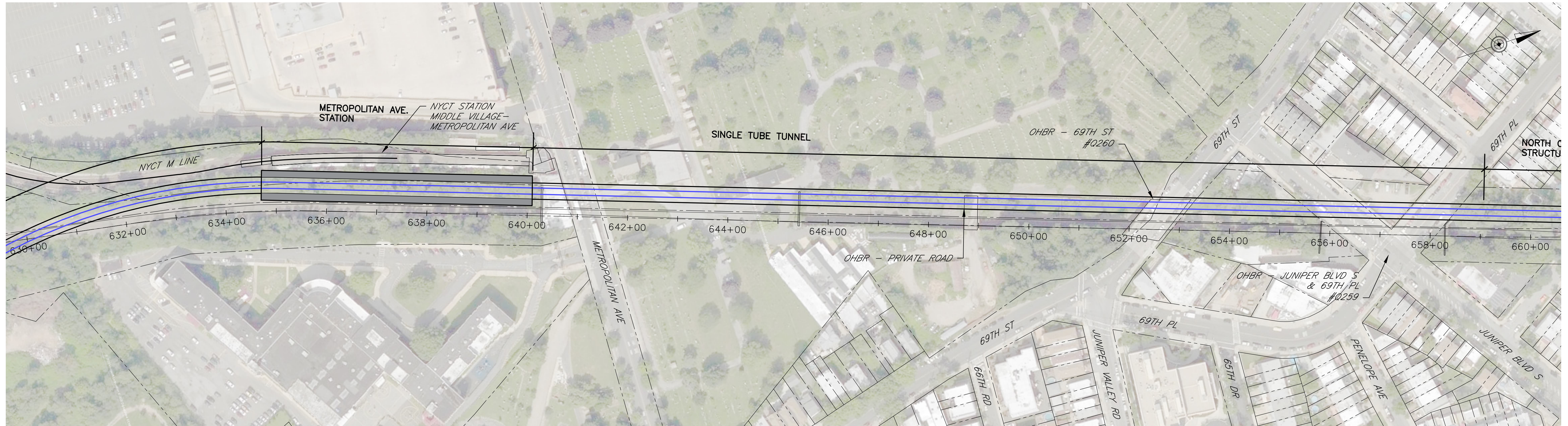
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MTA BAY RIDGE CONNECTOR

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LONG, DEEP CONCEPT

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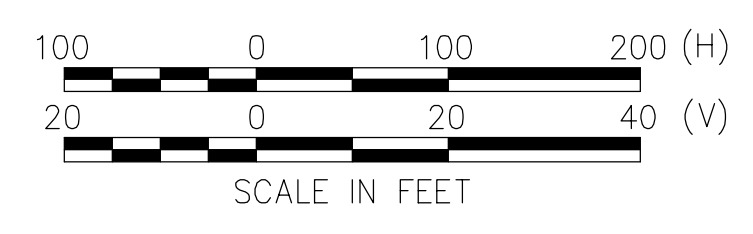
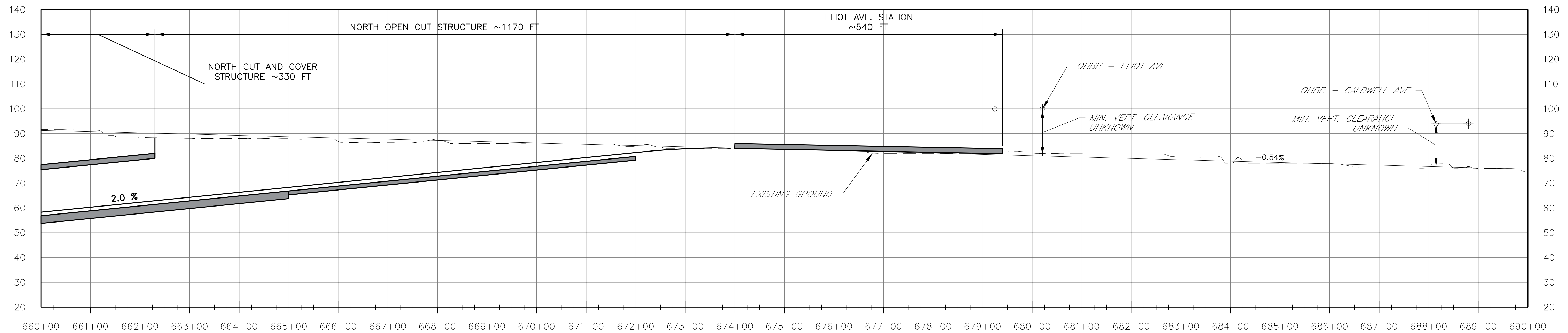
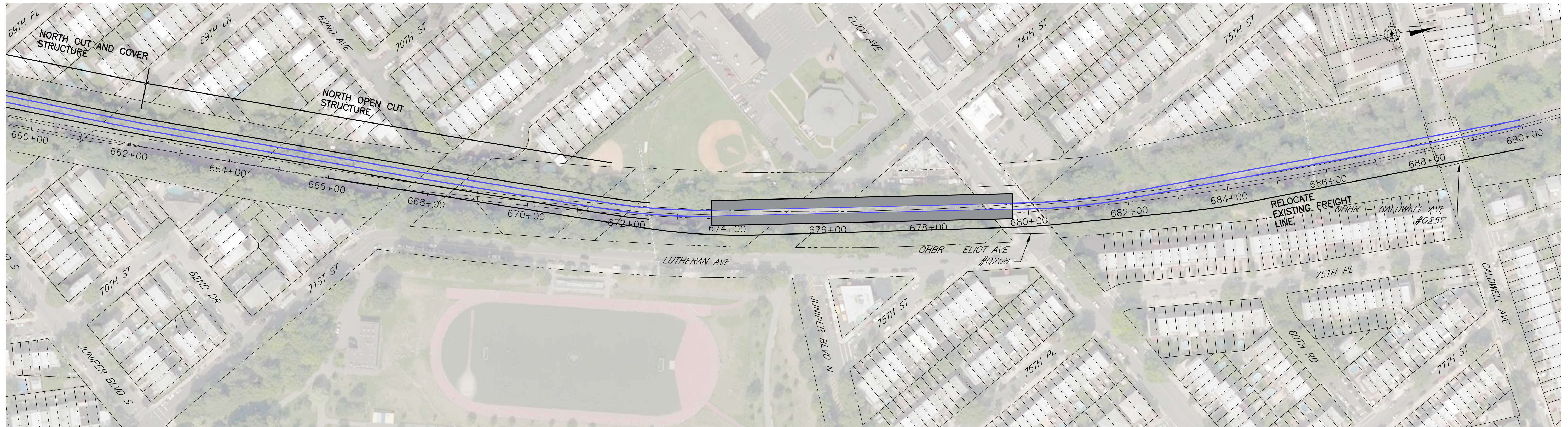
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