

UNION STATION
ACCESS AND CAPACITY IMPROVEMENT STUDY
PROJECT REPORT



Washington Metropolitan Area Transit Authority
Department of Planning and Joint Development

In Association with
District of Columbia Department of Transportation

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Executive Summary

Union Station is the largest intermodal transportation center in the Washington metropolitan region, hosting Metrorail, Amtrak, commuter rail from Maryland and Virginia, intercity and local bus services and other transportation modes. The Metrorail station at Union Station is the busiest station in the Metrorail system and serves the commute and leisure travel needs of thousands of residents and visitors from DC, Virginia, Maryland and the entire East Coast.

Built in the 1970s, this Metrorail station is reaching capacity and passengers experience crowding throughout the station on a daily basis. As travel demand at Union Station continues to grow from increased regional and local transit services, expanded intercity travel and the renewal of adjoining DC neighborhoods, enhancements to the Metrorail station are urgently needed, not only to relieve today's congestion but also to accommodate passenger growth in the years to come. The Washington Metropolitan Area Transit Authority ("Metro") undertook the Union Station Access and Capacity Improvement Study in partnership with the District of Columbia Department of Transportation (DDOT) and Union Station stakeholders. This study focused on the north mezzanine of the Metrorail station, where passengers experience serious congestion in the peak hours and large-scale development is planned for the areas to the north. The purpose of the study was to define improvements that would increase the station's capacity and accessibility and move passengers quickly and safely. It also recognized that reducing crowding and delay would enhance customers' experience and make public transportation pleasant and convenient.

This study applied innovative techniques in the identification of existing station conditions and development of capacity expansion alternatives. Metro combined engineering and architectural design with dynamic pedestrian simulation, which resulted in the identification of improvements that would fit compatibly with Union Station and benefit all transportation service providers and customers. Highlights of the study results and impacts are provided below.

Current Demand and Condition

The Metrorail station at Union Station is one of the oldest stations within the Metrorail system. Since its opening in 1976, the surrounding areas have undergone extensive transformation as manifested in the Metrorail daily boardings which went from 5,000 at opening to 35,000 today. However, this station has not received major capacity expansion except for the rehabilitation that occurred in the late 1980s and the planned rehabilitation in the next few years as part of the Red Line Rehabilitation Program.

Presently, more than 5,000 pedestrians use the north mezzanine in the morning rush hour and 6,000 in the evening rush hour. Pedestrian traffic within the north mezzanine is highly mixed—the unpaid space in the mezzanine, between the entrance door and Amtrak concourse escalators, accommodates sixteen pedestrian paths at any moment. More than 50% of the pedestrians experience severe congestion and delay at the north mezzanine in the peak hours. The narrow First Street entrance is crowded with mixed flows in and out of the station; approaches to escalators at mezzanine, platform and concourse are packed with passengers waiting to move from one level to the other—delaying travel time and raising safety concerns in the event of emergency.

Figure ES-1: Current Conditions at North Mezzanine (Peak Hour)

Mezzanine



Metrorail Platform



Future Development and Impact

Area growth remains strong for the next twenty years. The 2009 DDOT Union Station Intermodal Transportation Center Feasibility Study identified major development within the Union Station complex and adjacent areas, including:

- A H Street pedestrian passageway connecting the north mezzanine of Metrorail station with H Street
- A new intercity bus terminal on the parking deck and a streetcar terminal located in the unused H Street underpass
- The planned development to the north totaling five-million square feet within half-a-mile of Union Station, including the entire Burnham development and part of redevelopment north of Massachusetts Avenue.

The proposed development and facilities would directly impact Metrorail's north mezzanine, with 60% increase in pedestrian traffic. Without major capacity enhancements, Metrorail's north mezzanine at Union Station would be unable to accommodate the anticipated growth, leading to congested travel conditions for customers and impacting all transportation services at Union Station—Metrorail, intercity rail and bus, commuter rail, local bus and streetcar.

Proposed Improvements and Future Performance

In consideration of right-of-way constraints, WMATA worked closely with DDOT and Union Station stakeholders and developed two potential improvement alternatives for 2030: Partial Build and Full Build (illustrated in Figures 12 and 19).

- Partial Build. This alternative presented moderate expansion of access and capacity at the north mezzanine. It focused on improvements at the mezzanine level, including relocation of the First Street entrance, completion of the H street pedestrian passageway behind the mezzanine wall, addition of new Metrorail fare gates and ticketing machines and addition of two elevators to the Amtrak concourse. Figure 12 illustrates the proposed Partial Build.

- Full Build. This alternative introduced significant expansion of access and capacity. It included all improvements in the Partial Build and added vertical connections among the three levels of mezzanine—Metrorail platform, mezzanine and Amtrak concourse. The addition of a stairway between the mezzanine and Metrorail platform and two new escalators between the mezzanine and Amtrak concourse intended to provide multiple path choices for pedestrians traveling across three levels. Figure 19 illustrates the proposed Full Build.

Figure ES-2: Architectural Rendering of Relocated First Street Entrance
(Partial Build and Full Build)



Based on the pedestrian simulation, the Partial Build improvements would greatly reduce crowding at the First Street entrance and shorten the path to the Amtrak concourse. The opening of the pedestrian walkway under H Street would offer a direct connection to new development, streetcar and intercity bus terminal, divert new pedestrian traffic away from the First Street entrance and provide quick access to Metrorail and Amtrak. However, this alternative would not provide any capacity expansion to address the critical constraints of pedestrian movements from platform to mezzanine and concourse. The sheer increase in the vertical movements of pedestrians would intensify the mix and conflicts of pedestrian flows throughout the north mezzanine.

The Full Build alternative, on the other hand, would achieve significant relief of pedestrian crowding and conflicts at the mezzanine level and provide additional capacity for ridership growth beyond 2030. The expanded vertical capacity connecting the three levels in the Full Build would greatly alleviate peak crowding in the unpaid area, allowing pedestrians from the First Street entrance to walk smoothly toward their destinations with far less obstruction and delay. The new escalator set connected to the concourse would divert a large volume of passengers traveling to and from the north mezzanine. The existing escalators would accommodate fewer passengers and thus achieve reductions in passenger queues and clearance time during the peak hours. The addition of a new stair and new elevators on the Metrorail platform would speed up the exiting traffic, clearing up the platform in time for the next train to arrive.

Figure ES-3: Comparison of Partial Build and Full Build

	Partial Build Alternative	Full Build Alternative
North Mezzanine (Mezzanine Level)	<ul style="list-style-type: none"> • Reduced crowding at the First Street entrance • New connection to the north via the H St. passageway • Severe congestion in the unpaid area 	<ul style="list-style-type: none"> • Reduced crowding at the First Street entrance • New connection to the north via the H St. passageway • Significant crowding reduction in the unpaid area
Metrorail Platform	<ul style="list-style-type: none"> • No improvements • Severe crowding and delay for exiting passengers on platform 	<ul style="list-style-type: none"> • Alternative connections to main level with a stair and two elevators • Reduction in passenger delay to and from platform and reduction in platform crowding • Safety improvements on platform
Amtrak Concourse	<ul style="list-style-type: none"> • No relief to escalator congestion • Severe crowding at the escalator approaches on both mezzanine and concourse levels 	<ul style="list-style-type: none"> • Doubled escalator capacity for passengers reaching concourse • Significant reduction of crowding at the escalator approaches on both mezzanine and concourse levels
Travel Time	<ul style="list-style-type: none"> • Little time savings for passengers accessing the First Street entrance • Significant travel time savings for riders using the H. Street passageway 	<ul style="list-style-type: none"> • Moderate time savings for all users through north mezzanine • Significant travel time savings for riders using the H. Street passageway
Other Benefits	<ul style="list-style-type: none"> • Modest improvements in safety and security at the mezzanine level • Direct link to communities and new development to the north and surface transit in the H Street corridor 	<ul style="list-style-type: none"> • Significant improvements in safety and security at all three levels, in particular the Metrorail platform • Direct link to communities and new development to the north and surface transit in the H Street corridor

Conclusions and Benefits

The Union Station Access and Capacity Study found that the proposed capacity improvements in both build alternatives would be compatible with the existing building aesthetic and historic qualities and provide more connections to the existing and planned development and transportation services at Union Station. The proposed Full Build alternative would provide effective congestion relief within the entire north mezzanine and accommodate future ridership growth. These improvements are anticipated to improve accessibility to adjacent facilities and development and expand capacity across three levels of the north mezzanine to move customers quickly and safely.

All users traveling through the north mezzanine—regional and local transit passengers and intercity travelers—are expected to benefit from the proposed north mezzanine access and capacity improvements. Travel time savings is a direct economic benefit from the proposed access and capacity improvements and contributes to the economic competitiveness of the region and nation. It is estimated that by 2030, annual travel time savings for the Full Build alternative would reach 133,000 person-hours, including 33,500 person-hours saved for travelers going through the mezzanine itself and 99,500 person-hours for those using the H Street passageway.

Additionally, the proposed improvements would potentially shift more local and intercity travelers from automobiles to public transportation as the inter-city and local transit services expand over time, reducing vehicles miles traveled and bringing in numerous secondary benefits including reduced greenhouse gas emissions, a sustainability benefit. Other benefits include increased evacuation capacity at Union Station in the event of an emergency with the expansion of the egress capacity from the Amtrak concourse and Metrorail platform. The surrounding areas would benefit from the improved transit connection to Union Station, energizing the continuing renewal of neighborhoods and transit oriented development.

Union Station Introduction

Union Station is the largest intermodal transportation center in the Washington metropolitan area and the mid-Atlantic region. Located just east of Washington's central business district and blocks from the U.S. Capitol, Union Station plays a major role in the travel and commuting needs of thousands of residents and visitors to the national capital region from DC, Virginia, Maryland and the entire East Coast. The original train station was completed in 1909. Designed by noted architect Daniel Burnham, Union Station is listed on the National Register of Historic Places. Many modifications have been made over the years, with the most recent major upgrade and rehabilitation of Union Station's rail station occurred in the late 1980s. The Metrorail station at Union Station opened in 1976 and has undergone no major upgrade or renewal beyond routine maintenance projects and the addition of one mezzanine escalator and stair.

Union Station is a complex of several structures and serves multiple functions, as illustrated in Figure 1. In addition to the Metrorail station, it is Washington's Amtrak intercity passenger rail station, the terminal for MARC and Virginia Railway Express commuter rail services, a bus terminal serving intercity and local buses, a retail center of shops and restaurants, a community gathering place with meeting rooms and public spaces, and a tourist attraction. Each weekday 23,000 commuters and intercity rail riders make 45,000 trips through the station on 229 Amtrak, MARC and VRE trains and 35,000 passengers enter and leave the adjoining Metrorail station. The Metrorail Station at Union Station is the busiest station in the Metrorail system, with close to 70,000 passengers entering and exiting daily including 18,000 passengers transferring between Metrorail and railway services (Amtrak, MARC and VRE). These travelers are joined by 350 intercity bus passengers served by three different bus companies, 200 to 1,000 tour bus passengers depending on the season, hundreds of individuals parking at the station's parking garage and over 150 bicycle commuters and renters at the bike station.

The Metrorail station is located within and beneath the west side of Union Station and extends southward under Columbus Plaza. The space in which the Metrorail station was constructed is physically constrained; the arched ceiling in the train room is lower than the typical Metrorail station configuration, and other station components were designed to fit within this space. There are two station mezzanines that also function as entrances to Union Station, so they must accommodate more people than just transit riders.

As Union Station continues to experience growth from expanded intercity travel, commuter rail's growing popularity and the renewal of adjoining DC neighborhoods, improvements are needed to expand station access and capacity and enhance passenger experience. But designing these improvements is challenging. Space in Union Station is limited, and there are multiple functions that must be accommodated within this space. In addition, Union Station is physically complex, consisting of several structures built at different times to serve different purposes. The original passenger railroad station building is an architectural gem and a significant element in Washington's historic core; any changes must respect the station's design integrity and its location facing the United States Capitol.

Study Overview

Study Purpose

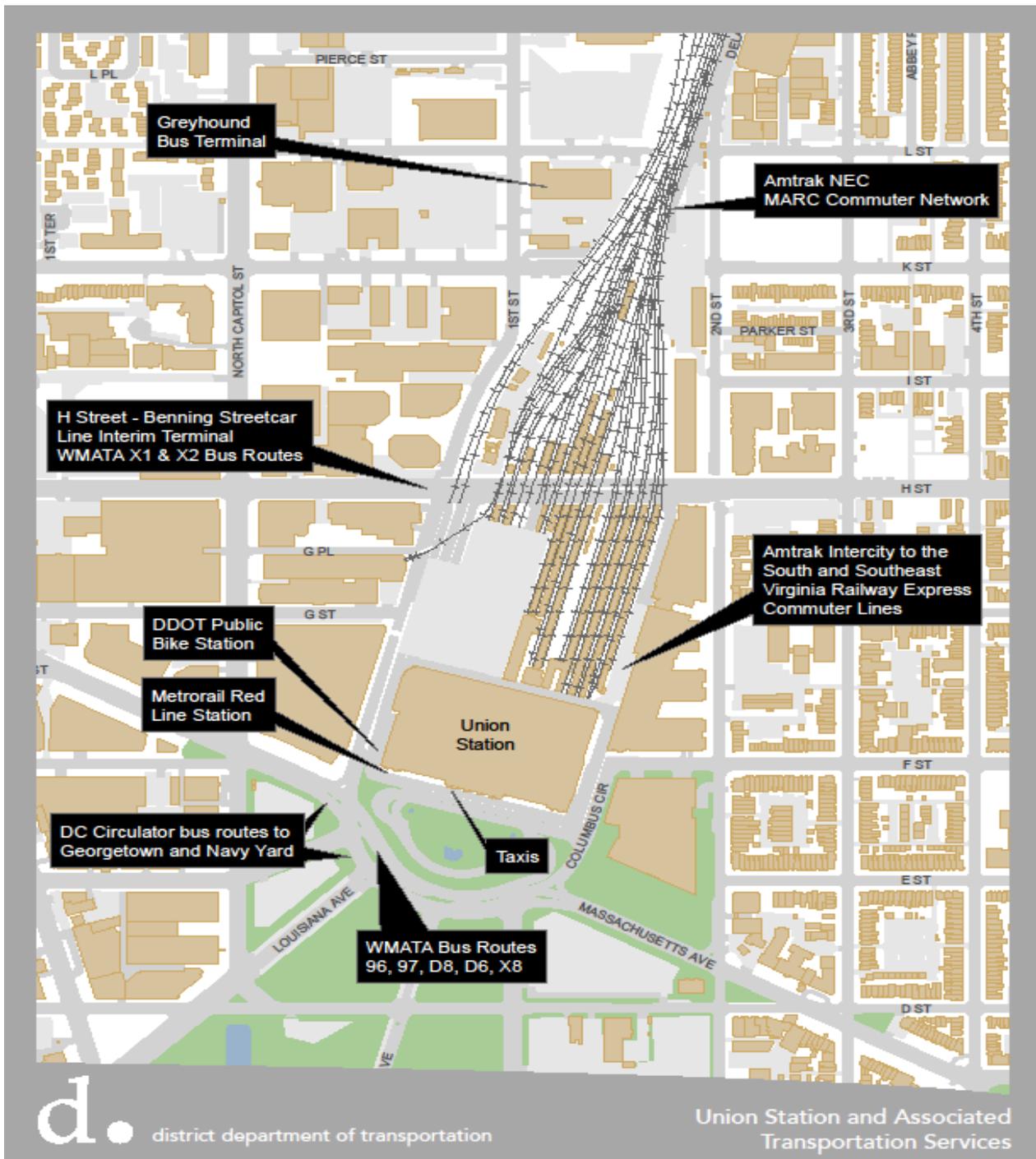
The Washington Metropolitan Area Transit Authority (“Metro”) conducted the Metro Union Station Access and Capacity Study in partnership with the District Department of Transportation (DDOT) to identify improvements that would enhance the Metrorail station’s performance. The study’s primary purpose was to define improvements that would increase the Metrorail station’s capacity and accessibility, especially for vertical circulation. This purpose focused on the functional need to move people quickly and safely. It also recognized that conditions in the station are an important element of customers’ experience, and that reducing crowding and delay will contribute to making public transportation pleasant and convenient. The study recognized that because the Metrorail station is an integral part of Union Station, Metrorail improvements should be designed where possible to benefit not only transit riders but also other people who use Union Station.

A key consideration of the design improvements was the ability to fit compatibly within the existing building and respect adjacent functions. The design process took into account Union Station’s aesthetic and historic qualities. Finally, improvements were designed to be constructed without undue disruption to Union Station’s daily operation and to be maintainable over their service lives. To better assess the performance of alternative designs, this study applied dynamic pedestrian simulation to identify and compare the effectiveness of individual improvements.

At Union Station there are multiple stakeholders with many parallel initiatives underway and stakeholder involvement was a key component of this study. The Union Station Redevelopment Corporation (USRC) assisted in facilitating coordination on this study since USRC was developing its own master plan and USRC represents several of the stakeholders.

Four consulting firms—Parsons Brinkerhoff (PB), KGP, AECOM and Legion—provided technical support for this study, with PB assisting in project coordination, KGP in design, and AECOM and Legion in pedestrian simulation.

Figure 1: Union Station and Associated Transportation Services



Source: DDOT

Scope and Methodology

In 2009, the District Department of Transportation (DDOT) completed the Union Station Intermodal Transportation Center Feasibility Study (USITC). The study recommended a variety of improvements to address railroad, traffic, transit, and pedestrian conditions, including potential improvements related to the Metrorail station. The study recommended that a Metrorail station access study should be performed to develop these improvements in more detail including a pedestrian passageway connecting the north mezzanine of Metrorail station with H Street, new streetcar and intercity bus termini and millions of square feet from planned area development adjacent to the north of Union Station.

Because nearly all of the identified development will occur at or around the north mezzanine of Metrorail station at Union Station, Metro initiated this Station Access and Capacity Improvement Study taking into consideration the planned development and expansion at Union Station. Improvements to the south mezzanine were initially explored; but given the pressing crowding issues at the north mezzanine the focus of the study shifted solely to the north mezzanine where large-scale development is planned. The objective of this study is to assess capacity deficiencies and develop alternative architectural and engineering solutions to enhance pedestrian access, increase station capacity, reduce travel time and improve connectivity to the other transportation modes.

Alternative improvements were developed at a conceptual level in accordance with Metro's design standards and evaluated for their appropriateness. To provide a basis for concept development, as-built drawings of the existing Union Station building and Metrorail facilities were obtained where possible. Extensive data collection was performed, including visual inspection, photo recording, and field measurement of existing conditions. Concurrent with the developing the physical improvements this study evaluated the flow of people through the Union Station Metrorail station. A pedestrian simulation model, using Legion pedestrian simulation software, was developed to calculate measures of effectiveness for pedestrian flow in both the existing station and the station with potential improvements. The study applied the following combination of methodologies and techniques to assist in the identification of present and future station conditions and the assessment of alternative access and capacity improvements.

- **Engineering feasibility assessment and design** to identify areas where proposed improvements are structurally feasible across multi-levels within the station.
- **Architectural design and rendering** to provide visual illustration of the physical improvements, ensure compatibility with and improvements to existing station architectural style, and facilitate communications with stakeholders.
- **Dynamic pedestrian simulation** to provide vivid graphical illustrations of station performance at all levels including current station and proposed improvements, pinpoint critical deficiencies within the station through graphics, and facilitate communications with stakeholders.
- **Measures of Effectiveness (MOE)** to quantify the station capacity performance and generate ways to capture the benefits of the proposed improvements, including travel time savings, queue clearance time and pedestrian level of service.
- **WMATA ridership projection tool** to capture the development of planned transit facilities and land use in the station area and build a demand projection for pedestrian traffic in and out off the study area.
- **Stakeholder involvement** throughout the study to identify limited available right-of-way belonging to individual stakeholders, eliminate proposals interfering with structures at the

very early stage, and reach agreement on the recommended improvements. Key stakeholder consists of DDOT, USRC, Amtrak, and different departments within Metro.

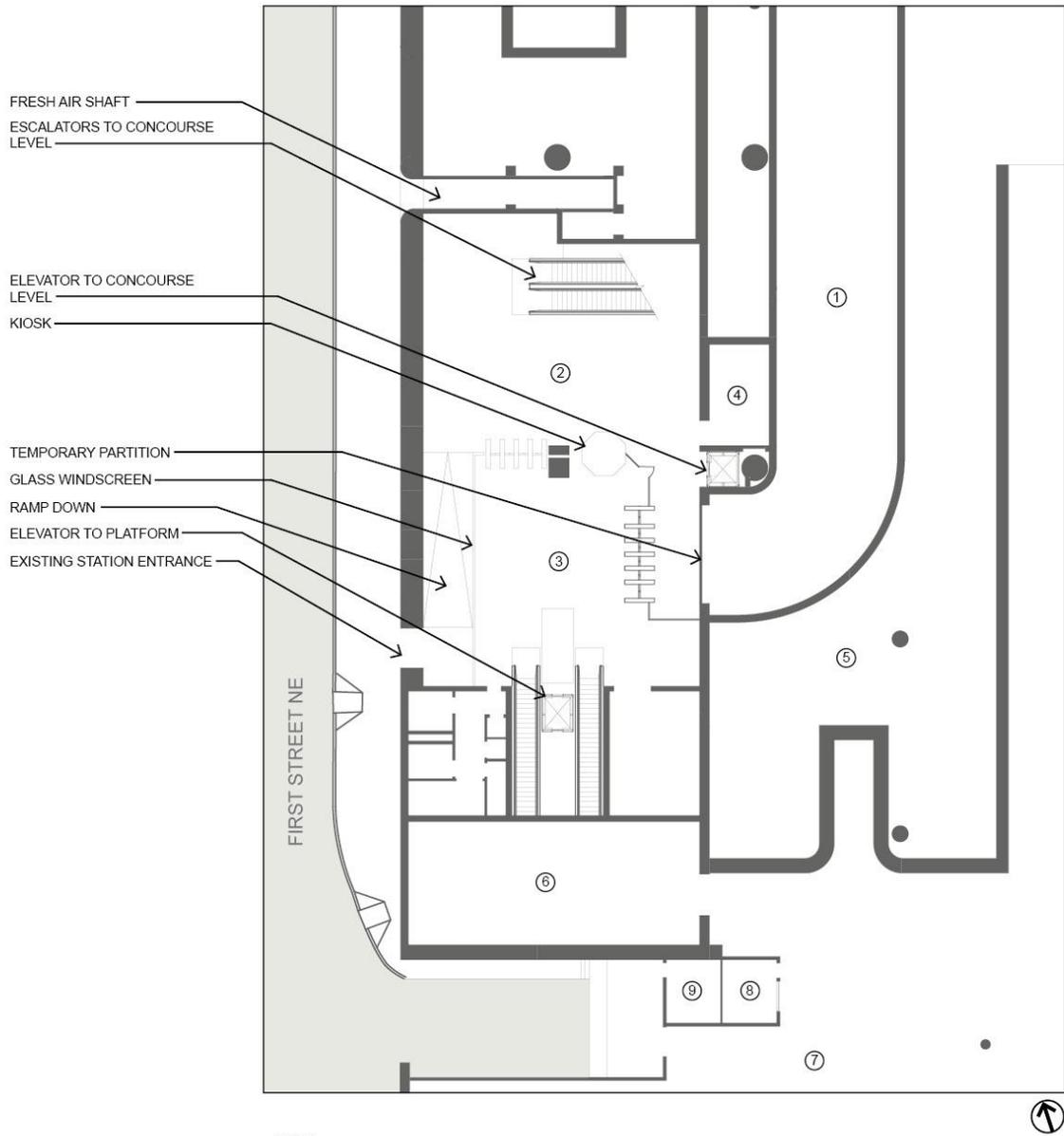
Union Station Metrorail Station

The Metrorail station at Union Station is among the first five stations Metro built and opened for service. On March 29, 1976, Metro opened the first segment on Red Line from Rhode Island to Farragut North. The station has two entrances. The south entrance is larger and can be accessed from the Union Station west portico using two escalators and directly from the Union Station lower level using stairs. The south mezzanine does not have any elevators and is not accessible to people in wheelchairs. There are 15 faregates, one of which is ADA accessible. The north entrance is more confined with limited space and can be accessed directly from First Street, NE and from the Amtrak concourse using two escalators. There are two sets of escalators and one elevator connecting the three vertical levels: Amtrak concourse, Metrorail mezzanine and Metrorail platform. Figure 2 illustrates the current configuration at the north mezzanine.

Over the years, Metro kept up with operating maintenance at Union Station to ensure state of good repair and provide reliable customer service. This year, Metro's FY11-FY16 Capital Improvement Program provided funding for major rehabilitation on the oldest Red Line segment, including Union Station. As a result of Metro's commitment to maintenance, most of the current facilities are still serving passengers, even though they already exceeded the designed life cycle. In the case of escalators and elevators, industrial standards define a life cycle of 20-25 years; however these facilities at Union Station are still transporting millions of riders after 34 years in service. Nonetheless, these old facilities, no matter how well they are maintained, must be eventually replaced with new systems equipped with advanced technology and energy efficiency.

With Metro's co-location with Amtrak and commuter rail, Metrorail ridership experienced substantial growth in the past three decades, as shown in Figure 3. More than 9 million passengers boarded Metrorail at Union Station during FY2010 (July 1, 2009 thru June 30, 2010) (Table 1).

Figure 2: Existing Conditions – North Mezzanine



KEY

- | | |
|-------------------------------------|-------------------|
| ① INCOMPLETE PASSAGEWAY TO H STREET | ⑧ SECURITY |
| ② FREE AREA | ⑨ PACKAGE EXPRESS |
| ③ PAID AREA | |
| ④ ELEVATOR MACHINE ROOM | |
| ⑤ UNEXCAVATED AREA | |
| ⑥ TRANSFORMER ROOM | |
| ⑦ AMTRAK SERVICE AREA | |

Figure 3: Historical Ridership Growth at Union Station
(Average Weekday Daily Boardings)

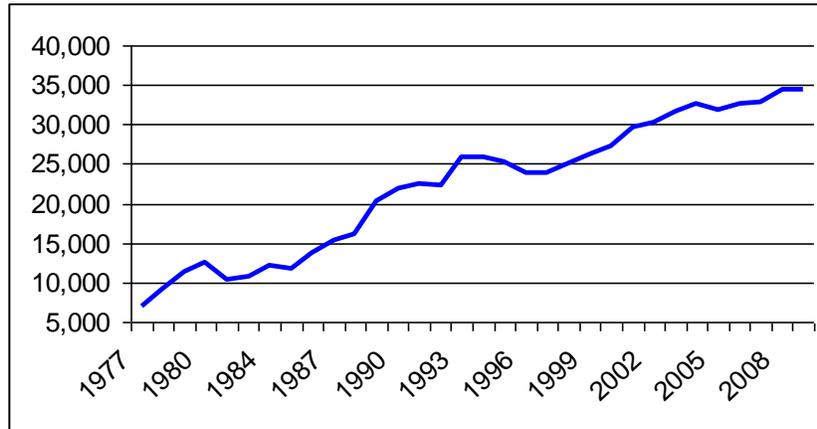
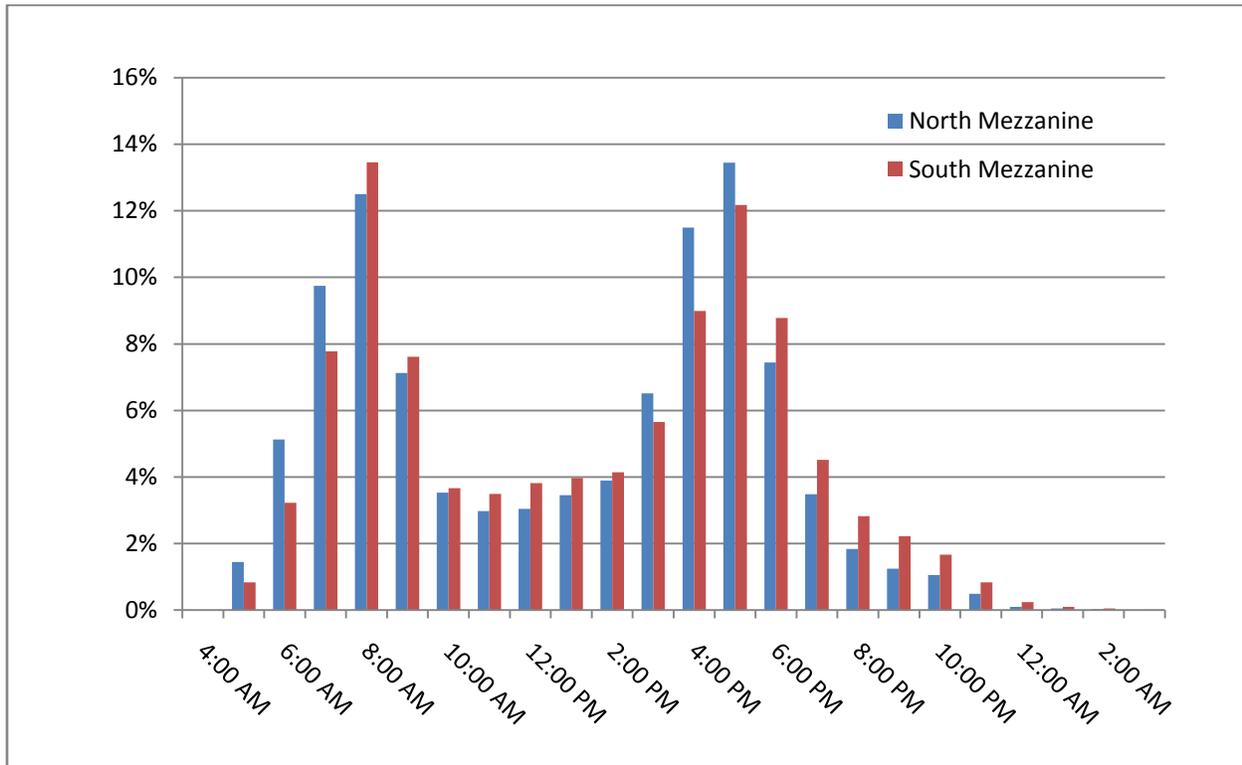


Table 1: Annual Station Boardings (in thousands)

	North Mezzanine	South Mezzanine	Subtotal
All Weekdays	3,585	4,391	7,976
All Sundays	208	419	627
All Saturdays	198	285	483
Total	3,991	5,095	9,086

Ridership at the Metrorail station peaks during the morning and evening rush hours (8am - 9am and 4pm – 5pm), each of which generates about 13% of the daily passenger volume inclusive of entries and exits (Figure 3). Entry and exit volumes exhibit identical peaking patterns throughout the day at this station.

Figure 4: Percentage Distribution of Hourly Volume at Metrorail Station
(Exits and Entries Combined)



North Mezzanine

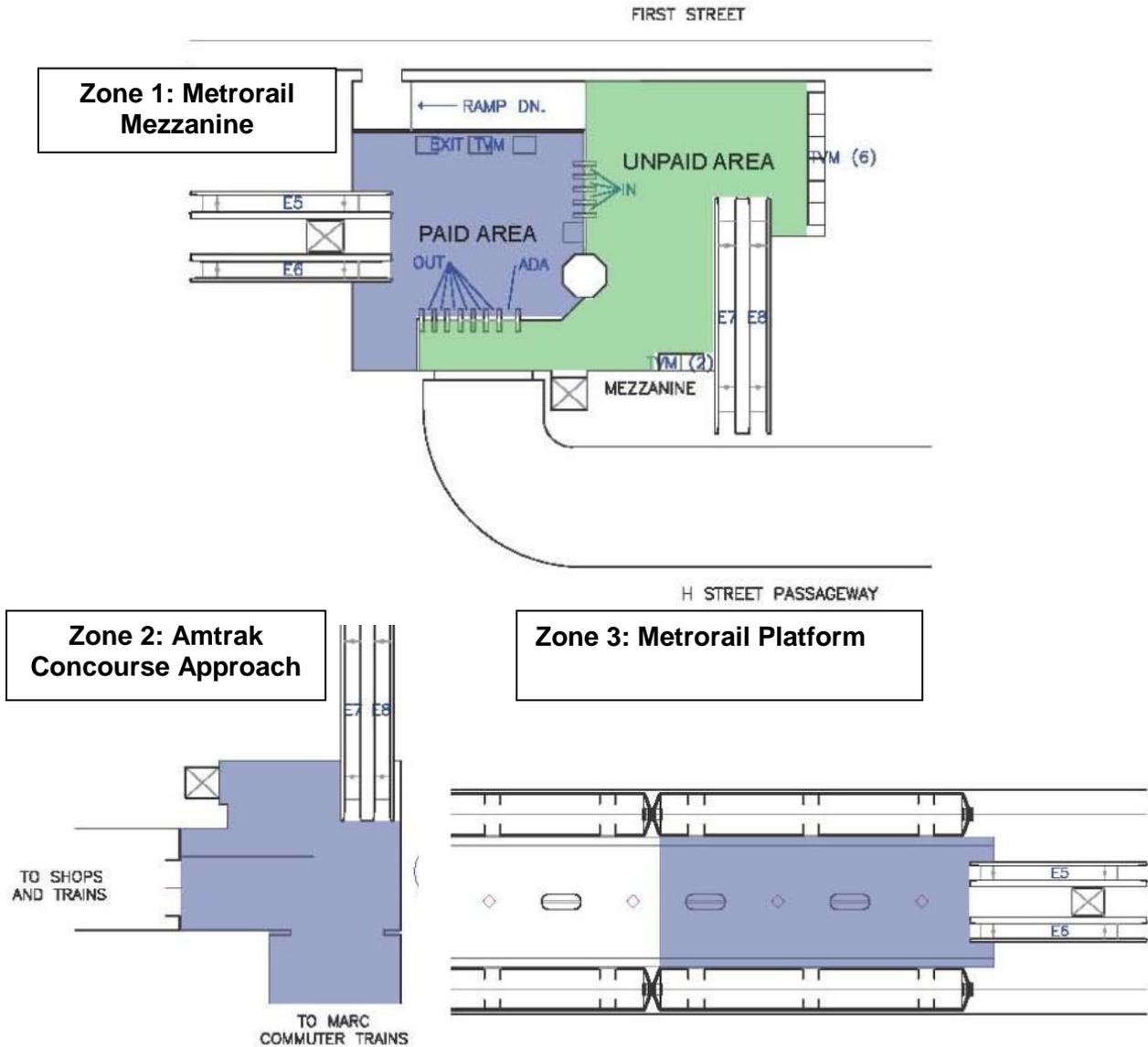
The north mezzanine, as shown in Figure 2, can be entered from First Street NE through a small opening in the stone wall, called the Burnham Wall, on Union Station’s west side; inside the wall a ramp connects the street level with the higher mezzanine level. The north mezzanine can also be entered by escalators and an elevator from the Amtrak concourse level. The north mezzanine is accessible to people in wheelchairs. There are 11 faregates, one of which is handicapped-accessible.

The north mezzanine includes the portal to an interior pedestrian passageway that runs northward toward H Street NE. The passageway was built at the same time as the Metrorail line, but was not completed and is not open for use. Its entrance from the mezzanine is blocked by a temporary wall, and its interior is an unfinished concrete shell. The passageway does not extend all the way to H Street; it ends 91 feet short. At its north end, the passageway is at about the same elevation as the original H Street, which passed under the railroad tracks. When the H Street overpass was built, this original H Street segment was blocked off with stone to complement the Burnham Wall and is not open to public access.

For the evaluation purpose, the north mezzanine is spatially divided into three study zones: Metrorail mezzanine on the ground level consisting of the First Street entrance, faregates and areas in between, Amtrak concourse approach to the Metrorail mezzanine on the upper level, and Metrorail platform on the lower level. The three zones are illustrated in Figure 5. Metro

performed pedestrian simulations to assess existing conditions and performance in each of the three component zones as well as connections between any of the two adjacent zones.

Figure 5: Study Zones at North Mezzanine of Metrorail Station (Union Station)



Present Demand and Performance

To understand the capacity constraints, the study assessed current ridership and pedestrian flows at the north mezzanine and developed projections for ridership and pedestrian volume for the year of 2030, consistent with the region's long-range planning horizon. In consideration of the peak surge during rush hours, the demand analysis concentrated on the peak pedestrian movement pattern and volume through the north mezzanine during 8am-9am and 5pm-6pm. Metro collected present pedestrian traffic data and developed a model to estimate future demand. All results presented are based on peak hours, unless otherwise noted.

Present Demand

Based on the September 2009 field counts, more than 5,000 pedestrians passed through the north mezzanine in the morning rush hour and 6,000 in the evening rush hour. The morning rush hour carries mostly commuters and light retail traffic, whereas the evening rush hour adds a high volume of tourists and business travelers.

Pedestrian traffic within the north mezzanine is highly directional and mixed. Metrorail and Amtrak/commuter rail generate the majority (95%) of pedestrian traffic, with streams of passengers from the Amtrak concourse and Metrorail exiting the First Street entrance throughout the morning peak and returning to the Amtrak concourse and Metrorail in the afternoon. The confined unpaid space at the mezzanine, between the entrance door and Amtrak concourse escalators, accommodates 16 pedestrian paths at any moments as passengers head to destinations (Table 2).

Table 2: 2009 Pedestrian Traffic within the North Mezzanine
8AM - 9AM

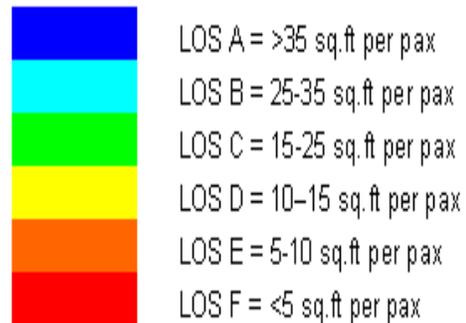
ORIGIN	DESTINATION					Total
	Amtrak Concourse	Amtrak Elevator	1st St. Entrance	Metro Platform EB	Metro Platform WB	
Amtrak Concourse			938	230	1424	2592
Amtrak Elevator			16	4	24	44
1st St. Entrance	135	4		10	65	214
Metro Platform EB	591	16	868			1475
Metro Platform WB	302	8	443			753
Total	1028	28	2265	245	1513	5078

5PM – 6PM

ORIGIN	DESTINATION					Total
	Amtrak Concourse	Amtrak Elevator	1st St. Entrance	Metro Platform EB	Metro Platform WB	
Amtrak Concourse			216	258	504	978
Amtrak Elevator			2	2	4	8
1st St. Entrance	1616	46		593	1162	3417
Metro Platform EB	1423	41	52			1516
Metro Platform WB	230	7	8			245
Total	3269	94	278	853	1670	6164

Present Performance

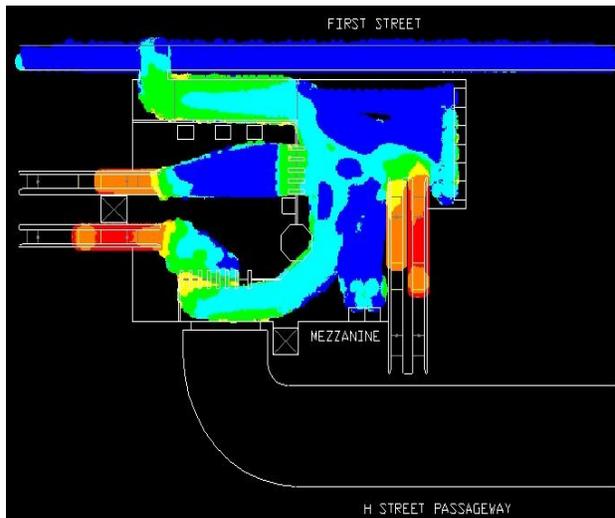
Under the current travel demand and operating condition, the north mezzanine experiences congested conditions on various circulation paths. The summary here uses the Level-of-Service (LOS) measure for pedestrian walking space density and corresponding “heat” maps to illustrate the overall peak hour performance. The pedestrian Level-of-Service, named as Fruin’s LOS, is applied in the analysis of pedestrian facilities. LOS E and F depict severe congestion with tight space among pedestrians.



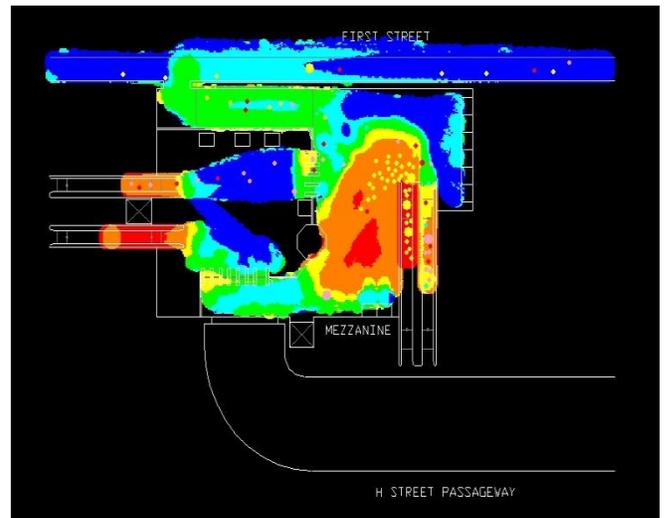
Other measures of effectiveness, including travel time and queue clearance time, are referenced in this report and summarized in Appendix 2. Travel time is the amount of time for a passenger to walk from origin to destination within the study zone, a measure to reflect user experience. Queue clearance time is the amount of time for an escalator or stair to dissipate passengers waiting to board, a measure to analyze the ability of vertical connections in meeting passenger demand.

Zone 1 - Metrorail Mezzanine. The unpaid area, between the 1st Street entrance, Metrorail faregates and Amtrak concourse escalators, is where multiple pedestrian paths converge. In the evening, the unpaid area essentially exists as a bottleneck. More than 50% of the pedestrians traveling through this area experienced LOS E or F, with spill-over of congestion all the way to the First Street entrance. Figure 6 identified continuous congestion and delay in the evening in Orange and Red, which represent conditions reaching LOS E and F.

Figure 6: Performance of Metrorail Mezzanine



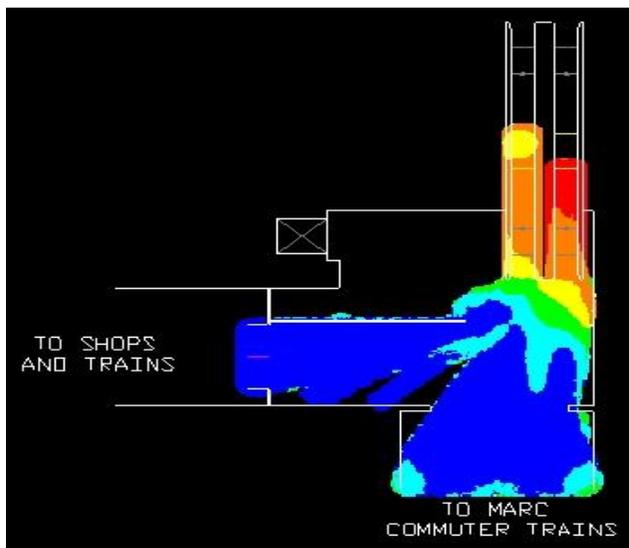
Unpaid Area (AM Hour)



Unpaid Area (PM Hour)

Zone 2 – Amtrak Concourse Approach. This area consists of escalators between the mezzanine and Amtrak concourse and the approach to escalators on the concourse. The heavy flow from the concourse to Metrorail and the 1st Street entrance causes congestion on the down-moving escalator in the morning (Red color in Figure 6's AM map) and the up-moving escalator in the afternoon (Red color in Figure 7's PM map). In addition, the concourse approach presents extended queuing condition in the morning with commuter rail passengers waiting to depart the concourse (see picture in Figure 7). In the afternoon, the queuing formed by those returning to Amtrak concourse spreads inside the Metrorail mezzanine zone as shown in Zone 1.

Figure 7: Performance of Amtrak Concourse Approach



Amtrak Concourse Approach (AM Hour)



Amtrak Concourse Approach (PM Hour)

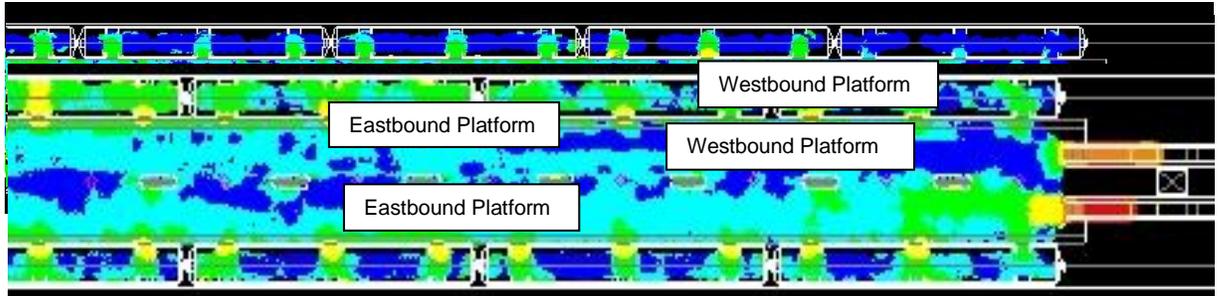
Zone 3 – Metrorail Platform. Severe platform congestion occurs continuously throughout most of the peak period when Metrorail Red Line is on a 3-minute headway. In reality, trains traveling in the same direction can arrive just one minute apart and both eastbound and westbound trains often arrive simultaneously.

Under such constrained operating conditions, the platform has to accommodate a surge of arriving passengers before it is able to clear residual queues from the previous train, resulting in delays to exiting passengers and potential safety hazards on the platform. Figure 8 illustrates the conditions on the platform and LOS graphics.

Figure 8: Performance of Metrorail Platform



Metrorail Platform (AM Hour)



Metrorail Platform (PM Hour)

Travel Time. Travel time measures the amount of time for a passenger to walk from origin to destination within the study area. Metrorail passengers leaving platform experienced noticeable trip time delay in the evening rush hour, as compared to the morning. The mean trip time in Table 3 averages variations in the flows and conditions during the peak hours; however very often, individual passengers use up to 4 minutes to complete a trip that would otherwise take less than 2 minutes in the morning.

Table 3: 2009 Average Travel Time for Metrorail Passengers
(unit: mm:ss)

Origin Zone	Destination Zone	AM	PM
Metrorail EB Platform	Amtrak Concourse Entrance	1:24	2:01
Metrorail EB Platform	First Street Entrance	1:22	1:57
Metrorail WB Platform	Amtrak Concourse Entrance	1:26	2:01
Metrorail WB Platform	First Street Entrance	1:24	1:50

Queue Clearance Time. Queue clearance time measures the amount of time for an escalator or stair to dissipate passengers waiting to board. It is used to analyze how well the capacity of escalators and elevators meets passenger demand. In 2009, passenger volume already exceeded the existing vertical capacity, with the worst queuing condition at the bottom of the escalator in the Mezzanine’s unpaid area. This condition leads to extended clearance time exceeding five minutes in the PM peak, inconveniencing passengers, delaying travel time and raising safety concerns. Table 4 presents average clearance time at these facilities.

Table 4: 2009 Escalator Average Clearance Time (Peak Hour)

	AM (mm:ss)	PM (mm:ss)
Metrorail Platform		
Down Escalator	00:20	00:27
Up Escalator	00:47	01:09
Amtrak Concourse Approach		
Down Escalator	00:59	00:49
Up Escalator	00:21	05:35

In summary, the base year performance pinpoints serious capacity constraints in all three zones, including:

- More than 50% of the pedestrians experience severe congestion and delay at the north mezzanine during the peak hours;
- The narrow First Street entrance was crowded with flows in and out of the station;
- The confined unpaid area between faregates and escalators to the Amtrak concourse is mixed with 16 pedestrian paths at any moment; and
- Approaches to escalators at mezzanine, concourse and platform are packed with passengers waiting to move from one level to the other.

Today’s congested conditions at north mezzanine cause inconvenience and delay to all users—Metrorail and commuter rail passengers, intercity travelers from bus and rail, local transit passengers and people going to retail on the concourse level at Union Station. On the Metrorail platform, the crowded condition in front of the only up-moving escalator raises safety concerns and calls for actions to eliminate potential safety hazards.

Future Demand

The 2009 DDOT Union Station Intermodal Transportation Center Feasibility Study (USITC) identified major development within the Union Station complex and surrounding areas, including a pedestrian passageway connecting the north mezzanine of Metrorail station with H Street, a new intercity bus terminal, and the planned development to the north totaling five-million square feet within half-a-mile of Union Station. Nearly all of the identified development would directly impact Metrorail's north mezzanine; it is anticipated that ridership at the Union Station Metrorail would grow substantially once the planned facilities and development are completed. To assess the future station performance, Metro developed projections for future-year demand using 2030 which is the same as the region's long-range planning year. The demand projection took into account Metrorail ridership generated by the planned area development, transfers from new transportation facilities terminating at Union Station and trend-based ridership growth on Metrorail, Amtrak and commuter rail.

This study projected future ridership and pedestrian traffic using a disaggregated approach, by separating the growth impact of land use development and transportation projects identified in the DDOT study. The individual projections were then assigned to respective pedestrian paths by identifying the shortest and/or least obstructed paths.

- Planned area development at NOMA and Burnham Place would exceed 5 million square feet upon completion. All of the planned development is within 2,500 feet from the north mezzanine, which would attract high Metrorail usage. Metro uses a Metrorail trip generation application to estimate transit demand from each of the planned development. The site-based projection is then assigned to individual paths. The Burnham Place, to be built above the Amtrak railway tracks, could generate about 800 Metrorail trips in the peak hour and the part of NOMA development close to Union Station (within half-a-mile of the north mezzanine) would generate about 600 Metrorail trips in the peak hour.

Figure 9: Location of Burnham Development



(Burnham Place illustrated in red above railway tracks)

- New transportation facilities identified in the 2009 DDOT study consists of H St pedestrian passageway connecting the north mezzanine with H Street, a new streetcar terminal and a new intercity bus facility. The projection assumes all these facilities would be completed by 2030 and derives Metrorail transfer estimates from the streetcar and intercity bus termini, which will be connected to Metrorail through the H St passageway. The intercity bus terminal is assumed to have three buses arriving and three buses departing in the peak hour, with 80% of bus passengers transferring to Metrorail. The streetcar terminal is assumed to generate transfers to Metrorail and Amtrak/commuter rail.
- Existing transportation facilities. Due to the lack of specific forecasts from railway services, Metro assigned trend-based growth factors to the 2009 Metrorail and Amtrak/commuter passenger traffic in the study zone to derive the 2030 projection. Based on a review of recent commuter rail ridership and access trends from the 2007 Metrorail Survey, the projection applies a compound annual growth rate of 1.5% for Amtrak and commuter rail trips within the study zone. Similarly, Metrorail's ridership is assigned an annual growth rate of 1% for the peak hours based on the results of the 2002 and 2007 Metrorail surveys.

With the above assumptions and methods, pedestrian traffic within the north mezzanine study zone is anticipated to increase by more than 60% from 2009 to 2030. This overall growth rate was then validated against the regional land use forecasts (Round 7.2), which projected a job growth of 59% from 2010 to 2030 in the transportation analysis zones surrounding the station. Table 5 presents pedestrian traffic projections within the study area.

Future Rail Operating Plan and Implications

Red Line trains presently operate every 3 minutes during the peak. With new railcars being gradually added to existing fleet, Metro will be operating 50% of 8-car consists before 2015 and is planning to implement 100% 8-car trains by 2020. The eventual 100% 8-car operations would help spread passenger loads on the platform, which is designed for 8-car trains.

At this peak train frequency, the surge exit effect, currently experienced by riders on a daily basis would intensify due to a growing volume of exiting riders and would further aggravate today's platform crowding and extend queues at escalators. In the meantime, new passengers, coming from railway services and new residential and hotel development around Union Station, would occupy the platform to wait for the arriving Metrorail trains. The two-directional passenger movements on the platform will lead to an increased level of conflicts inside this constrained platform space.

Table 5: 2030 Pedestrian Traffic within the North Mezzanine
8AM - 9AM

ORIGIN	DESTINATION						Total
	Amtrak Concourse	Amtrak Elevator	1st St. Entrance	H St. Passageway	Metro Platform EB	Metro Platform WB	
Amtrak Concourse			1295	247	247	1528	3317
Amtrak Elevator			113	21	21	133	288
1st St. Entrance	174	15			15	94	298
H St. Passageway	92	8			54	349	503
Metro Platform EB	833	72	1206	638			2749
Metro Platform WB	464	40	616	326			1446
Total	1563	135	3230	1232	337	2104	8601

5PM – 6PM

ORIGIN	DESTINATION						Total
	Amtrak Concourse	Amtrak Elevator	1st St. Entrance	H St. Passageway	Metro Platform EB	Metro Platform WB	
Amtrak Concourse			274	92	370	723	1459
Amtrak Elevator			24	8	32	63	127
1st St. Entrance	2185	190			800	1567	4742
H St. Passageway	246	21			327	640	1234
Metro Platform EB	1551	135	82	360			2128
Metro Platform WB	251	22	13	55			341
Total	4233	368	393	515	1529	2993	10031

Proposed Access and Capacity Improvements

The study identified and evaluated potential capacity and accessibility improvements for the north mezzanine. Improvements focused on expanding vertical circulation, reducing conflicting pedestrian flows, and enhancing connectivity to other transportation modes. The following discussions provide detailed descriptions and conceptual designs for the partial build and full build scenarios for each of the three zones in the study. Figures 12 through 18 illustrate the improvements for the north mezzanine, H Street entrance and passageway that define the partial build scenario. Figures 19 and 20 illustrate additional north mezzanine and platform improvements that in combination with the partial build define the full build scenario. An alternative conceptual design was developed and assessed after the completion of this study and results were included in the Appendix.

Partial Build Scenario

The partial build scenario includes moderate expansion for capacity and access improvements. This scenario focuses on the north mezzanine improvements, and completion of the H Street passageway and elevator access to H Street. Specifically the partial build scenario includes:

North Mezzanine and Platform

- Relocated First Street entrance
- Expanded fare collection system
 - Five new faregates
 - Four new fare vending machines
- Expanded Mezzanine to Amtrak Concourse access
 - Two elevators between mezzanine and Amtrak concourse
- Excavation for future mezzanine to platform vertical access

H Street Passageway and Entrance

- Completion of passageway
- Three new elevators and emergency stairs to H Street/Intercity bus terminal

Figures 11 and 12 depict the proposed partial build improvements at the Metrorail north mezzanine and Amtrak concourse.

North Mezzanine and Platform

Relocated First Street Entrance

The First Street station entrance could be improved by replacing the existing opening (Figure 10) in the Burnham Wall with a new larger opening north of the existing one, shown in Figure 11. This new opening would be directly opposite the existing escalators, increasing the entrance capacity and creating a more-direct path for people bound for other parts of Union Station and the Metrorail station.

Figure 10: First Street NE Station Entrance



Figure 11: Relocated First Street NE Station Entrance



With the relocated entrance the pedestrian ramp between the street level and the mezzanine level would not fit inside the station. A new ramp would have to be built outside the station on the sidewalk, requiring the sidewalk to be widened. A new entrance opening would have a canopy to reinforce the Metrorail station identity and to provide weather protection. Improved signs and lighting should be installed. The existing entrance opening could be filled in with stone blocks removed from the new opening or could be left open to introduce more light into the mezzanine. This portion of the Burnham Wall is not original; it was reconstructed when the Metrorail Red Line was built. Further design development would be needed to advance the

design that would be functionally effective and respectful of the Burnham Wall and its relationship to Union Station.

Relocating the entrance opening and the pedestrian ramp would provide additional mezzanine space, Faregates could be added, and the paid area could be enlarged into the area now occupied by the ramp. The enlarged entrance would resolve many of the conflicting movements between the Metrorail traffic and pedestrians traveling between the First Street entrance and Union Station concourse.

Expand Fare Collection Systems

The ramp from the existing entrance opening to the station mezzanine would become part of the 'Paid Area' of the mezzanine and would provide space for additional fare collection systems. Four additional fare vendors and five additional faregates would be provided including two additional ADA-accessible faregates to improve access for customers using wheelchairs, carrying luggage or pushing strollers. The existing fare vending machines located at the bottom of the existing escalators could be shifted northward into space now occupied by a fresh-air intake shaft to provide additional queue space in front of these vending machines minimizing conflicts. This would require reconfiguration of the intake shaft.

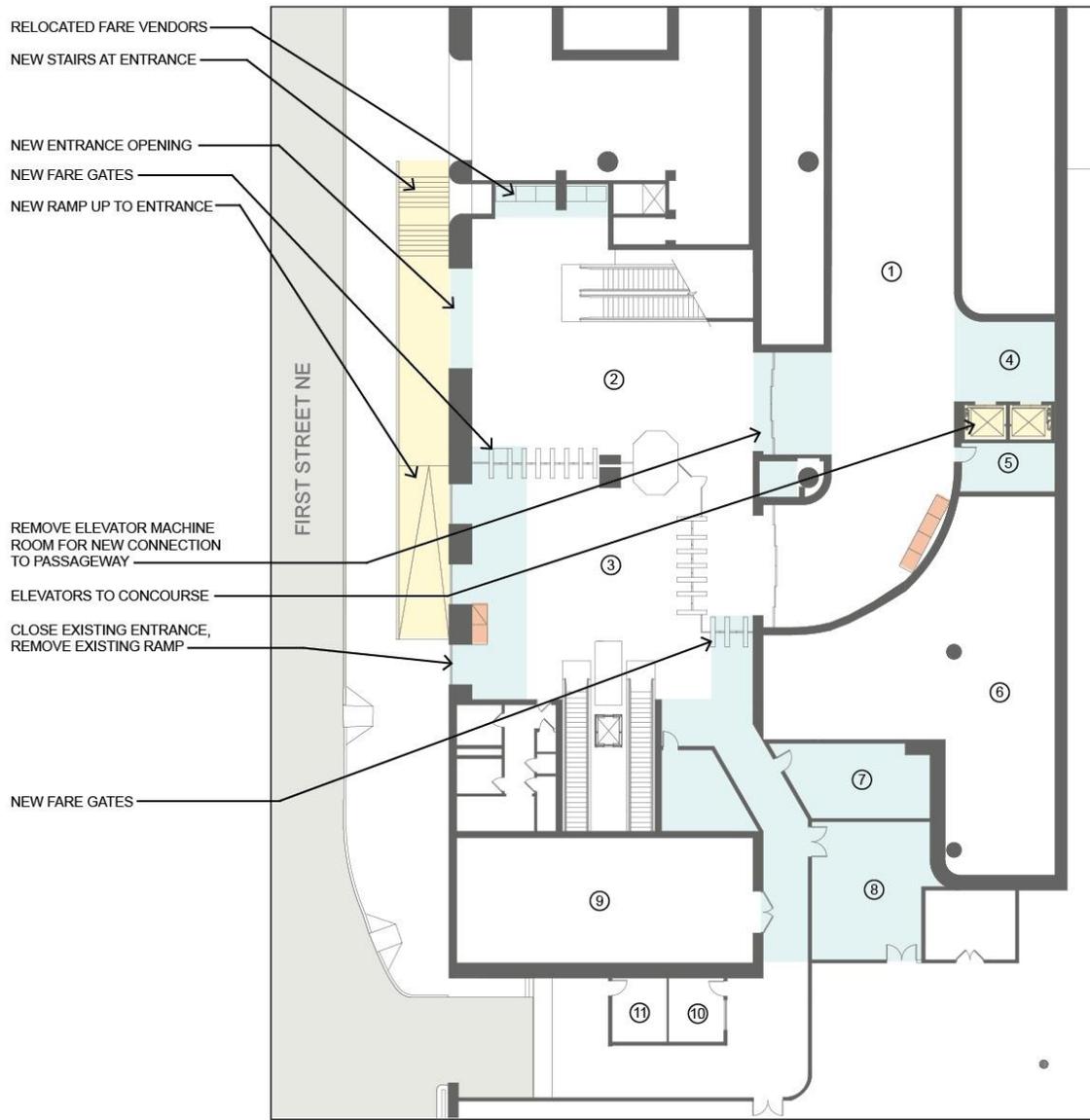
Expand Vertical Access

The north mezzanine could be expanded to provide vertical circulation between the Amtrak concourse and mezzanine with a new set of elevators, as shown in Figures 12 and 13. The new elevators could be installed next to the H Street passageway connecting the Amtrak concourse and mezzanine. Several possible locations for these elevators were considered; others were ruled out because of their impacts on existing uses. The location shown for the elevators was designed to allow them to extend to the upper deck of the parking garage to provide access to intercity buses. The structural framing for the parking garage has one wider-than-typical bay that originally accommodated escalators. The elevator location shown aligns with this wider bay. At the Amtrak concourse level, the elevators would be in the corridor leading to the MARC and Amtrak gates. The elevator opening should face south so that elevator queuing would not block the corridor. Accommodating elevators facing this direction would require modification to an existing facilities maintenance office and some mechanical space located on the corridor.

At the mezzanine level, the new elevators would be in an area next to the south end of the H Street passageway. This area is unexcavated and probably consists of fill deposited when Union Station was built. The existing wall of the H Street passageway would need to be removed and the fill excavated. The fill supports the Amtrak concourse floor, so a temporary floor structure would be necessary to bridge over this area during the excavation to allow people to continue to walk through the Amtrak concourse and Union Station corridor above.

With the new elevators, the existing elevator between the Amtrak concourse and the mezzanine and elevator machine room would be removed opening up space for better pedestrian flow to the H Street passageway.

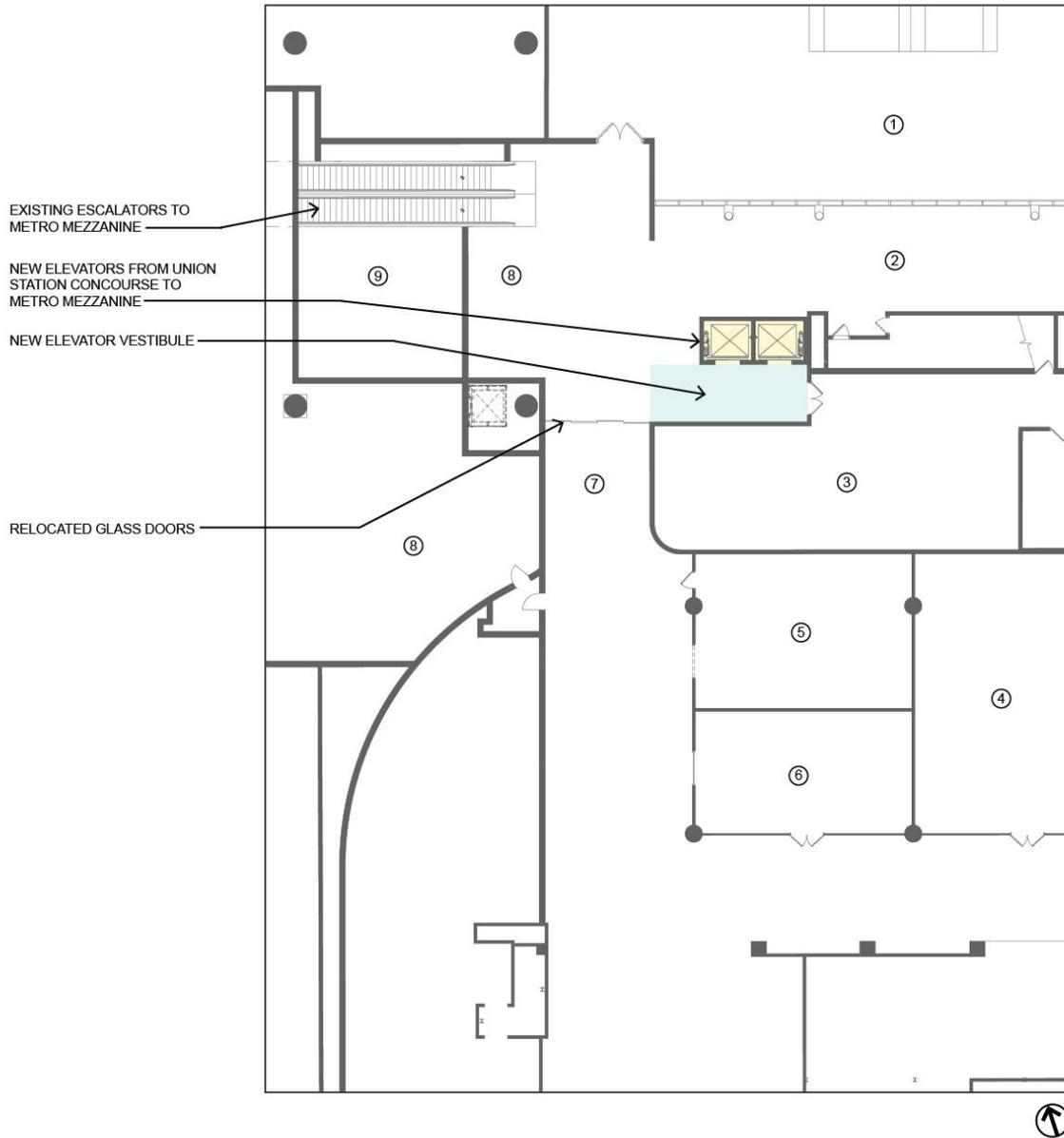
Figure 12: Proposed Partial Build Mezzanine Improvements



RELOCATED FARE VENDORS
 NEW STAIRS AT ENTRANCE
 NEW ENTRANCE OPENING
 NEW FARE GATES
 NEW RAMP UP TO ENTRANCE
 REMOVE ELEVATOR MACHINE ROOM FOR NEW CONNECTION TO PASSAGEWAY
 ELEVATORS TO CONCOURSE
 CLOSE EXISTING ENTRANCE, REMOVE EXISTING RAMP
 NEW FARE GATES

KEY		LEGEND
①	PASSAGEWAY TO H STREET	PROPOSED NEW FACILITIES AND CONSTRUCTION
②	FREE AREA	NEW STAIRS AND VERTICAL CIRCULATION
③	PAID AREA	NEW FARE VENDING MACHINES
④	ELEVATOR VESTIBULE	
⑤	ELEVATOR MACHINE ROOM	
⑥	UNEXCAVATED AREA	
⑦	ELECTRICAL ROOM	
⑧	MECHANICAL ROOM	
⑨	TRANSFORMER ROOM	
⑩	SECURITY	
⑪	PACKAGE EXPRESS	

Figure 13: Proposed Partial Build Concourse Improvements



KEY		LEGEND
①	AMTRAK/MARC PLATFORM	PROPOSED NEW FACILITIES AND CONSTRUCTION
②	CONCOURSE	NEW STAIRS AND VERTICAL CIRCULATION
③	MECHANICAL ROOM	
④	RESTAURANT	
⑤	POST OFFICE	
⑥	LIQUOR STORE	
⑦	CORRIDOR	
⑧	POSSIBLE RETAIL	
⑨	OPEN TO BELOW	

H Street Entrance and Passageway

A new H Street entrance would allow completion of the H Street passageway and provide direct station access to the developing NOMA neighborhood and the planned 2.4 million square foot air rights development above the Union Station tracks (Burnham Place). Creating the entrance would require opening the connection to the north mezzanine building the final segment of the passageway to reach H Street, finishing the passageway interior and providing vertical circulation between the passageway to the H Street overpass and Burnham Place development.

The connection of the H Street passageway to the Metrorail north mezzanine should be through two openings to provide sufficient pedestrian circulation. One opening already exists but is blocked by a temporary wall that would be removed. This opening is directly opposite the faregates, and it would not provide adequate capacity, so a second opening could be created by removing the elevator machine room. Figures 13 and 14 illustrate the proposed improvements at both ends of the H Street passageway.

The existing H Street passageway from the north mezzanine would need to be extended to the H Street tunnel to provide a direct connection between the Metro station and the planned interim DC streetcar platform. To connect to the inter-city bus terminal in the Union Station parking garage and Burnham Place vertical circulation would be required up to the parking garage and to H Street. Building the final segment to H Street would require relocating the Amtrak satellite commissary, which sits at track level above the passageway alignment. Coordination with Amtrak would be necessary to ensure the continued function of Amtrak's food services.

The existing passageway is a concrete box structure which has not been outfitted with appropriate finishes or electrical, mechanical or other systems needed to make it usable as a pedestrian passageway. The design intention is to line the interior with new finishes such as a perforated metal panel system that would allow space for acoustic treatment, mechanical ducts required for ventilation, lighting and the public address system. The walls would be designed to display art, information and entertainment as people walk through the space. Backlit panels would provide an opportunity for displays plus advertising space that could generate revenue for Metro. The existing flooring was designed for a moving walkway and would need to be replaced. The passageway floor slopes down as it moves north and some transition would be needed at the existing elevator machine room which would be the future new passageway entrance. A cast stone floor finish that would reflect more light, be easier to install and not be slippery when wet is recommended. A joint exists at the mezzanine entrance where a transition from the existing quarry tile to cast stone could be made. Indirect lighting as in most Metro public areas is recommended for the new passageway. Security cameras will be located along the passageway as needed for observation.

Each end of the passageway would have fire doors to provide a separation between spaces and control smoke. At the north mezzanine doors would separate the passageway from the mezzanine and would be automatic sliding glass panels similar to the ones separating Union Station and the Metro entrance at the Amtrak Concourse level. At the north end similar doors would be used to separate the passageway and the new streetcar platform area in the existing H Street tunnel.

A smoke exhaust system or pressurization of the passageway may be necessary to prevent smoke from collecting in the tunnel. A mechanical room would be located at each end of the tunnel for this purpose. The one next to the north mezzanine would be located in the newly excavated space to the south between the existing loading dock and the passageway. The

mechanical room at the north end would be located above the tunnel in the space created by the open-cut excavation and would be accessed from the Amtrak level above.

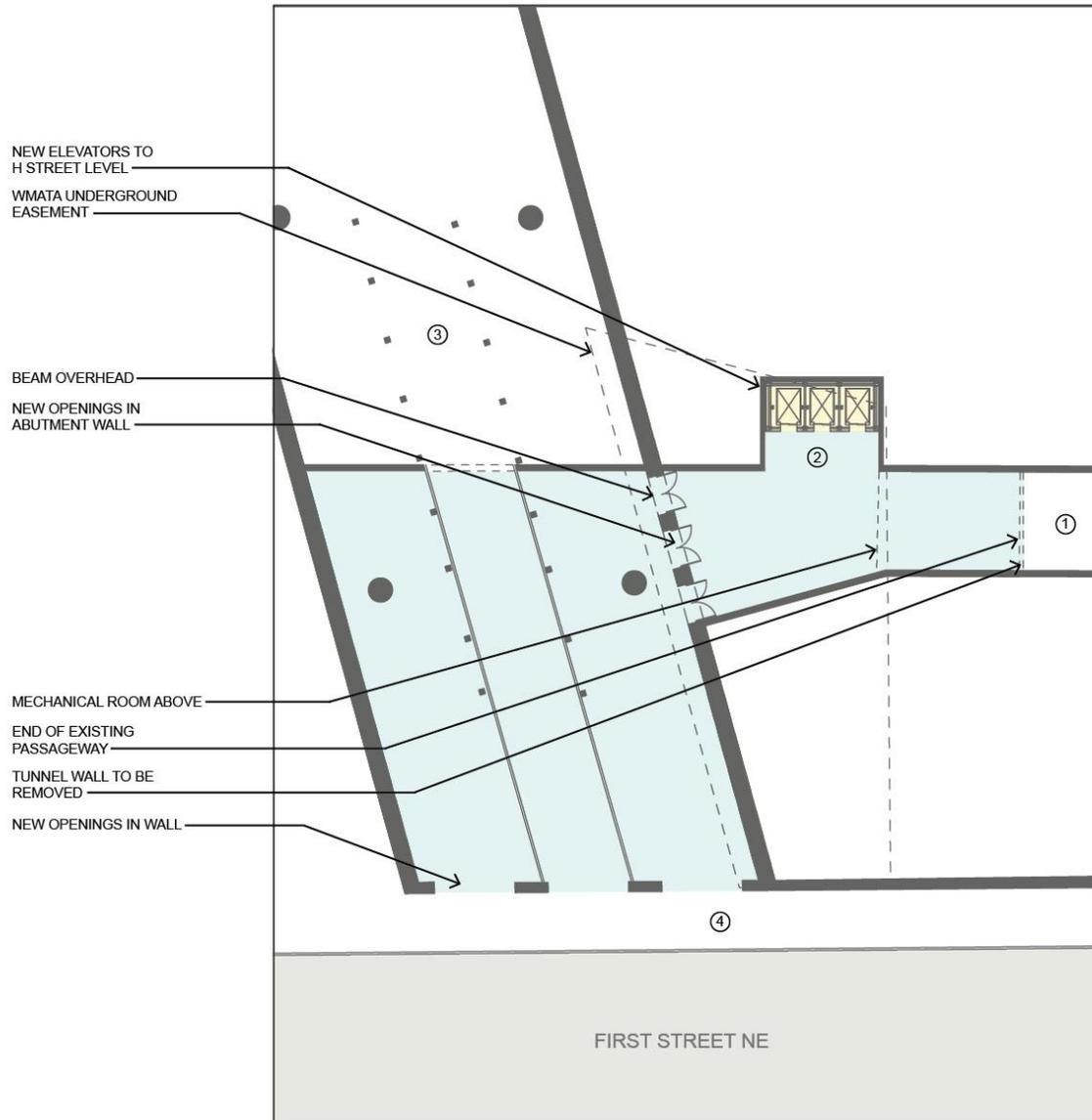
At the H Street end of the passageway new elevators and a stair would provide access up to H Street. The elevators may need to be designed to come up in the center of a proposed new Amtrak platform (a replacement of what was once in this location). The new platform would need to have adequate width for elevators and clearances for patrons. A new stair would also need to work with the Amtrak platforms and tracks. The exact location of this stair has not been determined at this time. Additional coordination with Amtrak is required. This stair will likely be required due to the length of the passageway (approximately 600 feet which equals the limit of a space without an exit under NFPA 130). The H Street tunnel may be considered an exit, but the streetcar platform would also need a means of egress from that area. The stair can serve both as a means of egress.

The new Amtrak platform may also cause the elevators to move out of the existing right-of-way which was set aside for WMATA. This would need to be discussed and worked out with Amtrak.

A new entrance would be built at H Street the end of the passageway including pedestrian connections to both the lower 1st Street level and the upper H Street overpass-Union Station parking garage bus deck levels. At the lower 1st Street level, a new entrance, shown in Figure 16 would be created by removing part of the wall that now blocks off the original H Street underpass from 1st Street. This could be done in conjunction with construction of the H Street-Benning Road streetcar line or as a separate project and would require careful design development to ensure compatibility with the Burnham Wall.

At the upper level, vertical circulation would be required to connect to the Union Station overpass and parking garage bus deck. This bus deck is several feet higher than the H Street overpass, and elevator access to both is desirable. Elevators could be designed to stop at both levels, but this would require doors on two sides of the elevator cabs, complicating the design. Instead, the proposed design would have only a single elevator lobby midway between the bus deck and the overpass levels and connected to both by ramps. This configuration would allow three high-speed elevators to provide the needed capacity. The precise location of the elevators must be coordinated with Amtrak, as their plans for Union Station include the reconstruction of additional tracks in the area where the elevators would be located.

Figure 14: Proposed Partial Build H Street Passageway Entrance at H Street Tunnel



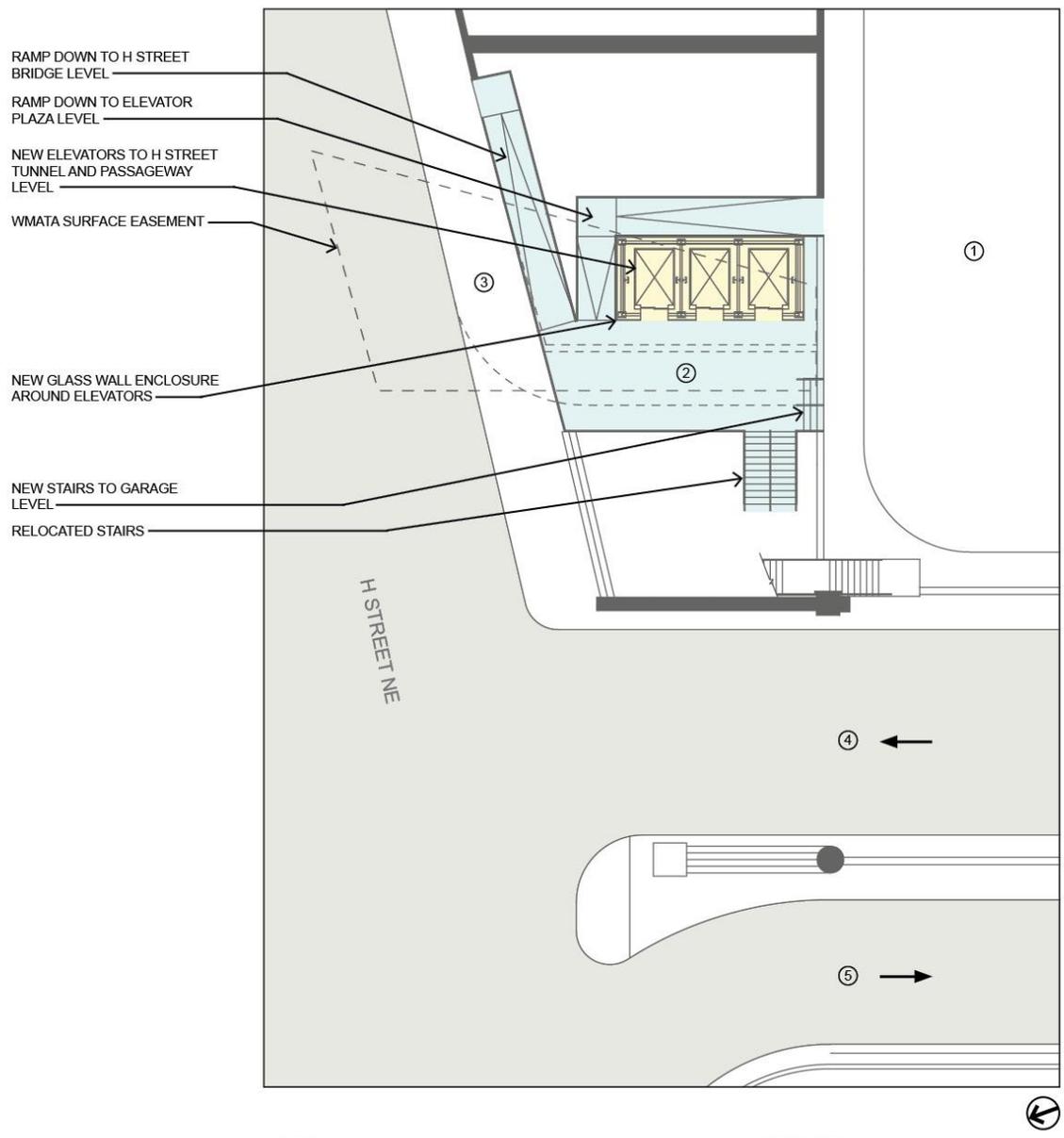
KEY

- ① EXISTING PASSAGEWAY
- ② NEW ELEVATOR VESTIBULE
- ③ H STREET UNDERPASS
- ④ 1ST STREET SIDEWALK

LEGEND

- PROPOSED NEW FACILITIES AND CONSTRUCTION
- NEW STAIRS AND VERTICAL CIRCULATION

Figure 15: Proposed Partial Build H Street Passageway Entrance at H Street



KEY	LEGEND
① PARKING GARAGE	PROPOSED NEW FACILITIES AND CONSTRUCTION
② NEW ELEVATOR LEVEL PLAZA	NEW STAIRS AND VERTICAL CIRCULATION
③ H STREET BRIDGE SIDEWALK	
④ PARKING GARAGE EXIT	
⑤ PARKING GARAGE ENTRANCE	

Figure 16: Cross Section Through Passageway Tunnel Looking East

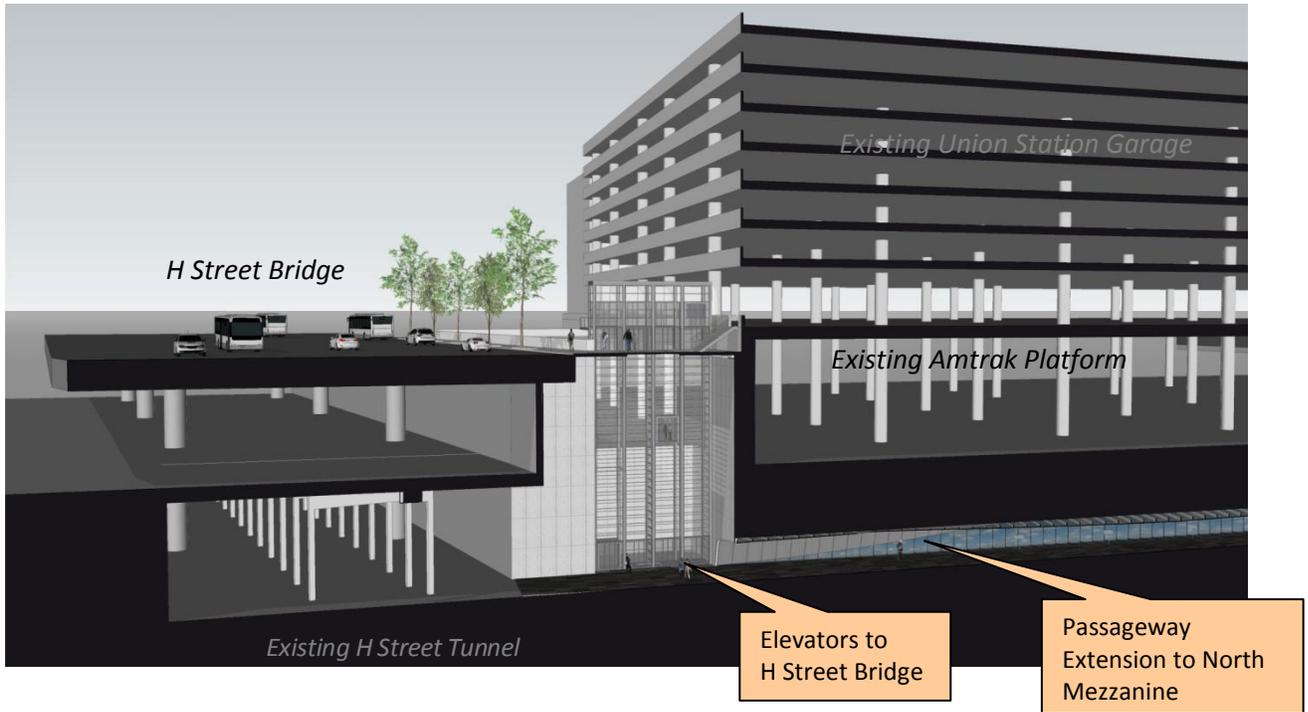


Figure 17: Garage Platform at H Street



Figure 18: Passageway Elevators at H Street



Full Build Scenario

The Full Build scenario consists of significant expansion of the north mezzanine and platform for improved capacity and access improvements. This scenario includes all the elements of the Partial Build scenario plus significant expansion of vertical circulation between the mezzanine and platform:

- Expanded Mezzanine to Platform access
 - New passageway and two new mezzanine to platform elevators
 - New mezzanine to platform stairway
- Expanded Mezzanine to Concourse access
 - Two escalators between mezzanine and Union Station retail corridor (i.e., bookstore, post office and liquor store)

Mezzanine to Platform Access

The Full Build scenario improves the vertical access between the north mezzanine and platform, as shown in Figure 19. One of the most important improvements to the north mezzanine is the addition of a stairway between the mezzanine and the platform. Adding a stairway is consistent with current WMATA design philosophy and would provide greater vertical access to relieve the crowding during the PM peak and also in the event of an emergency.

Space constraints limit the possible locations for a new stairway; the logical location is in the center of the existing escalators where the existing elevator is now. Adding a stairway would require relocation of the platform to mezzanine elevator. Potential new elevator locations are limited by the need to center the elevators on the platform and the need to provide access to them at the mezzanine level. Figure 14 shows the potential location for an elevator pair. At the platform level, the elevators would have to open on opposite sides to avoid opening toward the platform edge. At the mezzanine level, the elevators would be located in what is now the Amtrak package express loading dock. A new passageway would have to be built in unexcavated area

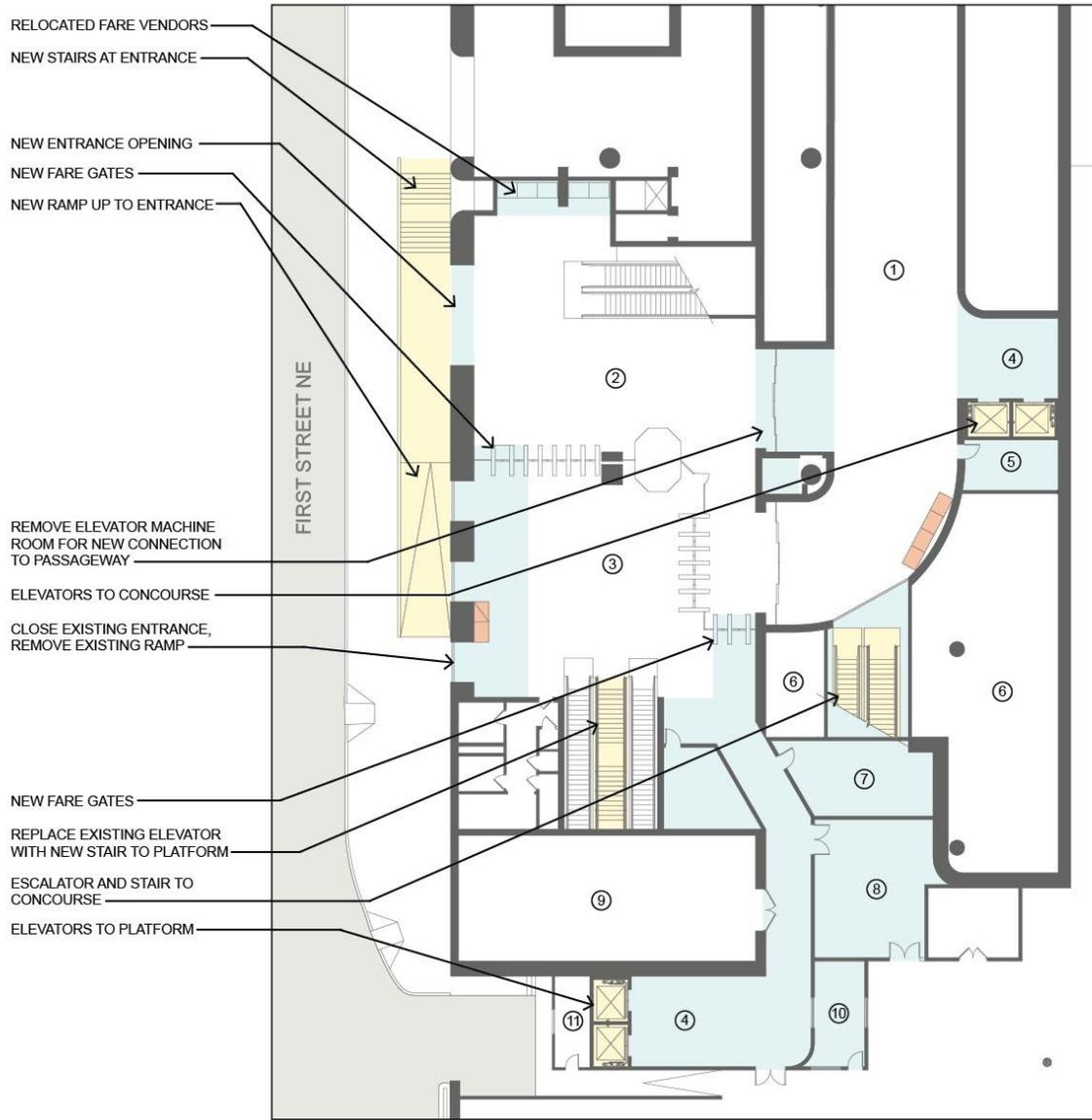
to provide access from the mezzanine to the elevators. The loading dock would have to be modified to preserve its function—the edge of the loading dock would be moved toward the exterior of the building and a new package express office built. The security office that faces the Union Station loading area would be relocated and could have windows into the new passageway to the elevators.

Mezzanine to Concourse Access

A new set of escalators or an escalator and stairway could be provided in the corridor between the bookstore and the liquor store, as shown in Figure 19. Although the escalators would narrow this corridor, most people using the corridor are coming from or going to the Metrorail mezzanine or the First Street entrance. These people would use the new escalators instead of continuing to use the existing escalators, diverting pedestrian volumes through the corridor.

An alternative would be to add a third escalator to the existing escalator bank (refer to Appendix 1). To avoid narrowing the clearance between the kiosk and this third escalator, the kiosk could be relocated in the expanded paid area of the mezzanine. This would provide some additional capacity without impacting the corridor between the bookstore and liquor store above; however this design would provide less capacity than the preferred alternative and thus is less effective in alleviating congestion at north mezzanine.

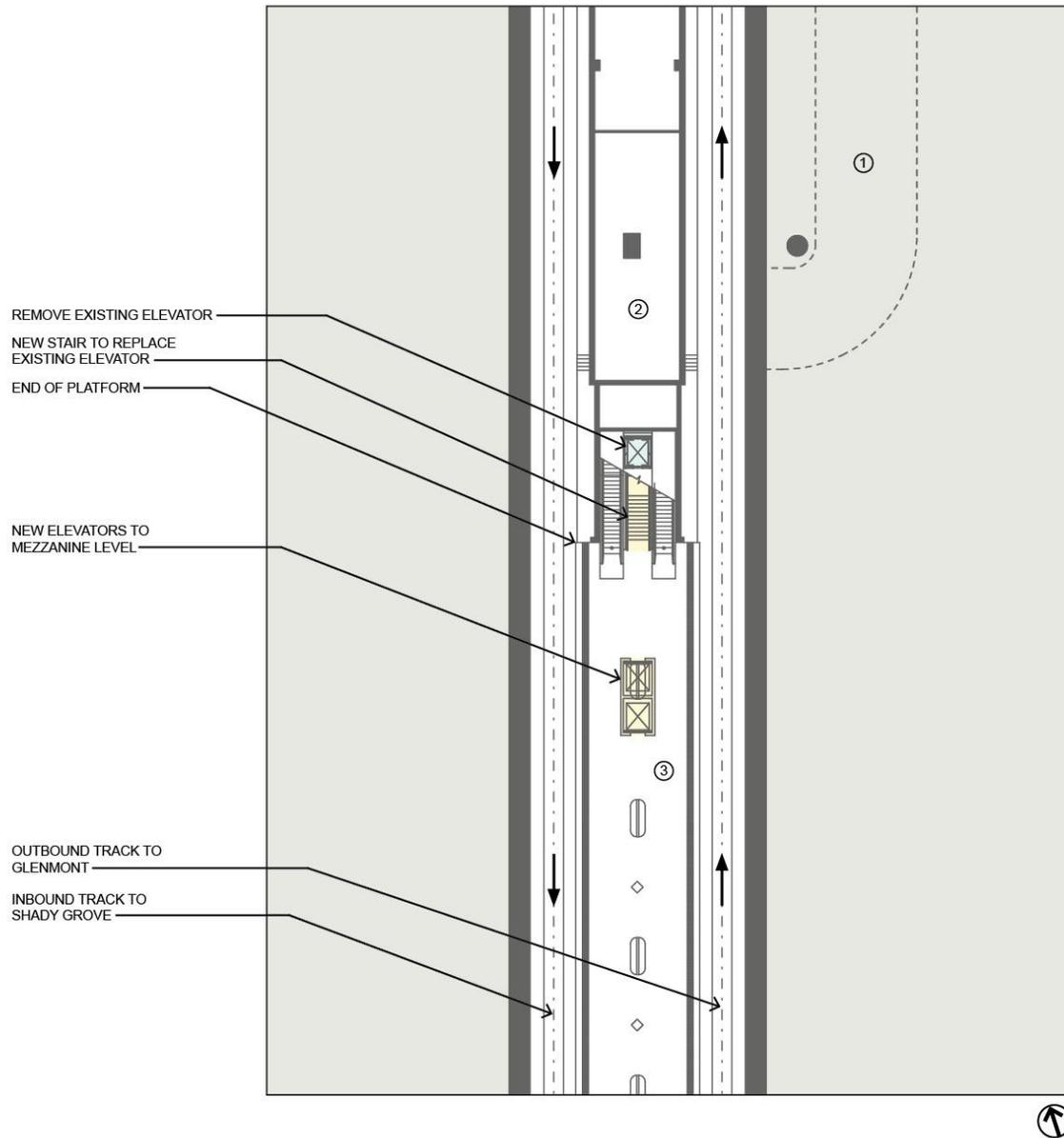
Figure 19: Proposed Full Build Mezzanine Improvements



- RELOCATED FARE VENDORS
- NEW STAIRS AT ENTRANCE
- NEW ENTRANCE OPENING
- NEW FARE GATES
- NEW RAMP UP TO ENTRANCE
- REMOVE ELEVATOR MACHINE ROOM FOR NEW CONNECTION TO PASSAGEWAY
- ELEVATORS TO CONCOURSE
- CLOSE EXISTING ENTRANCE, REMOVE EXISTING RAMP
- NEW FARE GATES
- REPLACE EXISTING ELEVATOR WITH NEW STAIR TO PLATFORM
- ESCALATOR AND STAIR TO CONCOURSE
- ELEVATORS TO PLATFORM

KEY		LEGEND
①	PASSAGEWAY TO H STREET	PROPOSED NEW FACILITIES AND CONSTRUCTION
②	FREE AREA	NEW STAIRS AND VERTICAL CIRCULATION
③	PAID AREA	NEW FARE VENDING MACHINES
④	ELEVATOR VESTIBULE	
⑤	ELEVATOR MACHINE ROOM	
⑥	UNEXCAVATED AREA	
⑦	ELECTRICAL ROOM	
⑧	MECHANICAL ROOM	
⑨	TRANSFORMER ROOM	
⑩	SECURITY	
⑪	PACKAGE EXPRESS	

Figure 20: Proposed Full Build Platform Concourse Improvements



KEY	LEGEND
① PASSAGEWAY ABOVE	PROPOSED NEW FACILITIES AND CONSTRUCTION
② SERVICE ROOMS	NEW STAIRS AND VERTICAL CIRCULATION
③ METRO PLATFORM	

Conceptual Cost Estimate

The estimated cost of the recommended improvements for the Full Build scenario is approximately \$36 Million (estimated in 2010 dollars) and includes the proposed full-build improvements for the north mezzanine, platform, and the H Street passageway. This represents an order of magnitude cost estimate based on conceptual designs. As the design development process advances these estimates will be further refined.

Table 6: Summary of Conceptual Cost Estimates

	Partial Build	Full Build
H Street Entrance and Passageway	\$11,048,000	\$11,048,000
North Mezzanine and Entrance	\$11,784,000	\$17,559,000
Total Estimated Construction Costs	\$22,832,000	\$28,607,000
Soft Costs (25% of Construction Costs)		
Design and Engineering (11%)	\$ 2,512,000	\$ 3,147,000
Design Management (7%)	\$ 1,598,000	\$ 2,003,000
Construction Management (7%)	\$ 1,598,000	\$ 2,003,000
Total Estimated Soft Costs	\$ 5,708,000	\$ 7,153,000
Total Estimated Costs	\$28,540,000	\$35,760,000

Assessment of Future Station Performance

The study uses the same measures of effectiveness for 2009 and 2030 in assessing the performance of various station circulation elements in the AM and PM peak hours. In addition, the study computes travel time savings for individual pedestrian paths and compares the results between the 2030 Partial Build and Full Build scenarios.

The 2030 Partial Build scenario assumes the relocation of the First Street door to provide direct access to the unpaid mezzanine area, and the opening of the H Street passageway to connect with the planned development, new transportation termini to the north, and two new elevators at the end of passageway to connect with the Amtrak concourse. However, the 2030 Partial Build does not have major capacity expansion for vertical circulation that connects platform, mezzanine and concourse. The 2030 Full Build not only inherits the improvements in the Partial Build, but also expands the vertical capacity across the three levels (Figures 21 - 23) and creates alternative paths from those traveling between Amtrak concourse and Metrorail mezzanine.

Metrorail Mezzanine

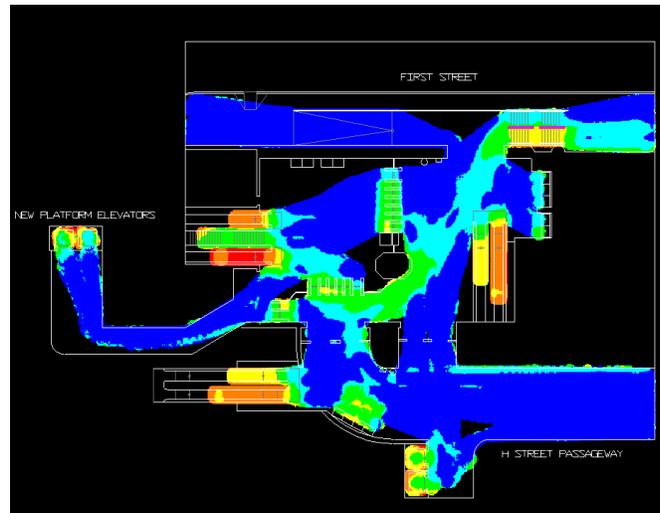
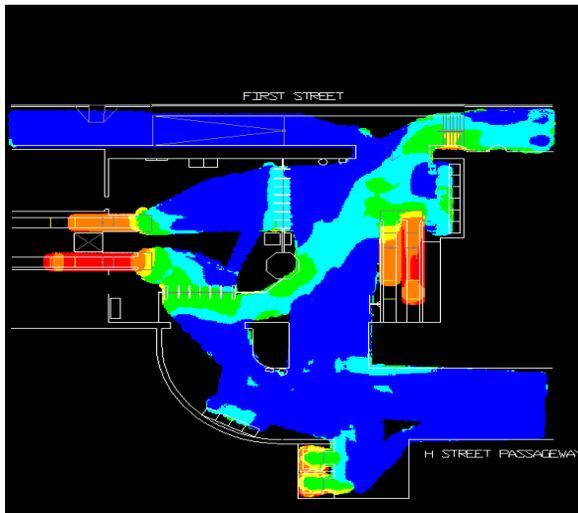
The 2030 Partial Build would provide modest expansion and capacity at the mezzanine level and improve access to the north. The relocation and widening of the First Street entrance would allow direct connection to the Amtrak concourse and alleviate pedestrian conflicts in the unpaid area. The H Street passageway would connect Metrorail with DC's interim streetcar terminal and new development, and divert pedestrian traffic from the First Street entrance. However, congestion is anticipated to be severe in the unpaid mezzanine area during the PM peak hour (Figure 21). Despite the realigned entrance door on the First St., the sheer increase in pedestrian volume in the next 20 years would intensify the mix and conflict of pedestrian traffic within this confined space. The crowding, started at the approach to the Amtrak concourse escalator, is anticipated to spill over to the outside of the entrance door, impacting pedestrian movements on the sidewalk.

With the proposed improvements in the Full Build scenario, the mezzanine would experience significant improvements. The expanded vertical capacity in the 2030 Full Build would reduce the crowding in the unpaid area, allowing pedestrians from the First Street entrance to walk smoothly toward their destinations with far less obstruction and delay. The newly added escalator set connected to the concourse would also divert a large volume of passengers going up and down the Amtrak concourse; the existing escalators would accommodate less passengers and achieve reductions in passenger queues and clearance time in the morning and evening peak periods.

Figure 21: Performance of Mezzanine
AM Peak Hour

2030 Partial Build

2030 Full Build



PM Peak Hour

2030 Partial Build

2030 Full Build



Amtrak Concourse Approach

Similar to the performance at the Mezzanine level, the Partial Build would not be able to relieve the peak pedestrian congestion going up and down the existing escalator set on the Amtrak

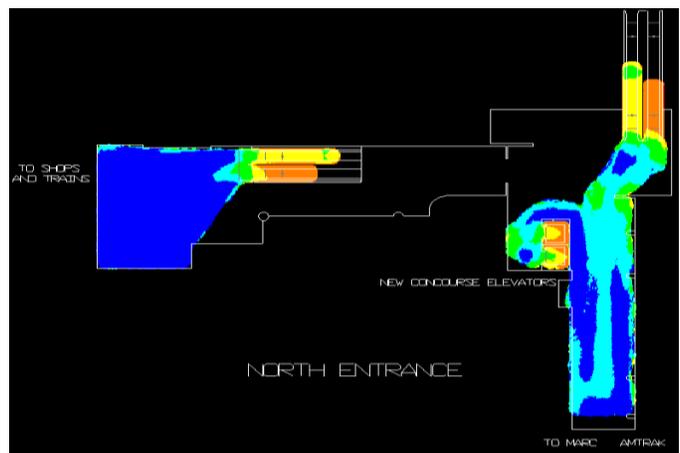
concourse, raising the congestion level to LOS F in the peak direction in the PM (Figure 22). The addition of one ADA elevator adds very limited capacity in the peak hour.

With the proposed Full Build, congestion at the level of LOS F as observed in the Partial Build would be eliminated from the concourse approach, except for occasional moments on the up-moving escalator to the concourse. Besides, the concourse approach would offer a new set of alternative escalators to the left in a new corridor, effectively diverting passenger flows from the existing escalator set.

Figure 22: Performance of Amtrak Concourse Approach
AM Peak Hour

2030 Partial Build

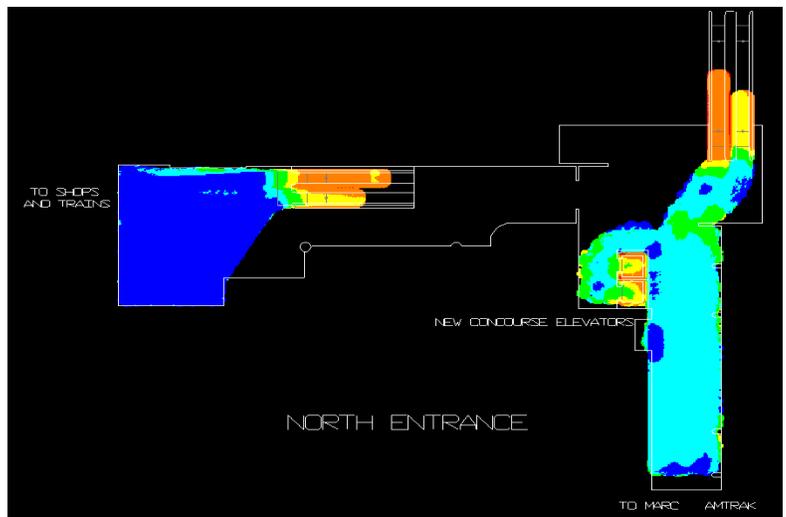
2030 Full Build



PM Peak Hour

2030 Partial Build

2030 Full Build



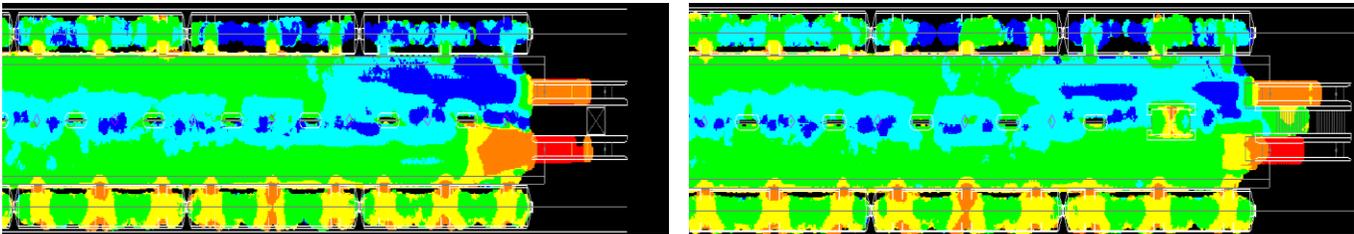
Metrorail Platform

The 2030 Partial Build and Full Build also performed differently on the platform. As shown in the figures below, in the PM peak, heavy queuing on the platform approach to escalators, as found in both 2009 Base and 2030 Partial Build in LOS E (orange color), would be significantly reduced to LOS D in the 2030 Full Build. The additions of a new stairway and two elevators in the 2030 Full Build would greatly enhance the capacity in the peak direction. Timely clearance of escalator queues and the Full Build would also help relieve current and future platform crowding.

Figure 23: Performance of Amtrak Concourse Approach
AM Peak Hour

2030 Partial Build

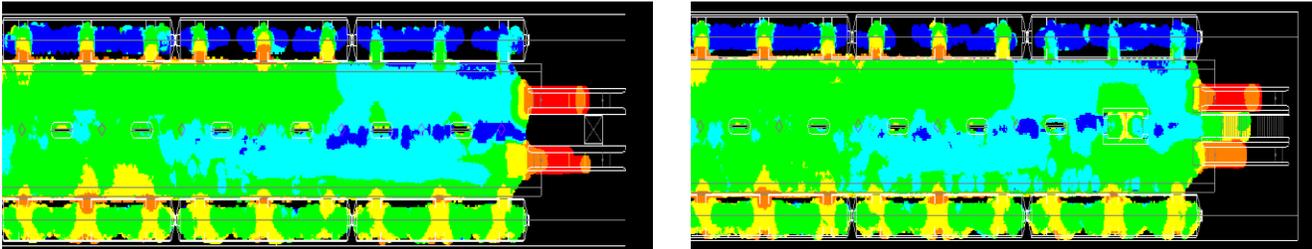
2030 Full Build



PM Peak Hour

2030 Partial Build

2030 Full Build



Travel Time Savings. Compared with the 2030 Partial Build, the proposed capacity improvements in the 2030 Full Build would benefit all users by reducing walking time and enhance passenger experience within the three zones of north mezzanine. Table 7 presents travel time savings for selected paths carrying high volume of pedestrian traffic. Detailed average travel time for individual pedestrian path is summarized in Appendix 2.

Numbers in black indicate reductions in travel time in the 2030 Full Build in comparison with the 2030 Partial Build, and numbers in red indicate increases in travel time. Among the widespread travel time gains on multiple pedestrian paths, Metrorail passengers exiting Union Station and pedestrians accessing the north mezzanine from outside would have the most travel time savings, ranging from 7 to 25 seconds per person.

The only minor travel time increases (in red) are observed at three locations, two of which are considered as within acceptable margins of error in the simulation. One location, identified for

having a 4-second increase, is located in a newly opened space in the Partial Build and Full Build. This new space would expect increased pedestrian activities from the H St. passageway, new concourse elevator and escalators and Metrorail exit faregates. It is anticipated this area would carry less traffic in 2030, mainly those access from the development to the north; therefore it would not incur pedestrian conflicts.

Table 7: Travel Time Saving Per Person (seconds)

	AM Peak Hour				PM Peak Hour			
	Amtrak Concourse	First Street Entrance	Metrorail Platform	H Street Passageway	Amtrak Concourse	First Street Entrance	Metrorail Platform	H Street Passageway
Amtrak Concourse		1	6			1	13	
First Street Entrance	-1		2		25		15	
Metrorail Platform	7	10		7	12	-2		4
H Street Passageway			-4				18	

Queue Clearance Time. Queue clearance times for the existing escalators are also reduced, as shown in Table 8. In the 2030 Full Build, escalators moving in the peak direction would not only operate smoothly but also outperform the today's conditions on the Amtrak concourse approach. In contrast, without the new stairway and new elevators, the 2030 Partial Build yields significant congestion.

Table 8: 2030 Average Escalator Clearance Time (Peak Hour)

	AM: 2009 Current	AM: 2030 Partial Build	AM: 2030 Full Build	PM: 2009 Current	PM: 2030 Partial Build	PM: 2030 Full Build
Metrorail Platform						
Down Escalator	00:20	00:45	00:27	00:27	19:42	02:02
Up Escalator	00:47	07:10	01:34	01:09	02:08	00:59
Amtrak Concourse Approach						
Down Escalator	00:59	02:37	00:39	00:49	00:40	00:27
Up Escalator	00:21	01:02	00:24	05:35	07:53	01:18

Note: number represents mm:ss

In summary, the proposed Full Build improvements are anticipated to significantly outperform the 2030 Partial Build scenario in all measures and would significantly expand access and capacity at Metrorail's north mezzanine, in particular the capacity for vertical pedestrian movements.

The addition of a new stairway and two elevators on the Metrorail platform would offer multiple travel path choices and alleviate the pressure on each single path, allowing the platform to quickly clear arriving passengers before the arrival of next train. The relocation and widening of

the First Street entrance would help reduce traffic conflicts in the unpaid area, eliminate spill-over of crowding to the outside of the First Street entrance, and shorten the path to the Amtrak concourse. The opening of the pedestrian walkway under H Street would offer a direct connection to new development, streetcar and intercity bus terminal, divert new pedestrian traffic away from the First Street entrance and provide quick access to Metrorail and Amtrak.

The cost difference between the two build scenarios is approximately \$7.2 million (Partial Build Scenario - \$28,540,000 and Full Build Scenario - \$35,760,000). The additional 25% in project costs to implement the 2030 Full Build would provide significant additional benefits in performance.

Other Project Impacts

Community Benefits

Improvements identified by the Union Station Metrorail Station Access and Capacity Improvement Study would provide the transportation and access links to tie the surrounding DC neighborhoods together and greatly expand transit connectivity in these neighborhoods.

Union Station sits between two redeveloping DC neighborhoods divided by railroad tracks and a grade separation. H Street, NE is a growing fifteen block stretch of entertainment and arts venues, restaurants and shops running directly east of the project area. The North of Massachusetts Ave. neighborhood or NOMA is a high density, mixed-use redevelopment area, and is home to federal agencies. The southeast corner of the NOMA district abuts the Union Station project area and the project's planned H Street passageway to Metrorail and elevators to H Street will directly benefit the neighborhood.

Poised to further bridge the physical divide between neighborhoods is the Burnham Place air rights development to be built on a platform over railway tracks. The illustration shows the planned Burnham Place development in red and NOMA neighborhood to the northwest. The H Street elevators will connect to the bridge on the north side of the parking garage shown behind Union Station.

Surface Transit Connectivity Benefits

The H Street – Benning Road corridor is home to a transit-riding collection of neighborhoods currently served by the X1 and X2 WMATA bus routes. Combined these routes carry an average of 312,000 riders a month, which makes it one of the five most popular bus corridors in the WMATA system. When the H Street elevators are constructed X route bus riders will have direct access to Union Station and the Metrorail Red line for the first time ever. The connection will allow transfer options to Metrorail and access to Amtrak, MARC, and VRE trains and intercity buses that are now hard to reach from stops several blocks away from the station to the east and west on H Street. As the transit-oriented development projects of NOMA and Burnham Place open streetcar, bus, Metrorail, Amtrak and commuter rail options will all be a convenient, relatively short walk away along landscaped, well-lighted streets and climate-controlled passageways. Residents and office workers will have many of their retail shopping needs within a short walk or bus ride either in Union Station or the retail space in NOMA or Burnham Place.

DC's interim streetcar terminal is located in the unused H Street underpass, adjacent to the Metrorail H Street passageway and planned elevators.

Safety and Security Benefits

By expanding the egress capacity of the Metrorail station as well as Union Station, the proposed Partial Build and Full Build alternatives improve the evacuation capacity of both stations in the event of an emergency. The Metrorail platform would greatly enhance safety performance in daily operations. The proposed stairway would reduce the length and duration of passenger queues in front of the up-moving escalator on the platform, allowing exiting passengers to leave the platform quickly before the arrival of next train. Additionally, the proposed improvements would shift more local, regional and intercity travelers from automobiles to safer methods of travel such as Metrobus, streetcar, commuter rail and intercity bus.

Economic Benefits

Travel time savings is a direct economic benefit from the proposed access and capacity improvements and contributes to the economic competitiveness of the region and nation. It is estimated that by 2030, annual travel time savings would reach 133,000 person-hours, including 33,500 person-hours saved for travelers going through the mezzanine itself and 99,500 person-hours for those using H Street passageway.

As the intercity bus becomes a more attractive option due to better connections between the Metrorail and the bus terminal, it is anticipated more intercity travelers are likely to switch modes from auto to bus to take advantage of smooth modal transfer at Union Station. This shift would result in reduced vehicles miles traveled (VMT) on roads, bringing in numerous secondary benefits including a reduction in the cost of auto operation and usage for travelers who switch modes (an economic competitiveness benefit), a reduction in society's accident-related costs (a safety benefit), and a reduction in society's environmental costs (a sustainability benefit).

Conclusion

The Union Station Access and Capacity Study found that the proposed capacity improvements in both build alternatives would be compatible with the existing building aesthetic and historic qualities and provide more connections to the existing and planned development and transportation services at Union Station. The proposed capacity improvements in the 2030 Full Build are effective in relieving congestion of pedestrian traffic and accommodating future ridership growth. Table 9 compares the impacts between Partial Build and Full Build.

The proposed Full Build improvements are anticipated to significantly expand access and capacity at Metrorail's north mezzanine, in particular the capacity for vertical pedestrian movements. The addition of a new stairway and two elevators on the Metrorail platform would offer multiple travel path choices and alleviate the pressure on each single path, allowing the platform to quickly clear arriving passengers before the arrival of next train. The relocation and widening of the First Street entrance would help reduce traffic conflicts in the unpaid area, eliminate spill-over of crowding to the outside of the First Street entrance, and shorten the path to the Amtrak concourse. The opening of the pedestrian walkway under H Street would offer a direct connection to new development, divert new pedestrian traffic away from the First Street entrance and provide quick access to Metrorail and Amtrak.

All users traveling through the north mezzanine—regional and local transit passengers and intercity travelers—are expected to benefit from the proposed north mezzanine circulation improvements. The time savings is an economic benefit for facility users and contributes to the economic competitiveness of the region and nation. It is estimated that by 2030, annual travel time savings for the Full Build would reach 133,000 person-hours, including 33,500 person-hours saved for travelers going through the mezzanine itself and 99,500 person-hours for those using the H Street passageway.

Figure 9: Comparison of Partial Build and Full Build

	Partial Build Alternative	Full Build Alternative
North Mezzanine (Mezzanine Level)	<ul style="list-style-type: none"> • Reduced crowding at the First Street entrance • New connection to the north via the H St. passageway • Severe congestion in the unpaid area 	<ul style="list-style-type: none"> • Reduced crowding at the First Street entrance • New connection to the north via the H St. passageway • Significant crowding reduction in the unpaid area
Metrorail Platform	<ul style="list-style-type: none"> • No improvements • Severe crowding and delay for exiting passengers on platform 	<ul style="list-style-type: none"> • Alternative connections to main level with a stair and two elevators • Reduction in passenger delay to and from platform and reduction in platform crowding • Safety improvements on platform
Amtrak Concourse	<ul style="list-style-type: none"> • No relief to escalator congestion • Severe crowding at the escalator approaches on both mezzanine and concourse levels 	<ul style="list-style-type: none"> • Doubled escalator capacity for passengers reaching concourse • Significant reduction of crowding at the escalator approaches on both mezzanine and concourse levels
Travel Time	<ul style="list-style-type: none"> • Little time savings for passengers accessing the First Street entrance • Significant travel time savings for riders using the H. Street passageway 	<ul style="list-style-type: none"> • Moderate time savings for all users through north mezzanine • Significant travel time savings for riders using the H. Street passageway
Other Benefits	<ul style="list-style-type: none"> • Modest improvements in safety and security at the mezzanine level • Direct link to communities and new development to the north and surface transit in the H Street corridor 	<ul style="list-style-type: none"> • Significant improvements in safety and security at all three levels, in particular the Metrorail platform • Direct link to communities and new development to the north and surface transit in the H Street corridor

Appendices

Appendix 1 – Union Station Metrorail Ridership Characteristics

Current Ridership Characteristics	North Mezzanine	South Mezzanine
Ridership		
Annual Boardings	4 million	5 million
Average Daily Boardings	15,200	18,800
Average PM Peak Hour Boardings	2,100	2,500
Daily Mode of Access to Metrorail		
Walk		60%
Rail (Amtrak/MARC/VRE)		27%
Metrobus/DC Circulator/Other Bus		6%
Driving/Kiss&Ride/Taxi		5%
Bike		0.4%
Others		1.6%
Residential Distribution of Metrorail Ridership		
DC Residents		30%
Maryland Residents		46%
Virginia Residents		17%
Others		8%

Note:

- Ridership: May 2009 System Ridership Report
- Mode of access and residential distribution: 2007 Metrorail Survey

Appendix 2 – 2030 North Mezzanine Performance

Station Performance (North Mezzanine)	Current	2030 Partial Build	2030 Full Build
Peak Hour Average Travel Time (Seconds)			
AM Peak Hour			
First Street Entrance to Metrorail Platform	2:30	2:50	2:48
First Street Entrance to Amtrak Concourse	1:00	0:45	0:46
H Street Passageway to Metrorail Platform	NA	2:50	2:54
H Street Passageway to Amtrak Concourse	NA	0:48	0:44
Metrorail Platform to First Street Entrance	2:14	2:13	2:03
Metrorail Platform to Amtrak Concourse	2:43	2:39	2:32
PM Peak Hour			
First Street Entrance to Metrorail Platform	2:31	3:11	2:56
First Street Entrance to Amtrak Concourse	1:15	1:12	0:47
H Street Passageway to Metrorail Platform	NA	3:15	2:57
H Street Passageway to Amtrak Concourse	NA	0:57	0:46
Metrorail Platform to First Street Entrance	2:21	1:57	1:59
Metrorail Platform to Amtrak Concourse	3:45	2:40	2:28
Peak Hour Average Space Density			
AM Peak Hour			
Mezzanine's Unpaid Area	LOS A	LOS A	LOS A
Mezzanine Paid Area (within Faregates)	LOS A	LOS A	LOS A
Metrorail Platform	LOS A	LOS C	LOS B
PM Peak Hour			
Mezzanine's Unpaid Area	LOS D	LOS B	LOS A
Mezzanine Paid Area (within Faregates)	LOS A	LOS B	LOS A
Metrorail Platform	LOS A	LOS C	LOS C

Note:

- Both travel time and space density measures reflect the average performance over the entire peak hour. Riders traveling during the peak of peak hour would experience a higher level of congestion than presented by both measures.
- Travel time increases observed in the Full Build are caused by the increased pedestrian traffic in the newly added unpaid area located between the south end of the H St. passageway and the new escalators to the Amtrak concourse. This area in the Partial Build would have much lower traffic volume due to the absence of the escalator set to the concourse.
- Space density is a simplified density for the defined space; however pedestrian distribution is not equal even within the same defined space. This measure could underestimate the effect of the distribution of people in a space. “Heat” map used in the summary report captures the moment of highly congested condition and is considered a better representation of the peak of peak condition than space density.

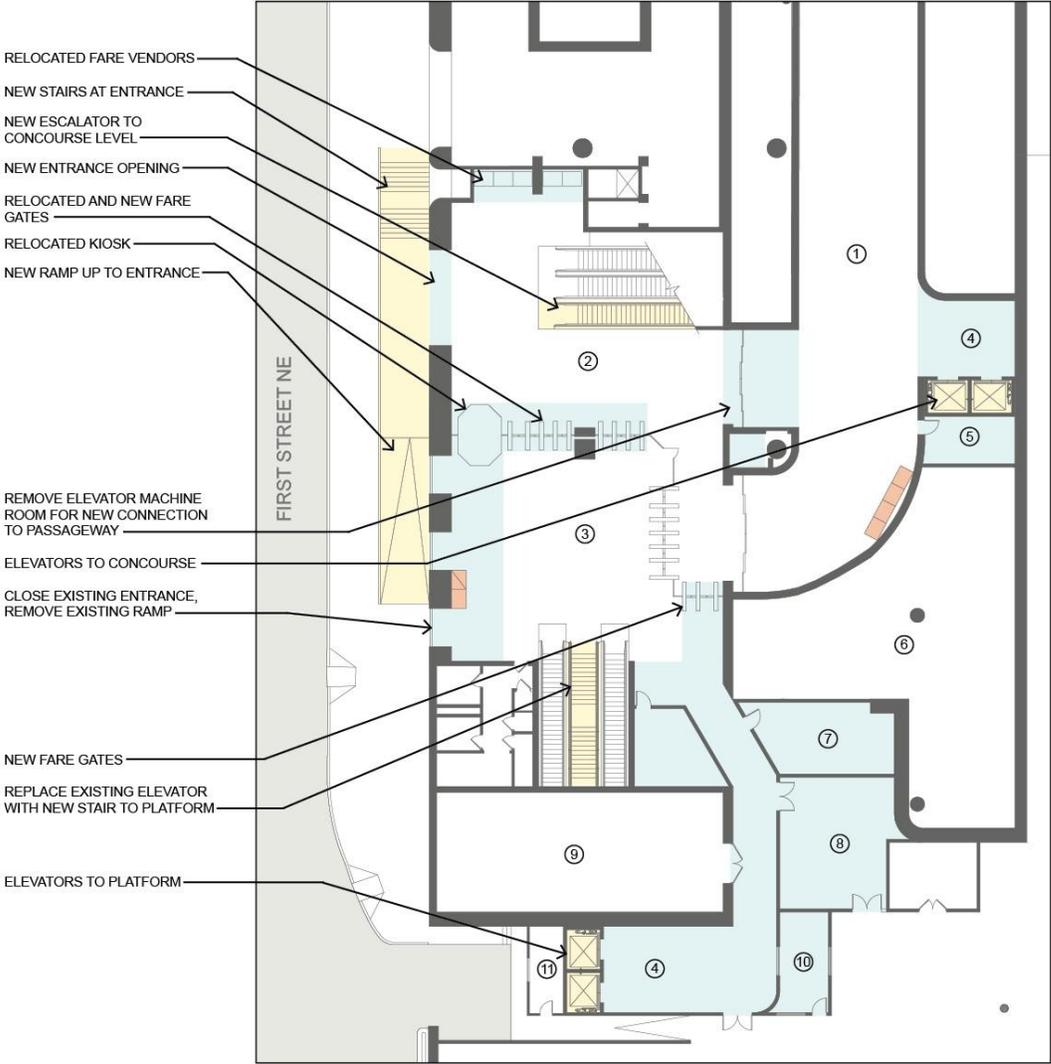
Appendix 3 - Alternative Design Concept for the North Mezzanine

In order to minimize the impact to the concourse level, an alternative concept to the Full Build was developed. As shown in Figure 24, a third escalator could be added to the existing bank (that runs from mezzanine to concourse level). The escalator would operate in the peak direction (down in the AM peak, up in the PM peak) providing some relief to the congestion that develops during the rush hours.

However, a drawback of this design is that the escalator would have to be located on the outside of the existing escalator bank, meaning that the clearance between these escalators and the control line would be reduced significantly. Therefore, the control line would have to be reconfigured with this option. As shown in Figure 24, the kiosk would be relocated to the area adjacent to the First Avenue entrance in order to free-up space next to the new escalator.

This option would have the same paid-zone improvements as the Full Build, as the new mezzanine to platform stair and elevators are included in this concept. As with the Full Build, all improvements included in the Partial Build scenario would also be a part this alternative.

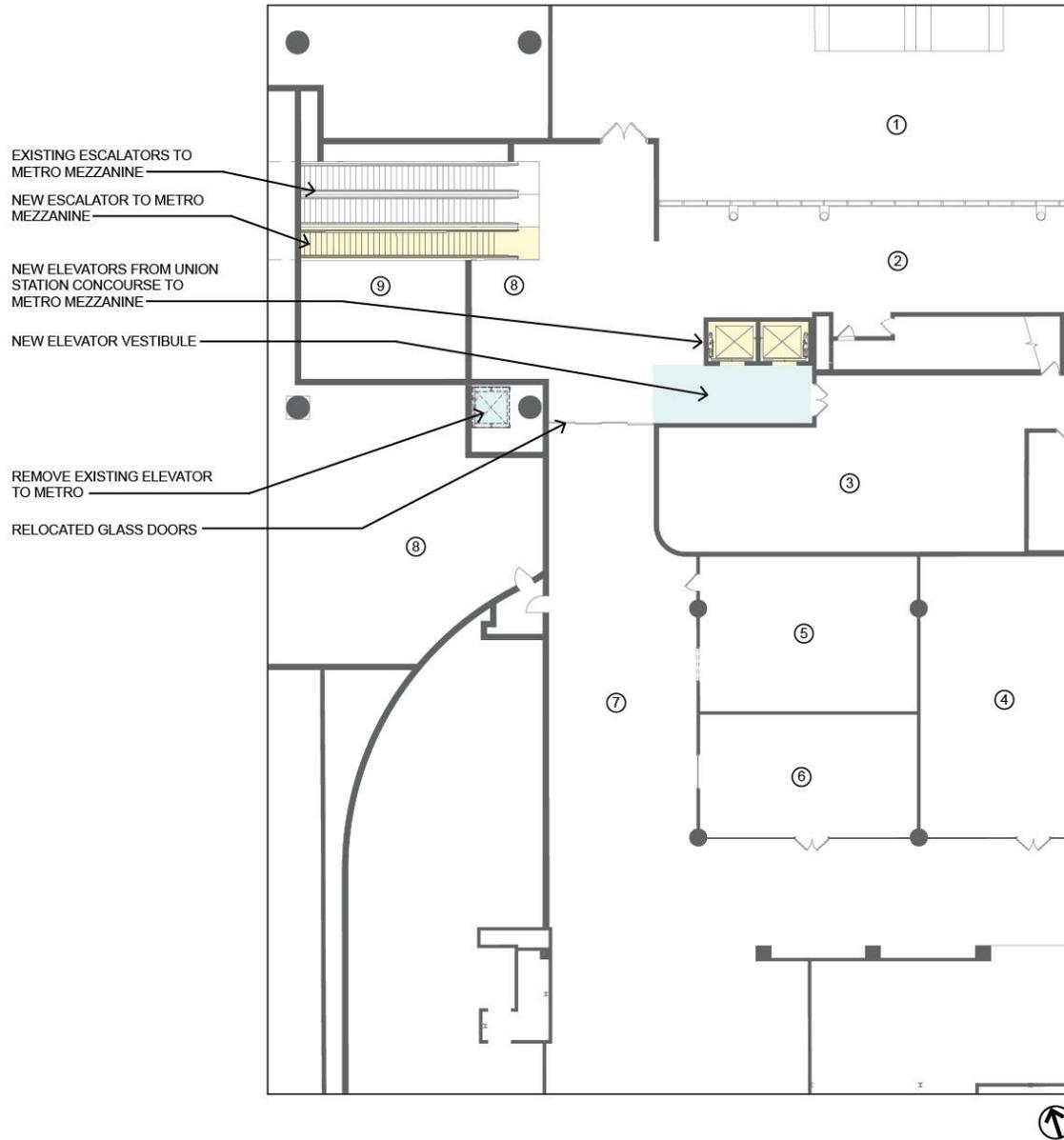
Figure 24: Alternative North Mezzanine Improvements



- RELOCATED FARE VENDORS
- NEW STAIRS AT ENTRANCE
- NEW ESCALATOR TO CONCOURSE LEVEL
- NEW ENTRANCE OPENING
- RELOCATED AND NEW FARE GATES
- RELOCATED KIOSK
- NEW RAMP UP TO ENTRANCE
- REMOVE ELEVATOR MACHINE ROOM FOR NEW CONNECTION TO PASSAGEWAY
- ELEVATORS TO CONCOURSE
- CLOSE EXISTING ENTRANCE, REMOVE EXISTING RAMP
- NEW FARE GATES
- REPLACE EXISTING ELEVATOR WITH NEW STAIR TO PLATFORM
- ELEVATORS TO PLATFORM

KEY		LEGEND
①	PASSAGEWAY TO H STREET	PROPOSED NEW FACILITIES AND CONSTRUCTION
②	FREE AREA	NEW STAIRS AND VERTICAL CIRCULATION
③	PAID AREA	NEW FARE VENDING MACHINES
④	ELEVATOR VESTIBULE	
⑤	ELEVATOR MACHINE ROOM	
⑥	UNEXCAVATED AREA	
⑦	ELECTRICAL ROOM	
⑧	MECHANICAL ROOM	
⑨	TRANSFORMER ROOM	
⑩	SECURITY	
⑪	PACKAGE EXPRESS	

Figure 25: Alternative Amtrak Concourse Improvements



KEY		LEGEND
① AMTRAK/MARC PLATFORM	⑧ POSSIBLE RETAIL	PROPOSED NEW FACILITIES AND CONSTRUCTION
② CONCOURSE	⑨ OPEN TO BELOW	NEW STAIRS AND VERTICAL CIRCULATION
③ MECHANICAL ROOM		
④ RESTAURANT		
⑤ POST OFFICE		
⑥ LIQUOR STORE		
⑦ CORRIDOR		

Appendix 4 - Performance of Alternative Design Concept

This alternative was analyzed by the pedestrian simulation during the PM peak hour to see how effective the third escalator would be at alleviating congestion in the north mezzanine. The following sections summarize the results.

Zone 1: Metrorail Mezzanine

As discussed in the main body of the document, the 2030 Partial Build shows severe congestion in the unpaid mezzanine during the PM Peak hour.

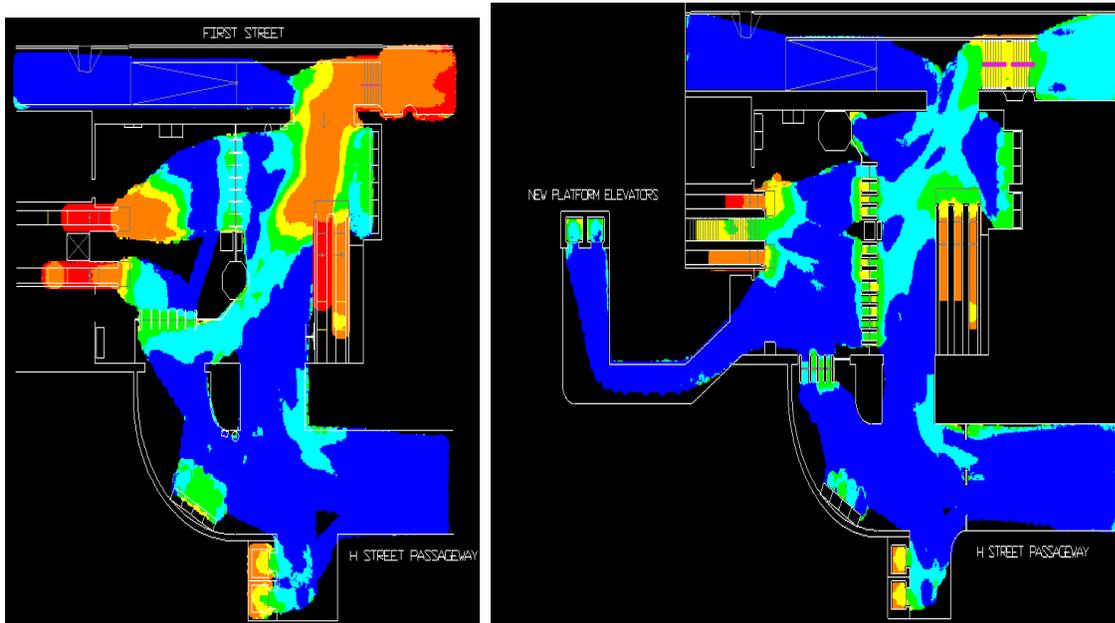
As shown in Figure A.3, the addition of a third escalator greatly reduces this congestion. In the Partial Build condition, the average queue lasted over seven minutes, with one queue modeled to last over twenty minutes (shown by the orange LOS E on the diagram). Under the alternative concept, the average queue cleared in less than a minute, resulting in a much improved level of service in the mezzanine over the PM peak hour. The relocation of the kiosk provides for more space between the turnstiles and the new escalator. However, the Full Build option is preferred for two reasons. First, by not adding the third escalator, it does NOT impact the clearance in front of the turnstiles. Second, by providing a separate escalator bank, it splits up the flow traveling between the Metrorail platform and the concourse level. This, in turn, lowers the density of people in front of the turnstiles and at the base of the existing escalators, which improves the level of service in the mezzanine as a whole.

Figure 26: Performance of North Mezzanine

PM Peak Hour

2030 Partial Build

2030 Alternative Build



Zone 2: Amtrak Concourse Approach

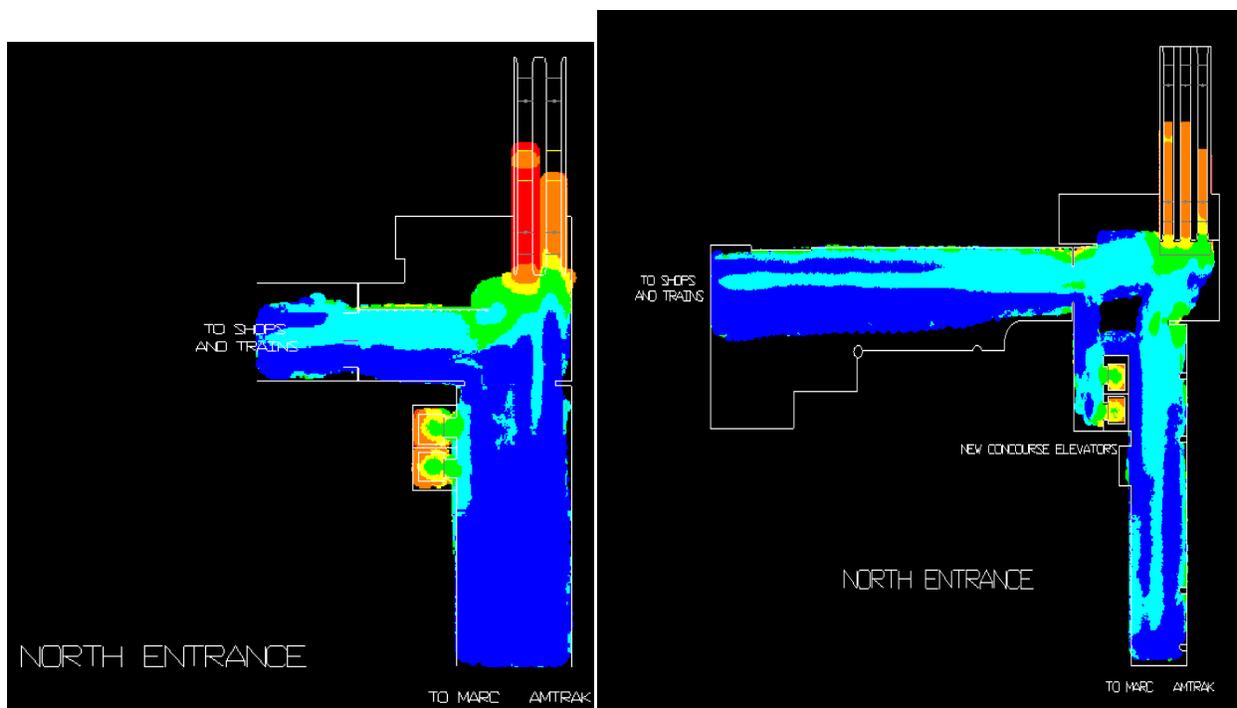
The additional escalator will reduce queuing on the concourse level during the AM peak, as arriving commuter rail volumes can overload the existing single escalator. However, this condition was not modeled in the simulation, as the focus was on the PM condition.

During the PM peak, two escalators traveling up instead of one will relieve congestion in the mezzanine; however, this will increase the density of people arriving on the concourse level at any given time. This does result in an increase in the number of passengers experiencing LOS E/F in this analysis zone from 3% in the Partial Build scenario to approximately 12% under the Alternative concept. However, much of this crowding is momentary in nature as people alight from the escalators. As shown on Figure A.4, the condition over the peak hour remains acceptable.

Figure 27: Performance of Amtrak Concourse Approach
PM Peak Hour

2030 Partial Build

2030 Alternative Build



Zone 3: Metrorail Platform

The Alternative Build scenario would have the same paid-zone improvements as the Full Build, as the new mezzanine to platform stair and elevators are included in this concept. Therefore, there is no difference in the analysis of the Metrorail platform than what is already discussed in the main body of the report.

Comparison of Full and Alternative Build Scenarios

The following table summarizes the differences and similarities between the model results for the Full Build and Alternative Build scenarios.

Table 10: Comparison of Full and Alternative Build Scenarios

	Full Build	Alternative Build
Platform Congestion	Platform congestion greatly improved, especially at northern end of the platform	Same as Full Build
Mezzanine Congestion	Much less congestion. Better unpaid circulation with two sets of escalators	Overall reduction in congestion, though unpaid area at base of escalators remains crowded
Vertical Circulation to Amtrak Level	Significant reduction in escalator queues	Significant reduction in escalator queues. However, only one escalator available for off-peak direction
Travel Time Savings	Moderate savings in the AM; significant in the PM	Time savings in PM condition is 1/2 of the Full Build

Appendix 5 - Design Drawings for the Full Build Scenario

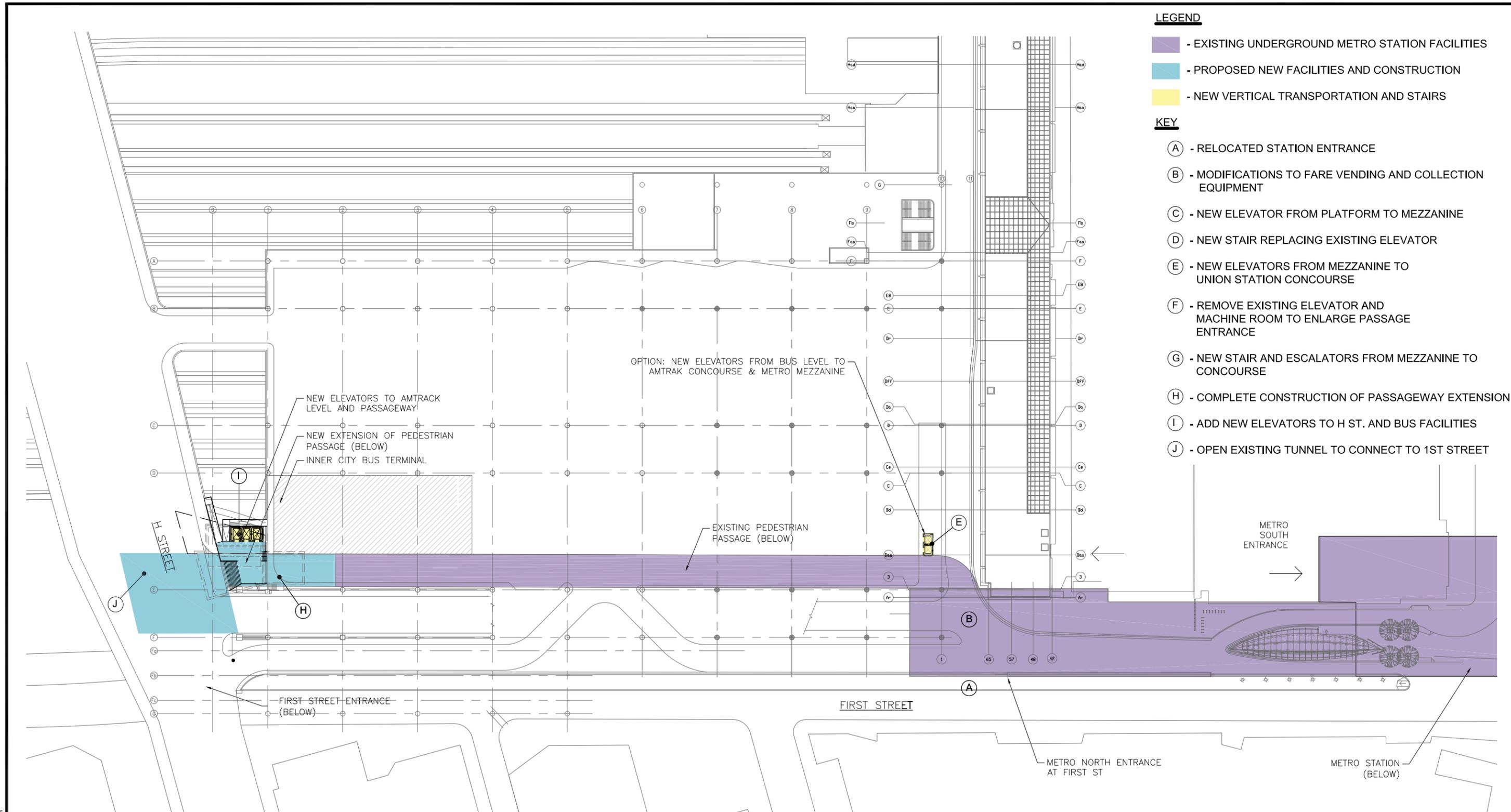
The following drawings expand on the design concept for the Full Build scenario.

LEGEND

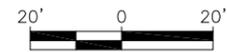
- EXISTING UNDERGROUND METRO STATION FACILITIES
- PROPOSED NEW FACILITIES AND CONSTRUCTION
- NEW VERTICAL TRANSPORTATION AND STAIRS

KEY

- (A) - RELOCATED STATION ENTRANCE
- (B) - MODIFICATIONS TO FARE VENDING AND COLLECTION EQUIPMENT
- (C) - NEW ELEVATOR FROM PLATFORM TO MEZZANINE
- (D) - NEW STAIR REPLACING EXISTING ELEVATOR
- (E) - NEW ELEVATORS FROM MEZZANINE TO UNION STATION CONCOURSE
- (F) - REMOVE EXISTING ELEVATOR AND MACHINE ROOM TO ENLARGE PASSAGE ENTRANCE
- (G) - NEW STAIR AND ESCALATORS FROM MEZZANINE TO CONCOURSE
- (H) - COMPLETE CONSTRUCTION OF PASSAGEWAY EXTENSION
- (I) - ADD NEW ELEVATORS TO H ST. AND BUS FACILITIES
- (J) - OPEN EXISTING TUNNEL TO CONNECT TO 1ST STREET



1 SITE PLAN



CONTRACT NO.

		REVISIONS	
DESIGNED	DATE	DATE	DESCRIPTION
BGALLAGHER	12.14.10		
DRAWN	12.14.10		
LBRUNSON	12.14.10		
CHECKED	12.14.10		
BGALLAGHER	12.14.10		
APPROVED	12.14.10		
SPETERSON	12.14.10		

KGP Design Studio
 1099 14TH Street NW Suite 101 L
 Washington DC 20005
 t. 202 822 2102 f. 202 822 2104

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

DEPARTMENT OF TRANSIT INFRASTRUCTURE
 AND ENGINEERING SERVICES/ OFFICE OF
 ENGINEERING SUPPORT SERVICES



a joint venture of:
 • Parsons Transportation Group Inc.
 • Parson Brinckerhoff Quade & Douglas, Inc.
 • Delon Hampton & Associates, Chartered

APPROVED _____

SUBMITTED _____
 PROJECT MANAGER

**UNION STATION INTER-MODAL ACCESS
 AND CAPACITY STUDY
 ARCHITECTURAL
 SITE PLAN**

SCALE AS NOTED

DRAWING NO. A-01

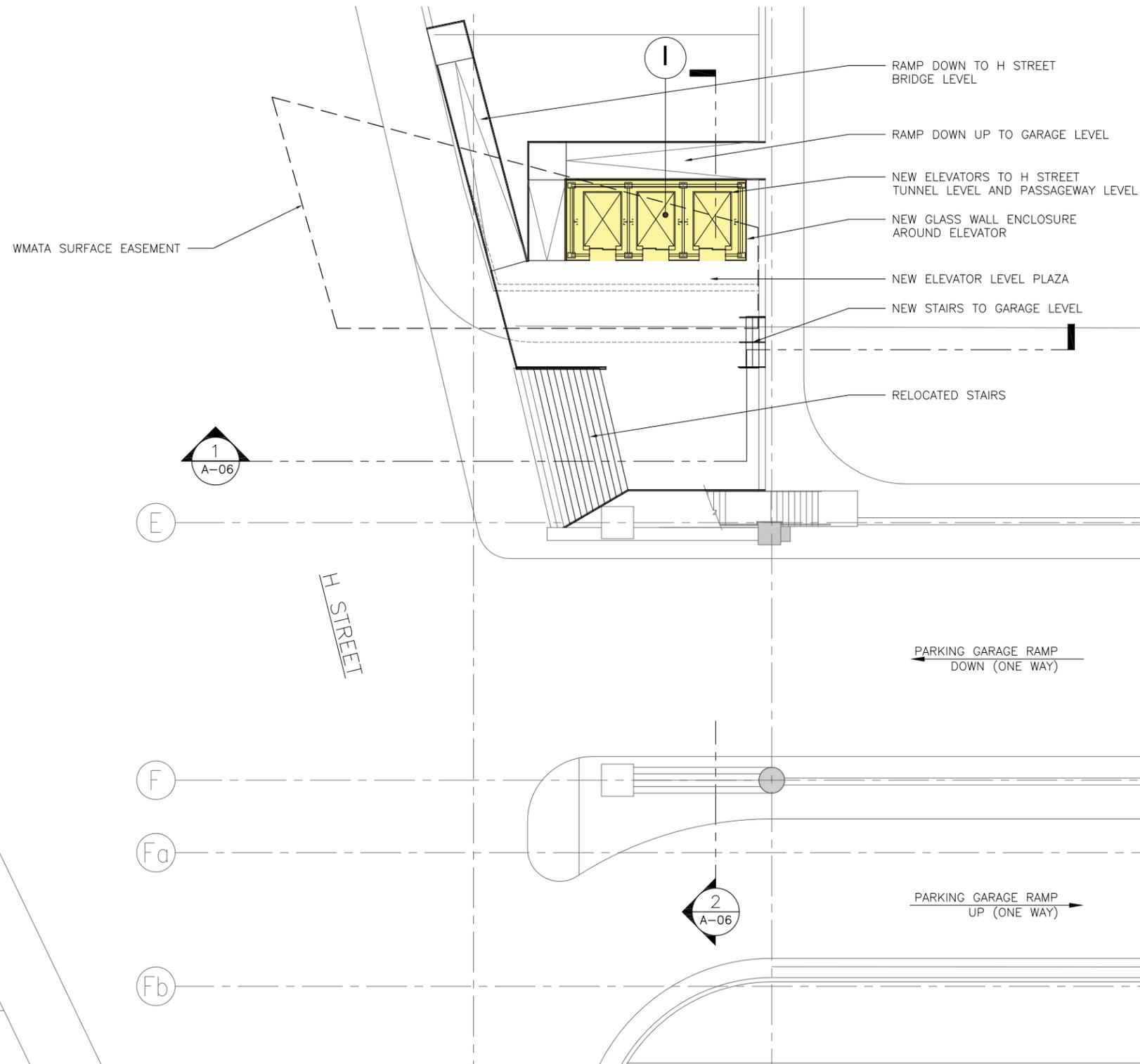
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LEGEND

- EXISTING UNDERGROUND METRO STATION FACILITIES
- PROPOSED NEW FACILITIES AND CONSTRUCTION
- NEW VERTICAL TRANSPORTATION AND STAIRS

KEY

- (A) - RELOCATED STATION ENTRANCE
- (B) - MODIFICATIONS TO FARE VENDING AND COLLECTION EQUIPMENT
- (C) - NEW ELEVATOR FROM PLATFORM TO MEZZANINE
- (D) - NEW STAIR REPLACING EXISTING ELEVATOR
- (E) - NEW ELEVATORS FROM MEZZANINE TO UNION STATION CONCOURSE
- (F) - REMOVE EXISTING ELEVATOR AND MACHINE ROOM TO ENLARGE PASSAGE ENTRANCE
- (G) - NEW STAIR AND ESCALATORS FROM MEZZANINE TO CONCOURSE
- (H) - COMPLETE CONSTRUCTION OF PASSAGEWAY EXTENSION
- (I) - ADD NEW ELEVATORS TO H ST. AND BUS FACILITIES
- (J) - OPEN EXISTING TUNNEL TO CONNECT TO 1ST STREET



1 H ST. PASSAGEWAY ACCESS - GARAGE LEVEL



CONTRACT NO.

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		REVISIONS	
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CHECKED	12.14.10		
BGALLAGHER	12.14.10		
APPROVED	12.14.10		
BGALLAGHER	12.14.10		

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P2D

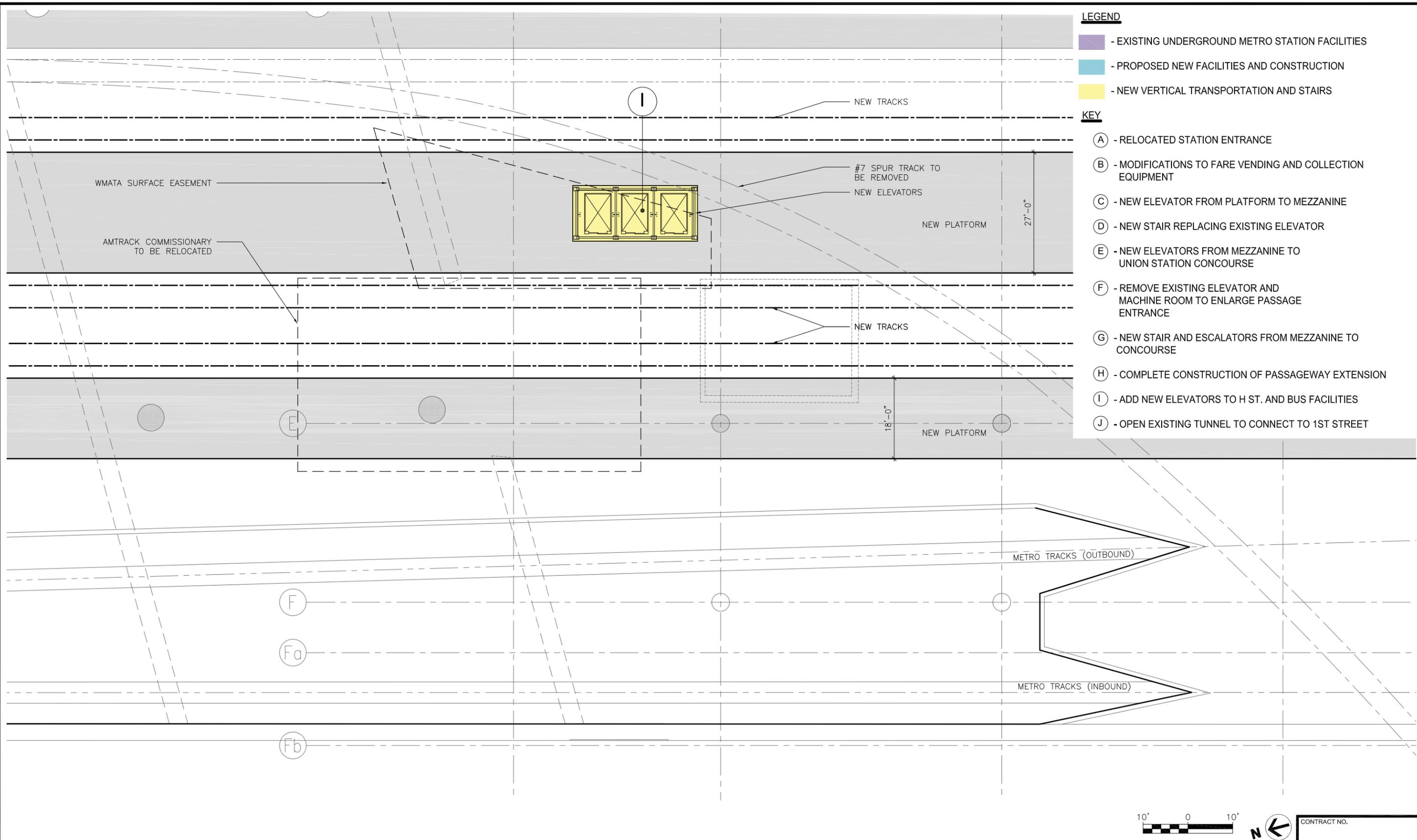
SUBMITTED _____
 PROJECT MANAGER

**UNION STATION INTER-MODAL ACCESS
 AND CAPACITY STUDY**

ARCHITECTURAL
H ST. PASSAGEWAY ACCESS - GARAGE LEVEL

SCALE AS NOTED

DRAWING NO. **A-02**



- LEGEND**
- EXISTING UNDERGROUND METRO STATION FACILITIES
 - PROPOSED NEW FACILITIES AND CONSTRUCTION
 - NEW VERTICAL TRANSPORTATION AND STAIRS
- KEY**
- (A) - RELOCATED STATION ENTRANCE
 - (B) - MODIFICATIONS TO FARE VENDING AND COLLECTION EQUIPMENT
 - (C) - NEW ELEVATOR FROM PLATFORM TO MEZZANINE
 - (D) - NEW STAIR REPLACING EXISTING ELEVATOR
 - (E) - NEW ELEVATORS FROM MEZZANINE TO UNION STATION CONCOURSE
 - (F) - REMOVE EXISTING ELEVATOR AND MACHINE ROOM TO ENLARGE PASSAGE ENTRANCE
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 - (H) - COMPLETE CONSTRUCTION OF PASSAGEWAY EXTENSION
 - (I) - ADD NEW ELEVATORS TO H ST. AND BUS FACILITIES
 - (J) - OPEN EXISTING TUNNEL TO CONNECT TO 1ST STREET



DESIGNED	BGALLAGHER	08.18.10
		DATE
DRAWN	LVARKULJA	08.18.10
		DATE
CHECKED	BGALLAGHER	08.18.10
		DATE
APPROVED	BGALLAGHER	08.18.10
		DATE

REVISIONS		
DATE	BY	DESCRIPTION

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**UNION STATION INTER-MODAL ACCESS
 AND CAPACITY STUDY
 AMTRAK PLATFORM STUDY**

H ST. PASSAGEWAY ACCESS - MECH. LEVEL

SCALE AS NOTED

DRAWING NO. **A-03**

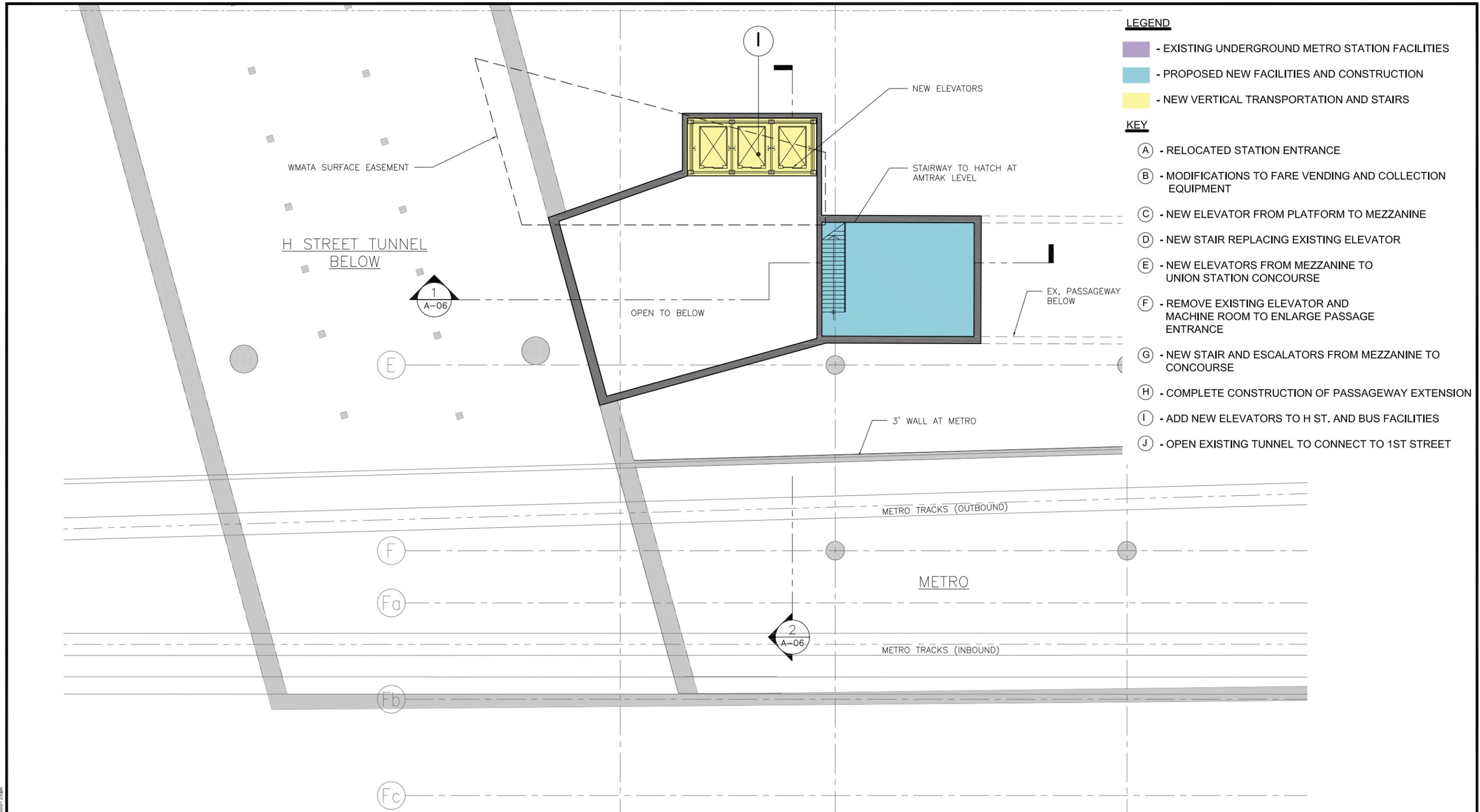
CONTRACT NO. _____

LEGEND

- EXISTING UNDERGROUND METRO STATION FACILITIES
- PROPOSED NEW FACILITIES AND CONSTRUCTION
- NEW VERTICAL TRANSPORTATION AND STAIRS

KEY

- (A) - RELOCATED STATION ENTRANCE
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1 H ST. PASSAGEWAY ACCESS - MECHANICAL ROOM LEVEL



CONTRACT NO.

DESIGNED	BGALLAGHER	12.14.10
DRAWN	LBRUNSON	12.14.10
CHECKED	BGALLAGHER	12.14.10
APPROVED	BGALLAGHER	12.14.10

REVISIONS		
DATE	BY	DESCRIPTION

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 •Delon Hampton & Associates, Chartered

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PROJECT MANAGER

**UNION STATION INTER-MODAL ACCESS
 AND CAPACITY STUDY
 ARCHITECTURAL
 H ST. PASSAGEWAY ACCESS - MECH. LEVEL**

SCALE
 AS NOTED

DRAWING NO.
A-04

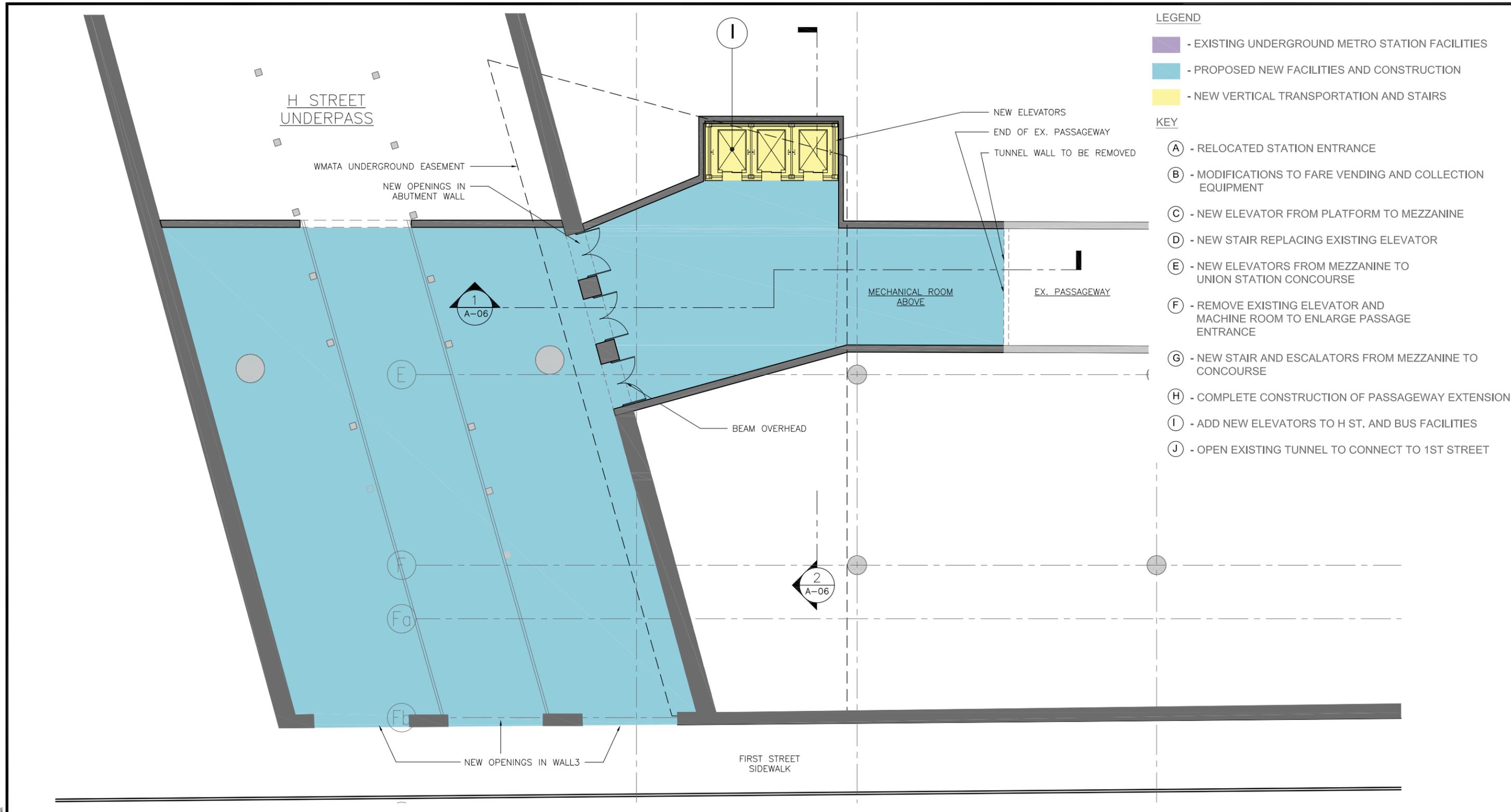
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LEGEND

- EXISTING UNDERGROUND METRO STATION FACILITIES
- PROPOSED NEW FACILITIES AND CONSTRUCTION
- NEW VERTICAL TRANSPORTATION AND STAIRS

KEY

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1 H ST. PASSAGEWAY ACCESS - 1 ST. PASSAGEWAY LEVEL



CONTRACT NO.

DESIGNED	BGALLAGHER	08.18.10
		DATE
DRAWN	LVARJULJA	08.18.10
		DATE
CHECKED	BGALLAGHER	08.18.10
		DATE
APPROVED	BGALLAGHER	08.18.10
		DATE

REVISIONS		
DATE	BY	DESCRIPTION

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SUBMITTED

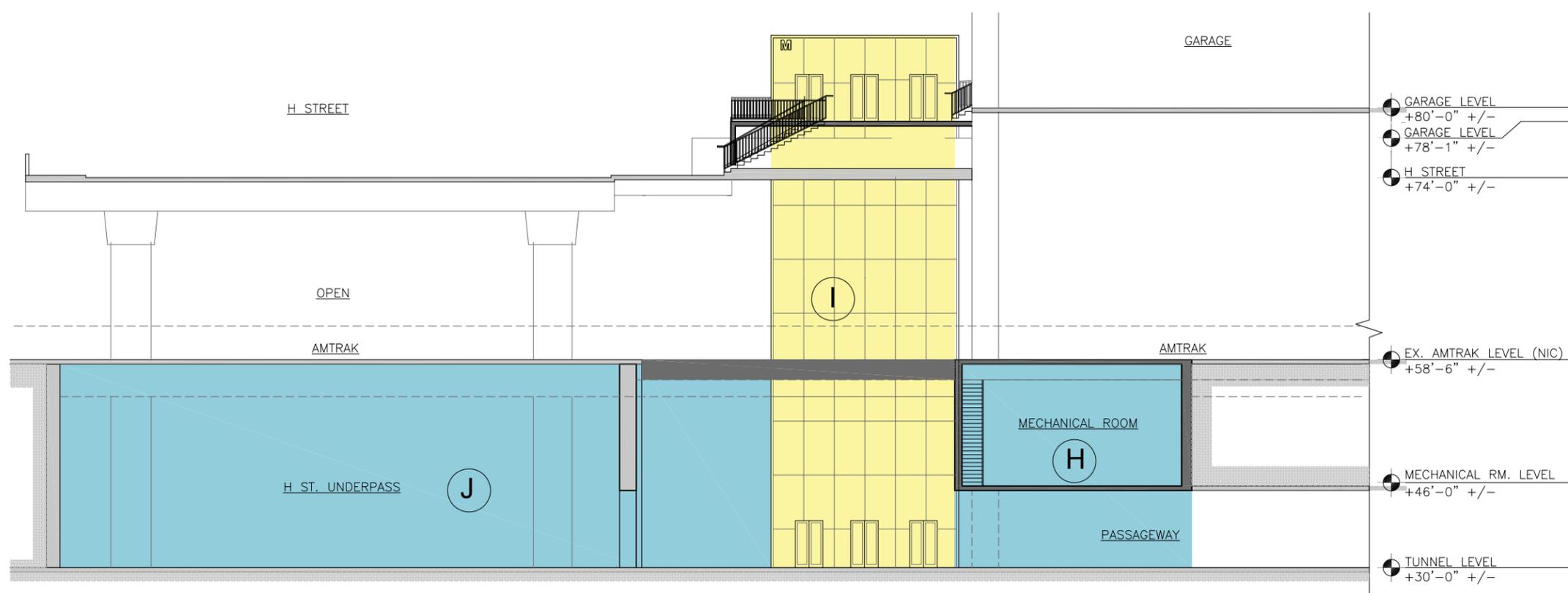
PROJECT MANAGER _____

**UNION STATION INTER-MODAL ACCESS
 AND CAPACITY STUDY
 ARCHITECTURAL
 H ST. PASSAGEWAY ACCESS - 1 ST. LEVEL**

SCALE
 AS NOTED

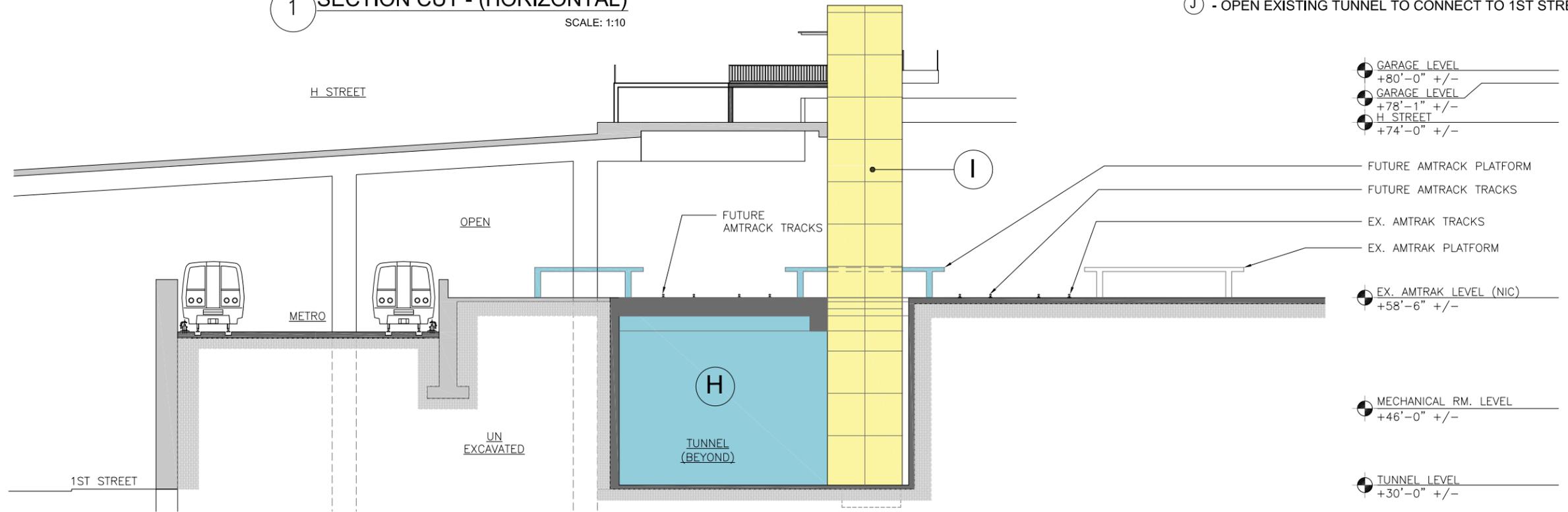
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1 SECTION CUT - (HORIZONTAL)
SCALE: 1:10

- LEGEND**
- EXISTING UNDERGROUND METRO STATION FACILITIES
 - PROPOSED NEW FACILITIES AND CONSTRUCTION
 - NEW VERTICAL TRANSPORTATION AND STAIRS
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2 SECTION CUT - (VERTICAL)



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		REVISIONS	
DESIGNED	DATE	DATE	DESCRIPTION
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DRAWN	12.14.10		
LBRUNSON	12.14.10		
CHECKED	12.14.10		
BGALLAGHER	12.14.10		
APPROVED	12.14.10		
BGALLAGHER	12.14.10		

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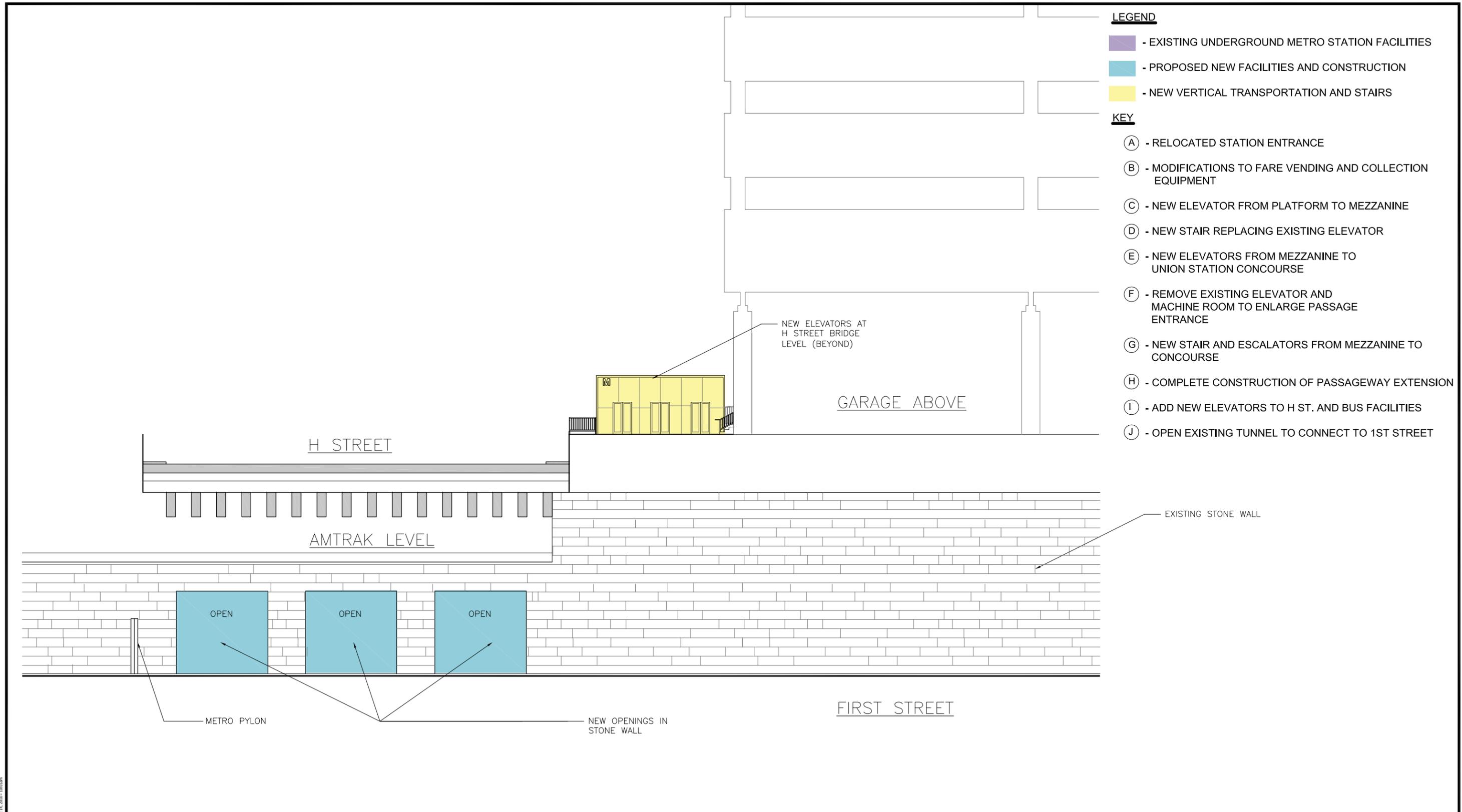
**UNION STATION INTER-MODAL ACCESS
AND CAPACITY STUDY**
ARCHITECTURAL
H ST. PASSAGEWAY ACCESS - SECTIONS
SCALE AS NOTED DRAWING NO. A-06

LEGEND

- EXISTING UNDERGROUND METRO STATION FACILITIES
- PROPOSED NEW FACILITIES AND CONSTRUCTION
- NEW VERTICAL TRANSPORTATION AND STAIRS

KEY

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1 1st STREET ELEVATION AT H STREET TUNNEL ENTRANCE



DESIGNED	BGALLAGHER	12.14.10
DRAWN	LVARKULIA	12.14.10
CHECKED	BGALLAGHER	12.14.10
APPROVED	BGALLAGHER	12.14.10

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DATE	BY	DESCRIPTION

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 PROJECT MANAGER

**UNION STATION INTER-MODAL ACCESS
 AND CAPACITY STUDY**

ARCHITECTURAL

1st ST ELEVATION AT H STREET ENTRANCE TUNNEL

SCALE AS NOTED

DRAWING NO. **A-07**

CONTRACT NO. _____

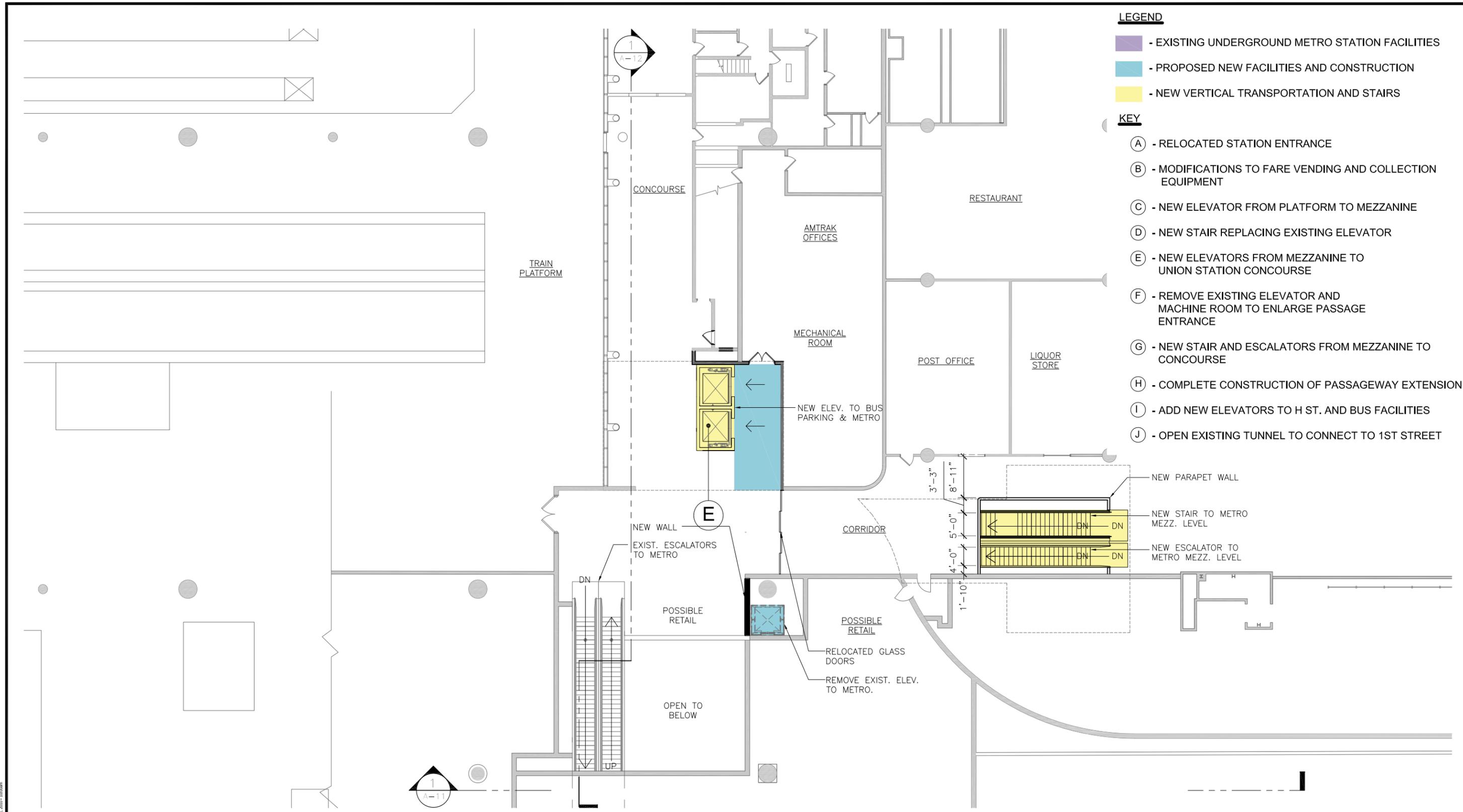
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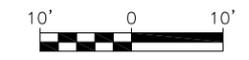
- EXISTING UNDERGROUND METRO STATION FACILITIES
- PROPOSED NEW FACILITIES AND CONSTRUCTION
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KEY

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1 METRO NORTH ENTRY - CONCOURSE LEVEL



CONTRACT NO.

DESIGNED	BGALLAGHER	12.14.10
DRAWN	LVARKULJA	12.14.10
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SCALE 1:20

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P2D
 SUBMITTED PROJECT MANAGER

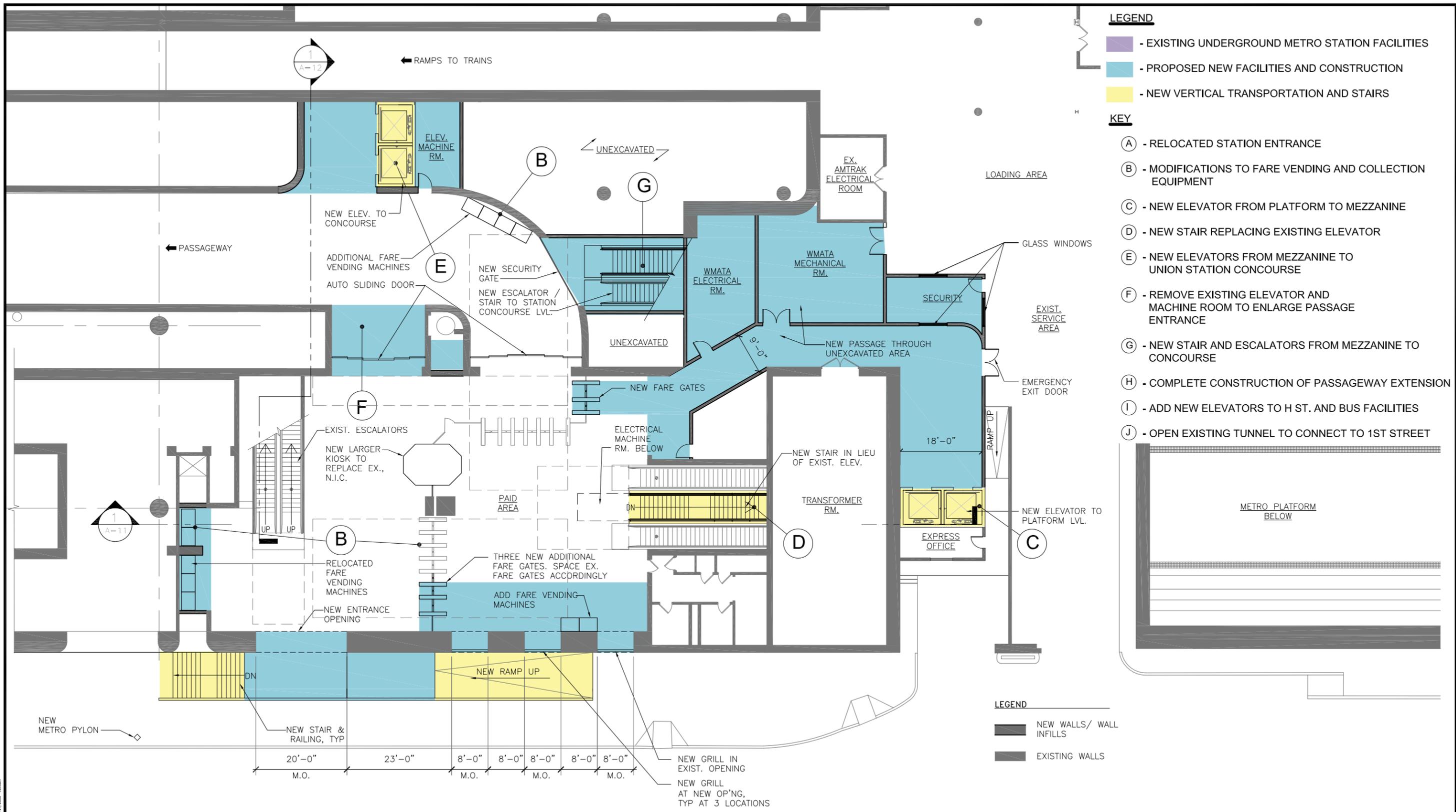
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 • Debon Hampton & Associates, Chartered

**UNION STATION INTER-MODAL ACCESS
 AND CAPACITY STUDY**
 ARCHITECTURAL
 METRO NORTH ENTRY - CONCOURSE LEVEL

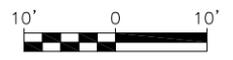
SCALE AS NOTED

DRAWING NO. **A-08**

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1 METRO NORTH ENTRY - PROPOSED MEZZANINE LEVEL



CONTRACT NO.

DESIGNED	BGALLAGHER	12.14.10
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APPROVED	BGALLAGHER	12.14.10

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DATE	BY	DESCRIPTION

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 AND ENGINEERING SERVICES/ OFFICE OF
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 SUBMITTED _____
 PROJECT MANAGER



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**UNION STATION INTER-MODAL ACCESS
 AND CAPACITY STUDY**
 ARCHITECTURAL
 METRO NORTH ENTRY - CONCOURSE LEVEL

SCALE
 AS NOTED

DRAWING NO.
 A-09

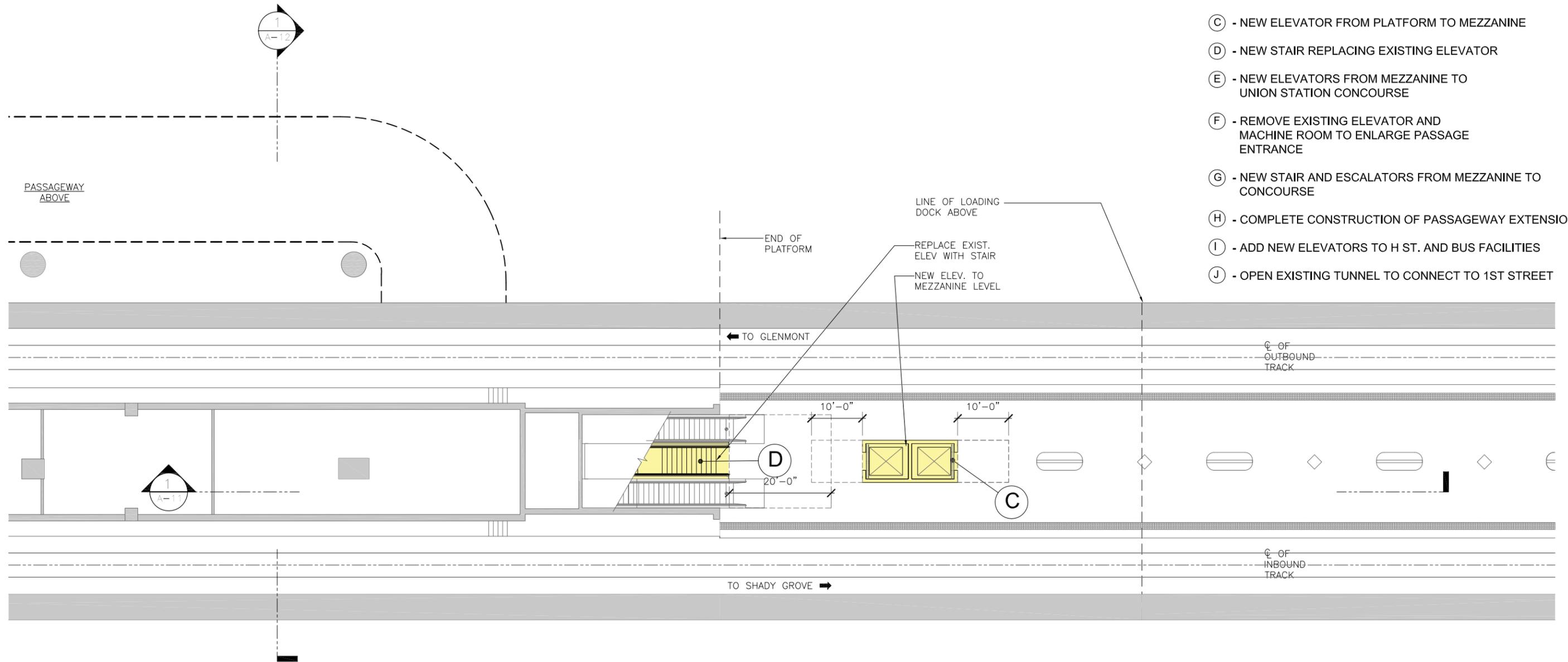
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LEGEND

- EXISTING UNDERGROUND METRO STATION FACILITIES
- PROPOSED NEW FACILITIES AND CONSTRUCTION
- NEW VERTICAL TRANSPORTATION AND STAIRS

KEY

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1 METRO NORTH ENTRY - PLATFORM LEVEL



CONTRACT NO.

DESIGNED			REVISIONS		
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION
08.18.10	BGALLAGHER				
08.18.10	LVARJULJA				
08.18.10	BGALLAGHER				
08.18.10	BGALLAGHER				

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 SUBMITTED PROJECT MANAGER

**UNION STATION INTER-MODAL ACCESS
 AND CAPACITY STUDY**
 ARCHITECTURAL
 METRO NORTH ENTRY - PLATFORM LEVEL

SCALE AS NOTED DRAWING NO. A-10

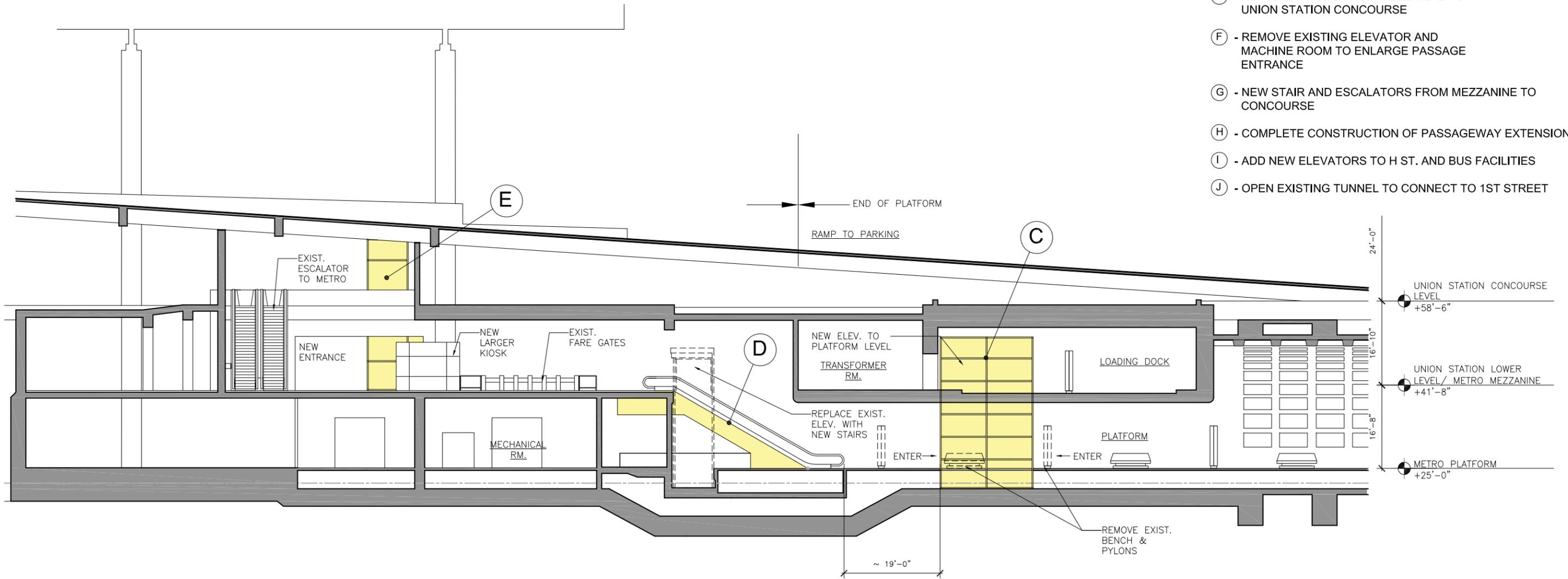
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LEGEND

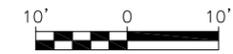
- EXISTING UNDERGROUND METRO STATION FACILITIES
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1 NORTH ENTRANCE LONGITUDINAL SECTION

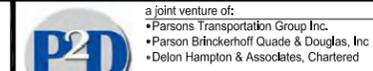


CONTRACT NO.

		REVISIONS	
DESIGNED	DATE	DATE	DESCRIPTION
BGALLAGHER	08.18.10		
DRAWN	08.18.10		
LVARJUKUJA	08.18.10		
CHECKED	08.18.10		
BGALLAGHER	08.18.10		
APPROVED	08.18.10		
BGALLAGHER	08.18.10		

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WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY
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 AND ENGINEERING SERVICES/ OFFICE OF
 ENGINEERING SUPPORT SERVICES
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 SUBMITTED PROJECT MANAGER



**UNION STATION INTER-MODAL ACCESS
 AND CAPACITY STUDY**
 ARCHITECTURAL
 NORTH ENTRANCE LONGITUDINAL SECTION
 SCALE AS NOTED
 DRAWING NO. A-11

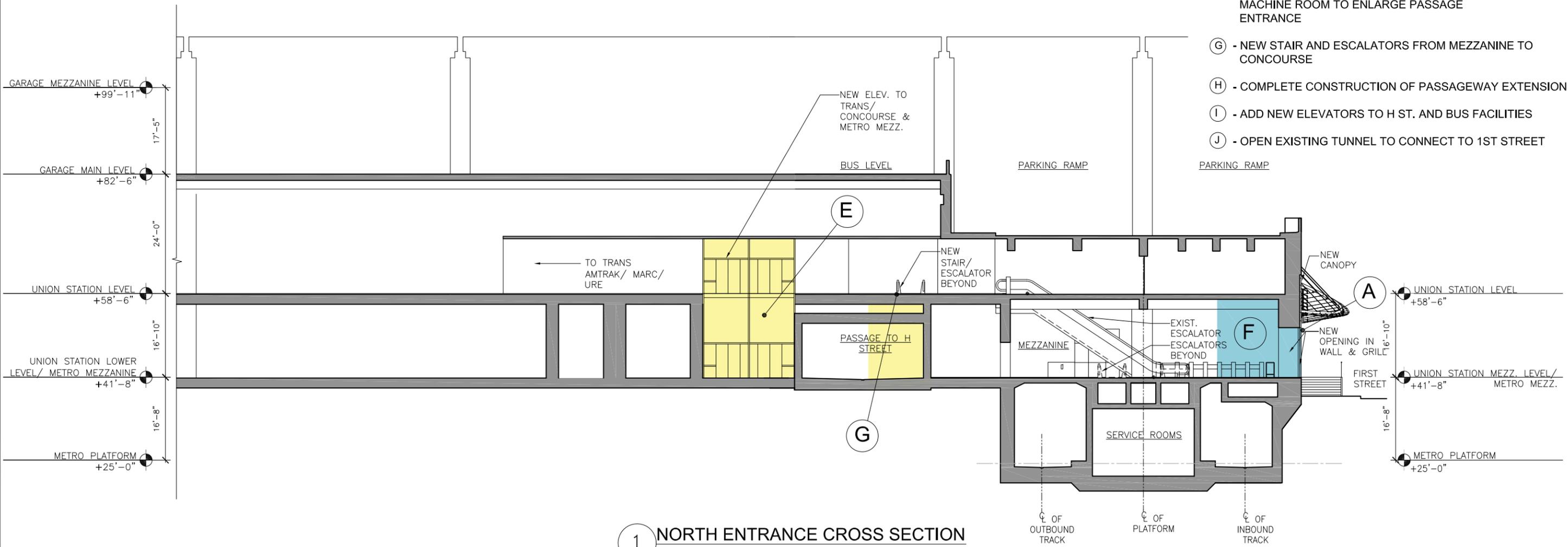
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LEGEND

- EXISTING UNDERGROUND METRO STATION FACILITIES
- PROPOSED NEW FACILITIES AND CONSTRUCTION
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1 NORTH ENTRANCE CROSS SECTION



CONTRACT NO.

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DESIGNED			DATE			REVISIONS		
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION			
08.18.10	BGALLAGHER							
08.18.10	LVARKULJA							
08.18.10	BGALLAGHER							
08.18.10	BGALLAGHER							

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SUBMITTED _____
 PROJECT MANAGER

UNION STATION INTER-MODAL ACCESS AND CAPACITY STUDY

ARCHITECTURAL
 NORTH ENTRANCE CROSS SECTION

SCALE AS NOTED

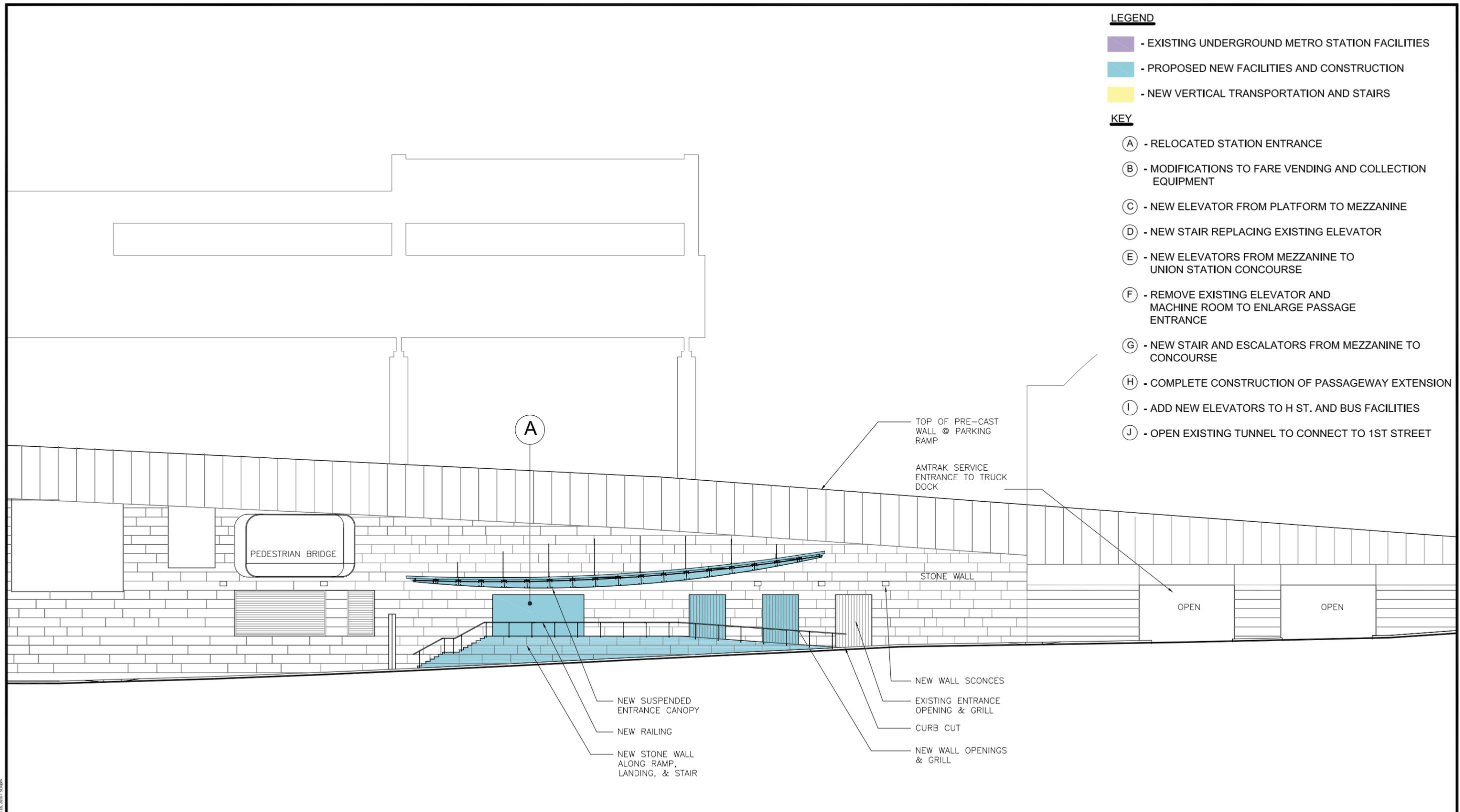
DRAWING NO. **A-12**

LEGEND

- EXISTING UNDERGROUND METRO STATION FACILITIES
- PROPOSED NEW FACILITIES AND CONSTRUCTION
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- (H) - COMPLETE CONSTRUCTION OF PASSAGEWAY EXTENSION
- (I) - ADD NEW ELEVATORS TO H ST. AND BUS FACILITIES
- (J) - OPEN EXISTING TUNNEL TO CONNECT TO 1ST STREET



1 1st STREET ELEVATION

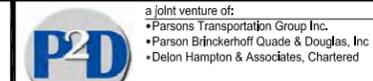


CONTRACT NO.

DESIGNED			REVISIONS		
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION
08.18.10	BGALLAGHER				
08.18.10	LVARUKULIA				
08.18.10	BGALLAGHER				
08.18.10	BGALLAGHER				

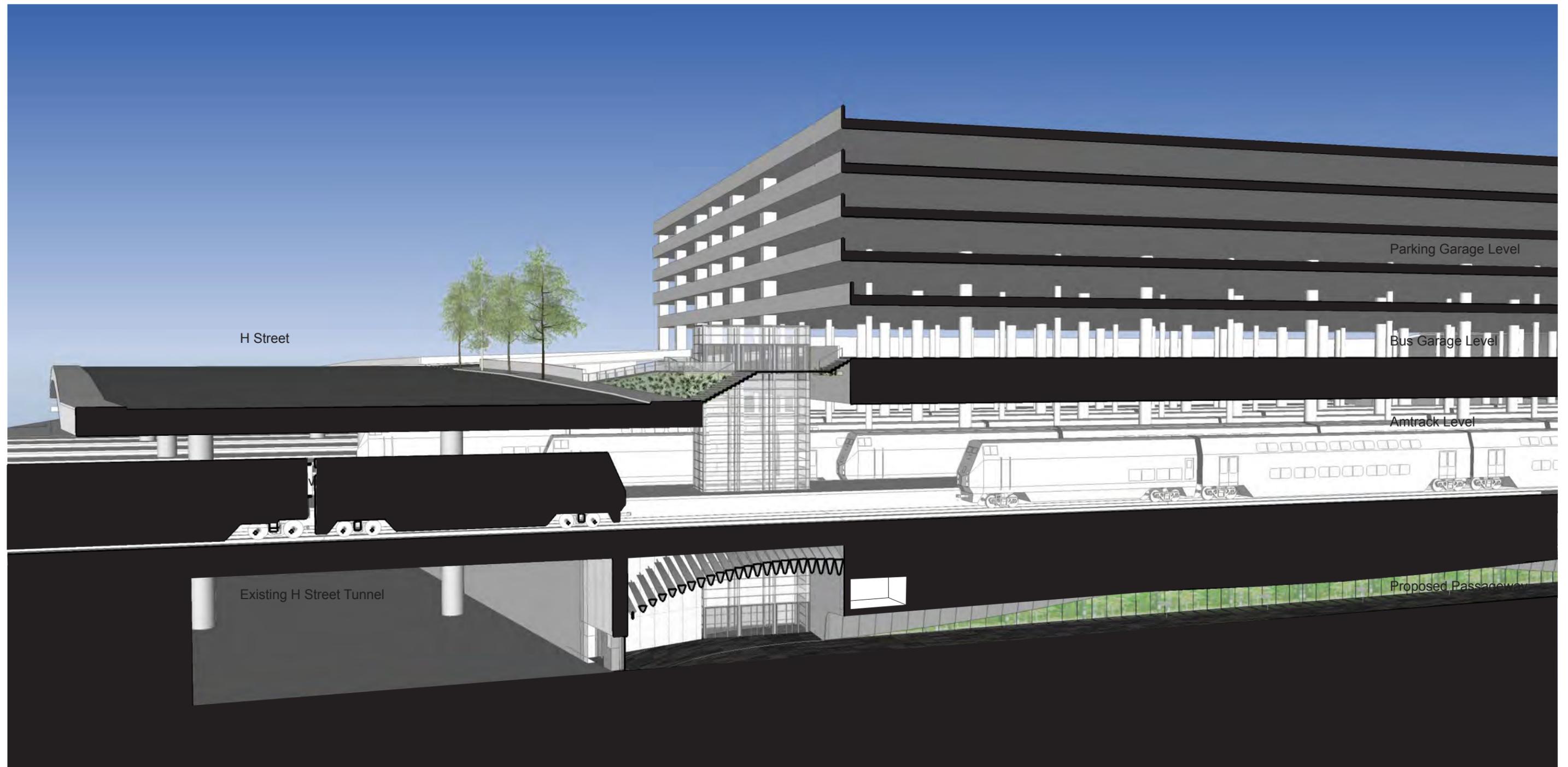
KGP Design Studio
 1099 14TH Street NW Suite 101 L
 Washington DC 20005
 t. 202 822 2102 f. 202 822 2104

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY
 DEPARTMENT OF TRANSIT INFRASTRUCTURE
 AND ENGINEERING SERVICES/ OFFICE OF
 ENGINEERING SUPPORT SERVICES
 APPROVED _____
 SUBMITTED PROJECT MANAGER

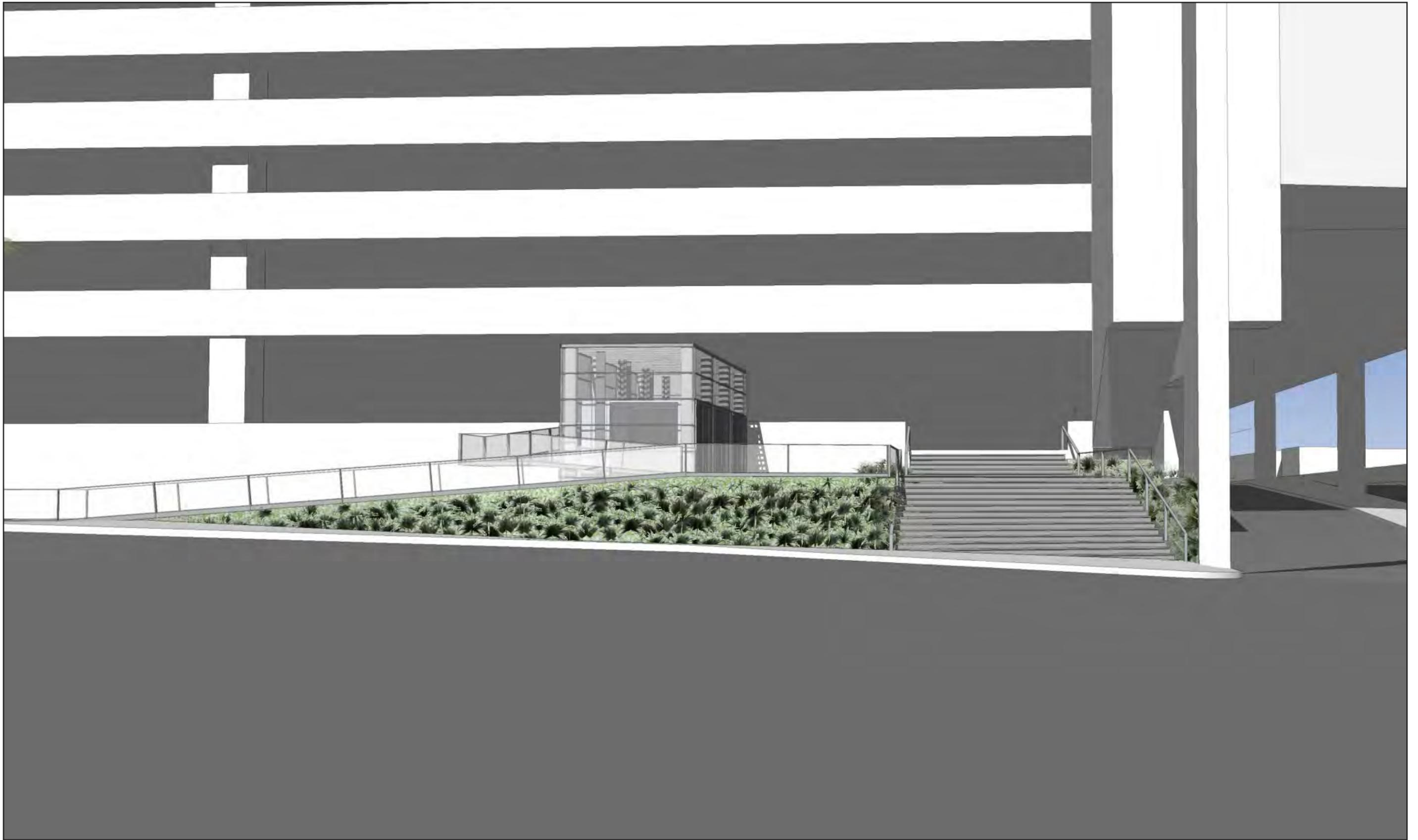


**UNION STATION INTER-MODAL ACCESS
 AND CAPACITY STUDY**
 ARCHITECTURAL
 1st STREET ELEVATION
 SCALE AS NOTED
 DRAWING NO. A-13

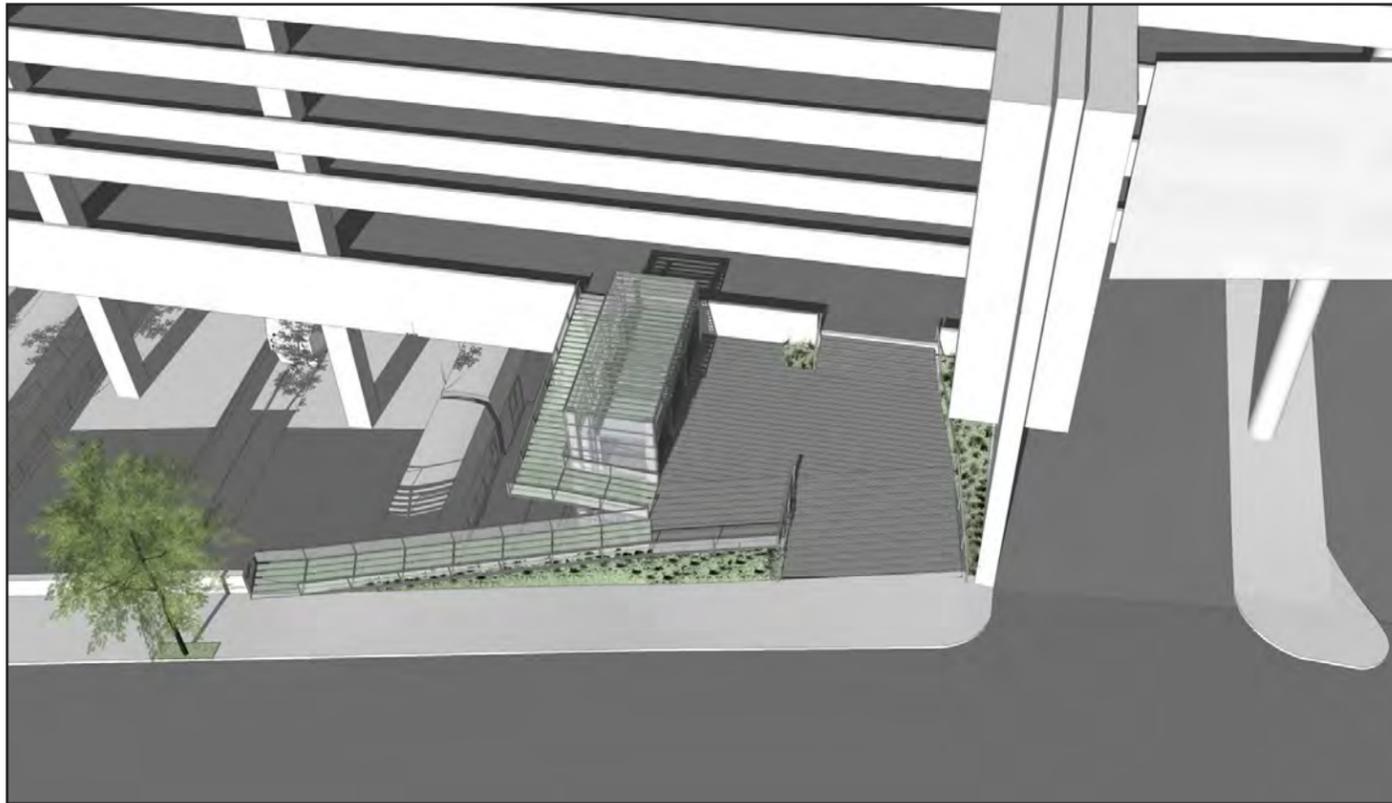
P:\1099_14th_Street_Line_Peak_1100_Drains_Concept\04_01.dwg Aug 18, 2010 - 5:28pm



H Street Entry and Passageway Cross Section (NTS)



Perspective from H Street



Aerial Perspective



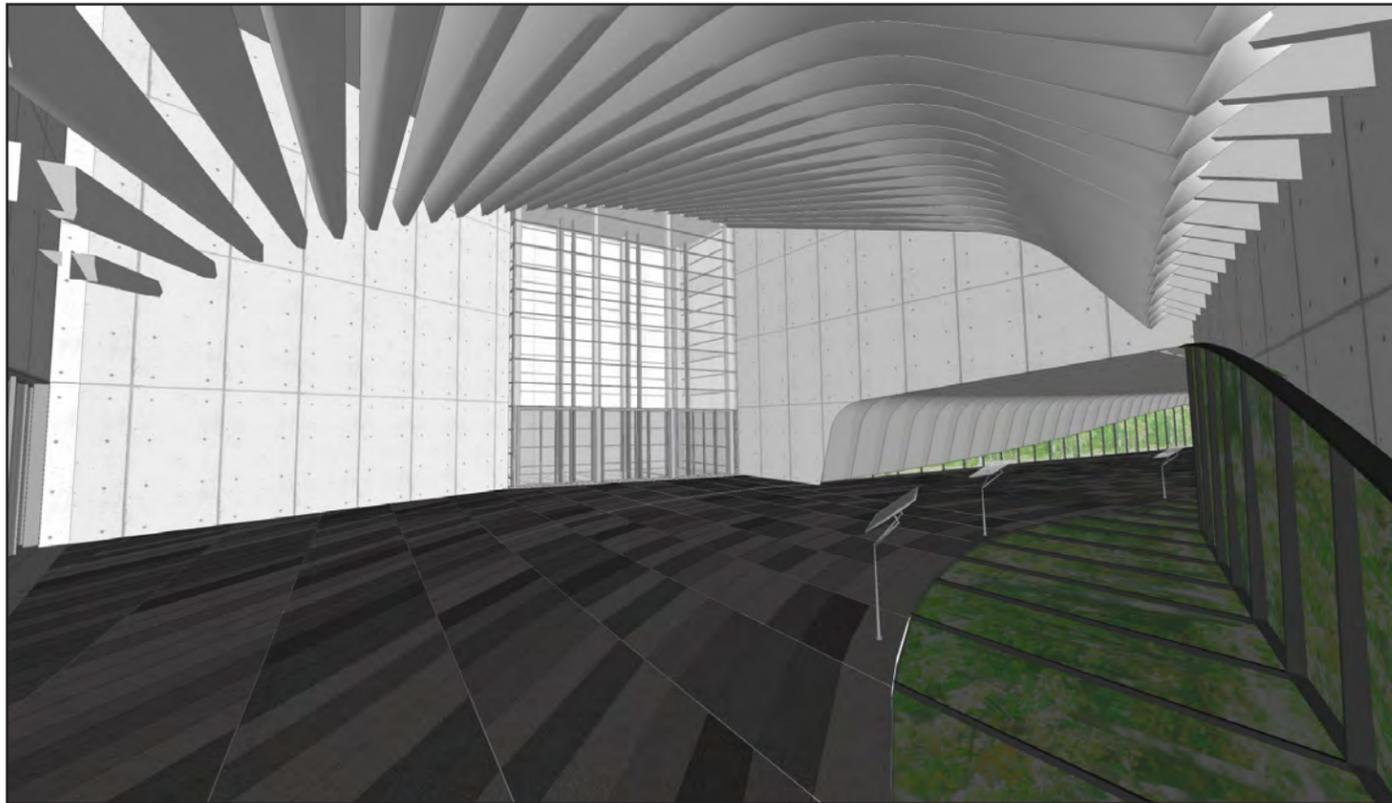
Perspective from H Street



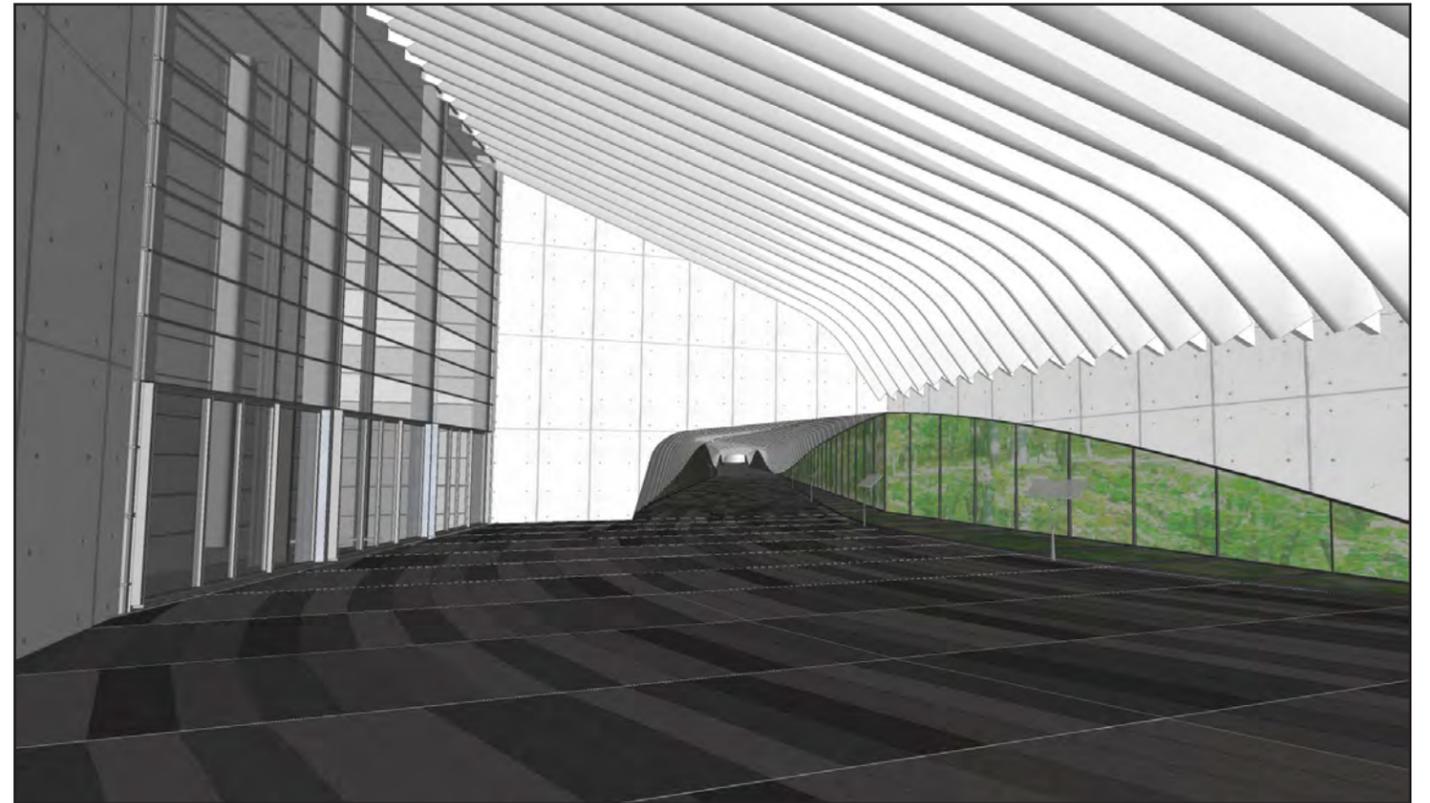
Perspective from H Street



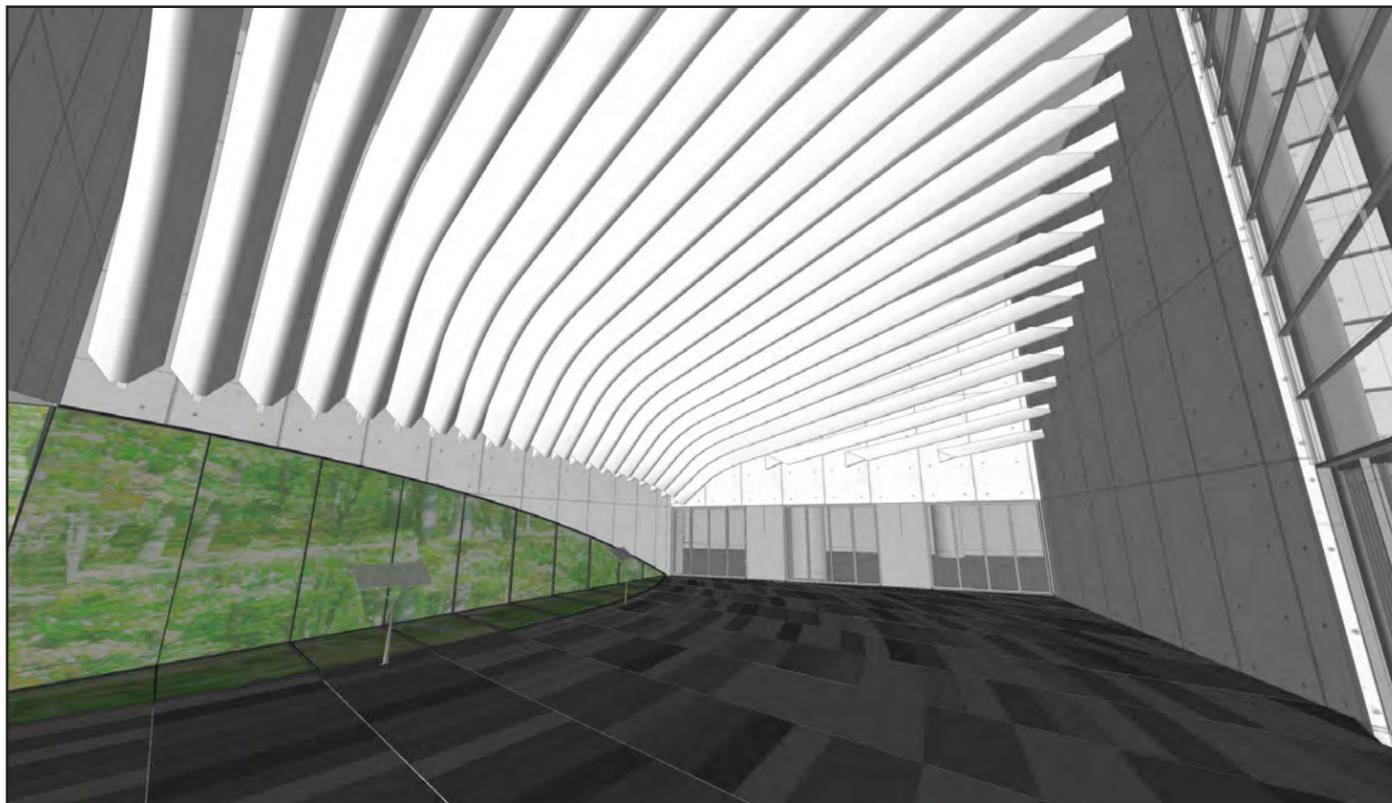
Hoistway at Platform Level



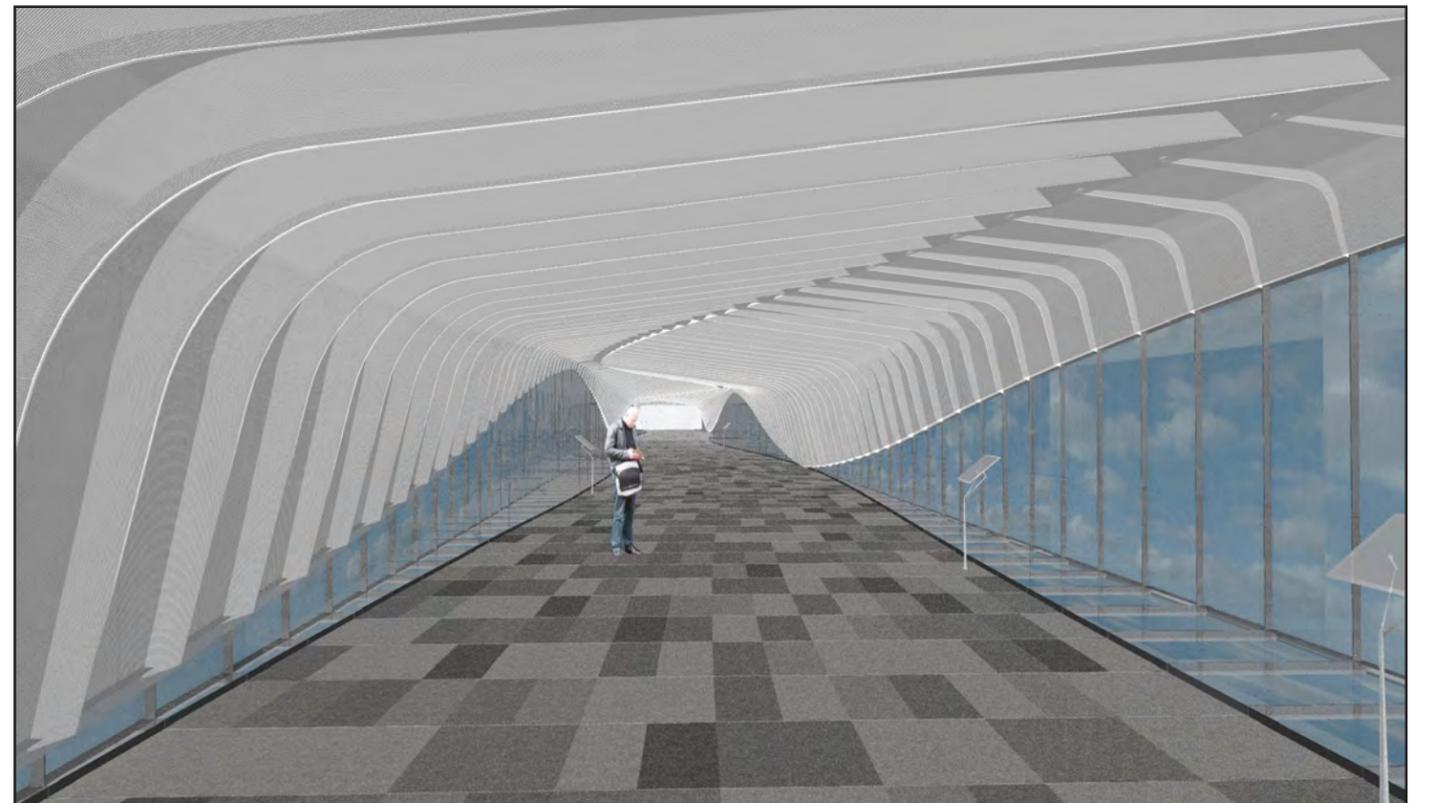
1st Street Entry Perspective



1st Street Entry Perspective



Perspective from Elevator Bay



Passageway Concept



Perspective of Passageway Entry on 1st Street



Perspective of New North Mezzanine Entry