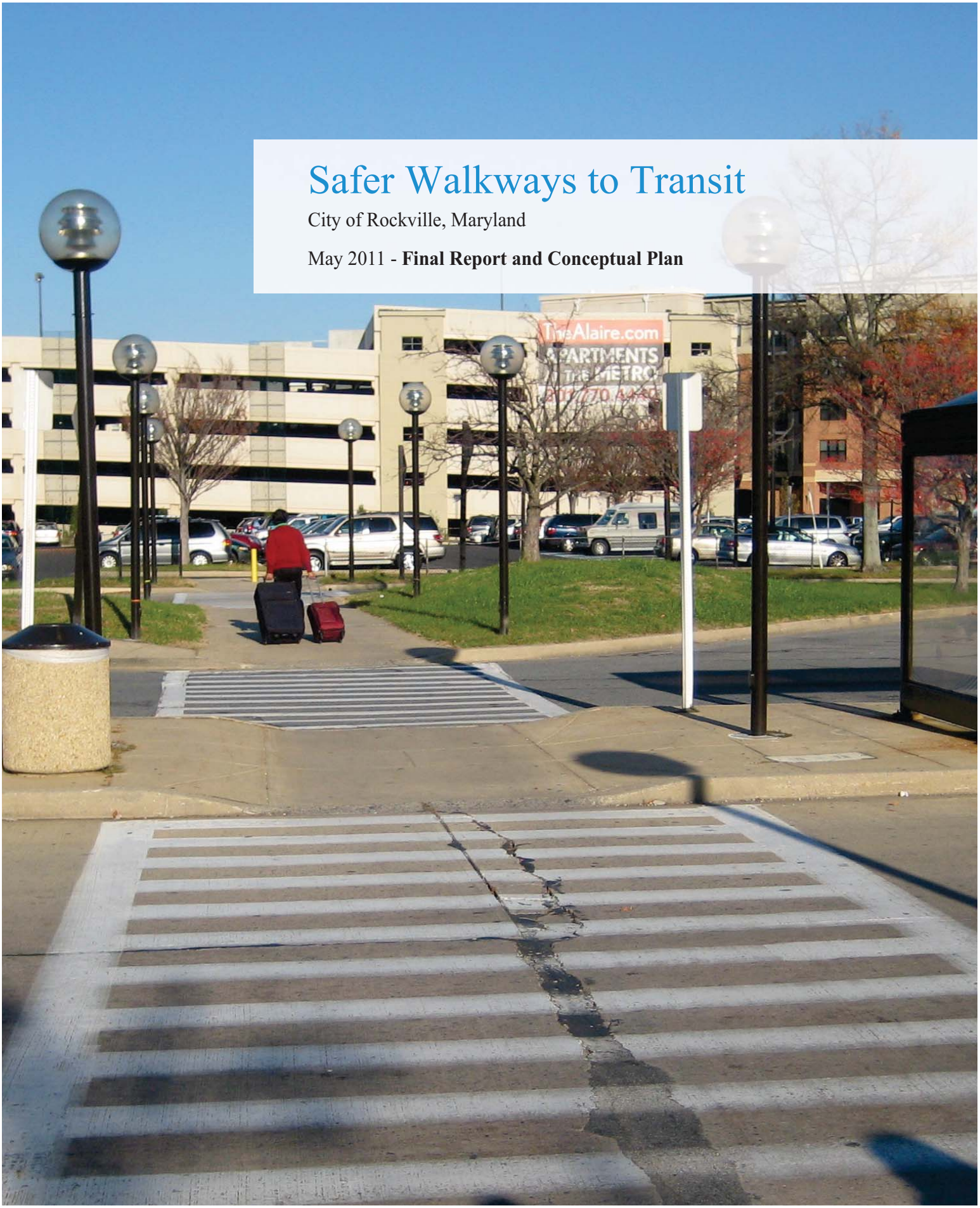
Safer Walkways to Transit

City of Rockville, Maryland

May 2011 - **Final Report and Conceptual Plan**



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City of Rockville

Safer Walkways to Transit

Final Report

03

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Executive Summary

To make public transit an attractive and useful transportation choice, it has to be convenient. Pedestrian access to and from a transit station must be safe, direct and engaging. Understanding this, the City of Rockville has initiated the Safer Walkways to Transit project, which was funded through a grant from the National Capital Region Transportation Planning Board's (TPB) Transportation/Land-Use Connections (TLC) program. This project seeks innovative ways to improve pedestrian safety and access to the Twinbrook Metro Station in Rockville, Maryland. Twinbrook Station is about 15 miles from downtown Washington DC, two stops away from the Shady Grove terminus of the Washington Metro Area Transportation Authority's (WMATA) Red Line. By identifying the major pedestrian routes to the station and studying current safety issues and opportunities, a conceptual pedestrian safety improvements plan has been developed to improve access to Twinbrook Station.

Beyond City boundaries: Collaboration and regional applicability

Due to the nature of the study area, the recommendations described in this plan cross jurisdictional and agency boundaries. The site itself spans the City of Rockville/Montgomery County line. The station area and rail alignment is owned by WMATA, and while many of the roads are owned and operated by the City of Rockville, some are owned or maintained by the County while others, such as Rockville Pike, are owned by the State of Maryland. As a result, the project could not be successful without collaboration from several agencies, including the City of Rockville, Montgomery County DOT, WMATA and the Maryland State Highway Administration. During a design workshop, members from each agency contributed ideas and concerns that were critical to the development of the final conceptual plans.

It is the hope that the recommendations presented can be applied regionally to other WMATA stations. The pedestrian safety toolbox in Section 2 draws from previous TLC work, and in turn could be used as a resource when considering station improvements at other suburban Metro stations where TOD growth is gaining traction and safe pedestrian transit access is increasingly becoming an issue. Furthermore, the methodology described in Section 1 for determining key pedestrian corridors and the actual ¼ and ½-mile walking distances from the station could serve as a model for identifying pedestrian routes as well as areas near other Metro stations with high TOD potential. Finally, the interactive Flash tool developed for the design workshop is a useful method for presenting ideas at public meetings and design charrettes. This tool will be made available on the TLC website.

Project outcome

Section 1 of this report identifies the key pedestrian corridors based on actual walking distance and pedestrian trip origins. A block-by-block analysis of the existing strengths, weaknesses and opportunities for pedestrian safety in the station area is described, with a focus on connectivity, pedestrian/bicycle infrastructure, vehicle infrastructure and land use.

Section 2 describes the Pedestrian Safety Toolbox- enhancements that can be employed not only in the station area, but throughout the City of Rockville. The complete toolbox, detailing each element in terms of impact on pedestrian safety, key design features, cost, and visual examples of successful implementation in other cities, can be found in Appendix A. The combination of several tools together along key corridors could provide significant improvement to pedestrian safety and encourage transit riders to walk to the station. The major categories of safety improvement tools include crossings, pedestrian and bicycle amenities, and vehicle and pedestrian awareness.

Section 3 contains the concept plans for each of the key pedestrian corridors to Twinbrook Station. These routes were prioritized based on pedestrian demand for that route within the actual ½ mile walking distance from the station entrance. Halpine Road west of the station has been given highest priority, as it is the only road that directly connects all of the higher-density residential development west of Jefferson Street to the station entrance. It is also the corridor with the highest number of pedestrian accident locations. Blocks that would benefit from redevelopment to more transit-friendly uses are also identified as long-term station area improvements that could encourage walking to transit.

Conclusion and Next Steps

Understanding the financial constraints common to most jurisdictions over the past several years, the next step for the City of Rockville is to use this plan to implement the study recommendations as funding allows. In doing so, it is important to note that the recommendations for improvements along each corridor focus specifically on pedestrian safety. Further study should be considered to analyze impacts to vehicle movement and level of service (LOS), which was out of scope for this study.

The recommended approach for implementing pedestrian safety improvements is on a corridor-by corridor basis, starting with the corridor assigned highest priority- Halpine Road west of Twinbrook Station, described in Section 3.1. This will create the feeling of a continuous and safe pedestrian route that will be more attractive to Metro passengers traveling between the station and destinations along Halpine Road and west of Jefferson Street. If a full corridor cannot be completed, priority should be given to intersections with historically high levels of pedestrian accidents.

In the longer-term, blocks recommended for redevelopment should be considered for inclusion in a future amendment of the Comprehensive Master Plan, or as a separate station area plan. Along with the current master-planning efforts for the Rockville Pike corridor, the Twinbrook Station area could benefit from a long-term neighborhood plan, as it has the potential to be transformed into a pedestrian-friendly, livable community.

1 Existing Conditions

This section describes the existing conditions for pedestrians who access the Metro at Twinbrook Station based on data collection and an extensive site survey of every block within ½ mile of the station. Major pedestrian access corridors were identified using origin-destination data and measuring actual travel distances along routes to identify the most direct paths. By cataloging this information into a pedestrian infrastructure database, it could be analyzed to identify strengths, weaknesses and potential opportunities to improve the pedestrian experience to and from the station.

Summary of Observations

The Metro rail alignment bisects the ½ mile study area. Overall, the pedestrian network on the east side of the Metro alignment, including the new TOD development as well as the single family housing neighborhood is of higher quality in terms of connectivity, infrastructure quality, and surrounding land uses. West of the Metro, development closest to the station is primarily automobile oriented, resulting in fewer access routes for pedestrians, longer walking distances and a higher number of pedestrian/vehicle accidents.

Connectivity
Connectivity, measured by block length and intersection density, is relatively low. Average block length in the neighborhoods east of the Metro rail alignment is about 475 feet, and west of the Metro alignment it is about 675 feet. Ideal block size for connectivity is typically thought to be 300 to 600 feet. For pedestrian and bicycle connects shorter distances are recommended of about 330 feet.[1] Intersection density, or number of intersections per square mile, is also low compared to similar cities.

Pedestrian/Bicycle Infrastructure
Long blocks, missing sidewalks and crosswalks, lack of pedestrian-scale lighting and complex intersection geometries are common challenges pedestrians must currently overcome when traveling between the station and other destinations. Most residential development west of the Metro is farther than a ½-mile walk from the station and requires pedestrians to cross Rockville Pike.

Vehicle Infrastructure
Most of the vehicle infrastructure in the area is designed to move cars freely and quickly. Channelized right turns that are not signalized can be found at several intersections including Twinbrook Parkway and Chapman Avenue, Bou Avenue and Chapman Avenue, and Rockville Pike and Congressional Lane. Due to the prominence of automobile-oriented land uses and parking throughout the site, almost every City block has at least two driveways, and more commonly has 3 to 6 driveways, disrupting pedestrian travel. West of the Metro alignment, Rockville Pike is a major transportation barrier about 85 feet wide that pedestrians must cross to access the station. East of the alignment, Twinbrook Parkway separates the station from major employment destinations.

[1] Dill, Jennifer. *Measuring Network Connectivity for Bicycling and Walking*, Portland State University, 2004

Land Use
Several office buildings are located within the ½ mile catchment area, and new transit-oriented residential development east of Metro alignment has improved the pedestrian realm and reduced walking distance to the station for those residents. However, the land uses along many streets, especially west of the Metro alignment are auto oriented and include surface parking lots, auto repair and gas stations, as well as service areas for delivery trucks. Few land uses are oriented towards transit, reducing eyes on the street and creating an unpleasant pedestrian experience.

1.1 Station Catchment Area and Demand

The first step in assessing the current pedestrian conditions around the Twinbrook Metro station was to understand:

- The **catchment area** from which the station attracts most riders who likely walk to the station,
- The **origins and destinations** of pedestrians traveling to and from the station.

With this information we can determine both the origins of most pedestrians traveling to and from the station, and the most direct routes available for them to take. These routes will become the focus for identifying pedestrian safety improvements.

Catchment Area

The catchment area of a transit station is the area from which it attracts most of its riders. For pedestrians, the catchment area is typically considered to be the ¼ to ½-mile radius around a heavy rail station, as this is approximately equivalent to a 5- to 10-minute walk for most people. However, depending on the density and connectivity of the street grid, pedestrians originating within the ½ mile radius may have to walk further than ½ mile to reach the station, depending on the directness of their available routes.

Figure 1 compares the ¼ and ½ mile typical catchment area to the actual ¼ and ½ mile catchment area as defined by travel distances from the station entrance following pedestrian paths and the street network. Note that, especially for the ¼ -mile, the actual travel distance covers significantly less than the larger estimated catchment area. This is due to a single point-of-entry to the station, large surface parking around the station and fencing, which limits the directness of pedestrian routes.

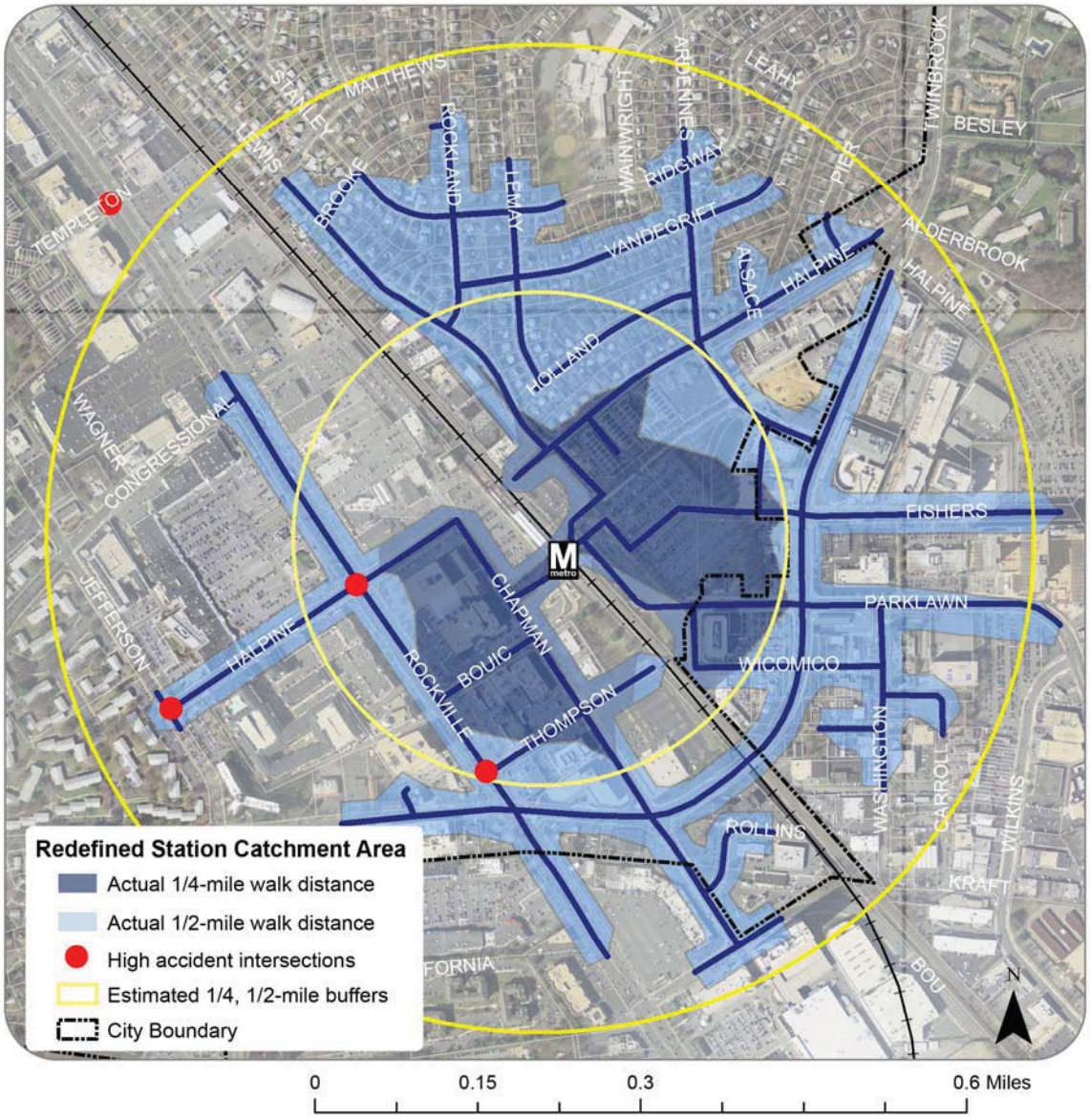


Figure 1: Actual 1/4- and 1/2- mile walking distances from Twinbrook Station

Origin of Pedestrian Access Trips

Based on a Journey-to-Work survey conducted by WMATA, we identified traffic analysis zones with the highest number of pedestrian trip origins (traveling to the station) and destinations (traveling from the station). As shown in Figure 2, the highest pedestrian generators are the residential neighborhoods on either side of Twinbrook Metro station. Note that most of the residential development west of the Metro rail alignment is farther than ½-mile from the station. "Big box" retail and other auto-oriented uses are found closer to the station, which tend to generate fewer transit trips.

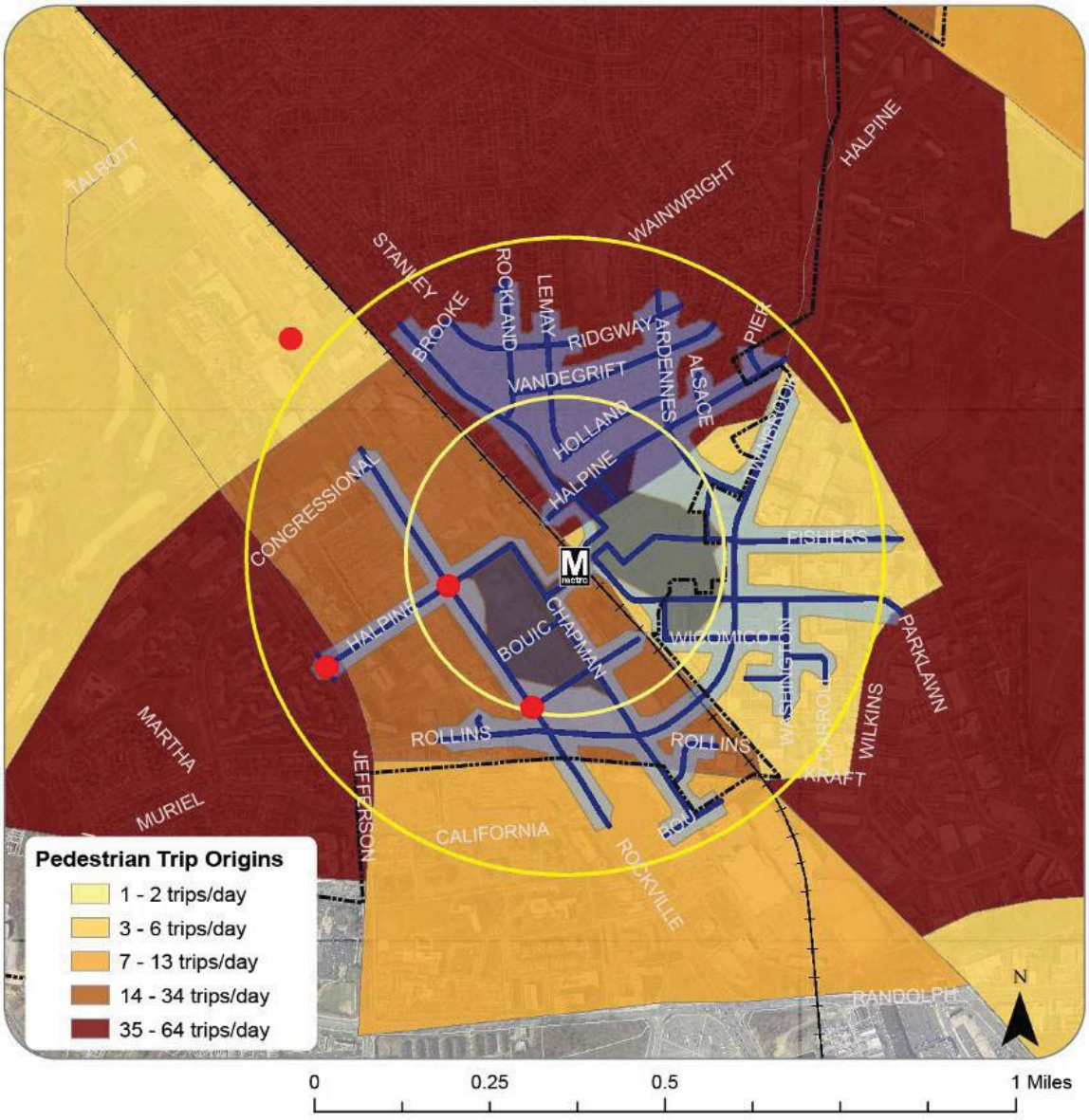


Figure 2: Pedestrian Trip Origins

Key Pedestrian Corridors

Using all road segments within the redefined catchment area to find the most direct pedestrian paths between the station and areas of high station demand, key pedestrian corridors were identified. For example, Halpine Road from Jefferson Street to Chapman Avenue is within the ½ mile walking distance and is the most direct path for all residential development west of Jefferson Street. Similarly, most of the residential streets northwest of the station feed into Halpine Road and Lewis Avenue, which both lead directly to the station and are thus considered major pedestrian corridors. These corridors, shown Figure 3, will be prioritized for potential safety improvements. Looking at these routes, there are areas of high pedestrian demand that are currently underserved by sufficient pedestrian routes to transit.

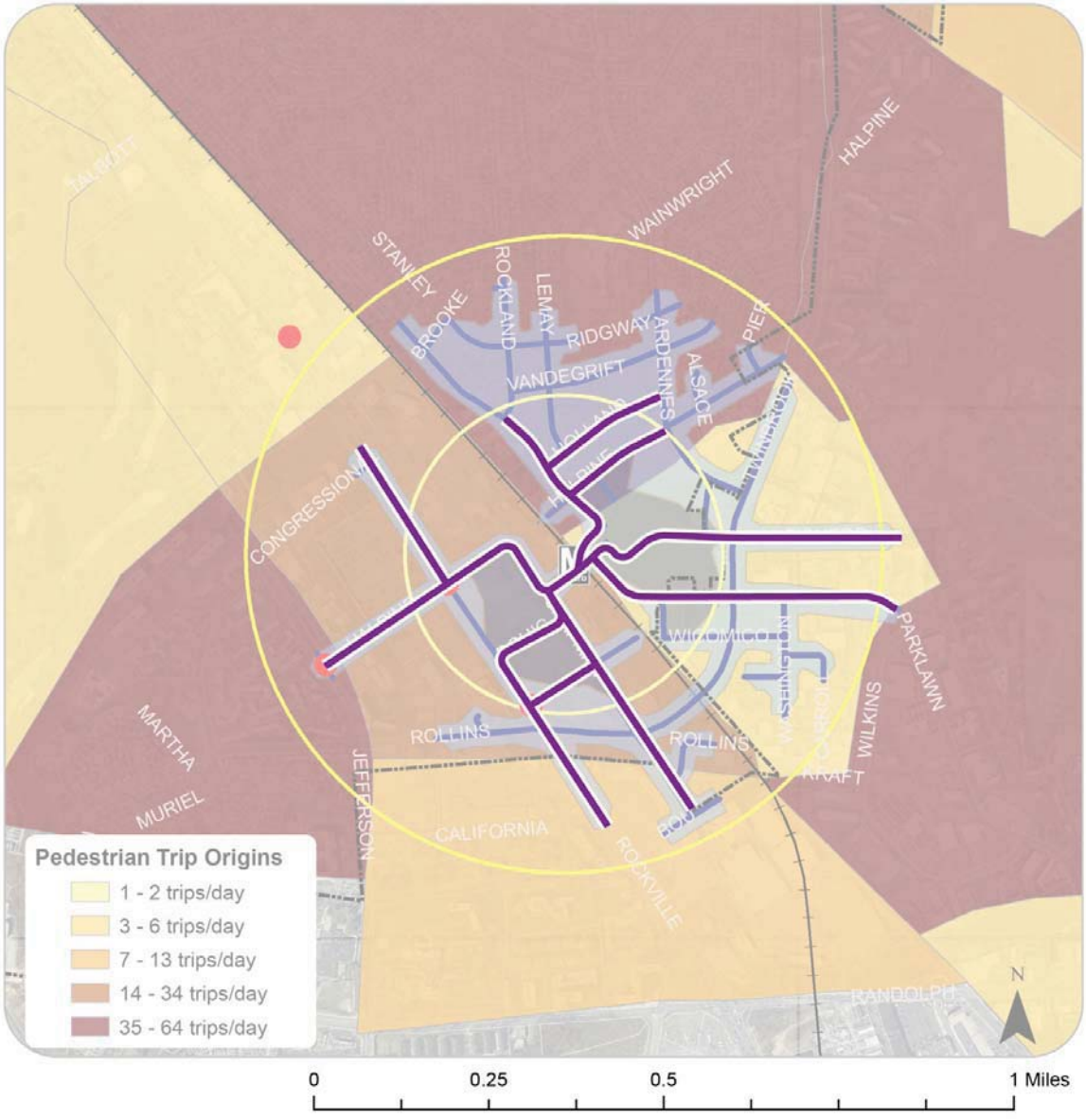


Figure 3: Major Pedestrian Station Access Paths

1.2 Pedestrian Facilities Database

Next, a detailed database of all of the pedestrian facilities along each block within the station catchment area was created. For the purposes of developing a database that is comprehensive and can be used and updated in the future, all of the streets within the estimated ½ mile walk radius of Twinbrook Station were included. Each block was evaluated in terms of four categories: Block details, pedestrian and bicycle facilities, vehicle facilities, and surrounding land use. Where dimensions for an attribute, such as sidewalk width, varied along the block, an average was recorded. Attributes include:

Block Detail

- To/From Streets
- Owner (City, County, State)
- Through Street – does the block continue across both intersections? (yes, no)
- Block Length – Length of block from intersection to intersection (feet)

Pedestrian / Bicycle Facilities

- Sidewalk sides – Presence of sidewalks (0, 1 or 2)
- Sidewalk width – Width of the walkable area, excluding landscaping (feet)
- Intersection crosswalks – Number of crosswalks on that block that occur at an intersection (0, 1, 2)
- Mid-block crossings – Number of midblock crossings on that block (0, 1)
- Crosswalk Type – Pavement marking and signalization (Standard, Standard Signal, Solid, Ladder, Zebra, etc.)
- Crossing distance (feet)
- Median – Presence of a median (yes, no)
- Pedestrian/Vehicle buffer – Presence of landscape or other buffer between sidewalk and street (yes, no)
- Bicycle facilities – Type, if any, of bicycle facility present (shared roadway, shared use path, etc)
- Pedestrian-scale lighting (yes, no)

Vehicle Infrastructure

- Travel Lanes – Number of travel lanes (#)
- Parking Lanes – Number of parking lanes (#)
- Driveways – Number of driveways on both sides of the street (#)

Land Use

- Ground floor use – Uses present along the ground floor of the block (residential, office, etc)

1.3 Strengths, Weaknesses, Opportunities

Using the pedestrian facilities database along with site visit observations, strengths, weaknesses and opportunities could be drawn for each of the major pedestrian corridors to the station, as well as for the overall pedestrian environment around Twinbrook Station.

1.3.1 Pedestrian Connectivity

Block lengths are important indicators of pedestrian connectivity and permeability throughout a neighborhood. Ideal block size for pedestrian connectivity is typically between 300 and 600 feet.

Strengths

- Average block length east of the Metro rail alignment is about 475 feet.
- The City of Rockville owns most of the streets in the traffic analysis zones that draw the highest number of pedestrians to the station. The City has the ability to improve many of the important pedestrian corridors.

Weaknesses

- Average block length in the neighborhoods west of the Metro rail alignment are long, about 675-ft. This limits the number of possible routes and lengthens distance to the station (Figure 4).
- Intersection density was calculated for the entire ½-mile area around the station. It was then compared to two neighborhoods of comparable population density and distance to their central business district. As shown in Table 1, Rockville has about half as many 4-way intersections as Bellevue, Washington. It does, however, have a higher intersection density than Tysons Corner in Fairfax, Virginia, which is highly auto-oriented.

Figure 4: Long, auto-oriented blocks reduce pedestrian permeability along Congressional Lane and Halpine Road (*maps.live.com*)

Table 1: Intersection Densities in Comparable Cities

Neighborhood	4-way Intersections per square mile	Population Density (persons/acre)	Distances to CBD (miles)
Bellevue, Washington	45	8.6	11
Twinbrook Station Area	23	7.2*	15
Tysons Corner, VA	12	10.7	8

* City of Rockville average (http://www.city-data.com/city/Rockville-Maryland.html)

Connectivity Opportunities

- Add or enhance mid-block crossings to link areas of heavy pedestrian demand, especially on Chapman Avenue near the Metro station, and along Halpine Avenue and Congressional Way as redevelopment occurs.*
- Identify safe pedestrian paths through long blocks as existing sites with large surface parking lots redevelop.
- Create design guidelines for development within 1/2 –mile of the station area that specify block length, building orientation, block size, etc. to improve pedestrian permeability

*High pedestrian volumes assumed based on analysis of key pedestrian paths to Twinbrook Station in Section 1.1.

1.3.2 Pedestrian/Bicycle Infrastructure

Pedestrian and bicycle infrastructure should be well-connected, barrier-free, safe and well-lit.

Strengths

- While some streets are missing sidewalks completely, most have a sidewalk on at least one side of the street, and most have a pedestrian buffer, usually a landscaping strip, between the walking area and the street.
- A few crosswalks on the east side of the Metro alignment, such as along Higgins Place, use different pavement materials to provide visual identification of pedestrian routes for drivers.
- Pedestrian scale lighting within the Metro station site.
- Newer streets in Halpine Village have a narrower vehicle right-of-way (roadway excluding sidewalk), wider sidewalks, mid-block crossings, limited vehicular parking and pedestrian-scale lighting, and could be used as a model for other streets in the site
- Flashing mid-block crossing on Chapman Avenue connecting to the station.
- Street network in the residential neighborhood east of the Metro alignment provides multiple routes for pedestrians, extending the pedestrian catchment area.
- Shared roadways for bicycles are designated along several streets in the ½-mile buffer, including: Halpine Road, Jefferson Street, Congressional Lane, Chapman Avenue, Bou Avenue, Lewis Avenue, and Ardennes Avenue (Figure 5).

Weaknesses

<u>Pedestrian/Bicycle Path Conditions</u>

- Bouic Avenue and Thompson Avenue west of the Metro alignment are missing sidewalks within the ¼ mile catchment area of the station. The block of Halpine Road closest to the rail alignment east of the station is also missing a sidewalk (Figure 6).

- Several crosswalks within the ½ mile catchment area are missing at intersections including:
  - Chapman and Halpine, Chapman and Bouic, Chapman and Thompson, Chapman and Twinbrook Parkway; and
  - Parklawn and Twinbrook Parkway, Parklawn and Wicomico (Metro station entrance).
- Few streets beyond the station area have pedestrian-scale lighting.

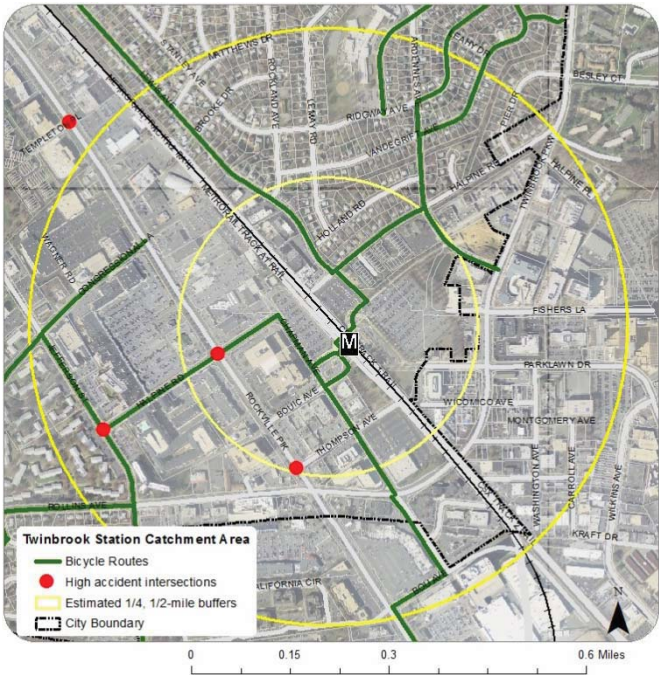


Figure 5: Twinbrook Station area bicycle routes

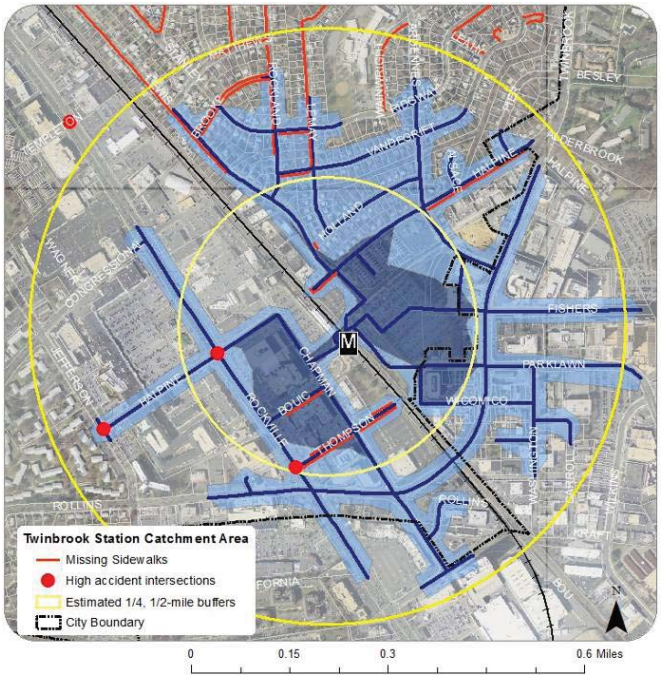


Figure 6: Missing sidewalks along streets in the catchment area

- The shared roadways that exist for bicycles do not have clearly visible signage or pavement markings.

Connectivity

- Long blocks and limited through streets west of the rail alignment reduce pedestrian route choice and result in longer travel distances.
- West of the rail alignment, only Halpine Road is within the ½ mile catchment and reaches the neighborhood west of Jefferson street, where the majority of pedestrians originate.

Safety

- Medians along Rockville Pike, Twinbrook Parkway, and others do not always extend to the crosswalks, leaving pedestrians vulnerable at intersections with no safe refuge if they cannot cross the entire street within the allotted pedestrian phase.
- Several intersections within the catchment area on the west side of the street have had 5 or more pedestrian/vehicle incidents during the period between 2004 and 2008, including:

  - Halpine Road and Jefferson Road;
  - Halpine Road and Rockville Pike, and;
  - Thompson Avenue and Rockville Pike.
- There is no exclusive pedestrian-only phase at any of the above intersections. This causes conflict between turning vehicles and crossing pedestrians.
- Pedestrian crossing distances of over 100 feet at intersections with channelized right turns along key pedestrian routes such as the intersection of Chapman Avenue and Twinbrook Parkway. These channelized turns enable high vehicle speeds and cause poor visibility for pedestrians and vehicles.

Pedestrian/Bicycle Infrastructure Opportunities

Paths

- Implement a pedestrian priority zone, or low-intensity "shared streets" through signage and street design on low traffic, high pedestrian volume blocks such as Chapman Ave near the Metro station to calm traffic and improve pedestrian safety and convenience (See Appendix A2.4 for shared streets design).
- Create additional pedestrian paths to the station west of the Metro. For example, Congressional Lane could connect to a pedestrian path east of Rockville Pike, and then along the Metro alignment to reach the station.
- Use bicycle pavement markings to indicate shared roadways in accordance with MUTCD.
- Reallocated underused on-street parking spaces to pedestrians and bicycles.
- Add wayfinding and safety signage to the immediate station area (See Appendix A3.1 for examples).
- Increase pedestrian scale lighting along the major pedestrian corridors to the station (Chapman Avenue, Halpine Road, Lewis and Parklawn Avenues).

Crossings

- Create pedestrian crossing zones at key station area entrances, particularly Chapman Avenue through signage, pavement markings, and raised crosswalks or intersections.
- Extend medians beyond the crosswalk, at intersections such as Halpine Road and Jefferson Street within the study area, to provide a refuge island for pedestrians from turning vehicles. This configuration currently exists on S. Stone street Avenue at Baltimore Road."
- Modify crossings to minimize grade-change for pedestrians by raising crosswalks and driveways to sidewalk level. Across wide streets, pedestrian refuge areas within medians should be at the same grade as the crosswalk.
- Enhance mid-block crossings with curb extensions.

Intersections

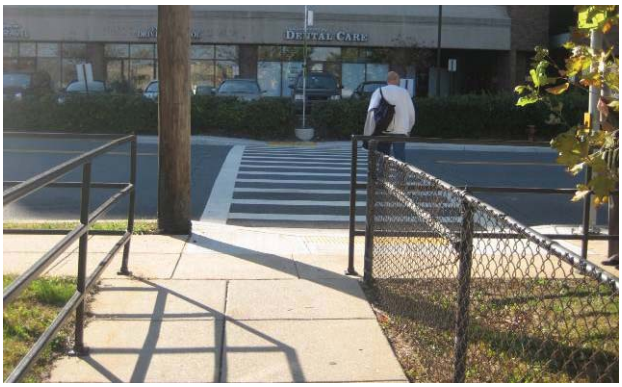
- Curb widening or "bulb-outs" at intersections can reduce crossing distances.

- Exclusive pedestrian phases or leading pedestrian intervals at major intersections could help reduce pedestrian-vehicular conflicts, especially at Halpine Road and Jefferson Street.
- Establish clear zones (no trees or other obstructions) and/or no parking zones at intersections to maximize sight distance for both pedestrians and vehicles. Length of clear zones depend on street type (See Appendix A1.2).

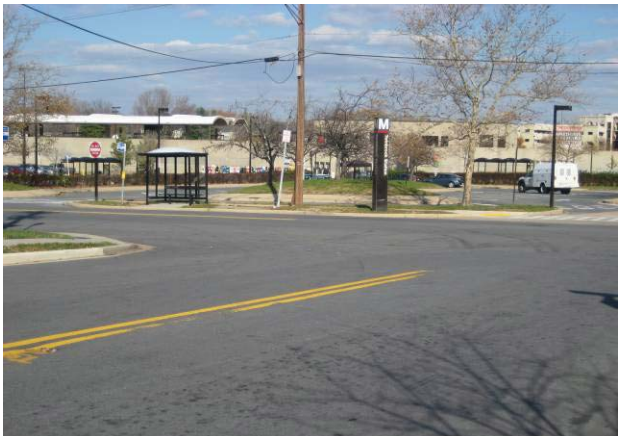
Missing crosswalks at Chapman Avenue and east side of Twinbrook Parkway

Narrow sidewalk along E. Jefferson St

Unprotected at-grade median



Internal sidewalk within the Metro station does not align with Chapman Avenue crosswalk



Missing crosswalks at Metro station entrance on Chapman Avenue

Signed ladder crossing leading to east Metro entrance

Figure 7: Existing Pedestrian Infrastructure

1.3.3 Vehicle Infrastructure and Barriers to Pedestrian Safety

Vehicular infrastructure will always be needed to support deliveries and automobile trips. The goal for safe access to transit is to create a pedestrian friendly environment that gracefully coexists with the automobile.

Strengths

- On-street parking on most streets provides a buffer between pedestrians and moving traffic.
- With the exception of Twinbrook Parkway, Rockville Pike, and Halpine Road, almost all streets in the study area have narrow vehicle roadway, with only one travel lane in each direction.

Weaknesses

- West of the Metro alignment, Rockville Pike is a major transportation barrier with a wide vehicle roadway (about 85-feet) that pedestrians must cross to access the station.
- Due to the prominence of automobile-oriented land uses throughout the site, almost every City block has at least two driveways, and many blocks have 3 to 6 (or more) driveways , disrupting pedestrian travel and increasing the opportunity for conflict. Particularly high driveway counts along pedestrian access routes include:
  - 7 driveways – Chapman Avenue (Bouic Avenue to Thompson Avenue)
  - 9 driveways – Congressional Place (Jefferson Street to Rockville Pike)
  - 18 driveways – Rollins Avenue (Jefferson Street to Rockville Pike)
  - 18 driveways – Lewis Avenue (Rockville Pike to Halpine Road)
- Halpine Road has four travel lanes and no parking or other traffic calming measures, leading to potentially dangerous high vehicle speeds
- Channelized right turns along key pedestrian routes such as Chapman Avenue at the intersection of Twinbrook Parkway cause high vehicle speeds and affect both pedestrian and vehicle visibility.

Vehicle Infrastructure Opportunities

- Consider public awareness or education campaigns that target both pedestrians, bicycles and motorists.
- Realign driveways at a flat grade where they intersect with the sidewalk to minimize grade-change for pedestrians.
- Use different paving treatment such as colored coating, thermoplastic stencils, textured paint or unique pavers (synthetic or asphalt) to alert both pedestrians and vehicles.
- Reduce the number of driveways by creating single entry-exit points, combining driveways and removing underutilized driveways.
- Modify signal timing at intersections such as Halpine Road and Jefferson Street, and consider pedestrian-only phases.

- Implement calming zones through street design, especially at gateways to the station and high pedestrian-volume areas (See Appendix A2.4).
- Increase warning signage to alert drivers near the station and along high pedestrian-volume corridors.
- Eliminate channelized right turns.

Frequent driveways for service vehicles and parking (Chapman Avenue)

Channelized right turns at major intersections (Twinbrook Parkway and Chapman Avenue)

Wide vehicle roadway compared to sidewalk (Hapline Road west of Metro)

Plentiful unused on-street parking adjacent to Station (Chapman Avenue)

Figure 8: Existing Vehicle Facilities

1.3.4 Land Use

While land use cannot be changed overnight, long term land use strategies that consider pedestrian access, amenities and safety can encourage more walking and greater transit ridership.

Strengths

- Several office buildings are located within the ½ mile catchment area.
- New transit-oriented residential development east of the Metro has improved the pedestrian realm and reduced walking distance to the station for those residents.

Weaknesses

- Chapman Avenue, which all pedestrians must walk along or cross to access the station, is primarily a service street for businesses fronting Rockville Pike. As such the ground floor use along the street is parking and service areas for delivery trucks.
- Nearly every block in the ½ mile area has some area dedicated to surface parking lots. Many also have vehicle services such as gas stations and auto repair shops that generally see high vehicle volumes and require several busy driveways that pedestrians must cross.
- Retail land uses along Rockville Pike are “big box” stores surrounded by large swaths of parking, virtually excluding pedestrians. These large store blocks significantly reduce the number of pedestrian paths on the West side of the Metro alignment between Jefferson Street and Chapman Avenue.
- Most of the County-owned streets are surrounded by warehouses or light industrial uses.
- The vast majority of land uses are set back from the sidewalk and do not front along major pedestrian corridors, reducing eyes on the street.

Land Use Opportunities

- Redevelop large surface parking lots.
- Encourage shared parking between complimentary uses to reduce parking and provide pedestrian and/or green space.
- Provide entrances to the retail uses whose service areas currently face Chapman Ave
- Consider higher residential development within the ½ mile catchment area west of the Metro.
- Consider redevelopment of auto-oriented uses, including gas stations, auto repair shops and others with pedestrian-friendly uses along the major pedestrian corridors to the station.
- Add public art or other pedestrian amenities along streets that do not currently have pedestrian-friendly land uses, to improve the pedestrian realm.

New residential TOD east of Metro alignment

Office building fronting Twinbrook Parkway

Low density retail and service entrances that back up to Chapman Avenue

Surface parking long at Twinbrook Station, east of rail alignment

Figure 9: Existing Land Uses

2 Pedestrian Safety Toolbox

In considering the current pedestrian safety issues and opportunities in the Twinbrook Station area, this toolbox describes possible safety enhancements that can be employed not only in the station area, but throughout the City of Rockville. Each element is described in terms of its impact on pedestrian safety, key features of proper implementation, estimated cost, and visual examples of how these elements have been successfully implemented in other cities.

For the Twinbrook Station area, these tools were considered in development of conceptual safety improvement plans along key transit access corridors used by pedestrians, and especially at intersections that are prone to pedestrian/vehicle conflict. The combination of several tools together along key corridors will provide significant improvement to pedestrian safety and encourage transit riders to walk to the station.

The safety improvements are categorized as follows:

1. Crossings
    a. Crosswalks and Medians
    b. Curbs
    c. Traffic Control
2. Pedestrian and Bicycle Amenities
    a. Pedestrian Paths
    b. Bicycle Infrastructure
    c. Amenities and Aesthetics
    d. Pedestrian Priority
3. Public Awareness
    a. Wayfinding and Signage
    b. Public Awareness Campaigns

The complete toolbox can be found in Appendix A of this document. It draws from several sources of pedestrian safety information, which are referenced at the end of the appendix.

3 Concept Plan

The pedestrian safety opportunities and toolbox led to the development of a concept plan for each of the key pedestrian corridors to Twinbrook Station. Figure 10 shows 6 routes, with 1 being the highest priority for implementation of safety improvements. These routes were prioritized based on pedestrian demand for that route (see analysis in Section 1.1) within the actual ½ mile walking distance from the station entrance. Halpine Road has been given highest priority as it is the only road that directly connects all of the higher-density residential development west of Jefferson Street to the station entrance. It is also the corridor with the highest number of pedestrian accident locations.

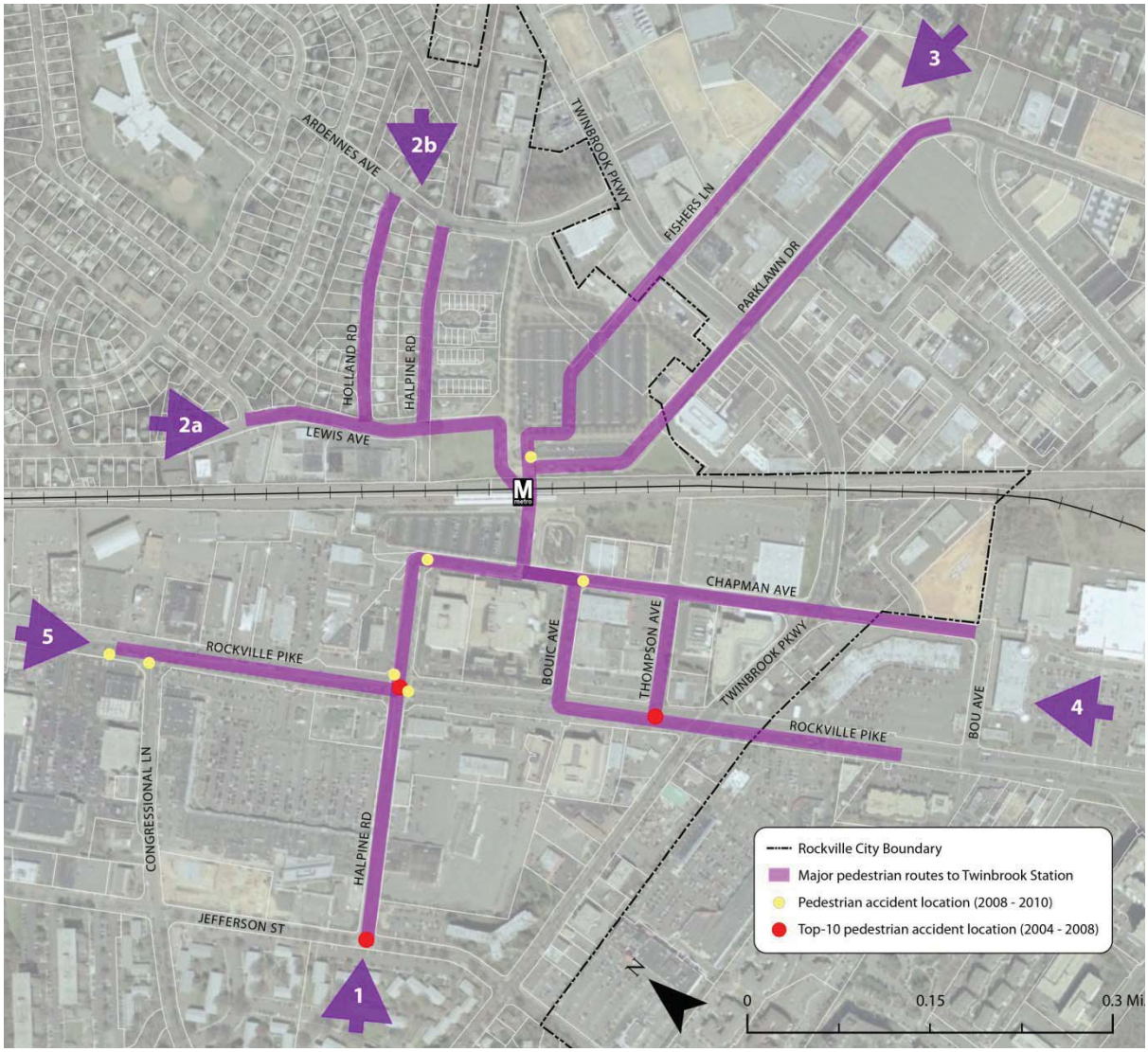


Figure 10: Prioritized pedestrian corridors to Twinbrook Station

It is important to note that the conceptual plans for each of the corridors described in the following sections represent improvements focused specifically on pedestrian safety. When considering implementation of these recommendations, further study should be considered to analyze costs and impacts to vehicle movement and level of service (LOS).

3.1 Corridor 1: Halpine Road (West of Station)

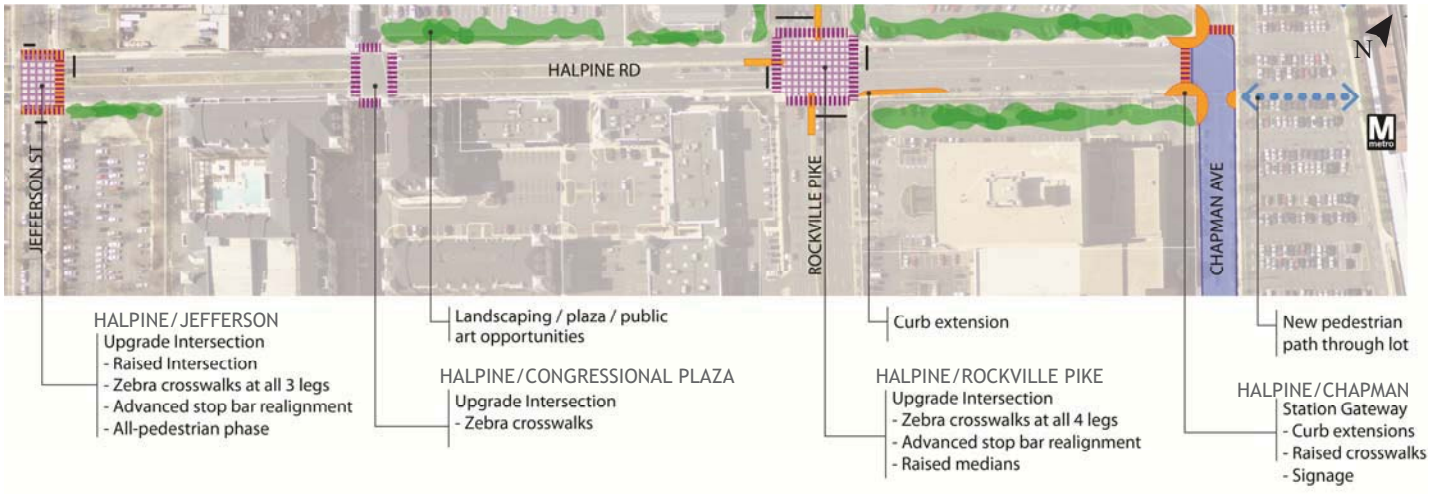


Figure 11: Corridor 1 Conceptual Plan

Halpine Road, shown in Figure 11, is the major pedestrian route to the station for all of the higher density residential development west of Jefferson Street, and high pedestrian/vehicle conflicts occur at the intersections of Halpine Road with both Jefferson Street and Rockville Pike. Along the entire corridor, awareness of pedestrian movement could be heightened, especially at intersections. Starting from the West, Halpine Road begins at Jefferson Street, creating a three-way intersection in which pedestrians crossing Jefferson Street do not have a dedicated crossing phase. Modifying the signal timing to allow for an exclusive pedestrian phase during the peak pedestrian movement is recommended, if practicable following further level of service analysis. Additionally, at night when visibility is difficult, a pedestrian-actuated Leading Pedestrian Interval (LPI) will give pedestrians a chance to enter the intersection crossing Jefferson Street before vehicles. This could be further enhanced by a No Turn on Red sign to ensure a dedicated pedestrian phase.

To increase visibility of pedestrian crossings, at each intersection along the route to the station, crosswalks should be upgraded to striped or zebra crossings. At Halpine Road and Jefferson Street it is recommended that the intersection be raised to the level of the sidewalk to further ease pedestrian movement for all abilities, to increase awareness of pedestrian crossings and reduce vehicle speeds.[2] At Halpine Road and Rockville Pike, another high accident intersection, striping or patterned pavement across the intersection will supplement the upgraded crossings to raise awareness that it is a major crossing without impacting to vehicular flow along Rockville Pike. Finally, at both the Jefferson Street and Rockville Pike intersections with Halpine Road, consideration should be made to repainting the advanced stop bars to be 10-feet from the crosswalk, further improving visibility and reaction time for both pedestrians and drivers. While the MUTCD recommends about 4-ft, placement of stop bars 10-ft from the crosswalk are commonly observed at major intersections.

[2] If a raised intersection is not feasible, striping or patterned pavement across the intersection is recommended.

At Rockville Pike and Halpine Road, pedestrians need a safe refuge from vehicle traffic when entering into the intersection. For each of the crossings where a median is present, it is recommended that the raised median be extended through the crosswalk, such that pedestrians are protected from turning vehicles passing through the intersection. This may involve realigning the crosswalks so that the medians do not extend into the intersection in a way that interferes with larger turning vehicles. Extending the curb into what becomes a parking lane along the southern edge of Halpine Road, east of Rockville Pike would reduce turning vehicle speeds and increase pedestrian space. It is likely that all of the on-street parking spaces could be preserved depending on the length of the curb extension.

Crossing Chapman Avenue is the final leg of the pedestrian trip to the station. As will be seen in subsequent corridors, Chapman Avenue between Halpine Road and Thompson Avenue serves as the western gateway to the station and is the highest area of pedestrian demand. To prioritize pedestrian movement above vehicles in this area, a shared street concept is proposed. At the entrances to the shared street area, such as the intersection of Chapman Avenue and Halpine Road, a raised crosswalk, curb bulb-outs/road narrowing, and shared street signage alert drivers that they are entering a pedestrian priority zone. Within the shared street zone along Chapman Avenue, treating the street surface using low-cost options such as colored coating, thermoplastic stencils, or textured paint, makes it clear that while vehicles are allowed, they must yield to pedestrians throughout the area. As an alternative to the shared street, raising and narrowing the intersections of Chapman Avenue at Halpine Road, Bouic Avenue and Thompson Avenue will have a traffic calming effect that gives priority to pedestrians.

Currently there is only one dedicated pedestrian path from Chapman Avenue to the station entrance, found between Halpine Road and Bouic Avenue. However, there is an opening in the fencing surrounding the Metro parking lot near the southeast corner of Halpine Road that allows pedestrians traveling along this corridor to cut through the parking lot to access the station. Creating a formal pedestrian path through the parking lot could encourage pedestrians to travel safely through the lot rather than diagonally cutting across rows of parking to reach the station entrance (Figure 13). This can be done without changing the number of parking spaces by using the landscaped strip that currently exists between one of the rows of spaces shown in Figure 12. In this case the opening in fencing should be realigned to lead directly to the new pedestrian path. If Champan Avenue becomes a shared street, the treated surface will replace the need for crosswalks within the zone, as the entire area will be prioritized for pedestrian crossings.

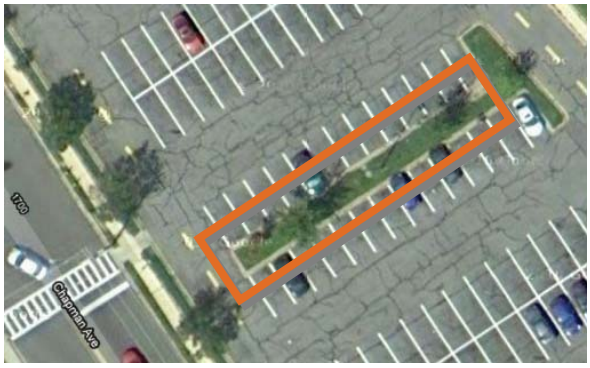


Figure 12: Existing Metro parking lot

Figure 13: Pedestrian path through parking lot (Washington DC)

Much of the built environment adjacent to the sidewalks along Halpine Road is allocated to seemingly underused surface parking. Reallocating some of this space to landscaping, public art features, small public plazas with seating or other pedestrian amenities can enhance activate the street and can create the perception of reduced roadway space, resulting in traffic calming and a more hospitable environment for pedestrians.

Corridor 1: Recommended Pedestrian Safety Toolbox Elements

Feature	Implementation Locations	Section of Toolbox (Appendix A)
Raised Crosswalks/Intersection	Jefferson/Halpine, Chapman/Halpine	A1.1
Raised Medians	Rockville Pike/Halpine	
Crosswalks	Jefferson/Halpine, Congressional Plaza/Halpine, Rockville Pike/Halpine	
Advanced Stop Line	Jefferson/Halpine, Rockville Pike/Halpine	
Curb Extensions	Rockville Pike/Halpine, Chapman/Halpine	A1.2
Pedestrian Signal Timing	Jefferson/Halpine	A1.3
Landscaping and/or Public Art	Along Halpine	A1.4
Shared Streets	Chapman between Halpine and Thompson	A2.4

3.2 Corridor 2a: Lewis Ave (East of Station)

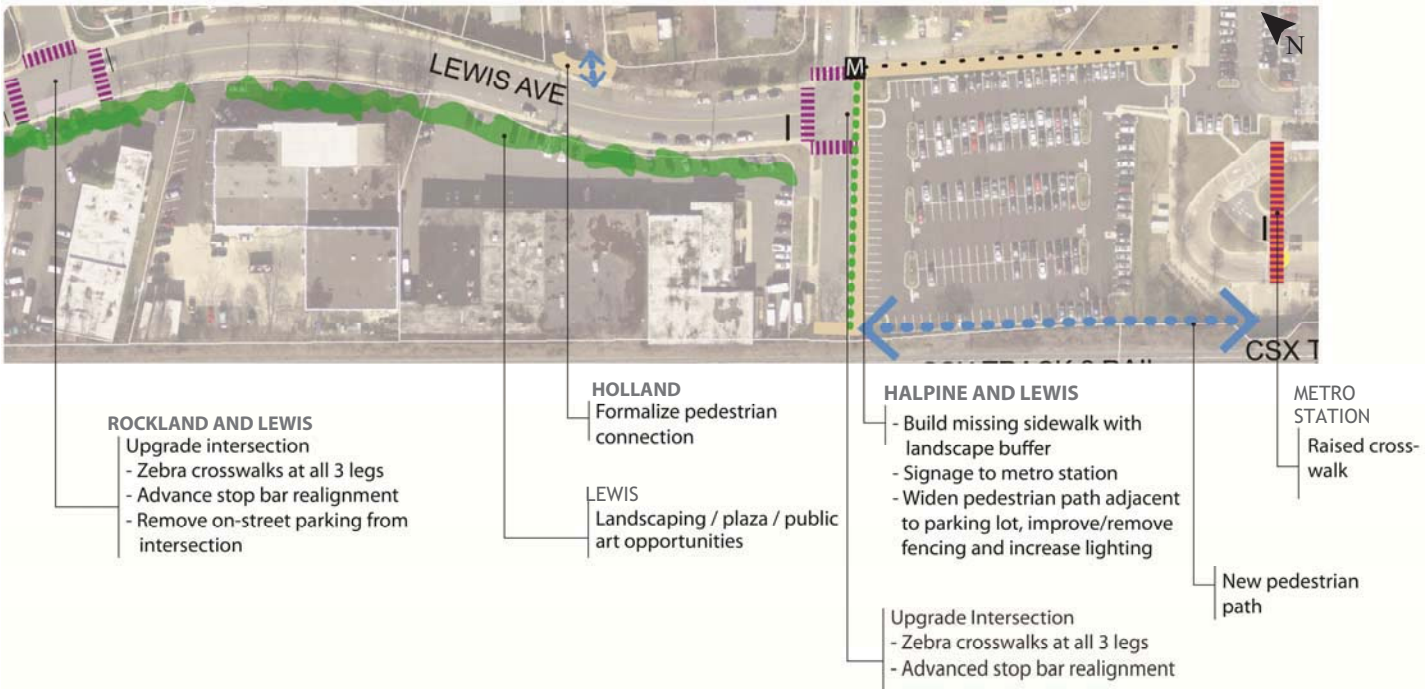


Figure 14: Corridor 2a Conceptual Plan

Corridor 2a and 2b are the two major pedestrian routes from the lower density, traditional single family residential neighborhood northeast of the station. As shown in Figure 14 above, Lewis Avenue runs parallel to the Metro rail alignment, ending at the Metro parking lot. There is an informal (unpaved) but well-used path from Holland Road to Lewis Avenue that could be improved by extending the Holland Road sidewalks to connect with the Lewis Avenue sidewalk. At the two unsignalized intersections closest to the station, Rockland Avenue and Halpine Road, striped or zebra crossings and advanced stop bars of at least 5 feet are recommended, as the majority of pedestrians will be crossing these intersections to reach the station. Currently all pedestrians from Lewis Avenue must use the dedicated pedestrian path northeast of the parking lot. This is a narrow path lined by the parking lot fence and lacks both eyes on the street and wayfinding signage, as the station entrance is not clearly visible from the path. Widening this path, improving pedestrian-scale lighting, and providing wayfinding at both ends of the path will improve the pedestrian experience and feeling of safety. There is also the potential to add a new path southwest of the parking lot, which would allow pedestrians traveling on Lewis Avenue a more direct route that avoids vehicles entering and exiting the parking lot.

Pedestrians traveling to the station from the east, including from the new TOD, must cross the kiss n’ride and bus drop-off areas to reach the station entrance. This involves crossing the bus and car entrance, followed by the car only driveway, and then the bus-only driveway. To improve pedestrian safety across this extended crossing, a raised crosswalk is proposed to reduce vehicle speeds and raise pedestrian visibility. A stop bar should also be added to the car-only driveway, similar to what exists for the bus-only area. An alternative or addition to the raised crosswalk could be in-street pedestrian crossing signs to further alert

vehicles. Note that the raised crosswalk is not as steep as a speed bump, and should be designed with the use of low-floor buses in mind.

Finally, landscaping or public art is recommended along the west side of Lewis Avenue where there are currently industrial, auto-oriented land uses. Future redevelopment in this area should be considered, given its proximity to transit and location along a major pedestrian path.

Corridor 2a: Recommended Pedestrian Safety Toolbox Elements

Feature	Implementation Locations	Section of Toolbox
Raised Crosswalks/Intersection	Metro Kiss N' Ride / Bus Drop-off area	A1.1
Crosswalks	Rockland/Lewis, Halpine/Lewis	
Advanced Stop Line	Rockland/Lewis, Halpine/Lewis	
Sidewalks and walkways	Holland, Halpine, east and west sides of Metro parking lot	A2.1
Lighting	Pedestrian path north of parking lot	A2.3
Landscaping and/or Public Art	Along Lewis	
Wayfinding and signage	Edge of Metro area, Kiss n'Ride area	A3.1

3.3 Corridor 2b: Halpine Road and Holland Road (East of Station)

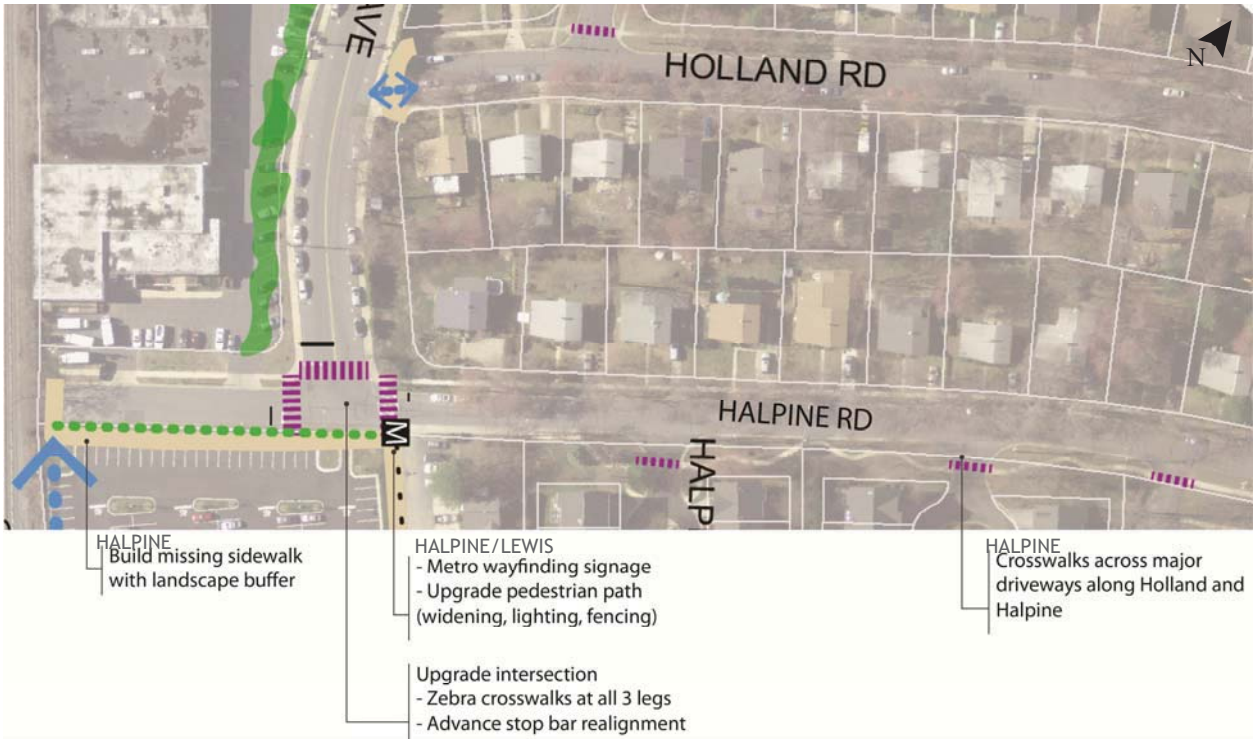


Figure 15: Corridor 2b Conceptual Plan

Holland Road and Halpine Road shown in Figure 15 above, in addition to Lewis Avenue described in Corridor 2a, make up the major routes to the station for pedestrians in the single-family neighborhood east of Twinbrook Station. These are low vehicle-volume streets and are fairly safe for pedestrian movement. Safety improvements along these routes include adding crosswalks across streets and driveways leading to multi-family developments such as Halpine Court, where a higher number of vehicles entering and exiting onto Halpine Road and Holland Road would be expected than from a the driveway of a single family residence.

Corridor 2b: Recommended Pedestrian Safety Toolbox Elements

Feature	Implementation Locations	Section of Toolbox
Crosswalks	Along Holland and Halpine	A1.1

3.4 Corridor 3: Parklawn Drive and Fishers Lane (East of Station)

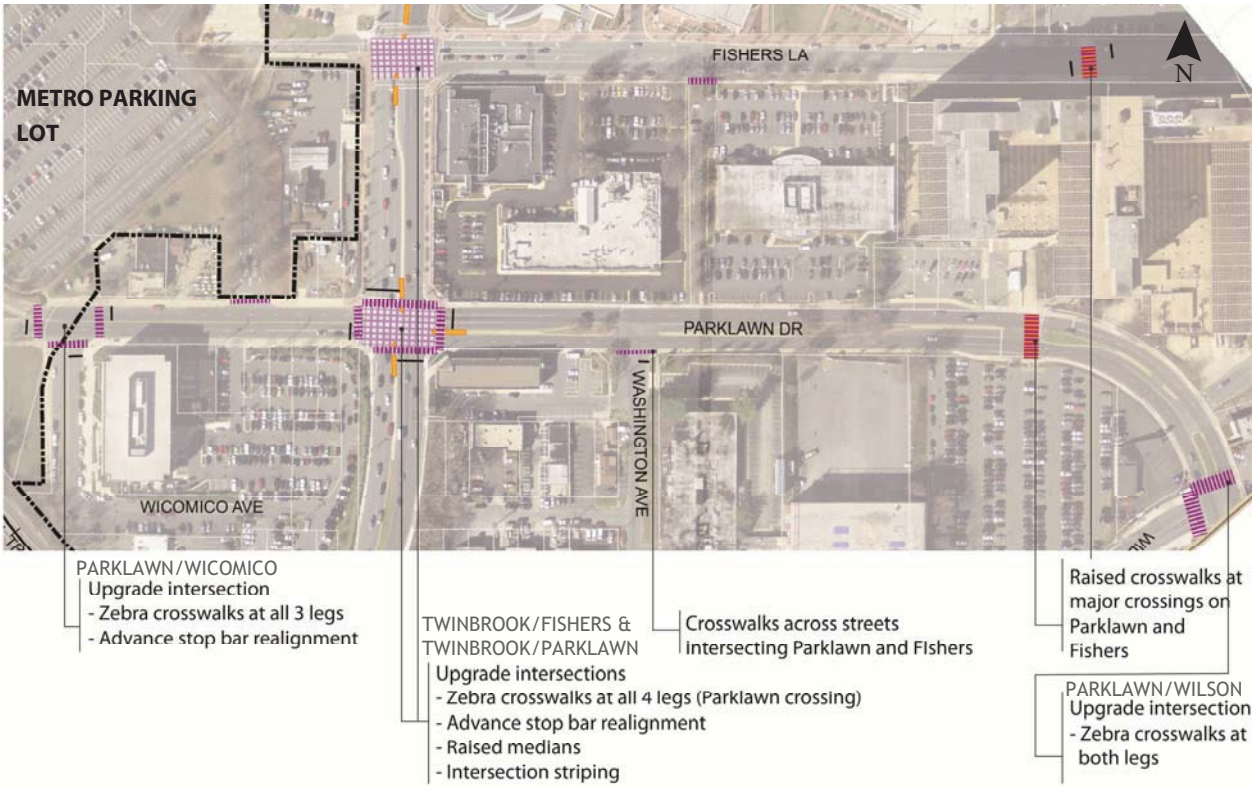


Figure 16: Corridor 3 Conceptual Plan

Fishers Lane and Parklawn Drive, shown above in Figure 16, connect the station to several transit trip generators including the new TOD development north of Fishers Lane, and office employment centers along both corridors. There is also some higher density residential development further east, connected to Twinbrook Station by these two roads. The Parklawn Drive and Wilkins Avenue intersection is missing a crosswalk along the northern edge, and all should be upgraded to striped or zebra crossings to improve visibility. Moving west towards the station, both Parklawn Drvie and Fishers Lane have mid-block crossings connecting large surface parking lots to office buildings. It is recommended to improve the crossings by adding raised crosswalks with advanced stop lines of at least 10 feet due to traffic volumes along the roadways. Crosswalks should also be added along both roads where they intersect with major driveways and smaller roadways such as Washington Avenue to create continuous, safe pedestrian paths to the station. The intersection of Parklawn Drive and Wicomico Avenue is also the entrance to the Metro station area, where buses and vehicles park and drop off or pick up passengers. Striped or zebra crossings and advanced stop bars are important here due to the high volume of both vehicles and pedestrians during peak hours.

Twinbrook Parkway is a major transportation barrier that pedestrians along this corridor must cross to reach the station. At the intersections of both Fishers Lane and Parklawn Drive, extending the existing raised medians to protect the crosswalks, and striping the intersections and crosswalks will improve pedestrian safety as described in Corridor 1. Note that at Twinbrook Parkway and Fishers

Lane, new crosswalks have already been installed with unique pavers, and thus do not need to be striped as they sufficiently draw attention to the pedestrian crossings.

Corridor 3: Recommended Pedestrian Safety Toolbox Elements

Feature	Implementation Locations	Section of Toolbox
Raised Crosswalks/Intersection	Parklawn, Fishers	A1.1
Raised Medians	Twinbrook/Fishers, Twinbrook/Parklawn	
Crosswalks	Fishers east of Twinbrook, Washington/Parklawn, Twinbrook/Parklawn, Wicomico/Parklawn, Wilson/Parklawn	
Advanced Stop Line	Twinbrook/Parklawn, Wicomico/Parklawn, Fishers	

3.5 Corridor 4: Rockville Pike and Chapman Avenue from South (West of Station)

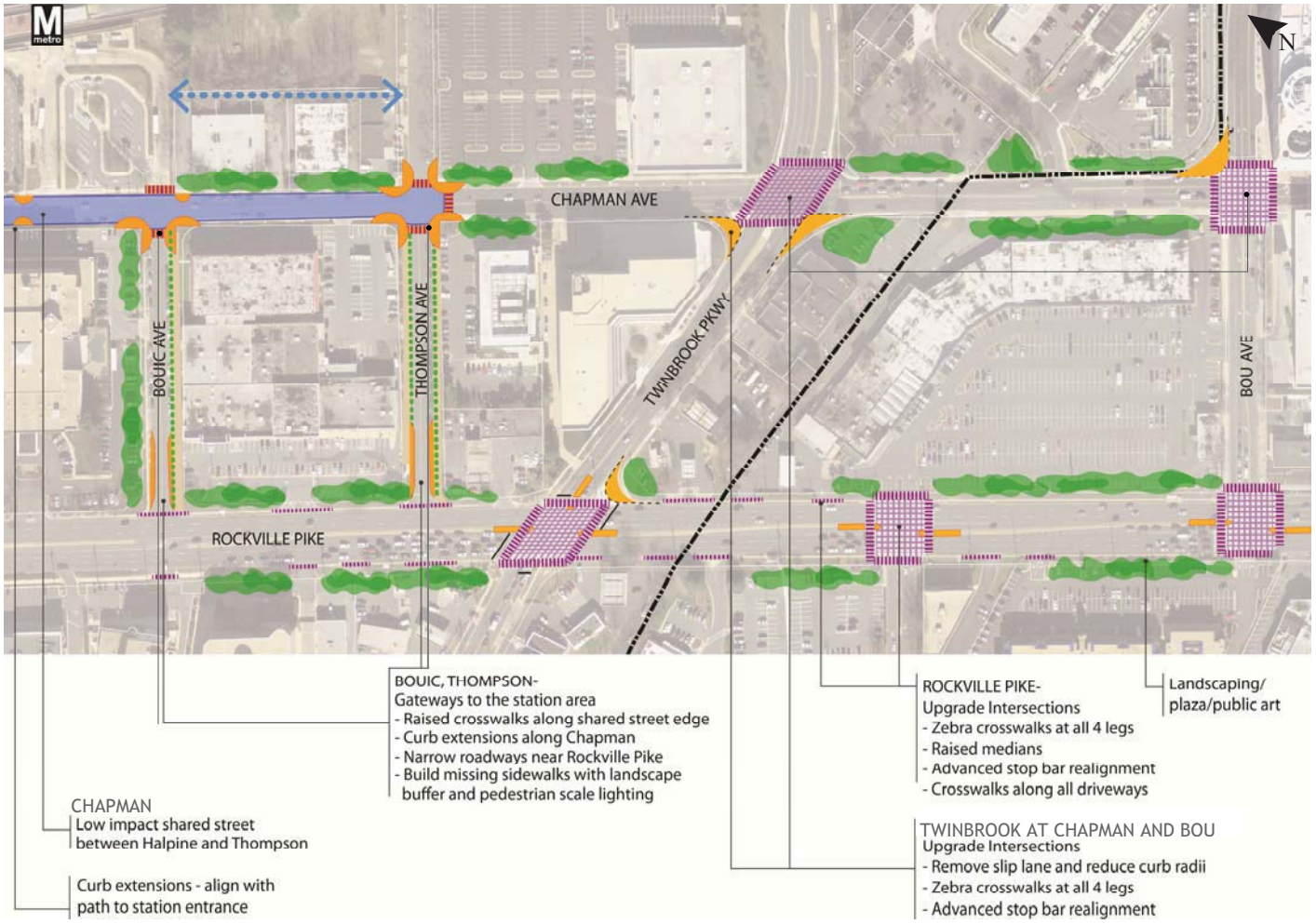


Figure 17: Corridor 4 Conceptual Plan

Chapman Avenue and Rockville Pike connect Twinbrook Station to areas southwest of the station, including a high-rise residential development at Bou Avenue and Champan Avenue, big box retail, and townhouses west of Rockville Pike. Along both of the corridors, landscaping or public art could help reduce the auto-oriented nature of the corridor. In the long-term many of the blocks would benefit from higher density, transit-friendly redevelopment supporting a mix of uses and reduced surface parking. As shown with the blue-dashed line in Figure 17 above, long-term redevelopment of the parcels surrounding the station could be designed with improved pedestrian permeability and station access in mind.

Several short-term safety measures could improve pedestrian connections to the station across Twinbrook Parkway and Rockville Pike, two major, high-volume roadways that are both physical and mental barriers to pedestrian station access. Along Rockville Pike, all of the signalized intersections could improve safety and visibility with striped or zebra crosswalks at all four legs of each intersection, treating the intersection with a special pavement pattern, extending the raised medians beyond the crosswalks to create pedestrian refuges, and ensuring all

advanced stop bars are at least 10-feet from the crosswalk. Across the many driveways along Rockville Pike that currently break up the pedestrian path, striped or treated crosswalks could be installed, and driveways could be realigned to a flat grade where they intersect with the sidewalk to minimize grade-change for pedestrians of all ages and abilities. Removing the slip lane at Rockville Pike and Twinbrook Parkway will extend the curb and reduce the crossing distance for pedestrians walking to the station along the east side of Rockville Pike.

Bouic and Thompson Avenues connect Rockville Pike to the station area. Curb extensions where both intersect with Rockville Pike, and sidewalks with landscaping along these blocks will increase dedicated pedestrian space and reduce vehicle speeds when transitioning to these narrower local roads. Raised crosswalks at the intersections with Chapman Avenue will alert vehicles that they are entering a pedestrian priority zone, as described in Corridor 1.

Along Chapman Avenue the major barrier between the residential tower at Bou Avenue and the station is Twinbrook Parkway. Crosswalks are missing from the east side of the Chapman Avenue/Twinbrook intersection, and two slip lanes on the west side of the street create a crossing distance of over 100-feet and dangerous conditions as vehicles take free right turns from Chapman Avenue to Twinbrook Parkway at higher speeds and with poor pedestrian and driver visibility due to the crosswalk alignment. Zebra crossings and intersection pavement treatment could be applied to this intersection, along with removal of at least one slip lane depending on further study on vehicular LOS impacts. There is a also a slip lane allowing free right turns for westbound vehicles on Bou Avenue. This segment of Bou Avenue seems to have low-traffic volumes, thus this also is a candidate for slip lane removal and intersection improvements.

Wayfinding and, in the longer term, realignment of the station entrance, will improve access from the west of the rail alignment, where there is currently poor visibility of the station entrance. Covered bicycle parking that is clearly visible from the station entrance will protect bicycles from the elements.

Corridor 4: Recommended Pedestrian Safety Toolbox Elements

Feature	Implementation Locations	Section of Toolbox
Raised Crosswalks/Intersection	Thompson/Chapman, Bouic/Chapman	A1.1
Raised Medians	All Rockville Pike intersections	
Crosswalks	Rockville Pike driveways and intersections, Twinbrook/Chapman, Bou/Chapman	
Advanced Stop Line	Twinbrook/Rockville Pike	
Curb Extensions	Bouic, Thompson	A1.2
Slip Lane Removal & Turn Radii Reduction	Rockville Pike/Twinbrook, Twinbrook/Chapman, Bou/Chapman	
Sidewalks	Bouic, Thompson	A2.1
Bicycle Parking	Station entrance	A2.2
Landscaping/Public Art	Along Rockville Pike, Chapman, Bouic	A2.3
Station Entrance	Metro station	A3.1

3.6 Corridor 5: Rockville Pike from North (West of Station)

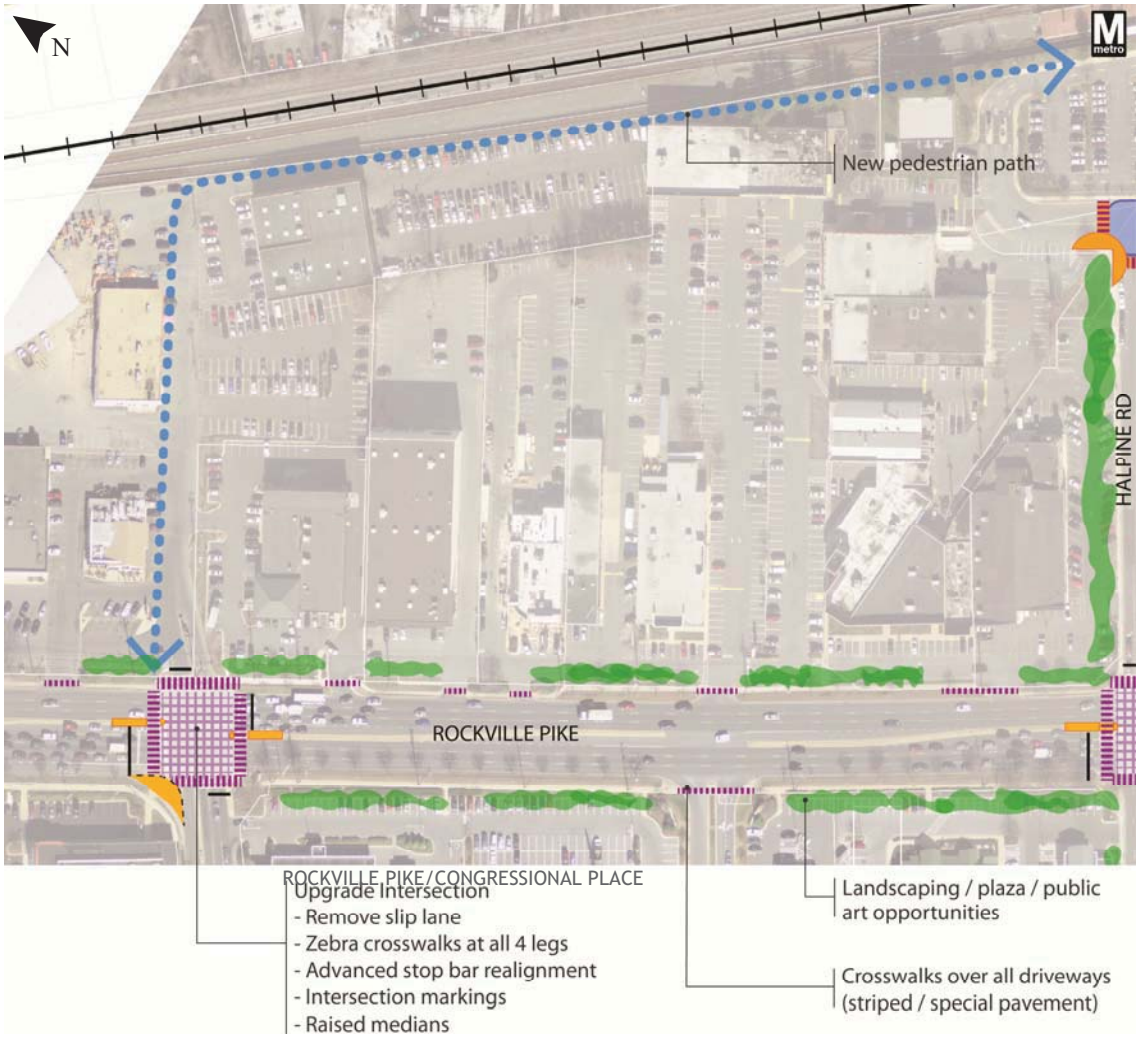


Figure 18: Corridor 5 Conceptual Plan

Rockville Pike north of Halpine Road is the final major pedestrian corridor connecting some residential and office development, much of which is beyond the ½ mile walk radius to the station, thus drawing fewer pedestrians than some of the other corridors. However, there have been pedestrian/vehicle accidents along this route, and the long blocks and auto-oriented nature of this corridor could be improved to increase pedestrian safety. At Rockville Pike and Congressional Place, shown in Figure 18 above, the channelized right turn could be removed and the intersection realigned to extend the curb and shorten crossing distances, especially since Congressional Place is a lower-volume street leading to a residential neighborhood. Zebra crossings, advanced stop bars 10-feet from the crosswalk, pavement design at the intersection and raised medians extended to create a pedestrian refuge will improve safety and encourage pedestrians to cross at the intersection rather than attempting to cross a busy street mid-block.

Adding crosswalks and flattening the many driveways along Rockville Pike, as well as landscaping, plazas and public art along the corridor could improve the

pedestrian environment similarly to the segment of Rockville Pike south of Halpine Road described in Corridor 4.

Finally, when redevelopment opportunities arise in the long-term, adding a new pedestrian path similarly to what is shown above will provide a new route from the townhouses accessible from Congressional Place.

Corridor 5: Recommended Pedestrian Safety Toolbox Elements

Feature	Implementation Locations	Section of Toolbox
Raised Medians	Rockville Pike/Congressional	A1.1
Crosswalks	Rockville Pike driveways, Rockville Pike/Congressional	
Advanced Stop Line	Rockville Pike/Congressional	
Slip Lane Removal & Turn Radii Reduction	Rockville Pike/Congressional	A1.2
Landscaping and/or Public Art	Along Rockville Pike	A2.3

3.7 Twinbrook Station Pedestrian Safety Plan

Figure 19 summarizes all of the proposed safety improvements for the Twinbrook Station area that could be carried out corridor-by-corridor over the next several years. In addition, given the City's continued interest in TOD near the station, blocks with a high potential for redevelopment are highlighted. These large blocks consist primarily of single-story, large scale retail stores, auto repair services, and vast amounts of surface parking that limit pedestrian permeability and encourage driving. However they are all located within the ½-mile walking distance from the station and could have a significant positive impact on transit ridership and an improved pedestrian environment if redeveloped into residential or office mixed-use villages with ground floor uses that activate the streets. Structured parking garages with ground floor retail could replace large surface lots.

The Division of Long Range Planning and Redevelopment oversees both Citywide and neighborhood plans for Rockville. While the station area is adjacent to several neighborhood civic associations, no single civic entity covers the entire 10-minute walking area around the station. Development of a Twinbrook Station area plan could help the City create a vision and planning framework for how the station area could grow. Along with the current master-planning efforts for the Rockville Pike corridor, the Twinbrook Station area has the potential to be transformed into a pedestrian-friendly, liveable community.

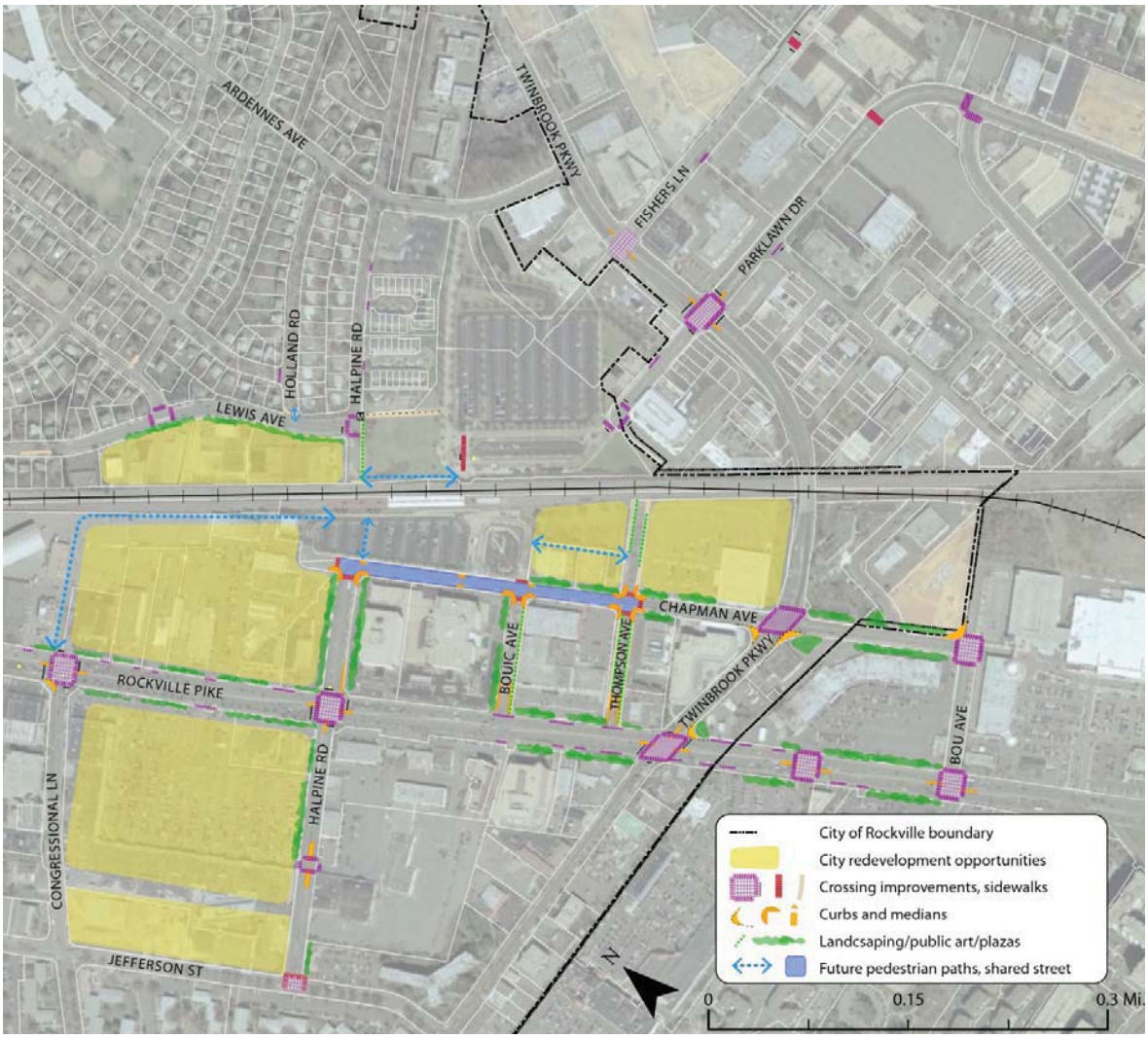


Figure 19: Twinbrook Station Conceptual Plan for Safer Walkways to Transit

Appendix A

Pedestrian Safety Toolbox

A1 Crossings

Crossings, both at intersections and mid-block, are key points of safety concerns along a pedestrian path. Pedestrian-vehicle conflicts at these points can be minimized by clearly designating time and space to pedestrian crossings, reducing pedestrian exposure to traffic, slowing vehicle speeds near pedestrian crossing areas, and improving visibility for both pedestrians and vehicles.

A1.1 Crosswalks and Medians

Feature	Application	Examples
Crosswalk Markings	Clearly marked crosswalks alert drivers to expect pedestrians crossing the street, and direct pedestrians to safe crossing locations. **Crosswalk Features** • Width of at least 8 feet • Should be present at all legs of an intersection • Use striped/zebra crosswalks at a minimum or a special pavement type or pattern to maximize visibility and international recognition • Curb ramps should be completely contained within the crosswalk width • Widen crosswalks at high pedestrian volume crossings and mid-block crossings • Use mid-block crossings along long blocks with high pedestrian crossing demand, every 350 – 500 feet to mimic traditional street grids **Estimated Cost:** For a two-lane crossing, a painted striped crosswalk is about $300, and a patterned concrete crosswalk is about $20,000.	 

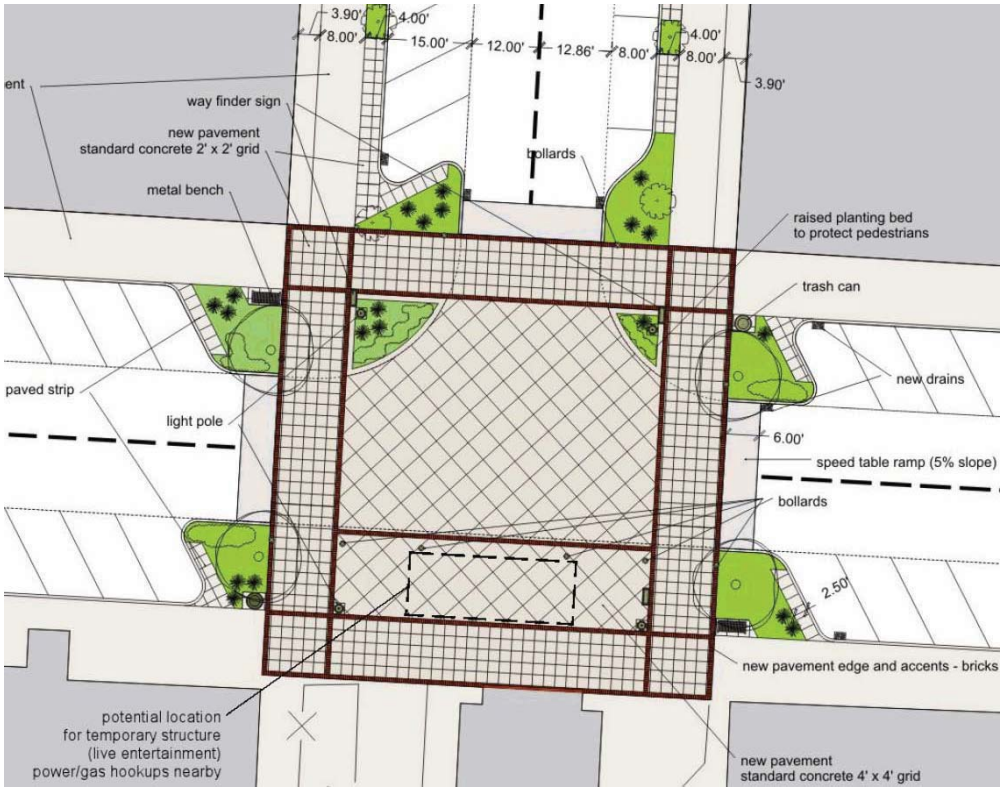
Raised Crosswalks

Raised crosswalks bring the level of the roadway to the sidewalk, improving visibility and forcing vehicles to slow before passing the crossing and providing a level pedestrian path from the curb. They should be considered where: low-volume streets intersect with high-volume streets; a street changes its function (i.e. from commercial throughway to residential); and at key civic locations such as transit stations. They can be used at intersections, where the entire intersection is raised or at mid-block crossings.

Raised Crosswalk Features

- Height is flush with sidewalk height
- Wide enough to allow front and rear wheels of a passenger car to be on top at the same time (about ten feet)
- Ideally used in combination with special paving treatment
- Signage to warn drivers of grade change

Estimated Cost:$15,000 to design and build one crosswalk leg



Source: http://www.historicdowntownsnohomish.com/HDS_StreetscapePlan.htm

Raised Medians

Raised medians provide a protected area in the middle of a crosswalk for pedestrians to stop safely while crossing. The island provides refuge for pedestrians in both traffic directions and can be designed to function as a public space, serving a ceremonial purpose on major roadways. They are useful on streets with four or more travel lanes, an existing median, multiple turn lanes, or areas with populations that may not be able to cross the street in the amount of time provided.

Raised Median Island Features

- Should be at least six feet wide to accommodate wheelchairs
- Pedestrian phase allows pedestrians to cross entire street within a single cycle
- Detectable warning surfaces signals pedestrian entrance into a safe zone
- Bollards, landscaped features or signs increase visibility of median while not obstructing drivers' view of pedestrians (2 to 4 feet high)

Estimated Cost: $4,000 - $30,000 per crossing depending on size and features

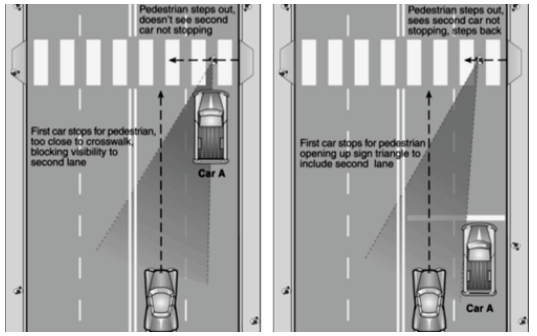
Advanced Stop or Yield Lines

By placing the vehicle stop line farther from the crosswalk, pedestrians and drivers have a clearer view of each other and have greater time to react. At mid-block crossings, when a driver stops close to the crosswalk to let a pedestrian cross, the pedestrian often cannot see when a vehicle in the 2nd lane is not stopping.

Key Features of Advanced Stop Lines

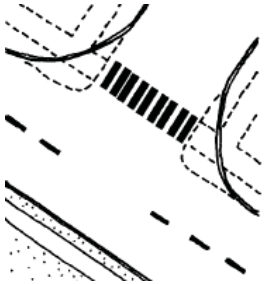
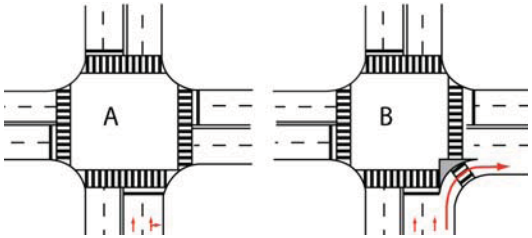
- At signalized intersections, locate the stop line a minimum of four feet in front of the crosswalk
- At unsignalized crossings locate the stop line 20 - 50 feet in front of the crosswalk

Estimated Cost: Minimal additional cost to a repainting/repaving project



Source: http://www.walkinginfo.org/

A1.2 Curbs

Feature	Application	Examples
Curb Extensions or "bulb-outs"	Bulb-outs extend the sidewalk space and reduce crossing distances for pedestrians, improving visibility and reducing turning vehicle speed. They can be installed at both intersections and mid-block crossings and can improve the pedestrian realm with amenities including benches and landscaping. **Bulb-out Features** • Ideal for streets with on-street parking- • At an intersection, curb ramps should be included for each crosswalk • Bulb should extend to full width of parking and should not extend into travel or bicycle lanes • Continue bulb-out along street as far as possible before returning to the curb, at least 5-feet beyond property line **Estimated Cost:** $5,000 - $25,000 per curb ($1,300 - 2,000 for temporary striping)	 
Reduce Curb Radii	Reconstructing the curb to a tighter turn will reduce vehicle turning speeds, shorten the pedestrian crossing distance and improve sight distance. **Reduced Curb Radii Features** • Design of radius depends on the angle between intersection streets and size of typical vehicles using the street (trucks, buses, cars, etc) • Streets with on-street parking or bicycle lanes can have smaller radii as vehicles have more space to turn **Estimated Cost:** $5,000 - $25,000 per curb ($2,500 - $4,000 for a painted curb)	 *Source: http://safety.fhwa.dot.gov/saferjourney/library/countermeasures/09.htm*
Remove Right Turn Slip Lanes	Channelized turns or slip lanes should be removed to create additional pedestrian space where possible. Slip lanes allow for higher vehicle speeds and increased pedestrian crossing length. Replacing a slip lane with a right turn lane creates a traditional right-angle intersection that improves safety, visibility and reduces pedestrian crossing length. **Removing Right-Turn Slip Lanes** • Remove corner median and add right turn lane to intersection • Consider No Turn on Red signs during peak periods of vehicle/pedestrian movement • If a channelized turn cannot be removed, consider a raised crosswalk and signage to slow vehicles and improve driver awareness of pedestrians **Estimated Cost:** $50,000 - $200,000 to reconfigure roadway and striping	 Slip Lane Removed Slip Lane Shown *Source: Arup*

Visual Clear Zones	Visual clear zones help drivers and pedestrians see each other upon approaching the intersection. A clear zone should be free of large trees, on-street parking and other visual obstructions. **Visual Clear Zone Features** • 60 foot clear zone for arterial streets (Rockville Pike, Twinbrook Pkwy) • 30 - 40 foot clear zones for collector streets (Chapman Ave, Halpine Road) • 20 foot clear zone along local streets non-residential driveways (Congressional Pl) • 10 foot vertical visual clearance in clear zones (i.e. under tree canopy, etc) **Estimated Cost:** Minimal for striping or signage ($300 / sign)	

A1.3 Traffic Control Devices

Feature	Application	Examples
Pedestrian Signal Timing	Signal timing adjustments can improve pedestrian safety and provide better separation between pedestrian and vehicle. **Pedestrian Signal Timing Improvements** • For concurrent phase signals (pedestrians and vehicles), fixed-time signals with shorter cycle length provides more crossing opportunities and shorter wait time, and pedestrian and vehicle movements should not conflict or overlap • A “pedestrian scramble” is an all-red, pedestrian-only phase that completely separates vehicles and pedestrians, but lengthens cycle time and wait time • A Leading Pedestrian Interval (LPI) is a brief all-red phase giving pedestrians an advance walk signal before drivers get a green light **Estimated Cost:** Very low cost to adjust signal timing	 
No Turn on Red	No turn on red signs reduce conflict between cars and pedestrians by prohibiting cars to turn right, into the path of crossing pedestrians. Prohibiting right-turns at intersections during the red phase complies with MUTCD standards. **No Turn on Red Features** • Can be restricted to certain times of day (peak hours) or at all times • An electronic sign or red arrow significantly decreases conflict. As an alternative, a No Turn on Red sign can be used • Ideal for use in conjunction with removals of right turn slip lanes **Estimated Cost:** $300 - $500 per sign, $1,000 - $3,000 for electronic signs	

A2 Pedestrian and Bicycle Amenities

Pedestrian and bicycle paths, lighting street furnishings, public art, and other amenities help calm traffic and create a comfortable, safe and attractive public realm.

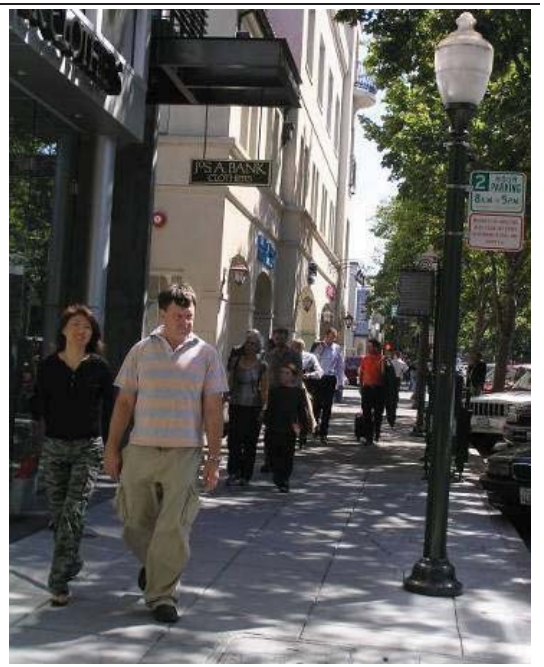
A2.1 Pedestrian Paths

Feature	Application	Examples
Sidewalks and Walkways	Sidewalks create the appropriate facility for walking within the public right-of-way, separated from vehicle traffic. They are associated with significant reductions in pedestrian collisions with motor vehicles and should create a continuous walking network serving all major destinations, especially transit. Dedicated off-street paths enhance the pedestrian network and can provide more direct and safe connections. **Sidewalk Features** • Minimum five feet wide clear pathway, which should be wider where demand is high • 4 to 6 foot wide buffer between walkway and street (i.e. landscape or street furniture zone) • Parked cars or bicycle lanes can provide an acceptable buffer • A flat sidewalk should be provided in area where driveways slope to the road • Walking are should be free from obstructions (street furniture, trees, electrical poles) • Sidewalks should occur on both sides of all streets • Sidewalks and walkways should be well-lit for safety and comfort **Estimated Cost:** $15/linear foot for curb, $11/square foot for walkway	
Alleys/ Laneways	Well designed and well lit alleys run between or behind buildings, are usually restricted to pedestrians and small service vehicles, and can break up long blocks to increase pedestrian permeability. **Alley Features** • Maintenance important to keep clean and well lit • Should connect to adjacent streets on both ends so as not to create a dead end • Permeable pavement can reduce runoff and prevent flooding **Estimated Cost:** $3 - $15 per square foot of permeable pavement, $200 - $5,000 for lighting	

A2.2 Bicycle Infrastructure

Feature	Application	Examples
Shared Roadway	On shared roadways, bicyclists share the road with other vehicles. These are routes that have been identified as preferred bike routes but do not have a right-of-way wide enough for dedicated lanes, and thus need to be signed appropriately to improve safety. **Shared Roadway Features** • Signs along bicycle route provide wayfinding to cyclists and awareness to drivers • "Sharrows" alert drivers to share the road, and show cyclists where they should ride • Place sharrows on the right side of the road with a 2.5 foot gap between parking lane to minimize conflict with moving vehicles as well as opening doors of parked cars **Estimated Cost:** Low cost for striping and signage on existing shared roadways	
Bicycle Lanes	Bike lanes are the area of the roadway designated for non-motorized bicycle use, separated from vehicles by pavement markings, and in some cases by small medians. They improve safety and comfort by increasing visibility and awareness of cyclists. **Bicycle Lane Features** • Typically five feet wide per direction of travel • Striped lane with bicycle logo indication • Painted lanes increase visibility • Median-separated protect bicycles from vehicles along high traffic volume roads • Bicycle boxes at intersections can give cyclists a head start before cars **Estimated Cost:** $1,000 to $5,000 per mile	
Bicycle Parking	Bicycle parking at transit stations should be visible, plentiful and protected from the elements. Bicycle lockers further ensure protection from theft or vandalism. **Bicycle Parking Features** • Easily accessible from bike paths • Visible from all areas of the station • Located in close proximity to all station entrances • Include some covered bicycle racks to protect bikes from rain and snow • Provide a range of options from short-term racks to long-term bicycle lockers **Estimated Cost:** For purchase and installation, $150 - $300 per rack (parks two bikes), and $1,000 - $4,000 per bike locker (parks two bikes)	

A2.3 Amenities and Aesthetics

Feature	Application	Examples
Pavement Material	Different materials such as concrete or pavers for crosswalks or painted patterns for pedestrian priority areas provide visual identification of pedestrian routes, and create interesting public spaces. **Pavement Material Features** • A range of materials exist to call attention to pedestrian zones • Dyed or naturally colored materials may last longer than painting **Estimated Cost:** Varies depending on material	 Red Rubber  Painted Concrete
Lighting	Pedestrian-scaled lighting along sidewalks and paths enhance pedestrian safety and security by lighting areas at night, making pedestrians visible to drivers and others. Pedestrian-scale lighting complements, but does not replace, street lights. **Lighting Features** • Height of pedestrian-scale lighting should be 12 - 14 feet above the sidewalk • Lighting levels should be uniform in height and illumination so as not to distract drivers • Light poles should not obstruct walkway • All sidewalks and intersections should be well-lit • Opportunity to increase energy efficiency by using LED lights to reduce energy costs (up to 70% compared to traditional systems) **Estimated Cost:** Varies depending on fixture type and service agreement with local utility companies	

Street Furniture

Street furniture, especially along commercial corridors, enhances pedestrian areas by allowing people to socialize and activate the public space. This improves safety, adding eyes on the street and slowing traffic by narrowing the perceived road width. All street furniture should not obstruct pedestrian walkways.

Street Furniture Features:

- Fixed or movable chairs, tables and benches
- Water Fountains
- Trash receptacles
- Food vendors / kiosks
- Shade (tree canopy or umbrellas)
- Multi-unit news racks

Estimated Cost: Varies depending on the type of street furniture

Landscaping

Landscaping treatments can range from planted strips along roadways to small pocket parks on corners to improve aesthetics. Landscaped streets create the perception of reduced roadway space, resulting in traffic calming and a more hospitable environment for bicycles and pedestrians.

Landscaping Features

- Planters for trees, flowers and shrubs are a low-cost alternative to street planting
- Locate between vehicle travel lanes and sidewalk to provide a pedestrian buffer

Estimated Cost: Varies depending on type of landscaping

Public Art

Public art enhances the pedestrian environment and can be installations that have a functional purpose or purely aesthetic. Public are can help revitalize areas with few eyes on the street.

Public Art Features

- Locate along high volume pedestrian corridors and/or at transit stations
- Can include: unique bicycle racks, wayfinding signs, historic information panels, sculptures, hanging flags, public art seating and other unique objects
- Can provide safety awareness (see Public Awareness Campaigns in Section 3.2)

Estimated Cost: Varies depending on type of public art

A2.4 Pedestrian Priority

Feature	Application	Examples
Shared Streets	A shared street allows all users – pedestrians, bicyclists and vehicles – to move within the same space. Shared streets provide a pedestrian priority zone where vehicles are allowed but must yield to pedestrians. They encourage visual and personal communication between pedestrians and motorists to avoid conflicts, promoting slow vehicular speeds and relatively unconstrained pedestrian movement. **Shared Streets Features** Many elements of shared streets do not require significant street reconstruction, while certain treatments require greater intervention. Features for three intensity levels are described below. • Low intensity: Treated surfaces, signage • Medium intensity: Planters, bicycle racks, lighting, waste and recycling receptacles, tactile strip guidance, kiosks/ newsstands, bollards, street lamps, street trees, seating • High intensity: Stormwater collection, distinctive pavers, flush surface delineated curb, flush surface (no curb) **Estimated Cost:** Varies depending on level of intensity	 Example of high intensity shared street  Rendering of low intensity shared street

A3 Vehicle and Pedestrian Awareness

Giving heightened attention to presence of pedestrians, guiding pedestrians to follow the appropriate paths and crossings, and creating an easily identifiable, iconic transit station are just a few of the measures that can increase safety and improve the overall pedestrian experience between the station and major destinations.

A3.1 Wayfinding and Signage

Feature	Application	Examples
Activated Flashing Signs	Activated flashing beacons alert drivers to a pedestrian crossing in the crosswalk ahead, causing drivers to stop further from the crosswalk, and significantly reduce pedestrian delay. **Flashing Sign Features** • Flashing yellow lights activated by the pedestrian pushing a button at the curb, or by automated pedestrian detection • Mounted on poles over roadway for high visibility (left photo) • On narrower streets rectangular flashing beacons can be used to supplement a standard pedestrian warning sign (right photo) **Estimated Cost:** $10,000 - $75,000 depending on sign choice	
In-Street Pedestrian Crossing Sign	In-street pedestrian crossing signs are used at unsignalized crosswalks. They are more noticeable than roadside signs and have a traffic-calming effect, effectively narrowing the inside lanes. **In-Street Pedestrian Crossing Sign Features** • Overall sign height is about 47-inches • Place in front of crosswalk, fixed on median if present • If no median present, can use multiple signs **Estimated Cost:** $275 per sign	

Wayfinding

Signs near transit guiding pedestrians and cyclists towards destinations in the area, making it easier for residents and visitors to navigate the station area and creating a sense of place.

Wayfinding Features

- Pedestrian –scale signs
- Greater guidance upon approaching/departing the station
- Uniform and consistent series of signs throughout the area
- Complimentary to existing signage

Estimated Cost: $500 or more per sign

Station Entrances

Transit stations can serve as iconic structures for a city with legible and identifiable access paths to the station entrance. The station entrance should be highly visible and permeable, creating easy access into and out of the station at all times of day. The station area should be attractive and well-lit, with a comfortable waiting area that is protected from the weather. Retail (small coffee shop or kiosk) in the station area encourages greater activity and vibrancy. Pedestrian and bicycle access should be physically separated from vehicle drop-off areas and parking.

Station Entrance Features

- Pedestrian-scale lighting throughout station area
- Entrance paths from adjacent street grid are direct, clear of obstacles and highly visible
- Wayfinding signs to direct passengers to local transit and other destinations
- Small retail kiosk in station area
- Public art
- Bicycle parking

Estimated Cost: Varies depending on elements used to improve station entrance and access

A3.2 Public Awareness Campaigns

Feature	Application	Examples
Public Awareness Campaigns	Public awareness safety campaigns geared towards pedestrians, cyclists and motorists improves understanding of safety rules and issues. Signs and fliers can be implemented at bus stops and transit stations, along the sidewalk, at public parking facilities, public buildings, schools, offices and through use of public art or other innovative means. **Public Awareness Campaign Features** • Easily understood (multilingual if needed) • Coordinated marketing to all users (pedestrian, bicycle, vehicle) • Approach can be city-wide or target specific streets/intersections • Support from business owners, City, transit agencies, schools, etc • Can be launched in conjunction with implementation of pedestrian safety improvements • Local radio and TV broadcasts can expand campaign to a wider audience **Estimated Cost:** Varies depending on elements used to improve station entrance and access	

Sources

This toolbox draws from previous Arup work as well as many pedestrian and bicycle safety sources, including:

- Walkinginfo.org
- Bicyclinginfo.org
- Federal Highway Administration's Pedestrian Safety Countermeasure Deployment Project, http://safety.fhwa.dot.gov/
- San Francisco Better Streets Plan, http://www.sf-planning.org/ftp/BetterStreets/index.htm
- New Carrollton Interim Pedestrian Safety Improvements Report (A previous Transportation/Land Use Connections project sponsored by the National Capital Region Transportation Planning Board), http://www.mwcog.org/transportation/activities/tlc/pdf/NewCarrolltonPedSafety.pdf
- New York Bicycling Coalition's Bicycling and Pedestrian Safety Manual, http://www.nybc.net/programs/NYBCManual_Chapter4.pdf