Table of Contents

Phase One – The Macro Level Report

Executive Summary

Section 1 – Identification of Major Transportation, Safety, and Mobility Issues

Figure 1 - Study Area & Master Plan Overview

A. Major Issues

B. Specific Intersection Issues Which Affect Safety and Mobility

Section 2 – Accident Analysis

Figure 2 – Pedestrian Crash Locations

Table 1 – Pedestrian and Bicycle Crash Details

Table 2 – Total Intersection Crashes

Section 3 – Parking Utilization and Analysis

Figure 3 – Vehicular Parking Utilization – Surface Lots, Garages, and Metered (On-street) Parking

Figure 4 – Vehicular Parking Utilization – Surface Lots, Garages, and Metered (On-street) Parking

Figure 5 – Bike Rack Utilization

Figure 6 – Bike Rack Utilization

Table 3 – Parking Utilization – Lots and Garages Near Carnegie Mellon University

Table 4 – Parking Utilization – Metered (On-street) Parking Near Carnegie Mellon University

Section 4 – Land Use and Relationship to Transportation

Figure 7 – Land Use

Figure 8 – Street Network

Figure 9 – Public Transit

Figure 10 – Bike Routes

Figure 11 – Sidewalks

Figure 12 – Pedestrian Corridors & Destinations

Section 5 – Concept Alternatives

Figure 13 – Street Sections Forbes Avenue

Figure 14 – Street Sections Forbes Avenue

Figure 15 – Street Sections Fifth Avenue

Figure 16 – Street Sections South Craig Street

Figure 17 – Street Sections Morewood Avenue

Figure 18 – Intersection Panoramas, Fifth Avenue

Figure 19 - Intersection Panoramas, Fifth Avenue

Figure 20 - Intersection Panoramas, Forbes Avenue

Figure 21 - Intersection Panoramas, Forbes Avenue

Appendix A – Scope of Work

Appendix B – Non-Motorized Safety Toolbox

CMU Pedestrian Safety Mobility Study

Phase One – The Macro Level Report

Executive Summary

This report addresses the major transportation safety and mobility issues within the Carnegie Mellon campus, and will be incorporated into the CMU Institutional Master Plan 2010. It will be utilized in the future as a core document to facilitate growth of the campus and transform the surrounding street system into a pedestrian and bicycle friendly system, serving not only the future campus, but also the surrounding neighborhoods.

However, it can be much more than that, as the following excerpts from the MOVEPGH document demonstrate:

"The City has acknowledged that an automobile dominated transportation network is not sustainable and has initiated efforts to enhance and augment its network through projects and policy that further diversify its transportation system. A system of finite proportion based on Pittsburgh's geographic, cultural, and socio-economic setting that has evolved around the Single Occupancy Vehicle cannot be improved through the addition of auto-capacity. It is necessary to take a step back and consider moving people instead of their cars.

The paradigm shift of moving people, goods and services rather than just automobiles will guide the provision of safe and efficient facilities (for all modes) to the greatest extent possible. A greater degree of equity between modes and Quality of Service improvements that affect transportation choice will support modes that enhance our quality of life and constitute a performance-based system. The intent is to apply a Complete Streets policy approach across a collection of rights of way to produce a Complete Multimodal System. MOVEPGH will identify the transportation policy and multimodal system development opportunities that allow the City to accomplish this. Consequentially, MOVEPGH will outline strategies to enhance safety, maximize transportation efficiency, decrease Single Occupancy Vehicle dependency, and position the City to secure project funding. Safety is paramount when considering transportation. The City's transportation network can be best defined as a spaghetti network of pot holed, circumlunar, one-way, narrow streets that can puncture tires, shorten site lines, and confuse drivers. Nevertheless, speeding and aggressive driving continue to be a major issue for law enforcement. With the rising number of bicyclists and pedestrians, speeding and aggressive driving hazards are greatly amplified. It is anticipated that improved design, policy, and enforcement initiatives will directly result in safer streets as well as improved efficiency for all street users.

In recent years, the number of commuting cyclists and pedestrians has been growing within the City. According to the 2008 American Community Survey, the City ranks 16th (1%) in the nation for commuters who bike to work and ranks second (12.4%) for those who walk to work. This is ultimately a result of nearly 15% (American Community Survey, 2008) of the City's residents not owning an automobile. These percentages are expected to increase as the City actively encourages residents to walk and/or bike to work, school, church, the grocery store, etc. instead of driving. As a result, a need for enhancements to improve the City's biking and walking friendliness must be addressed. The City's over arching goal is to continue this trend and encourage residents to leave their cars at home".

With this bold effort, the city itself will be transformed. In addition it is quite clear the results of the Oakland /CMU Pedestrian Mobility study can become the model for implementing the strategies of MOVEPGH and an outstanding showcase for the paradigm shift of putting people ahead of vehicles.

The study has already enlightened many stakeholders to the major issues all of which have a direct effect on the movements of people: the students, faculty employees of Carnegie Mellon University, as well as the public at large within the study area. The six major issues are as follows:

+ Lack of ADA and Traffic Signal Standards Compliance at Intersections
+ Lack of Long Term Pavement Markings at Intersections
+ Lack of Wayfinding/Destination Signage
+ Narrow Sidewalks – Far Below Required Capacity
+ Lack of Buffer Between Sidewalks and Vehicle Travel Lanes
+ Excess Speeds on Forbes and Fifth Avenues

All of these issues directly affect the entire campus and neighborhood population. In our investigation of accidents, while there was no apparent direct correlation to the pedestrian and bicycle accidents, as well as overall accidents, that any one intersection is of particular concern for pedestrian safety in the study area. However, the overall number of pedestrian crashes, as well as the total number of crashes does represent a significant traffic safety concern, and will be addressed via our final recommendations and resolution of the six (6) issues noted above.

Our analysis of the overall parking situation has revealed that there is significant underutilization of major automobile facilities across the entire campus, with some facilities less than 50% utilized at midday. Conversely, there is a strong and growing demand for additional bicycle parking throughout campus, with one-half of the bicycle racks at or over 100% utilization.

In our development of the land use components, it became vividly clear that while east-west movement within the current campus plan were adequate, and significantly improved in the proposed 2010 Master Plan via the addition of facilities across the Neville/Boundary Street ravine, the same cannot be said for north-south movements, where there is a severe deficiency for all users, and in particular significant restraints to the movement of pedestrians via existing north south corridors. These movements are particularly compromised by the lack of sufficient crossings of the entire length of Forbes Avenue within the study area, as well as the eastern portion of Fifth Avenue.

The result of our focus on the six (6) major issues and the balance of our investigations to date have lead us to the development of concepts for, first and foremost, increasing the safety of the ten (10) intersections and travel corridors between them while also becoming the catalyst to a transformation of these corridors into truly pedestrian and bicycle friendly facilities. Due to the numerous deficiencies our broadest effort was on Forbes Avenue where separate traffic calming, pedestrian and bicycle focused concepts were developed, while realizing the final recommendation may well be hybrid of all three (3) concepts. For Morewood Avenue, Fifth Avenue, and Craig Street the limitations of right-of-way, buildings, and topography all played a role. However, viable options have been presented to significantly enhance safety on each of these facilities.

With the upcoming input of the key stakeholders: Carnegie Library of Pittsburgh, Carnegie Museums of Art & Natural History, City of Pittsburgh School Board, Craig Street Merchants, Diocese of Pittsburgh-Central Catholic High School, Oakland Community Council, Port Authority of Allegheny County, Shadyside Action Coalition, Squirrel Hill Urban Coalition, and the University of Pittsburgh, we will achieve a sense of consensus and priority for moving the concepts forward into sound recommendations. Furthering these efforts will be a public workshop to be held to assist GAI and the project sponsors, the Oakland Transportation Management Association and Carnegie Mellon University to finalize the range of recommendations.

In conclusion, we feel the objective of the study afforded via the funding of PennDOT's Pennsylvania Community Transportation Initiative Program will be well served by the outcomes and recommendations. We also feel the transformation of the study area into a "people first" pedestrian and bicycle friendly environment will become a model for the city and the region.

Section 1 - Identification of Major Transportation, Safety, and Mobility Issues

The discussion below is a compilation of observations from three (3) field views conducted by the staffs of GAI Consultants and Kittleson Associates, over a three (3) month period from June through September 2010. The field view encompassed the entire study area as shown on Figure 1 which follows. Although some contributing factors listed below have changed slightly since the field views were conducted, six (6) major issues within the study area have been demonstrated consistently.

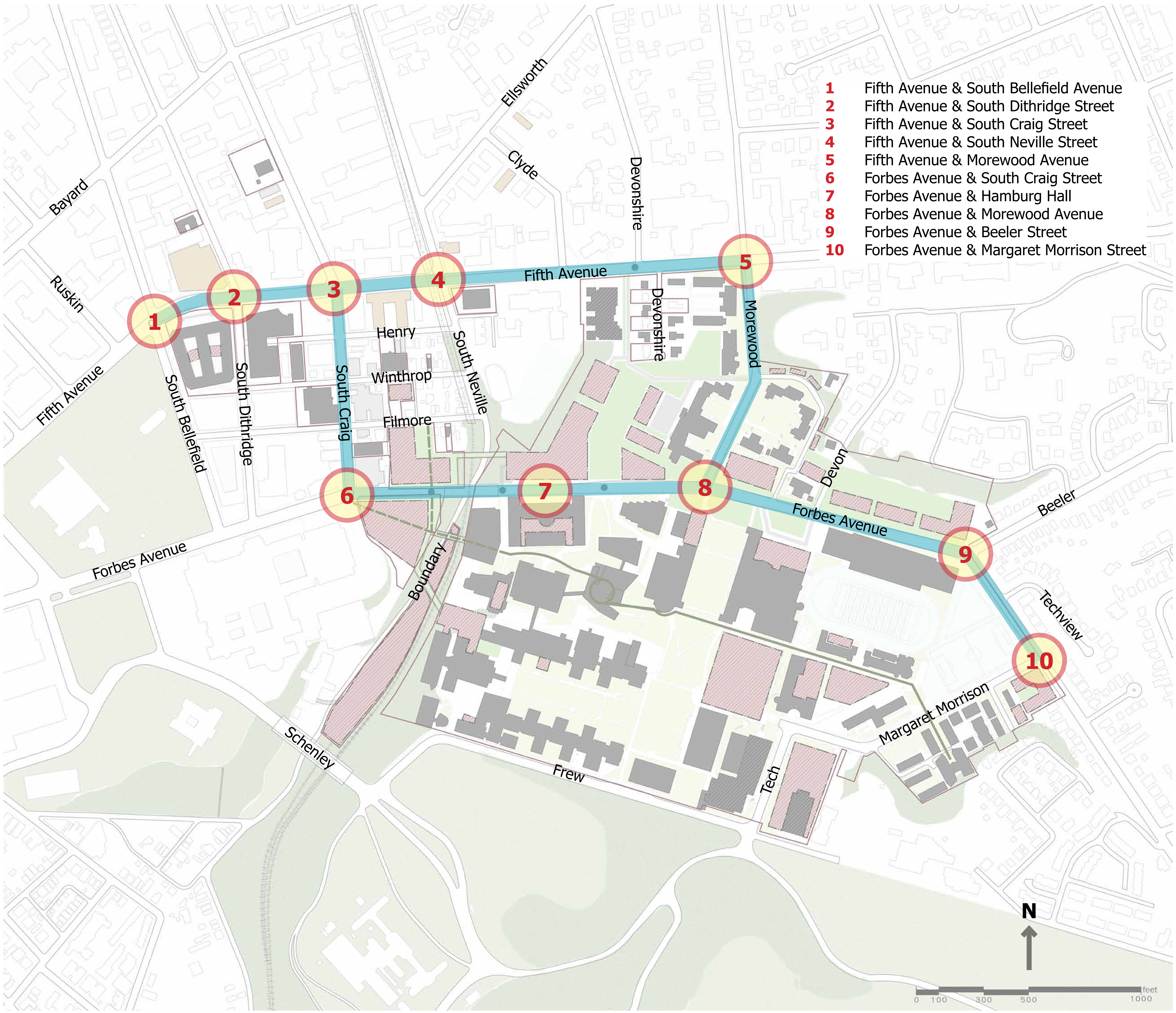


Figure 1
Study Area & Master Plan Overview

The study area addresses both Fifth Avenue and Forbes Avenue, main arterials that extend through the CMU campus and connect Oakland to Shadyside and Squirrel Hill, as well as South Craig Street and Morewood Avenue, which serve as connectors between the arterials. The two avenues, key east-west arterials, also serve as important inter-campus connections and, more often than not, act as barriers to the campus. Forbes Avenue effectively bisects the campus, creating pedestrian/vehicle conflicts throughout the breadth of the campus. Fifth Avenue, on the northern edge of the campus, creates a similar condition for many students who live in the dense residential area of North Oakland. Both South Craig Street and Morewood Avenue are important pedestrian and vehicular connections, and are integral to the campus community.

Key

Existing Buildings

Proposed Development

Source: CMU's 2010 Campus Master Plan is shown as the base condition for proposed development

Oakland/CMU
Pedestrian Safety Mobility Study

October 15, 2010

PCTI PENNSYLVANIA COMMUNITY TRANSPORTATION INITIATIVE
Oakland Transportation Management Association
Carnegie Mellon
gai consultants transforming ideas into reality

A. Major Issues

1. Lack of ADA and Traffic Signal Standards Compliance at Intersections

Curb ramps enable persons in wheelchairs and with strollers to safely and easily cross at intersections, and are required in order to meet federal ADA accessibility standards. Two (2) directional ramps are normally provided at each corner, with one (1) leading to each crosswalk. All study area intersections have at least some form of curb ramp, but all the curb ramps in the study area are non-compliant with current standards, and many individual crosswalks do not have corresponding ramps**.** For instance, Fifth Avenue lacks curb ramps on its southern side at the unsignalized intersections between Neville Street and Morewood Avenue.

Photo 1 -- A busy intersection, Fifth at Neville, with substantial elderly pedestrian crossings but no ADA ramps at this crossing.

Pedestrian signal heads indicate to pedestrians when they are permitted to use a crosswalk at a signalized intersection. More importantly, the pedestrian clearance interval (i.e., the flashing don't walk phase) warns pedestrian of an impending phase change, allowing pedestrians to safely clear the intersection prior to traffic entering the intersection. Without pedestrian signal heads, many pedestrians are either stranded in the crosswalk after the phase changes or are unclear on whether it is safe to cross, creating a potentially unsafe situations.

Note that all new pedestrian signals must include countdown timers per the MUTCD to inform pedestrians of the time remaining in the flashing "don't walk" phase.

Most of the signalized intersections in the study area have traditional pedestrian signal heads, while other intersections have no pedestrian signals at all. No intersections currently have countdown pedestrian signals. Intersections with no pedestrian signal heads should be prioritized for pedestrian signal head retrofits as soon as possible. Existing pedestrian signal heads should be replaced with countdown timers.

Proposed Solution: Develop an implementation plan to upgrade all ten (10) intersections within the study area to current ADA and traffic signal standards. Refer to Appendix B (pgs. 3-5) for an overview of this item of work.

2. **Lack of Long Term Pavement Markings at Intersections**

Marked crosswalks indicate to motorists the location of a crosswalk and can be accompanied by signs, curb extensions, and/or median refuge islands. Most signalized intersections in the study area, as well as several unsignalized locations, have marked crosswalks. However, none of the crosswalks feature high-visibility striping and all were extremely faded. The lack of long-term, well-defined crosswalks, stop bars, and lane striping represents a significant safety and mobility issue, particularly for incoming freshmen and graduate students who are unfamiliar with the campus, and may be unaccustomed to urban street conditions. Although the City does repaint the crosswalks periodically, there is a need for more aggressive striping and marking throughout the study area, preferably with more durable material than paint. In addition, all crossings within the study area should be variable width, a minimum of 8-feet, and up to 20-feet wide, dependent upon the results of the traffic counts.

Photo 2 - Morewood at Forbes Avenue, a high-density pedestrian crossing with no visible pedestrian crosswalks.

Proposed Solution: Develop an immediate action plan to install special emphasis, variable width, barred cross walk markings in epoxy paint, at all ten (10) study area intersections. Refer to appendix B (pg. 6) for an overview of this proposed action.

3. Lack of Wayfinding/Destination Signage

A comprehensive pedestrian and bicycle network connects destinations and enables people to travel safely and comfortably between locations. As a campus environment with a traditional urban street grid, the study area generally has good connectivity. The primary exception is Junction Hollow ravine that cuts through the campus along South Neville and Boundary Streets, with the only crossings at Forbes Avenue on a bridge, and at Fifth Avenue. In addition, Neville Avenue/Boundary Street lacks pedestrian facilities, even though there is access to buildings and parking from this roadway that could generate considerable pedestrian and bicyclist activity. Future planned improvements that add an additional link for pedestrians and bicyclists will help improve network continuity.

Photo 3 - The major outbound bus stop at Forbes and Morewood for commuting students, with no local or campus wayfinding present.

Wayfinding systems indicating the location of destinations, transit facilities, and areas of interest are beneficial to all roadway users. Wayfinding targeted at cyclists typically includes distance and average travel times to these destinations, while pedestrian wayfinding often include maps, directions, and point of interest.

All existing wayfinding in the study area is directed at drivers, indicating City- and University-related destinations. While there are some signs at recently built and acquired buildings, and at information desks within core buildings, there remains an opportunity to complement the existing wayfinding with much more detailed information for bicyclists and pedestrians, as well as vehicles. Hard evidence of this is demonstrated in Figures 3 through 6, which show that while multiple parking facilities are at capacity, numerous large facilities and a surprising number of bicycle racks are underutilized, many near the core areas of the campus. The initial wayfinding signage will be of course static. However, interactive signing that can be applied to smart phone internet and vehicle interfacing should be a long-term goal.

Off-street pathways provide additional connectivity, and a comfortable pedestrian and bicycling environment when well-designed. If there are a high volume of users, wider paths and striping, or other treatments can be used to decrease conflicts between bikes and pedestrians.

The Carnegie Mellon University campus provides a number of off-street pathways. However, the near total lack of internal campus signage makes these pathways underutilized. There are considerable opportunities via an aggressive signing campaign to connect these to a more complete pedestrian and bicycle network in the study area, which already exists as vividly depicted in Figure 10.

For example, there is currently no way for students to realize that there are major campus facilities across the Forbes Avenue Bridge toward the west, where there are six (6) major buildings. (See Figure 1).

Proposed Solution: Develop concept plans for a three-tiered plan for wayfinding and destination signing. The first tier would be to develop a concept plan for an internal static wayfinding and destination signing plan for internal use throughout the Carnegie Mellon Campus. The second tier would be to implement the city-wide effort to upgrade destination signage and integrate it via the city-wide “City of Pittsburgh Bicycle Route and Sign Plan” with supplemental signage for major Carnegie Mellon University destination elements throughout the study area. The third-tier would be a full interactive wayfinding system, with complete interactive capabilities with vehicle telematics systems and smart phone applications. Refer to Appendix B for an overview of the scope of the proposed.

4. Narrow Sidewalks – Far Below Required Capacity – With Additional Restrictions

Much of Forbes and Fifth Avenues have relatively narrow sidewalks, five feet or less and immediately adjacent to the travel lane. Wider sidewalks and/or more separation between pedestrian and cars would make both roads a safer and more attractive pedestrian environment and provide opportunities for safe bicycle routing.

In general, sidewalks should have adequate width to accommodate persons in wheelchairs, allow pedestrians to pass one another, and provide comfort for pedestrians to walk two or three abreast in high activity areas. The U.S. Access Board specifies that sidewalks should be at least 4-feet wide at all times, including locations where fixed elements obstruct a portion of the path. While nearly all locations met these requirements, there are several specific locations (e.g., Forbes Avenue/Beeler Street) where poles, hydrants, etc., are in the sidewalk, and reduce the effective width close to or below the legal minimum.

In an attempt to establish a campus-like environment throughout the corridor, and to reposition Forbes Avenue as the "Main Street" to the campus, minimum standard widths should be established for the entire campus environment. In the campus core, around the "Cut" and the "Mall", the sidewalks are 8-feet wide; this should be the minimum standard where practical along all city streets in the study area. In many locations there will likely be a need for even wider sidewalks, especially at the more congested intersections where pedestrians and bicyclists congregate for various reasons (i.e. transit stops and high volume intersections) with exclusive pedestrian phases.

The lack of facilities and good alternatives for bicyclists has prompted risky bicycle riding behavior, and many riders use the already narrow sidewalks, in particular along Forbes and Fifth, but also notably along Craig Street, considered a bicycle friendly environment. The principal inhibiting factors are obvious in Figure 10, which depicts the bike routes. Notably, Forbes Avenue is a cautionary bike route over its entire length in this study area. Fifth Avenue is cautionary for

Photo 4 - Northeast corner of Morewood at Forbes Avenue. The landing area for wheelchair occurs over block stone and grass. The block stone is utilized in numerous places along Forbes Avenue in an attempt to widen pedestrian pathways. The area settles and subsequently becomes filled with silt and standing water during rains and ice in freezing weather.

Photo 5 - An area along Fifth near Morewood Avenue with a recently constructed sidewalk far below standards.

Bellefield Avenue to Neville Street, but not even denoted at the cautionary level, indicating unsafe and not recommended passage from Neville Street to Morewood Avenue.

Creating dedicated bicycle facilities to connect such existing “bikable” streets, and other bicycle facilities provides the highest benefit to cost ratio of any bicycle improvements. Just as with pedestrian facilities, a complete network of safe and comfortable bicycle routes will encourage more cycling and prompt better riding behavior.

Proposed Solution: Develop a long range plan to reconstruct all sidewalks within the study area and abutting the campus boundaries to create a true campus environment for all users, pedestrians, and cyclists alike. The final plan should reflect the typical sections developed for the Study, either by retaining the curb alignment or by offset alignments with the creation of verges/tree lawns. Refer to Figures 13 through 17 for concepts to provide this system.

5. Lack of Buffer Between Sidewalks and Vehicle Travel Lanes

Sidewalks not only need to provide adequate width for walking, but should also provide sufficient separation between pedestrians and vehicles to create a comfortable walking environment. Separation can be achieved through wider sidewalks, landscape strips/verges, tree islands, and/or on-street parking. While some sidewalks such as Craig Street, in the area do have separation and thus are inviting to pedestrians, most sidewalks in the study area have insufficient buffer areas between the sidewalk and the travel lanes. This is particularly true along Forbes and Fifth Avenues. Wider sidewalks and/or more separation between pedestrians and cars would make both roads a more attractive pedestrian environment. This is dramatically shown on Figure 11, where almost no trees exist between sidewalk and curb, and almost all sidewalks are adjacent to the curb.

Photo 7 - This photo was taken along Morewood Avenue the major access route to dormitories and fraternity houses. Not only is no buffer afforded here, but pedestrian couples passing in opposite directions, a common occurrence, cannot pass each other. Therefore, on occasion pedestrians will step in the street to pass.

Landscaping can affect pedestrian comfort both positively and negatively, and should be considered in design of sidewalks and pathways. Some sidewalks in the study area have buffer strips of grass or planted trees, a verge, or tree lawn, between the roadway and the sidewalk, which can make the sidewalk feel safer and more protected from the roadway.

However, it should be noted that this will be challenging and will likely require additional elements to be addressed, such as the need to dedicate permanent public easements if sidewalks are relocated onto university property.

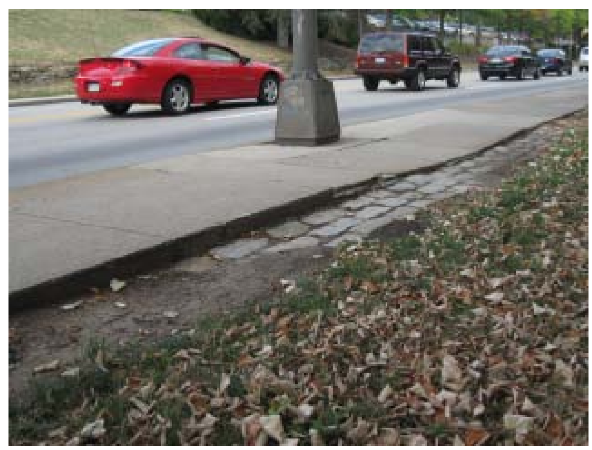


Photo 8 - A buffer or tree lawn here would eliminate the need for pedestrians to move around this light pole along Forbes Avenue near Beeler Street. Settlement of the block stone here approaches 6 inches.

Proposed Solution: Develop a phased short and long range plan in concert with Major Issue 4, and in concert with the Master Plan to create verges or tree lawns to reposition Forbes as the "Main Street" of campus. The final plan should fully or closely match all typical sections developed for the Study. See Figures 13 and 14.

6. Excess Speeds on Forbes and Fifth Avenues

The exclusive pedestrian phases at several intersections within the study area create large queues at the intersection and large gaps of traffic free roadway in the street section beyond the signal. Upon a green signal, these large queues form platoons of vehicles that move along the nearly empty streets at high rates of speed. Both Forbes and Fifth Avenues, as four-lane sections, create an obvious invitation to move at higher speeds, as well as fostering attempts to "beat" the next red phase at the upcoming intersection. Refer to Figures 13 through 17 for alternative concept designs for Forbes and Fifth Avenue, and Craig and Morewood Streets.

This creates a substantial risk for much slower moving bicyclists and to crossing pedestrians. (Note that signs are properly posted in much of the study area prohibiting bicyclists from riding on the sidewalks in accordance with Pennsylvania law banning bike riders from the sidewalk in business districts). However, the lack of safe and comfortable on-street alternatives, along with the observed high speeds causes many cyclists to continue to ride on the sidewalk. In addition, frequent buses and the lack of dedicated bicycle facilities simply prevent many cyclists from comfortably riding on the roadway. Thus, bicycles have no reasonable alternative to traverse campus.

While exclusive pedestrian phases can improve safety and operations by eliminating pedestrian-vehicle conflicts, they are not appropriate in every situation. Exclusive pedestrian phases result in longer total cycle lengths, which increase average intersection delay for pedestrians and motorists alike. In addition, pedestrians often choose to ignore the signal and cross with parallel traffic movements, which can create conflicts with turning vehicles. Noticeable noncompliance with the exclusive pedestrian phases is evident at all intersections where it is employed in the study areas. Further analysis will be conducted when the capacity analyses are completed for the intersections to determine if the exclusive phases can be eliminated without raising safety concerns.

Photo 9 - This photo was taken at 5:15 PM during weekday rush hour. The shot looks east on Forbes Avenue back towards Craig Street. It clearly demonstrates the effect the exclusive pedestrian phase at Craig Street produces by creating large gaps in vehicle occupancy between the exclusive pedestrian phases. Subsequently, during the green phase of the following cycle a large platoon of vehicles is released accelerating to high speed well above the speed limit due to the open road condition.

The land use map, Figure 7, notes the heavy movement of pedestrians moving north-south through the study area, which automatically requires crossing Forbes and/or Fifth Avenues, while the closely spaced intersections of Bellefield Avenue, Dithridge Street, and Craig Street can handle these flows, the wide spacing of signals, and therefore pedestrian crossings, throughout the balance of the study area, forces high concentration of pedestrians that utilize existing crossings, or indirectly encourages jaywalking. This pent up demand for additional pedestrian crossings of Forbes Avenue provided at Craig Street where significant pedestrian noncompliance occurs outside of the exclusive pedestrian phase, with pedestrians often crossing at will.

Photo 10 – This photo taken at the height of rush hour shows the problem of jaywalking between Morewood Avenue and Craig Street.

The demand for an increase in pedestrian crossings cannot be ignored, and will require solutions along Forbes Avenue, especially from Craig Street to Beeler Street, a distance of nearly two-thirds of a mile, with only three (3) pedestrian crossings through the heart of the CMU campus.

Figures 1 and 10 vividly demonstrate the inadequacy of north-south pedestrian movement with no pedestrian through movements accommodated between (and across) Forbes and Fifth, from Craig Street to Morewood Avenue, a distance of over 1500-feet.

Proposed Solution: Develop a plan for the elimination of the exclusive pedestrian phase, which contributes to excessive speeds on Forbes and Fifth Avenues, and confirm that intersection capacities would not be lowered below acceptable levels. Pedestrian movements would then be accommodated via the normal phases of the traffic signals, along with leading pedestrian intervals implemented in the traffic signal timings and coordination plans, and by introducing additional crossings of Forbes Avenue. In addition, the concept plans are presented on Figures 13 through 16 depict significant measures for calming traffic on Forbes and Fifth Avenues, which will greatly enhance pedestrian and bicycle safety, the key objective of this study. (The implementation of the 2010 Master Plan will yield additional crossing design lines across Forbes Avenue and future action/new crossings).

B. Specific Intersection Issues Which Affect Safety and Mobility

1. Fifth Avenue at Bellefield Avenue

- Lack of advance directional signing. The current signing is too close to the intersection and causes confusion during peak hours.
- A very large depression exists in the left turn lane on Bellefield at Fifth, slowing traffic in the lane to a near crawl condition and/or causing sudden weaving into the center lane to avoid the situation.
- No pedestrian signals exist.
- Dual left turns from Northbound Bellefield Avenue to Westbound Fifth Avenue are prevalent, although this move is prohibited.
- Lack of guide striping for left turn and right turn movements.
- Lack of “No Pedestrian Crossing” signage on the east side of the intersection.

2. Fifth Avenue at Dithridge Avenue

- Excess speeds on Fifth, greater than 35 miles per hour.
- The pedestrian signal on northwest corner is blocked by foliage.

3. Fifth Avenue at Craig Street

- No pedestrian signal head on the southeast corner, only a three-section signal head exists there.
- Lack of advanced directional signage for left turn lanes on north and southbound movements on Craig.
- Significant pedestrian noncompliance to exclusive pedestrian phase.
- Significant bicyclist noncompliance to exclusive pedestrian phase.

4. Fifth Avenue at Neville Street

- Illegible northbound turning restriction timing on northbound Neville.
- Excessive queuing of school buses at Central Catholic blocking eastbound curb lane of Fifth Avenue, from approximately 2:30 PM to 3:30 PM. The overall length of this queue varies but generally occupies two (2) blocks, Craig Street to Neville Street, and Neville Street to just slightly beyond mid-block eastward to Morewood Avenue. This causes a severe degradation of capacity on Fifth Avenue, which persists into the PM peak hour.
- Idling of same school buses in the above queue formation.
- A Catholic priest is directing traffic mid block on Fifth Avenue between Neville and Morewood Streets during the school bus period noted above.

5. **Fifth Avenue at Morewood Avenue**
   + A nearly full lane offset exists for southbound and northbound through movements on Morewood Avenue crossing Fifth Avenue
   + High speeds exist on Fifth Avenue, approximately 40 mph.
6. **Forbes Avenue at South Craig Street**
   + Blind pedestrians are not accommodated in ADA crosswalks, although signage is present.
   + Neither campus nor Port Authority buses are using turnout along eastbound Fifth Avenue.
   + Neither campus nor Port Authority buses pull to the curb to discharge or board passengers, blocking both lanes in peak hours and the thru lane in off-peak hours, right lane on westbound Forbes.
   + Buses along right lane of eastbound Fifth Avenue encroach into eastbound through lane to navigate the short radius without overtopping sidewalk area at southeast corner of intersection, causing a potential for sideswipe accidents.
   + Significant pedestrian noncompliance to exclusive pedestrian phase.
   + Significant bicyclist noncompliance to exclusive pedestrian phase.
   + Narrow crosswalks exist throughout the intersection
   + Pedestrians are unaware of the requirement to activate the exclusive pedestrian phase, thereby often blocking the sidewalk or occupying vehicle lanes in the street waiting for the cycle to be activated.
7. **Forbes Avenue at Hamburg Hall**
   + High speeds exist on Forbes Avenue, approximately 40 mph.
   + Crosswalks not recently restriped, although all others on Forbes Avenue were recently done.
   + Large gaps in through traffic eastbound and westbound exist due to the platoon effect of the exclusive pedestrian phases at both Craig Street and Morewood Avenue. Therefore at the end of the pedestrian cycle moderate to large platoons of vehicles are released along Forbes Avenue, often at high speeds
   + Very high incidence of jaywalking exists between Morewood Avenue and Hamburg Hall and parking driveway, significantly encouraged by the large gaps in vehicle traffic due to the platoon effect mentioned above in item A.6.
8. **Forbes Avenue at Morewood Avenue**
   + Extremely narrow through sidewalks exist on all approaches.
   + High speeds on Forbes Avenue, approximately 40 mph.
   + Extremely narrow crosswalks exist.
   + Large pools of patrons at both eastbound and westbound bus turnouts, essentially blocking sidewalks.
   + Pedestrians pool and stand in the bus turnout lane in peak hours due to lack of adequate storage at bus stops on the narrow sidewalks

+ All Buses, campus and Port Authority, routinely do not fully pull into eastbound and westbound bus turnouts.
+ Conflicts exist with substantial bicycle through traffic on Forbes and buses idling in through lanes to pickup or discharge passengers, with bicyclists occasionally weaving between patrons and the buses they are boarding or alighting from rather than routing around buses to the left to avoid high speed traffic on Forbes Avenue
+ The narrow ADA ramp to the "The Cut" is also highly utilized by bicyclists, setting up conflicts between disabled and bicyclists.
+ A tripping hazard exists in the western crosswalk due to a sunken water valve box in the center of the crosswalk approximately 3-inches deep.
+ A drop off of approximately 6 inches exists to a storm drain at rear edge of sidewalk at southwest corner.
+ Significant pedestrian noncompliance to exclusive pedestrian phase.
+ Significant bicyclist noncompliance to exclusive pedestrian phase.
+ Idling campus buses dwell in the holding area in front of the Morewood Gardens dormitory.

Photo 13 - Cyclist utilizing ADA ramp from the main campus "Cut" to Morewood Avenue. This is the only ADA access to and from the "Cut", the main pedestrian circulation area of the existing main campus.

Photo 11 - At the outbound bus stop at Forbes and Morewood Avenue, heavy loads of commuting students congregate to depart campus during evening rush hour. The burgundy bus is in the right travel lane of Forbes Avenue, blocking the through traffic (and had arrived at the stop prior to the gold bus). This location should be further studied for development of a full transit platform per Chapter 914 of the City of Pittsburgh Development Code.

Photo 12 - Bicyclist is blocked from proceeding through bus loading area due to narrow sidewalk. (behind the left pool of pedestrians). The potential exists here to provide a path for through pedestrians and bicyclists to bypass the bus patrons and provide pedestrian access around the rear side of this shelter.

9. Forbes Avenue at Beeler Street

+ Additional “no pedestrian crossing” at west side of intersection appears warranted due to alignment of this intersection.
+ High speeds on Forbes Avenue exist along the curb lane as drivers weave into the through lane to avoid lane drop at Margaret Morrison Street.
+ No pedestrian signals exist.

10. Forbes Avenue at Margaret Morrison Street

+ Lack of pedestrian signals.
+ Foliage of trees blocking “right turn only” signage in eastbound lane.
+ Limited use of eastbound right turn lane overall, especially in peak hours.
+ Weaving of traffic from right turn lane at the intersection into the through lane eastbound, occasionally beyond the intersection.

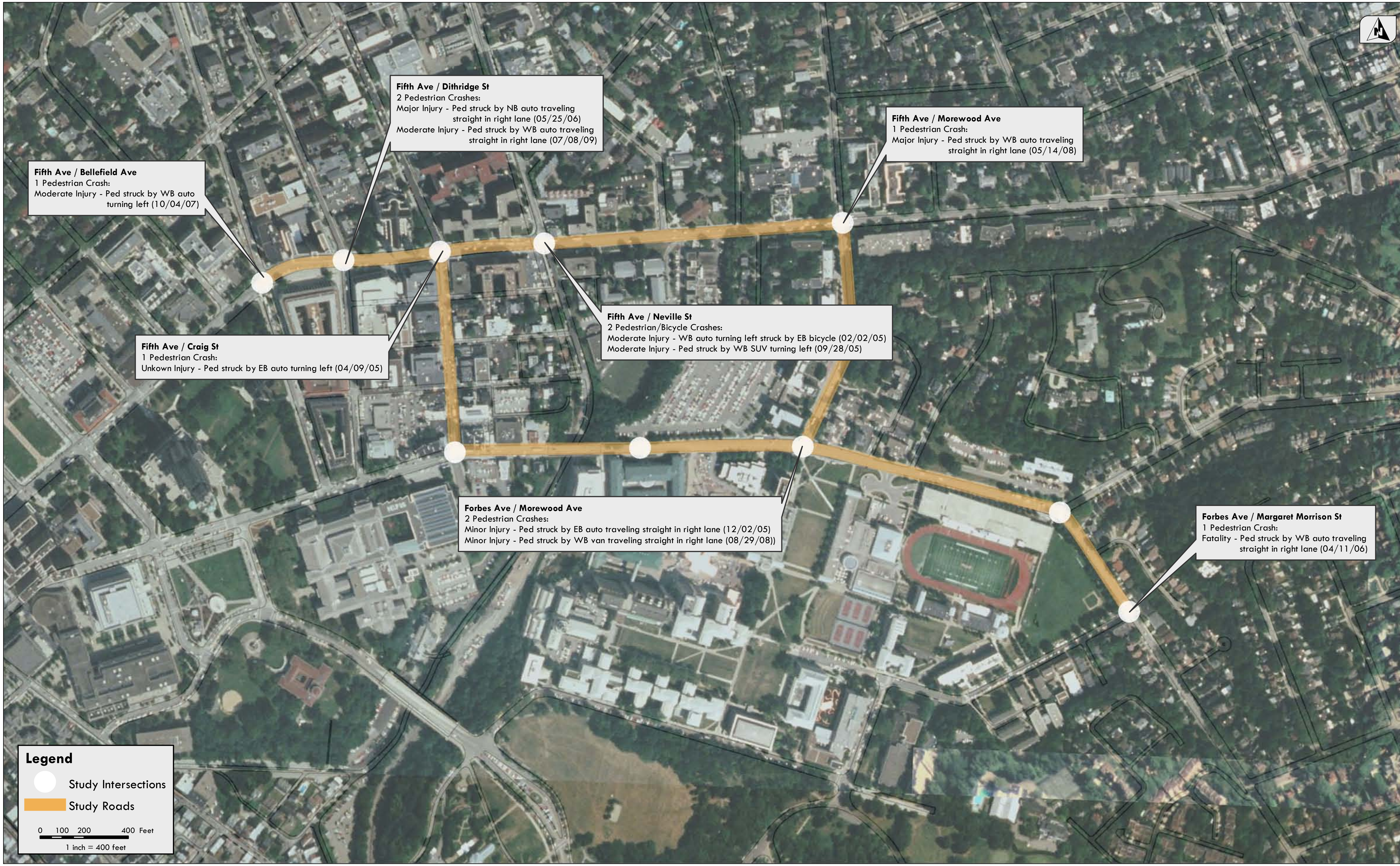
Photo 14 - Eastbound rush hour traffic near Margaret Morrison Street. The right turn lane is lightly utilized here, which causes extensive weaving mid-block and occasional weaving through the intersection at Margaret Morrison Street, an unsafe practice.

Section 2 – Accident Analysis

Crash Data Analysis Approach

The study area includes ten (10) intersections located along Fifth Avenue and Forbes Avenue in the vicinity of the Carnegie Mellon University campus in the Oakland neighborhood of Pittsburgh, Pa. Crash data for the study area was obtained from PennDOT and covers years 2005 through 2009. The data shows that there were a total of 93 crashes over this period, of which 77 occurred along Fifth Avenue and 16 along Forbes Avenue. There were 44 injury-causing crashes, and one (1) led to a fatality. Additionally, ten (10) of these crashes involved pedestrians or bicycles. Table 1 shows a breakdown of the details for each of these crashes, while Table 2 shows the breakdown of all crashes by year and type.

Pedestrian crashes occurred at seven (7) different intersections, and from the data, it is not apparent that any one intersection is of particular concern for pedestrian safety in the study area. However, the overall number of pedestrian crashes, as well as the total number of crashes (particularly along Fifth Avenue at Neville Street and Morewood Avenue) does represent a significant traffic safety concern. There is likely an opportunity to improve safety for all road users along these corridors. The information collected through the field review, data analysis, and improvements toolbox will be used to identify specific improvements to address these safety challenges.



PCTI Pennsylvania Community Transportation Initiative

Figure 2: Pedestrian Crash Locations

Oakland/CMU Pedestrian Safety Mobility Study

October 2010

Kittelson & Associates, Inc.

gai consultants

Table 1: Pedestrian and Bicycle Crash Details

Intersection	Date	Crash Description	Type	Injuries	Severity
1 - 5th Ave & Bellefield Ave	10/4/2007	Pedestrian struck by WB turning left in LTL	Ped	1	Moderate
2 - 5th Ave & Dithridge St	5/25/2006	Pedestrian struck by NB auto traveling straight in RL	Ped	1	Major
2 - 5th Ave & Dithridge St	7/8/2009	Pedestrian struck by WB auto traveling straight in RL	Ped	1	Moderate
3 - 5th Ave & Craig St	4/9/2005	Pedestrian struck by EB auto turning left in LTL	Ped	1	Unknown
4 - 5th Ave & Neville St	2/2/2005	WB auto turning in LTL struck by EB bicycle traveling straight in RL	Angle	1	Moderate
4 - 5th Ave & Neville St	9/28/2005	Pedestrian struck by WB SUV turning left	Ped	1	Moderate
5 - 5th Ave & Morewood Ave	5/14/2008	Pedestrian struck by WB auto traveling straight in RL	Ped	1	Major
8 - Forbes Ave &Morewood Ave	12/2/2005	Pedestrian struck by EB auto traveling straight in RL	Ped	1	Minor
8 - Forbes Ave &Morewood Ave	8/29/2008	Pedestrian struck by WB van traveling straight in RL	Ped	1	Minor
10 - Forbes Ave & Margaret Morrison St	4/11/2006	Pedestrian struck by WB auto traveling straight in RL	Ped	1	Fatal

Table 2: Total Intersection Crashes

		Crashes by year					Crashes by Type							Totals	Injury Crashes	Fatal Crashes
		2005	2006	2007	2008	2009	Ped/ Bike	Angle	Rear-end	Side-swipe	Fixed Object	Head-on	Other			
Intersection	1 - 5th Ave & Bellefield Ave	2	0	2	0	1	1	3	1	-	-	-	-	5	3	0
	2 - 5th Ave & Dithridge St	0	3	2	3	2	2	6	2	-	-	-	-	10	5	0
	3 - 5th Ave & Craig St	1	3	4	0	1	1	7	-	1	-	-	-	9	7	0
	4 - 5th Ave & Neville St	6	6	4	3	6	2	18	3	1	1	-	-	25	13	0
	5 - 5th Ave & Morewood Ave	6	7	7	5	3	1	18	3	1	2	2	1	28	10	0
	6 - Forbes Ave & S Craig St	1	0	1	2	0	-	2	2	-	-	-	-	4	2	0
	7 - Forbes Ave & Parking lot	0	0	0	0	0	-	-	-	-	-	-	-	0	0	0
	8 - Forbes Ave & Morewood Ave	1	0	0	1	1	2	1	-	-	-	-	-	3	2	0
	9 - Forbes Ave & Beeler St	0	0	0	0	0	-	-	-	-	-	-	-	0	0	0
	10 - Forbes Ave & Margaret Morrison St	0	2	0	0	2	1	-	1	1	1	-	-	4	0	1
Midblock on Forbes Ave		0	0	1	1	3	-	2	1	-	2	-	-	5	2	0
Study Area Totals		*17*	*21*	*21*	*15*	*19*	*10*	*57*	*13*	*4*	*6*	*2*	*1*	*93*	*44*	*1*

Section 3 – Parking Utilization and Analysis

GAI obtained inventories for campus parking garages, surface lots, and bike racks from the Carnegie Mellon University Parking and Transportation Services. Inventories for metered (on-street) parking facilities within the study area were obtained from the Pittsburgh Parking Authority. GAI reduced the inventories into formats suitable for collecting field data, and took parking occupancy counts (a minimum of three[3]) at each location during weekday, 10:00 AM to 2:00 PM time periods in September of 2010.

Average utilization rates were calculated for each location (see Tables 3 and 4). The range of rates varied from:

- Surface Lots: 33% at Hamburg Hall to 100% at Margaret Morrison and West Campus – (only 11% of the 19 lots counted were full)
- Garages: 46% at Gates to 100% at 5th and Craig – (only 17% of the six [6] garages counted were full)
- Bike Racks: 33% at Roberts Engineering Hall to 133% at Newell-Simon Hall – (notably, 50% of the 22 racks counted were utilized at 100% or more)

The overall utilization rate for the 3,011 parking spaces and bike racks counted was 78%. Individual count locations and their respective utilization rates are shown on Figures 2, 3, 4, and 5.

Vehicular Parking Findings:

Further study analysis will be required, but with a utilization rate of only 82% for surface lots and 75% for garages, a clear mandate exists for developing a projection of need lower than that utilized for the current campus configuration. Additionally as the wayfinding program is developed, static signage, as well as future active real time signage should be developed for all university parking facilities, vehicles, and bicycles.

Bike Rack Findings:

1. The results of the study indicate the need for an additional bike rack at Newell-Simon Hall, where the three existing racks had bikes affixed to their sides, equating to a utilization rate of 133%, as well as all locations where the utilization was at 90% or higher as follows:
   - Doherty Apartments (100% utilization)
   - Fine Arts (100% utilization)
   - Fraternities (100% utilization)
   - Gates (100% utilization)
   - Henry Street (100% utilization)
   - Morewood (100% utilization)
   - Porter-Hamerschlag-Wean (100% utilization)
   - Scaife Hall (100% utilization)
   - Hamerschlag Hall (100% utilization)
   - 407 South Craig (100% utilization)

These rates also indicate a clear need for additional racks.

2. The need for a full bike rack or multiple racks is also evident along Craig Street near Forbes Avenue, where an average of five (5) bikes were affixed to various parking meters during the parking occupancy counts.

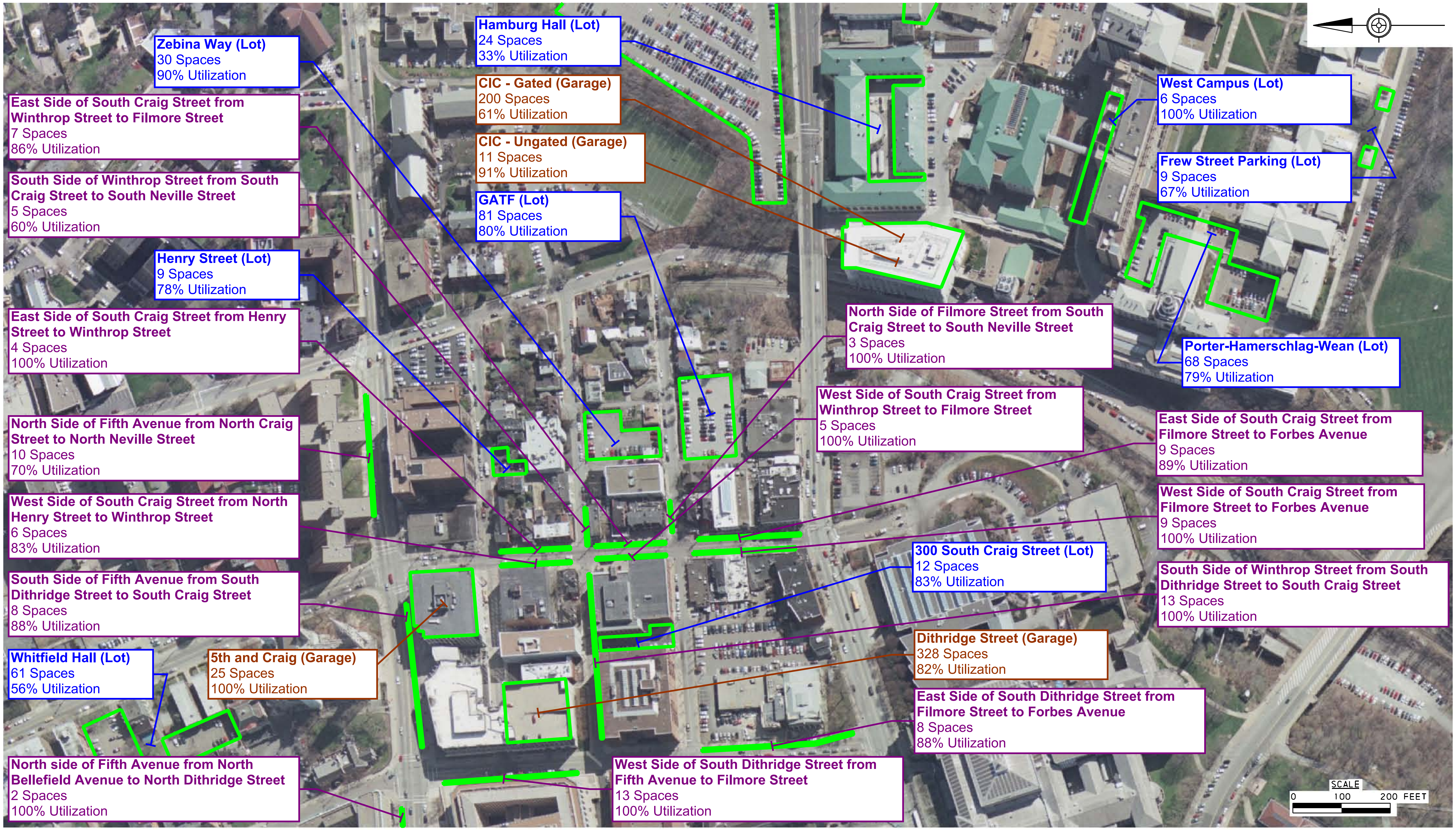


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Figure 3
Vehicular Parking Utilization - Surface Lots, Garages, and Metered (On-street) Parking

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Legend:

Surface Lot	Garage	Metered (On-Street)
__ Spaces	__ Spaces	__ Spaces
__% Utilization	__% Utilization	__% Utilization

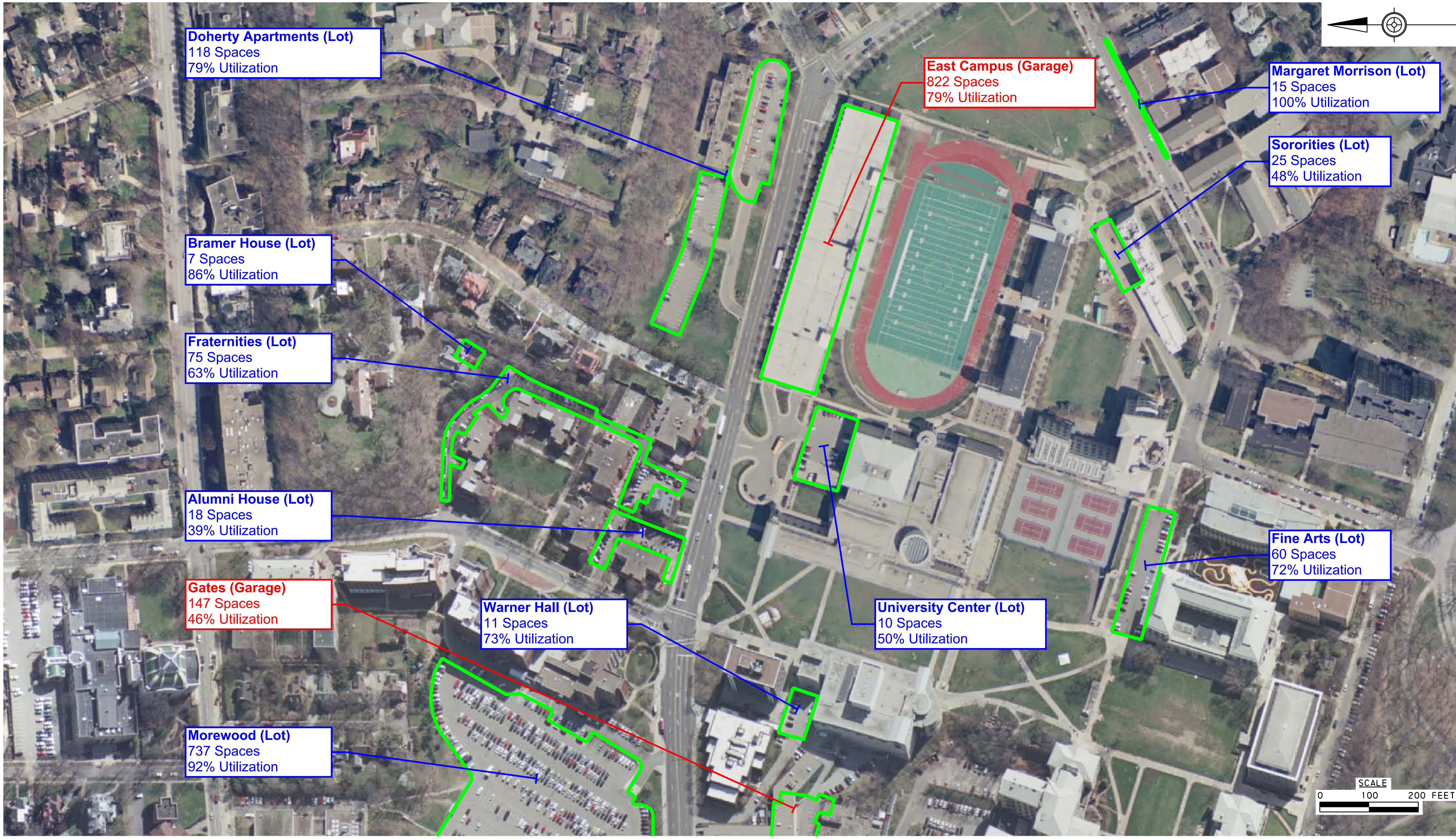

Figure 4
Vehicular Parking Utilization - Surface Lots, Garages, and Metered (On-street) Parking

Legend:

Surface Lot	Garage
__ Spaces	__ Spaces
__% Utilization	__% Utilization

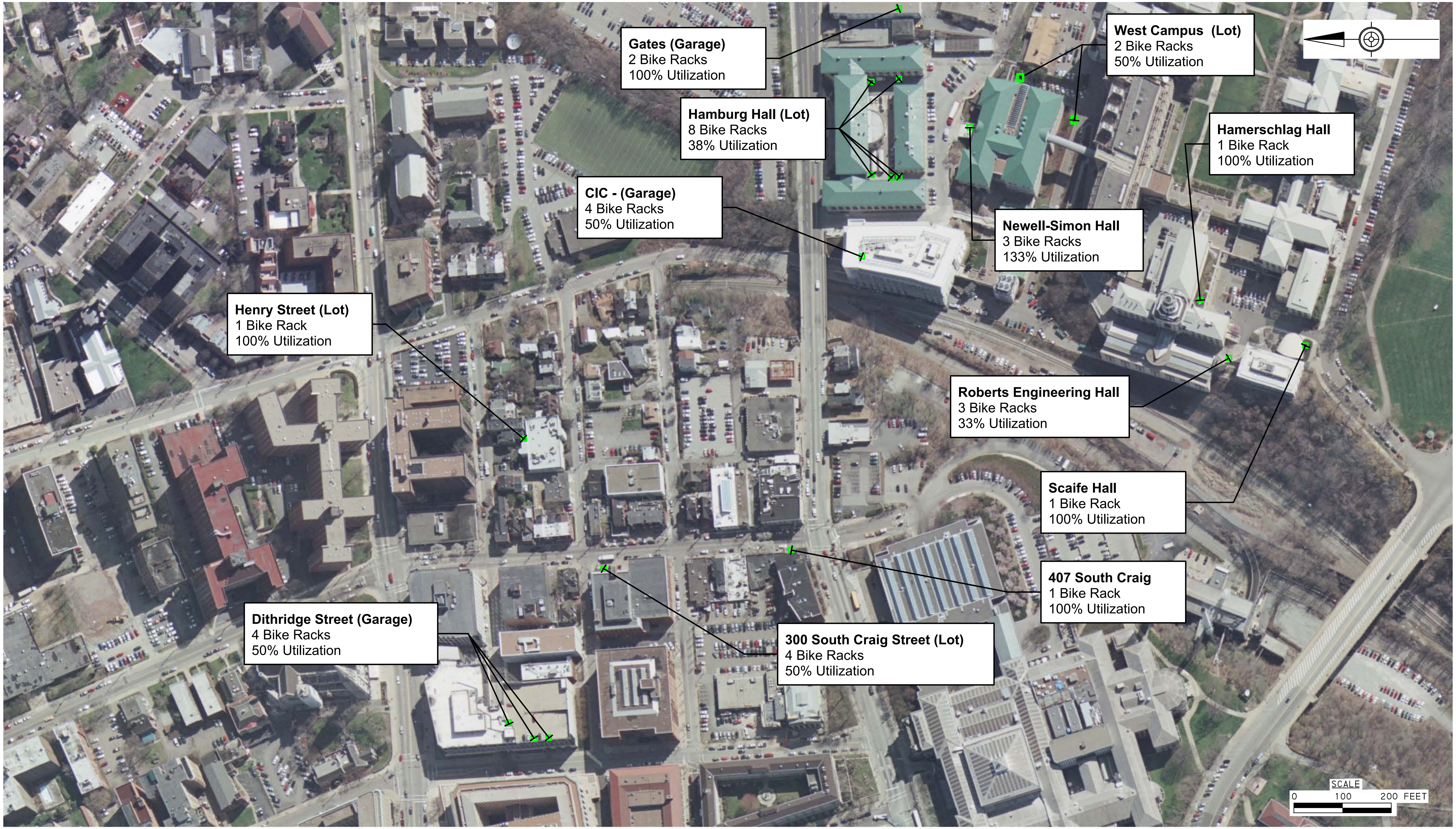

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Figure 5
Bike Rack Utilization

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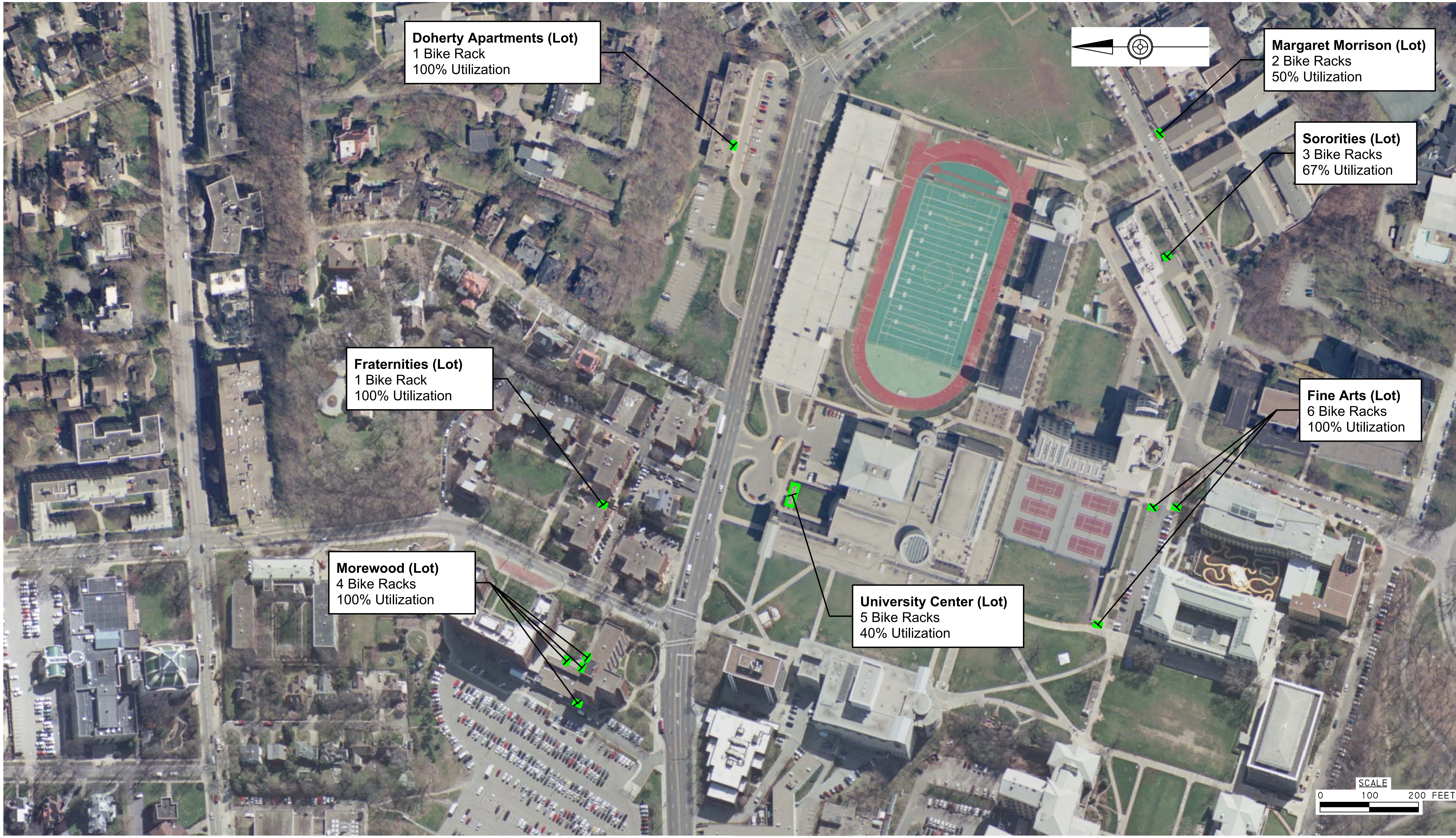

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Figure 6
Bike Rack Utilization

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Table 3

Parking Utilization - Lots and Garages Near Carnegie Mellon University

Location		Total	Disabled	Motorcycle	Meters	Bike Racks
300 South Craig Street (Lot)	Spaces:	12	-	-	-	4
	10:30	8	-	-	-	1
	11:21	12	-	-	-	1
	12:00	11	-	-	-	2
	12:49	12	-	-	-	2
	1:11	8	-	-	-	2
	1:30	11	-	-	-	2
	1:51	10	-	-	-	2
	Average:	10	-	-	-	2
	Utilization:	83%	-	-	-	50%
6555 Penn Avenue (Lot)	Spaces:	55	2	-	5	-
			(Not Counted, Off Campus)			
Alumni House (Lot)	Spaces:	18	1	-	-	-
	10:15	7	0	-	-	-
	10:55	7	0	-	-	-
	11:35	7	0	-	-	-
	12:05	7	0	-	-	-
	12:30	6	0	-	-	-
	1:05	7	0	-	-	-
	1:40	6	0	-	-	-
	Average:	7	0	-	-	-
	Utilization:	39%	0%	-	-	-
Bramer House (Lot)	Spaces:	7	-	-	-	-
	10:10	6	-	-	-	-
	11:50	6	-	-	-	-
	11:30	6	-	-	-	-
	12:00	6	-	-	-	-
	12:25	5	-	-	-	-
	1:00	5	-	-	-	-
	1:35	6	-	-	-	-
	Average:	6	-	-	-	-
	Utilization:	86%	-	-	-	-
CIC - Gated (Garage)	Spaces:	200	-	-	-	2
	11:00	121	-	-	-	1
	12:00	127	-	-	-	1
	1:10	117	-	-	-	1
	1:50	123	-	-	-	1
	Average:	122	-	-	-	1
	Utilization:	61%	-	-	-	50%
CIC - Ungated (Garage)	Spaces:	11	-	-	-	2
	10:50	9	-	-	-	1
	12:00	9	-	-	-	1
	1:10	10	-	-	-	1
	1:50	10	-	-	-	1
	Average:	10	-	-	-	1
	Utilization:	91%	-	-	-	50%

Table 3 (Cont'd)
Parking Utilization - Lots and Garages Near Carnegie Mellon University

Location		Total	Disabled	Motorcycle	Meters	Bike Racks
Dithridge Street (Garage)	Spaces:	328	-	-	-	4
	10:05	244	-	-	-	1
	11:06	273	-	-	-	1
	11:46	279	-	-	-	2
	12:35	275	-	-	-	2
	1:05	278	-	-	-	2
	Average:	270	-	-	-	2
	Utilization:	82%	-	-	-	50%
Doherty Apartments (Lot)	Spaces:	118	-	-	-	1
	10:20	88	-	-	-	1
	11:00	90	-	-	-	1
	11:40	95	-	-	-	1
	12:15	97	-	-	-	1
	12:40	95	-	-	-	1
	1:10	92	-	-	-	1
	1:50	93	-	-	-	1
	Average:	93	-	-	-	1
	Utilization:	79%	-	-	-	100%
East Campus (Garage)	Spaces:	822	19	-	-	-
	9:52	680	7	-	-	-
	12:10	634	6	-	-	-
	1:05	643	8	-	-	-
	Average:	652	7	-	-	-
	Utilization:	79%	37%	-	-	-
5th and Craig (Garage)	Spaces:	25	-	-	-	-
	11:17	25	-	-	-	-
	11:57	25	-	-	-	-
	12:45	25	-	-	-	-
	1:10	25	-	-	-	-
	1:28	25	-	-	-	-
	1:50	25	-	-	-	-
	Average:	25	-	-	-	-
	Utilization:	100%	-	-	-	-
Fine Arts (Lot)	Spaces:	60	4	-	-	6
	10:20	37	4	-	-	6
	11:30	46	4	-	-	6
	12:30	43	4	-	-	6
	1:25	45	4	-	-	6
	Average:	43	4	-	-	6
	Utilization:	72%	100%	-	-	100%
Fraternities (Lot)	Spaces:	75	-	-	-	1
	10:10	39	-	-	-	1
	10:50	44	-	-	-	1
	11:30	48	-	-	-	1
	12:00	49	-	-	-	1
	12:25	50	-	-	-	1
	1:00	48	-	-	-	1
	1:35	52	-	-	-	1
	Average:	47	-	-	-	1
	Utilization:	63%	-	-	-	100%

Parking Utilization - Lots and Garages Near Carnegie Mellon University

Location		Total	Disabled	Motorcycle	Meters	Bike Racks
Frew Street Parking (Lot)	Spaces:	9	9	-	-	-
	10:25	5	5	-	-	-
	11:35	6	6	-	-	-
	12:40	5	5	-	-	-
	1:30	6	6	-	-	-
	Average:	6	6	-	-	-
	Utilization:	67%	67%	-	-	-
Gates (Garage)	Spaces:	147	5	-	-	2
	10:50	61	3	-	-	2
	12:30	72	2	-	-	2
	1:32	70	3	-	-	2
	Average:	68	3	-	-	2
	Utilization:	46%	60%	-	-	100%
GATF (Lot)	Spaces:	81	2	-	-	-
	11:08	67	2	-	-	-
	12:44	64	2	-	-	-
	1:43	64	2	-	-	-
	Average:	65	2	-	-	-
	Utilization:	80%	100%	-	-	-
Hamburg Hall (Lot)	Spaces:	24	1	6	-	8
	11:15	7	1	5	-	3
	12:50	9	1	5	-	3
	1:50	7	1	7	-	3
	Average:	8	1	6	-	3
	Utilization:	33%	100%	100%	-	38%
Henry Street (Lot)	Spaces:	9	-	-	-	1
	10:47	7	-	-	-	1
Note: An automatic lift with boom	11:30	7	-	-	-	1
for a painting crew was parked in	12:20	8	-	-	-	0
one (1) spot for the duration of the	12:57	7	-	-	-	1
counts.	1:20	6	-	-	-	1
	1:39	8	-	-	-	1
	1:59	9	-	-	-	1
	Average:	7	-	-	-	1
	Utilization:	78%	-	-	-	100%
Margaret Morrison (Lot)	Spaces:	15	-	-	-	2
	10:07	15	-	-	-	1
	11:25	15	-	-	-	1
	12:25	15	-	-	-	1
	1:20	15	-	-	-	1
	Average:	15	-	-	-	1
	Utilization:	100%	-	-	-	50%
Morewood (Lot)	Spaces:	737	8	-	15	4
	10:00	649	1	-	14	4
	10:40	673	1	-	14	4
	11:20	683	1	-	13	4
	11:50	688	1	-	13	4
	12:15	682	1	-	14	4
	12:55	689	1	-	13	4
	1:25	694	1	-	10	4
	Average:	680	1	-	13	4
	Utilization:	92%	13%	-	87%	100%

Table 3 (Cont'd)
Parking Utilization - Lots and Garages Near Carnegie Mellon University

Location		Total	Disabled	Motorcycle	Meters	Bike Racks
Porter-Hamerschlag-Wean (Lot)	Spaces:	68	4	8	-	-
	10:30	51	1	7	-	-
	11:40	53	1	6	-	-
	12:50	57	2	7	-	-
	1:35	55	2	7	-	-
	Average:	54	2	7	-	-
	Utilization:	79%	50%	88%	-	-
Pittsburgh Technology Center (Lot)		91	-	-	-	-
			(Not Counted, Off Campus)			
Sororities (Lot)	Spaces:	25	-	-	-	3
	9:50	13	-	-	-	2
	11:20	15	-	-	-	2
	12:25	9	-	-	-	2
	1:20	11	-	-	-	2
	Average:	12	-	-	-	2
	Utilization:	48%	-	-	-	67%
University Center (Lot)	Spaces:	10	1	2	-	5
	11:29	5	0	0	-	1
	1:00	7	0	0	-	2
	1:57	4	1	0	-	3
	Average:	5	0	0	-	2
	Utilization:	50%	0%	0%	-	40%
Warner Hall (Lot)	Spaces:	11	5	-	-	-
	11:25	10	2	-	-	-
	12:54	8	2	-	-	-
	1:55	7	3	-	-	-
	Average:	8	2	-	-	-
	Utilization:	73%	40%	-	-	-
West Campus (Lot)	Spaces:	6	3	-	-	2
	10:45	5	0	-	-	1
	11:50	4	0	-	-	1
	12:55	7	1	-	-	1
	1:40	7	1	-	-	2
	Average:	6	1	-	-	1
	Utilization:	100%	33%	-	-	50%
Whitfield Hall (Lot)	Spaces:	61	1	-	10	-
	10:55	36	1	-	9	-
	11:35	37	1	-	9	-
	12:27	31	1	-	10	-
	1:00	26	1	-	10	-
	1:22	31	1	-	10	-
	1:43	35	1	-	10	-
	2:05	40	1	-	10	-
	Average:	34	1	-	10	-
	Utilization:	56%	100%	-	100%	-

Table 3 (Cont'd)

Parking Utilization - Lots and Garages Near Carnegie Mellon University

Location		Total	Disabled	Motorcycle	Meters	Bike Racks
Zebina Way (Lot)	Spaces:	30	-	-	-	-
	10:39	27	-	-	-	-
	11:26	27	-	-	-	-
	12:15	26	-	-	-	-
	12:54	25	-	-	-	-
	1:18	26	-	-	-	-
	1:37	28	-	-	-	-
	1:58	29	-	-	-	-
	Average:	27	-	-	-	-
	Utilization:	90%	-	-	-	-
Maggie Stoefronts	Spaces:	(Not, Counted, Could Not Locate)				1
Hill Dorms	Spaces:	(Not, Counted, Could Not Locate)				6
Scaife Hall	Spaces:	-	-	-	-	1
	10:35	-	-	-	-	1
	11:35	-	-	-	-	1
	12:45	-	-	-	-	2
	1:35	-	-	-	-	1
	Average:	-	-	-	-	1
	Utilization:	-	-	-	-	100%
Hamerschlag Hall	Spaces:	-	-	-	-	1
	10:35	-	-	-	-	1
	11:40	-	-	-	-	1
	12:45	-	-	-	-	1
	1:35	-	-	-	-	1
	Average:	-	-	-	-	1
	Utilization:	-	-	-	-	100%
Roberts Engineering Hall	Spaces:	-	-	-	-	3
	10:40	-	-	-	-	1
	11:45	-	-	-	-	1
	12:50	-	-	-	-	1
	1:40	-	-	-	-	1
	Average:	-	-	-	-	1
	Utilization:	-	-	-	-	33%
407 South Craig	Spaces:	-	-	-	-	1
	10:33	-	-	-	-	1
	11:23	-	-	-	-	1
	12:01	-	-	-	-	1
	12:50	-	-	-	-	1
	1:14	-	-	-	-	1
	1:33	-	-	-	-	1
	1:54	-	-	-	-	1
	Average:	-	-	-	-	1
	Utilization:	-	-	-	-	100%
Newell-Simon Hall	Spaces:	-	-	-	-	3
	11:10	-	-	-	-	4
	11:50	-	-	-	-	4
	12:55	-	-	-	-	5
	1:45	-	-	-	-	5
	Average:	-	-	-	-	4
	Utilization:	-	-	-	-	133%
	Sum of all "Spaces:" =	2909	63	16	25	56
	Sum of all "Average:" =	2280	30	13	23	38
	Total Utilization =	**78%**	**48%**	**81%**	**92%**	**68%**

Table 4

Parking Utilization - Metered (On-street) Parking Near Carnegie Mellon University

Location		Total	1-hour	2-hour	4-hour	Disabled	Loading
North side of Fifth Avenue from North Bellefield Avenue to North Dithridge Street	Spaces:	2	-	2	-	-	-
	10:20	2	-	2	-	-	-
	11:00	2	-	2	-	-	-
	11:40	2	-	2	-	-	-
	12:30	2	-	2	-	-	-
	1:02	2	-	2	-	-	-
	1:24	2	-	2	-	-	-
	1:46	2	-	2	-	-	-
	Average:	2	-	2	-	-	-
	Utilization:	100%	-	100%	-	-	-
South Side of Fifth Avenue from South Dithridge Street to South Craig Street	Spaces:	8	8	-	-	-	-
	10:20	6	6	-	-	-	-
	10:59	8	8	-	-	-	-
	11:39	6	6	-	-	-	-
	12:30	8	8	-	-	-	-
	1:02	7	7	-	-	-	-
	1:24	6	6	-	-	-	-
	1:46	6	6	-	-	-	-
	Average:	7	7	-	-	-	-
	Utilization:	88%	88%	-	-	-	-
North Side of Fifth Avenue from North Craig Street to North Neville Street	Spaces:	10	-	8	-	2	-
	10:50	8	-	8	-	0	-
	11:31	5	-	5	-	0	-
	12:22	3	-	3	-	0	-
	12:58	6	-	6	-	0	-
	1:21	8	-	8	-	0	-
	1:41	9	-	8	-	1	-
	2:01	8	-	7	-	1	-
	Average:	7	-	6	-	0	-
	Utilization:	70%	-	75%	-	0%	-
South Side of Winthrop Street from South Dithridge Street to South Craig Street	Spaces:	13	-	13	-	-	-
	10:30	13	-	13	-	-	-
	11:20	12	-	12	-	-	-
	11:58	13	-	13	-	-	-
	12:47	13	-	13	-	-	-
	1:11	13	-	13	-	-	-
	1:30	13	-	13	-	-	-
	1:51	12	-	12	-	-	-
	Average:	13	-	13	-	-	-
	Utilization:	100%	-	100%	-	-	-
South Side of Winthrop Street from South Craig Street to South Neville Street	Spaces:	5	-	4	-	-	1
	10:36	2	-	2	-	-	0
	11:25	3	-	3	-	-	0
	12:11	4	-	4	-	-	0
	12:52	4	-	4	-	-	0
	1:17	4	-	4	-	-	0
	1:36	4	-	4	-	-	0
	1:57	2	-	2	-	-	0
	Average:	3	-	3	-	-	0
	Utilization:	60%	-	75%	-	-	0%

Table 4 (Cont'd)
Parking Utilization - Metered (On-street) Parking Near Carnegie Mellon University

Location		Total	1-hour	2-hour	4-hour	Disabled	Loading
North Side of Filmore Street from South Craig Street to South Neville Street	Spaces:	3	-	3	-	-	-
	10:35	2	-	2	-	-	-
	11:24	3	-	3	-	-	-
	12:10	3	-	3	-	-	-
	12:51	3	-	3	-	-	-
	1:17	3	-	3	-	-	-
	1:36	3	-	3	-	-	-
	1:57	2	-	2	-	-	-
	Average:	3	-	3	-	-	-
	Utilization:	100%	-	100%	-	-	-
West Side of South Dithridge Street from Fifth Avenue to Filmore Street	Spaces:	13	-	-	13	-	-
	10:22	13	-	-	13	-	-
	11:00	13	-	-	13	-	-
	11:40	13	-	-	13	-	-
	12:31	13	-	-	13	-	-
	1:03	13	-	-	13	-	-
	1:25	13	-	-	13	-	-
	1:47	13	-	-	13	-	-
	Average:	13	-	-	13	-	-
	Utilization:	100%	-	-	100%	-	-
East Side of South Dithridge Street from Filmore Street to Forbes Avenue	Spaces:	8	-	-	5	-	3
	10:23	8	-	-	5	-	3
	11:02	5	-	-	5	-	0
	11:41	7	-	-	5	-	2
	12:32	8	-	-	5	-	3
	1:03	8	-	-	5	-	3
	1:25	8	-	-	5	-	3
	1:47	8	-	-	5	-	3
	Average:	7	-	-	5	-	2
	Utilization:	88%	-	-	100%	-	67%
West Side of South Craig Street from Henry Street to Winthrop Street	Spaces:	6	6	-	-	-	-
	10:29	4	4	-	-	-	-
	11:18	4	4	-	-	-	-
	11:58	5	5	-	-	-	-
	12:46	5	5	-	-	-	-
	1:11	6	6	-	-	-	-
	1:29	5	5	-	-	-	-
	1:50	6	6	-	-	-	-
	Average:	5	5	-	-	-	-
	Utilization:	83%	83%	-	-	-	-
West Side of South Craig Street from Winthrop Street to Filmore Street	Spaces:	5	5	-	-	-	-
	10:32	3	3	-	-	-	-
	11:23	5	5	-	-	-	-
	12:01	5	5	-	-	-	-
	12:50	5	5	-	-	-	-
	1:14	5	5	-	-	-	-
	1:33	5	5	-	-	-	-
	1:54	5	5	-	-	-	-
	Average:	5	5	-	-	-	-
	Utilization:	100%	100%	-	-	-	-

Table 4 (Cont'd)

Parking Utilization - Metered (On-street) Parking Near Carnegie Mellon University

Location		Total	1-hour	2-hour	4-hour	Disabled	Loading
West Side of South Craig Street	Spaces:	9	8	-	-	-	1
from Filmore Street to Forbes	10:33	9	8	-	-	-	1
Avenue	11:23	9	8	-	-	-	1
	12:01	8	8	-	-	-	0
Note: An average of four (4)	12:50	9	8	-	-	-	1
bikes were chained to parking	1:14	8	7	-	-	-	1
meters at this location at the	1:33	8	7	-	-	-	1
time of each count.	1:54	9	8	-	-	-	1
	Average:	9	8	-	-	-	1
	Utilization:	100%	100%	-	-	-	100%
East Side of South Craig Street	Spaces:	9	8	-	-	-	1
from Filmore Street to Forbes	10:34	8	8	-	-	-	0
Avenue	11:24	8	8	-	-	-	0
	12:10	8	8	-	-	-	0
Note: An average of one (1) bike	12:51	8	7	-	-	-	1
was chained to a parking meter	1:17	7	6	-	-	-	1
at this location at the time of	1:36	8	8	-	-	-	0
each count.	1:57	8	8	-	-	-	0
	Average:	8	8	-	-	-	0
	Utilization:	89%	100%	-	-	-	0%
East Side of South Craig Street	Spaces:	7	7	-	-	-	-
from Winthrop Street to Filmore	10:35	4	4	-	-	-	-
Street	11:25	7	7	-	-	-	-
	12:11	7	7	-	-	-	-
	12:51	7	7	-	-	-	-
	1:17	7	7	-	-	-	-
	1:36	7	7	-	-	-	-
	1:57	6	6	-	-	-	-
	Average:	6	6	-	-	-	-
	Utilization:	86%	86%	-	-	-	-
East Side of South Craig Street	Spaces:	4	4	-	-	-	-
from Henry Street to Winthrop	10:45	1	1	-	-	-	-
Street	11:29	4	4	-	-	-	-
	12:19	4	4	-	-	-	-
	12:56	4	4	-	-	-	-
	1:20	4	4	-	-	-	-
	1:39	4	4	-	-	-	-
	1:59	4	4	-	-	-	-
	Average:	4	4	-	-	-	-
	Utilization:	100%	100%	-	-	-	-
	Sum of all "Spaces:" =	102	46	30	18	2	6
	Sum of all "Average:" =	92	43	27	18	0	3
	Total Utilization =	**90%**	**93%**	**90%**	**100%**	**0%**	**50%**

Section 4 – Land Use and Relationship to Transportation

In order to effectively understand the complexity and interconnectedness of the study area, an urban design analysis that breaks down the various land uses and dissects the various modes of transportation was conducted indicating the following:

+ Land Use
+ Street Network
+ Public Transit
+ Bike Routes
+ Sidewalks
+ Pedestrian Corridors & Destinations

In general, the primary land use in the Fifth and Forbes Avenue corridor is institutional (CMU, Pitt, and UPMC campuses) but also includes neighborhood commercial along South Craig Street and vast residential areas to the north and east. The study area also lies between these residential areas and downtown Pittsburgh, which leads to a strong commuter (motorists, cyclists, and pedestrians) flow to and across the study area on a constant basis.

The foundation of the street network is Fifth and Forbes Avenues, serving as the main east-west arterials, with South Bellefield Avenue, South Craig Street, and Morewood Avenue providing the connections between. This network can be visualized as a “ladder” system with Fifth and Forbes acting as the supports and the other streets acting as the rungs. The study area is well served by public transit, which is provided by the Port Authority of Allegheny County. In addition to the many bus stops and handful of bus shelters in the area, there are two bus layover areas located near the intersection of Forbes and Morewood Avenues, at the core of the current campus of the university.

However, even to the casual observer, the "ladder" is missing a few rungs in the north-south network in pedestrian and vehicular movements between Forbes and Fifth Avenues. For vehicles, Craig Street and Morewood Avenue are separated by almost 1500 feet, not a major detriment but one, which causes congestion on each of these streets in the peak hours. Neville Street occupies the ravine below Forbes Avenue, and connectedness of this street to the network above on Forbes is problematic, but connectedness via pedestrian and cyclist movements can certainly be enhanced, along with future parking facilities, which can contribute to sufficient local diversion of vehicles during peak hours hopefully reducing congestion on Morewood Avenue and Craig Street. The pedestrian deficiencies lie in the lack of cross campus north-south routes other than through the open lot opposite Hamburg Hall. However more significant deficiencies exist for pedestrians crossing Forbes Avenue with only one legal crossing between Craig Street and Morewood Avenue, again at Hamburg Hall.

For cyclists, the popularity of bike commuting has seen a significant increase on the roads throughout the City in the past few years. This has resulted in several actions by the City of Pittsburgh. The first action is the ongoing development a bike route planning and signage study. The second more direct action was the conversion of an on-street parking lane on Forbes Avenue from Margaret Morrison Street to Schenley Park (just outside of the study area). Cycling is also popular on the CMU campus, which is evident by the lack of available bike parking. The study area is well connected to the regional bike trail network via South Neville Street at the intersection with Fifth Avenue. From there, cyclists can travel south along Boundary Street to get on the Panther Hollow Trail. This trail connects to the Eliza Furnace Trail, which is part of the Great Allegheny Passage that links Pittsburgh to Washington, DC. Sidewalks in the study area are typically narrow and are located directly adjacent to the street curb. The lack of a tree lawn and street trees in the study area generally contributes to increased traffic speeds and pedestrian safety concerns, each identified as major issues, and both of which will be addressed by this study.

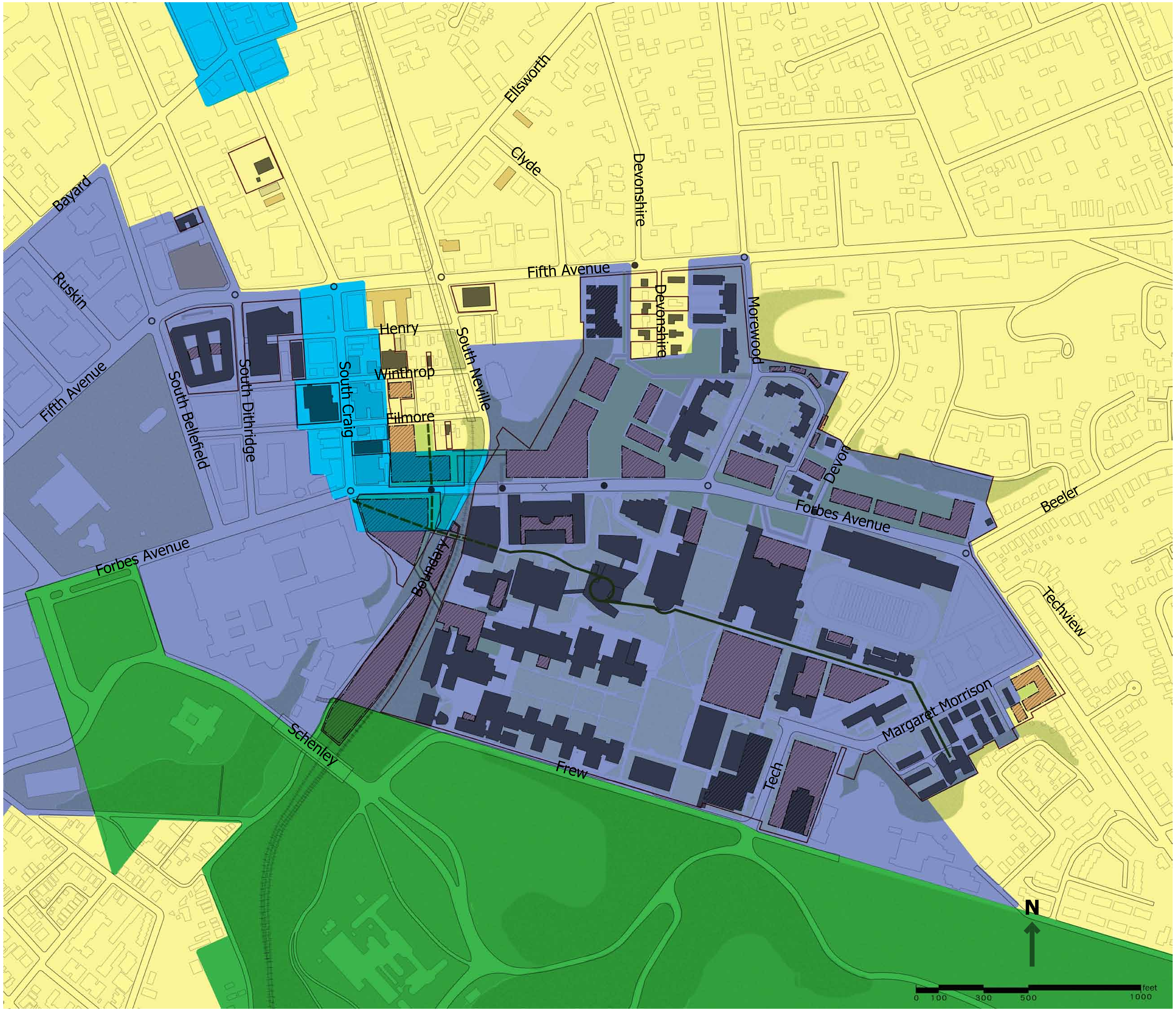

Figure 7
Land Use

The existing land use in the study area is predominantly educational and medical including the CMU campus, Carnegie Museum, the Pitt campus, and UPMC facilities. This includes most of Forbes, and Morewood, all South Bellefield and South Dithridge, and portions of South Neville. The section of Forbes between South Craig and South Neville, and South Craig between Forbes and Fifth is predominantly neighborhood commercial and professional office uses. North and east of the CMU campus and South Craig Street business district is predominantly residential of varying densities. Schenley Park, a major regional open space destination, borders the CMU campus to the south. Therefore, there is a dominant pedestrian flow south and west from the residential areas to campus and park destinations beyond.

Key

- Education/Medical (zoning: EMI)
- Special (zoning: OPR-B)
- Residential (zoning: R1A-H, R1D-L, R1D-VL, R2-H, R2-L, RM-H, RM-VH, RM-M, RP)
- Open Space (zoning: P)

Source: City of Pittsburgh Department of City Planning

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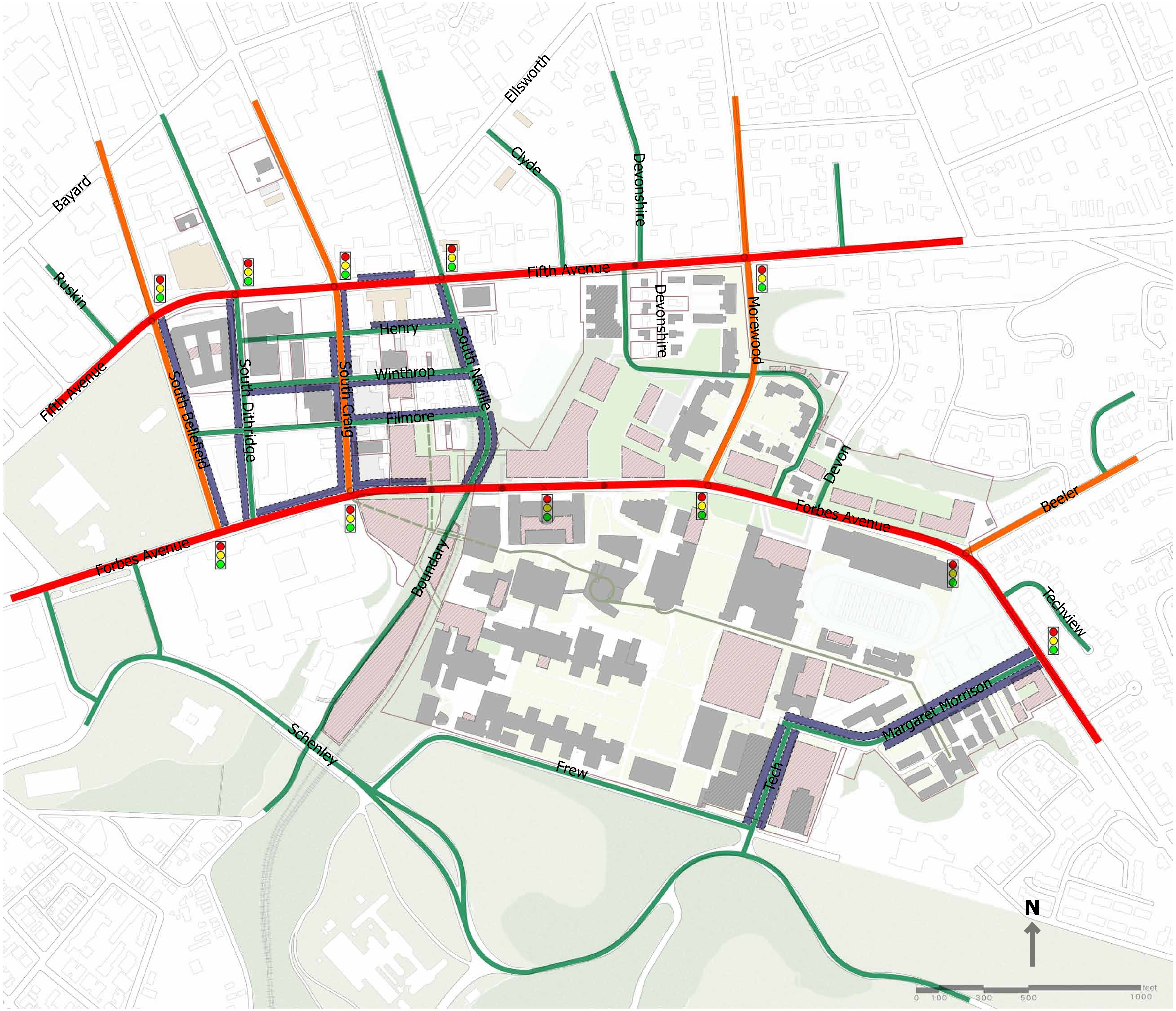
October 15, 2010

Figure 8
Street Network



There are three basic working classifications of roadways within the study area based. Arterials include Forbes and Fifth Avenues that run east-west, connecting the Shadyside and Squirrel Hill neighborhoods to Oakland and beyond through the CMU campus. Forbes Avenue bisects the historic campus area to planned expansion areas to the north. North-south collector streets include South Bellefield Avenue, South Craig Street, and Morewood Avenue, which connect South Oakland and the CMU campus to North Oakland and Shadyside. Other neighborhood streets that run north-south include South Dithridge and South Neville/Boundary Street. Signalized intersections occur along Fifth at South Bellefield, South Dithridge, South Craig, and South Neville, and along Forbes at South Bellefield, South Craig, Hamburg Hall, Morewood, Beeler, and Margaret Morrison.

Key

- Arterial
- Collector
- Neighborhood
- On-Street Parking
- Signalized Intersection

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Pedestrian Safety Mobility Study

October 15, 2010

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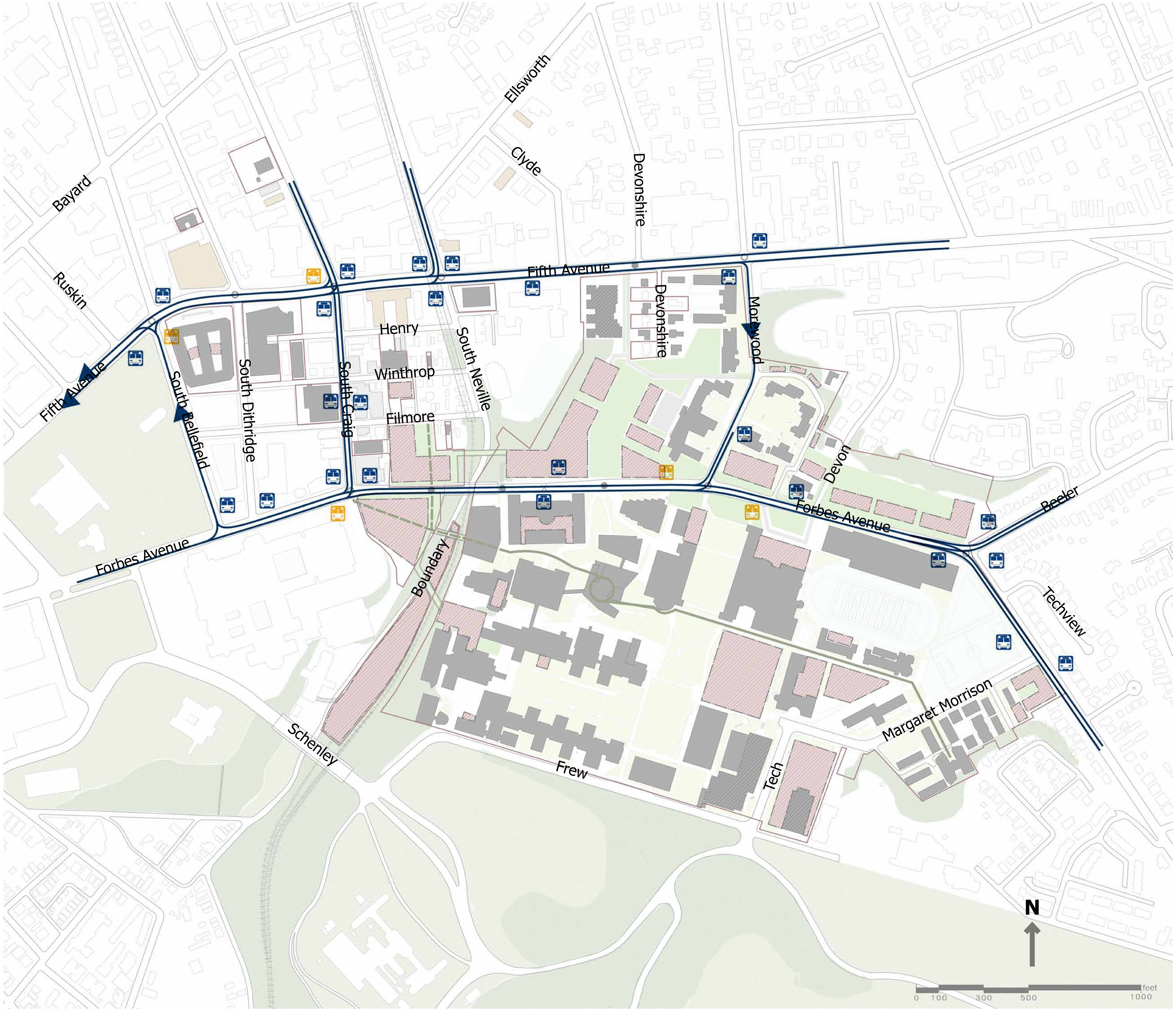

Figure 9
Public Transit

The study area is well served by public transit in the form of buses. Fifth and Forbes carry all of the east-west traffic while South Bellefield, South Craig, and Morewood handle the north-south routes. Buses traveling along North Neville (north of Fifth Avenue) connect to and from the East Busway, an express route to Downtown, at Centre Avenue. The 28X, or Airport Flyer, bus loops through the study area along South Bellefield, Fifth, Morewood, and Forbes. Only a handful of bus stops are equipped with shelters located at Forbes and Morewood, Forbes and South Craig, Fifth and North Craig, and Fifth and South Bellefield. The diagram reflects current changes in the bus schedule that took effect September 5, 2010.

Key

- Bus Route
- Bus Stop w/ Shelter
- Bus Stop

Source: Port Authority of Allegheny County (effective September 5, 2010)

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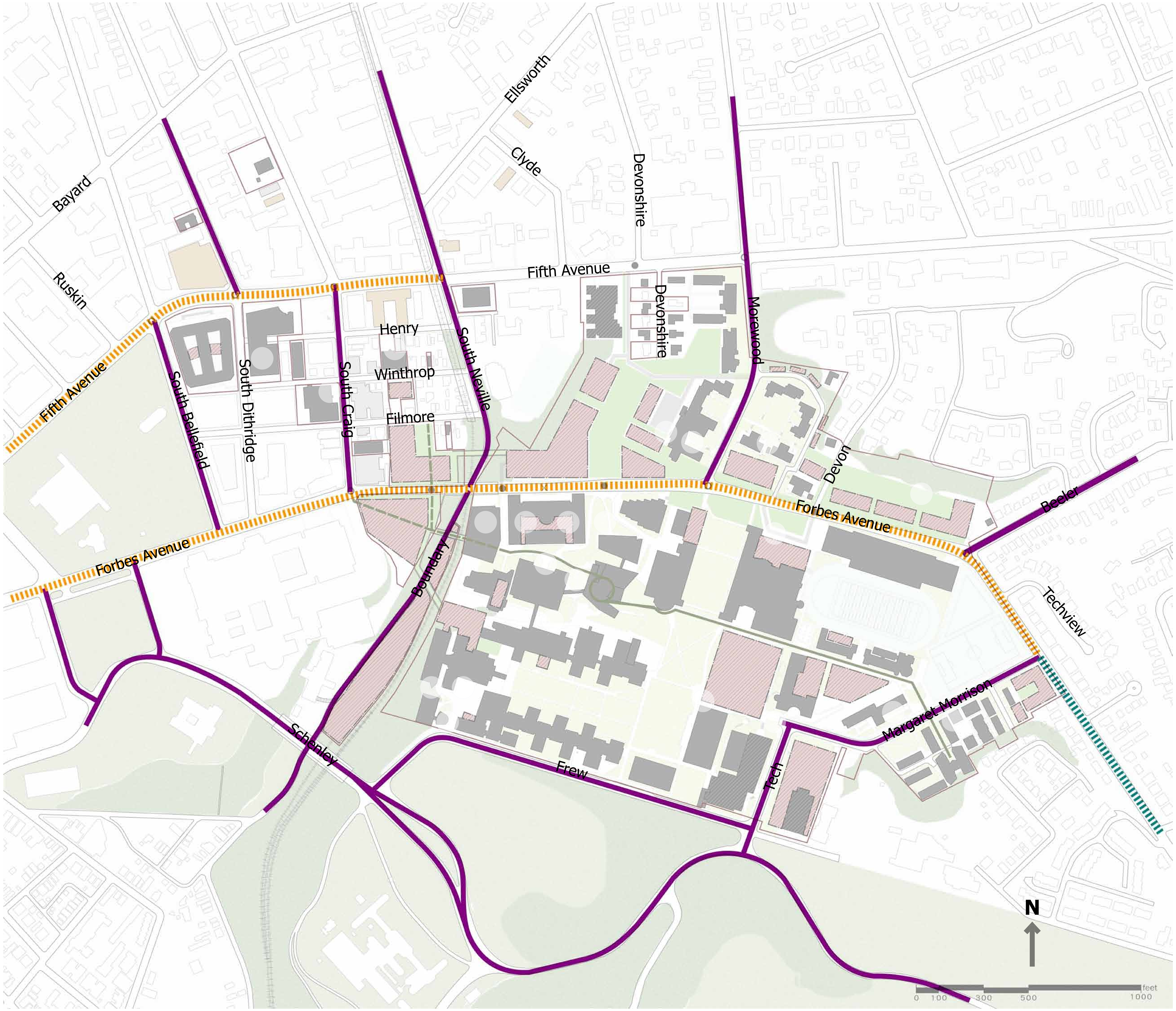
Figure 10
Bike Routes



Existing bike routes in the study area reflect a similar pattern to the street network hierarchy. The information represented on the diagram is taken from the most current version of the Bike Pittsburgh Map released earlier in 2010. The City of Pittsburgh is currently undertaking a bicycle route planning study that will further define bike routes and destinations within the study area and beyond. There is a dedicated bike lane on outbound Forbes Avenue from Margaret Morrison to Schenley Park. On-street bike routes include South Bellefield, South Craig, South Neville/Boundary, Morewood, and Beeler. Cautionary bike routes include Forbes from Margaret Morrison west to Oakland, and Fifth from South Neville west to Oakland. It is important to note that the Boundary Street bike route connects to the Panther Hollow Trail that ties into the Eliza Furnace Trail, which is part of the Great Allegheny Passage trail linking Pittsburgh to Washington, DC.

Key

- Dedicated Bike Lane
- On-Street Bike Route
- Cautionary Bike route
- Bicycle Parking

Source: BikePGH's "Pittsburgh Bike Map" (2010) and CMU Parking and Transportation Services

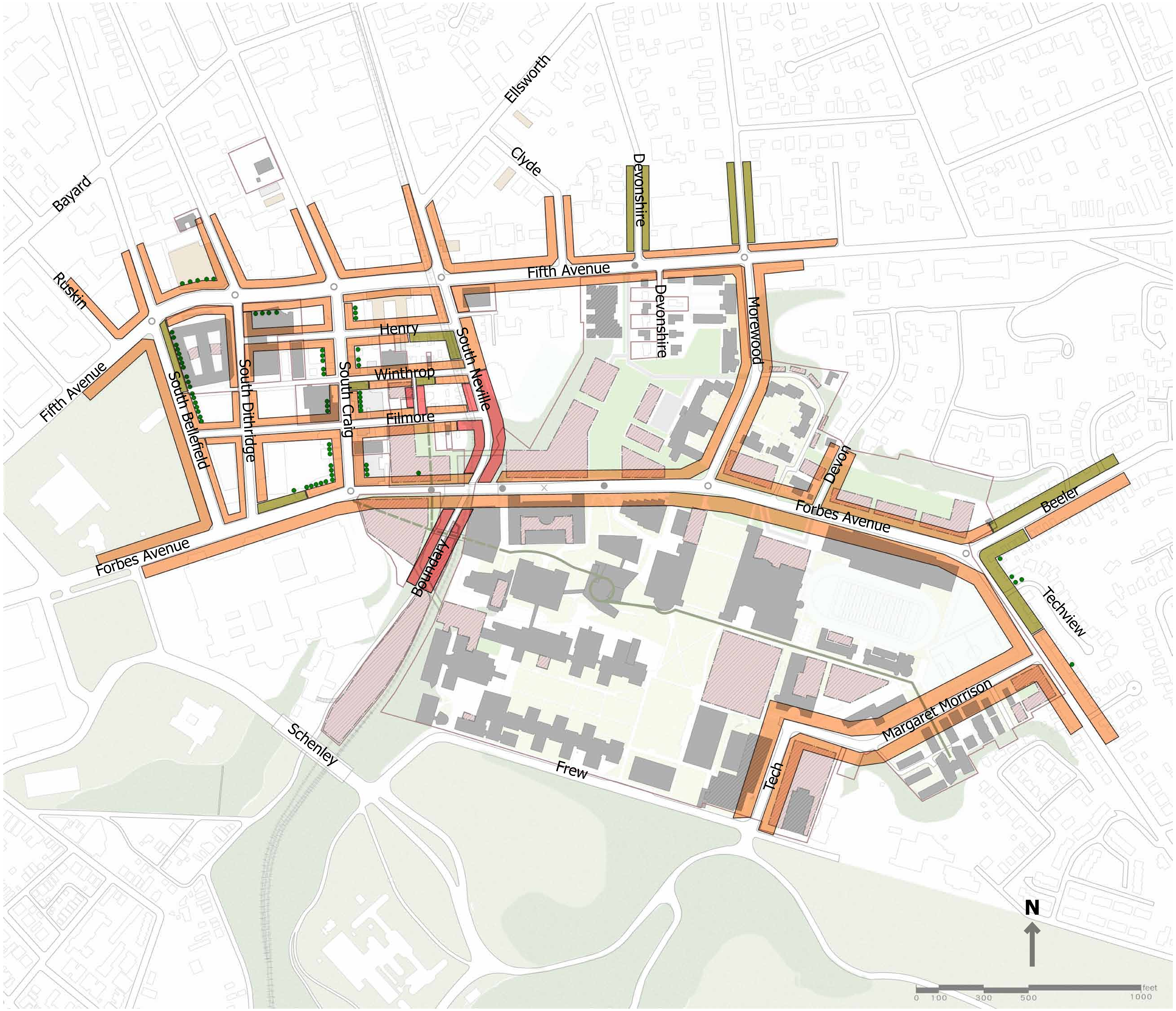


Figure 11
Sidewalks

A majority of the pedestrian circulation system within the study area is comprised of sidewalks directly adjacent to the street curb. Only a small portions of Forbes, between South Dithridge and South Craig and Beeler and Margaret Morrison, and South Bellefield contain tree lawns ("verges"). South Neville, south of Winthrop, and all of Boundary are void of sidewalks entirely. The lack of tree lawns means that most of the streets do not contain street trees within the public right-of-way. Street trees exist along the east side of South Bellefield, between Winthrop and Fifth, and along South Craig, between Forbes and Fifth. The trees along the remaining streets in the study area occur predominantly on private property.

Key

- Sidewalks Against Curb
- Sidewalks Against Tree Lawn
- No Sidewalks
- Street Trees within R/W

Source: GAI field reviews

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October 15, 2010

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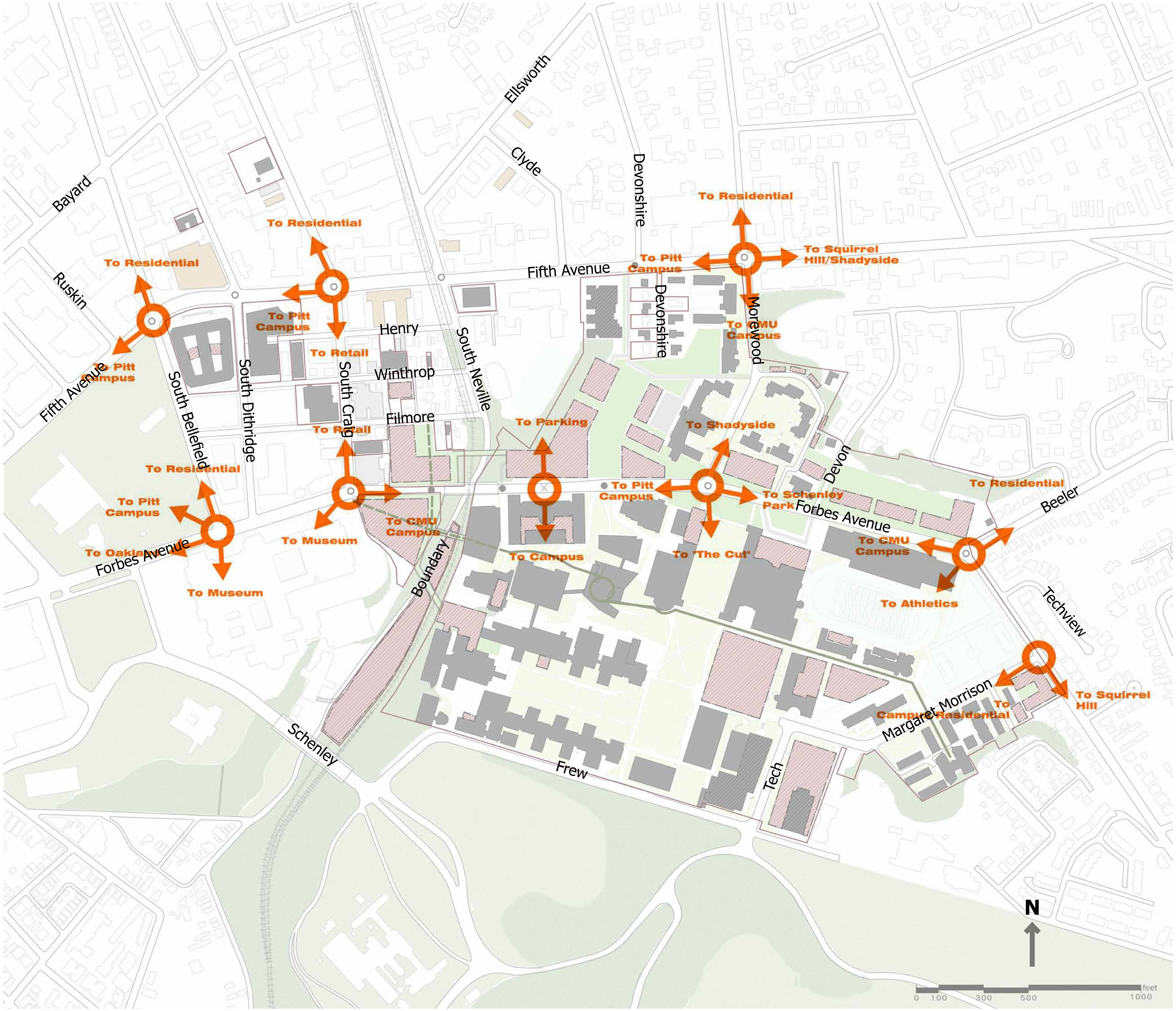

Figure 12
Pedestrian Corridors & Destinations

The Fifth and Forbes east-west corridors carry vehicular and pedestrian traffic to and from the Oakland and Squirrel Hill neighborhoods and beyond. Oakland destinations include the CMU campus, Pitt campus, UPMC, the Oakland business district, Schenley Park, and the Carnegie Museum. The north-south streets carry traffic from the North Oakland and Shadyside neighborhoods to destinations south including the Carnegie Museum (using South Dithridge), South Craig Street business district, CMU campus (using South Craig, South Neville, Morewood, and Beeler), and Panther Hollow Trail/Eliza Furnace Trail (using South Neville/Boundary).

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Section 5 – Concept Alternative Designs

The concepts presented herein were developed within Smart Transportation and Complete Streets guidelines with the intent of presenting options to increase overall safety and mobility for all users. However there are also the realities of funding, physical constraints and time to consider as the Study moves forward to define the optimal solutions for the 10 intersections and the intersecting street corridors between them.

The concepts were developed with several goals in mind. First it was determined that as the campus will now be greatly expanded, the study looked inward to the campus to determine if there were elements of the campus environment which could be utilized throughout the study area. Two key factors were identified which can be translated into the Forbes Avenue corridor to create a campus-like environment while at the same time achieve the study objectives of safety and mobility. These two factors are wider sidewalks and separation of pedestrians from the street environment. To this end the sections along Forbes and Morewood Avenues were developed. However bicyclists were not accommodated fully until a section was developed with the bike track/lane. As these concepts were presented to the project sponsors, it was noted that a likely hybrid of the concepts would emerge from the individual concepts and hopefully move forward into final recommendations.

For Craig Street the density of the street with the retail aspect creates its own environment, which we felt needed to be retained but enhanced. The high concentration of pedestrian, cyclist and vehicle uses all overlapping, often creates unsafe conditions, which must be addressed within a very confined street envelope. The physical constraint of the buildings themselves precludes a range of options.

Fifth Avenue likewise has a range of constraints from multiple users, such as a large elderly population, students of two campuses, CMU and Pitt, and high volumes of local and downtown commuting traffic, not in conflict but also not fully under the influence of the current or future campus of the university. To serve the many users of the street environment will prove challenging but will be resolved in the next stages of the study.

These next stages, the interview and public workshop sessions, will be critical to the success and direction of the project. Therefore, at this time it would be premature to assume any concept will move forward until the interview sessions are conducted with the key stakeholders and the public workshop will been held. With the combined input of these two events, the concepts can then be distilled into sound recommendations for design and implementation.

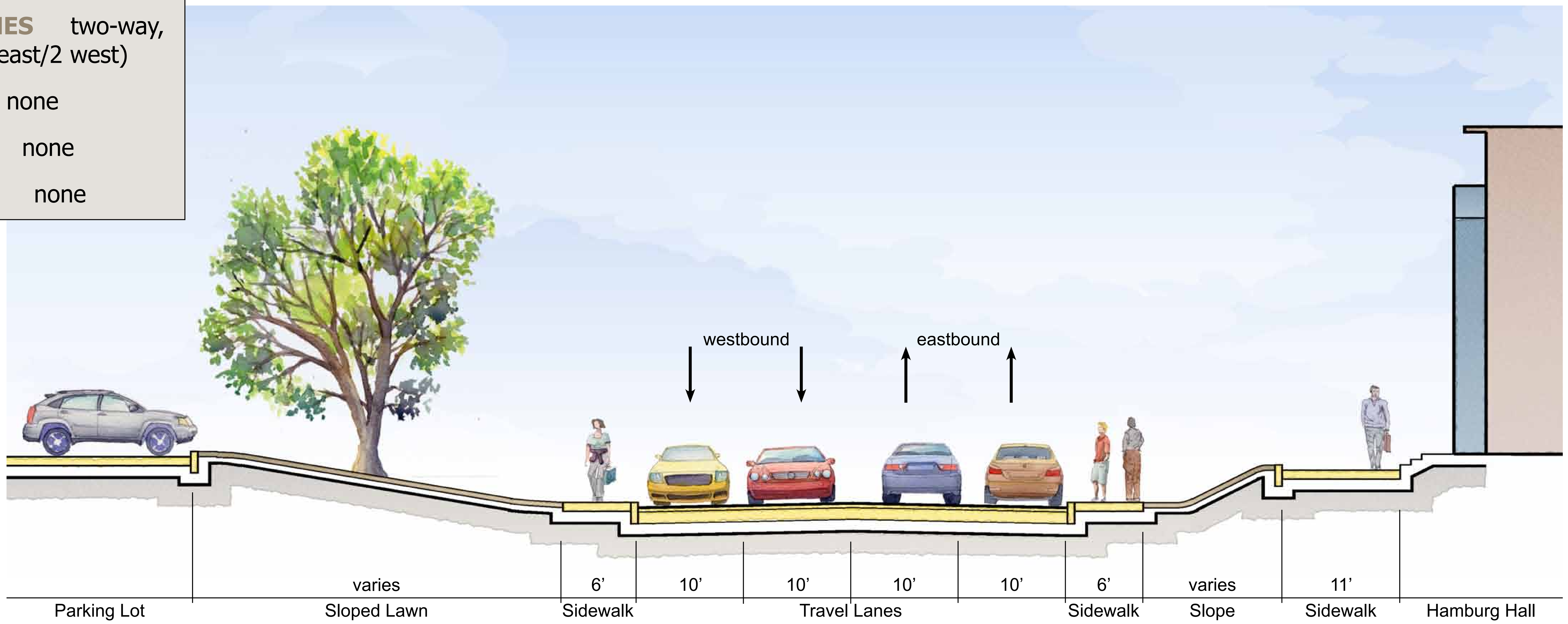
SPEED LIMIT 25 mph

TRAVEL LANES two-way, four lanes (2 east/2 west)

PARKING none

BIKE LANE none

TREE LAWN none



Forbes Avenue - Existing Conditions Concept

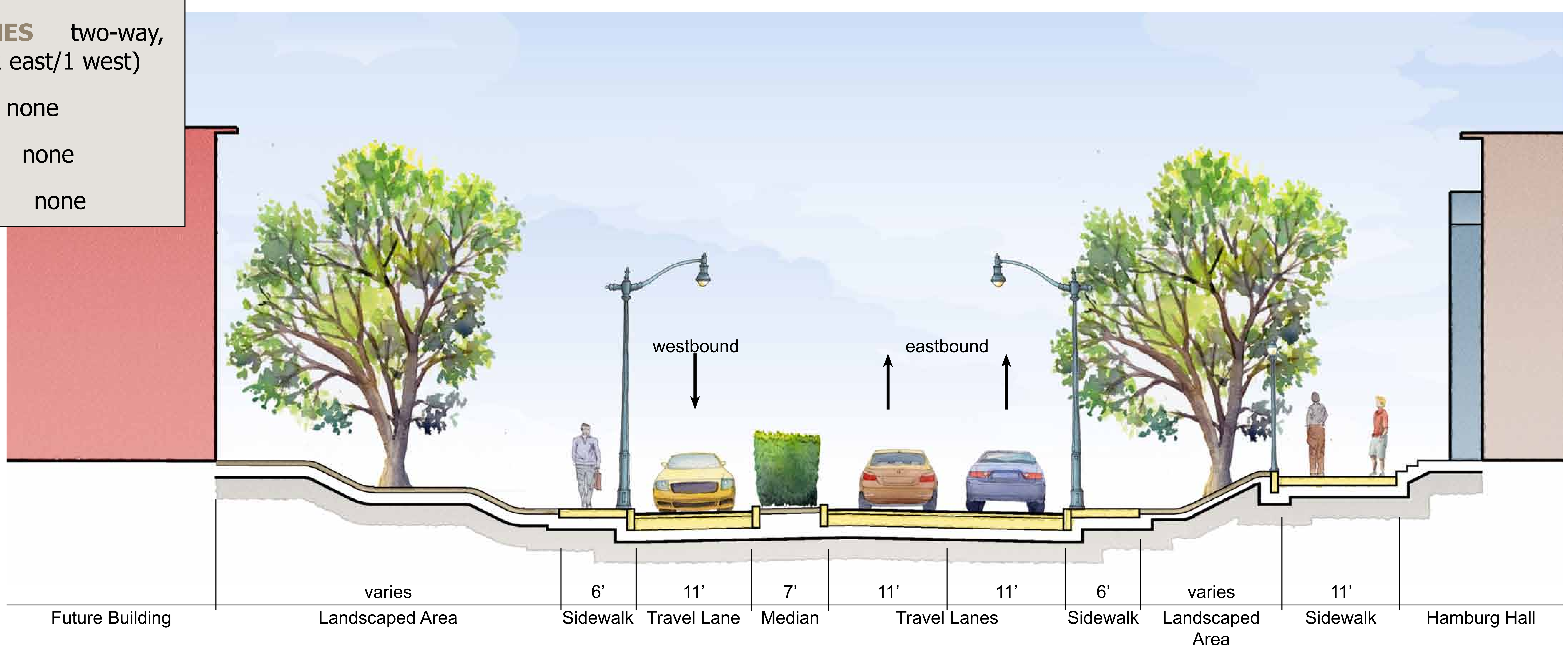
SPEED LIMIT 25 mph

TRAVEL LANES two-way, three lanes (2 east/1 west)

PARKING none

BIKE LANE none

TREE LAWN none



Forbes Avenue - Median Alternative Concept

Figure 13
Street Sections
Forbes Avenue

Forbes Avenue - Existing Conditions

This section depicts a narrow 40-foot wide section with 10-foot wide lanes operating as a PENNDOT owned arterial through campus.

- High speeds over 35 mph at times
- No campus environment
- Sidewalks narrow and adjacent to the roadway, below ADA standards in some areas
- No tree lawns
- No accommodation for bicyclists
- Large gaps in traffic, even during rush hours

Forbes Avenue - Median Alternative Concept

This section depicts a median with low-level trees and shrubs occupying the left lane of inbound Forbes Avenue to act as a traffic calming feature.

- Provides some campus-like effects
- Will have a modest effect on slowing travel speeds
- Can be varied to accommodate turning lanes
- A landscaped area is created along the south curb line to provide a long-term canopy over west/out-bound Forbes Avenue
- Costly construction for the creating a tree lawn in the former travel lane
- Creates tree lawn on outbound side of Forbes, and subsequent campus like environment

Figure 14
Street Sections
Forbes Avenue

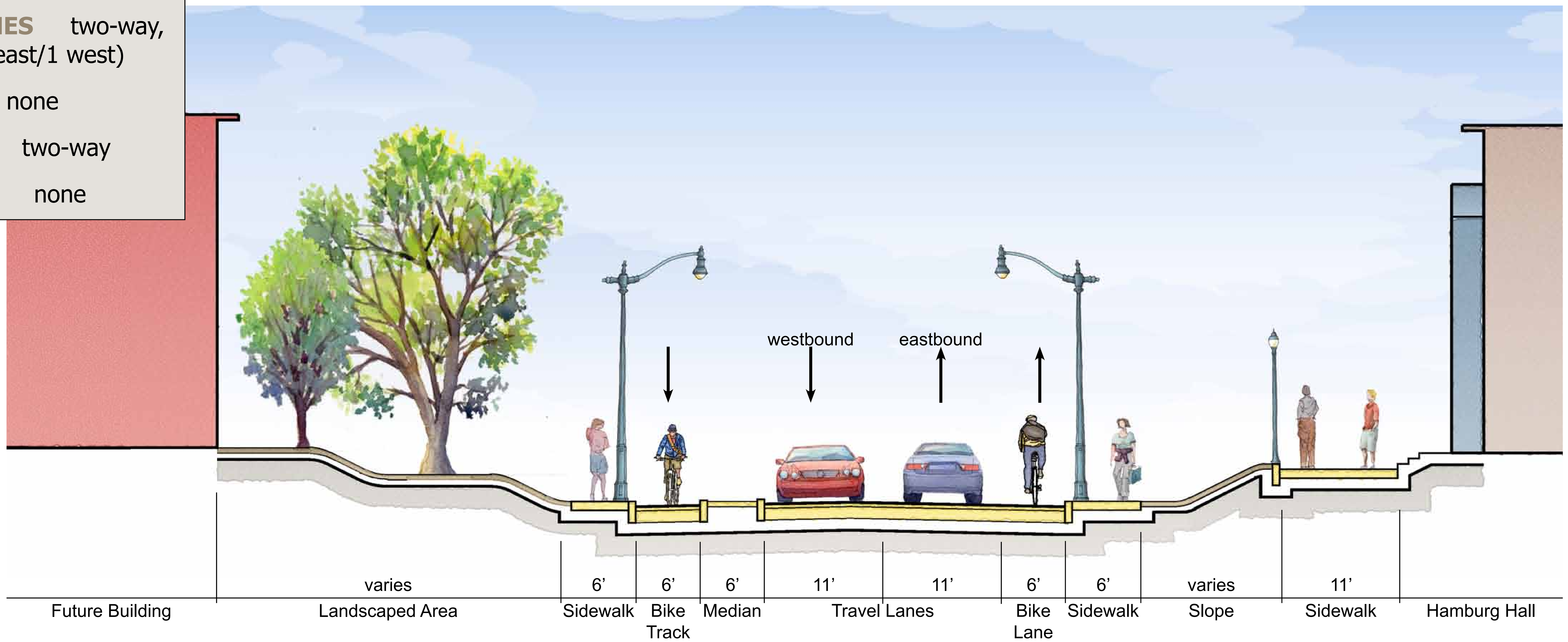
SPEED LIMIT 25 mph

TRAVEL LANES two-way, two lanes (1 east/1 west)

PARKING none

BIKE LANE two-way

TREE LAWN none



Forbes Avenue - Bike Lane Alternative Concept

Forbes Avenue - Bike Lane Alternative Concept

This section introduces a bike track inbound and a bike lane outbound on Forbes Avenue. Any combination is possible with dual bike track and dual bikes lanes also possible with this section. Forbes Avenue is recued to two lanes, one lane in each direction.

- Accommodate bicyclists
- Achieves traffic calming
- Ease of construction and economical for the separated lane

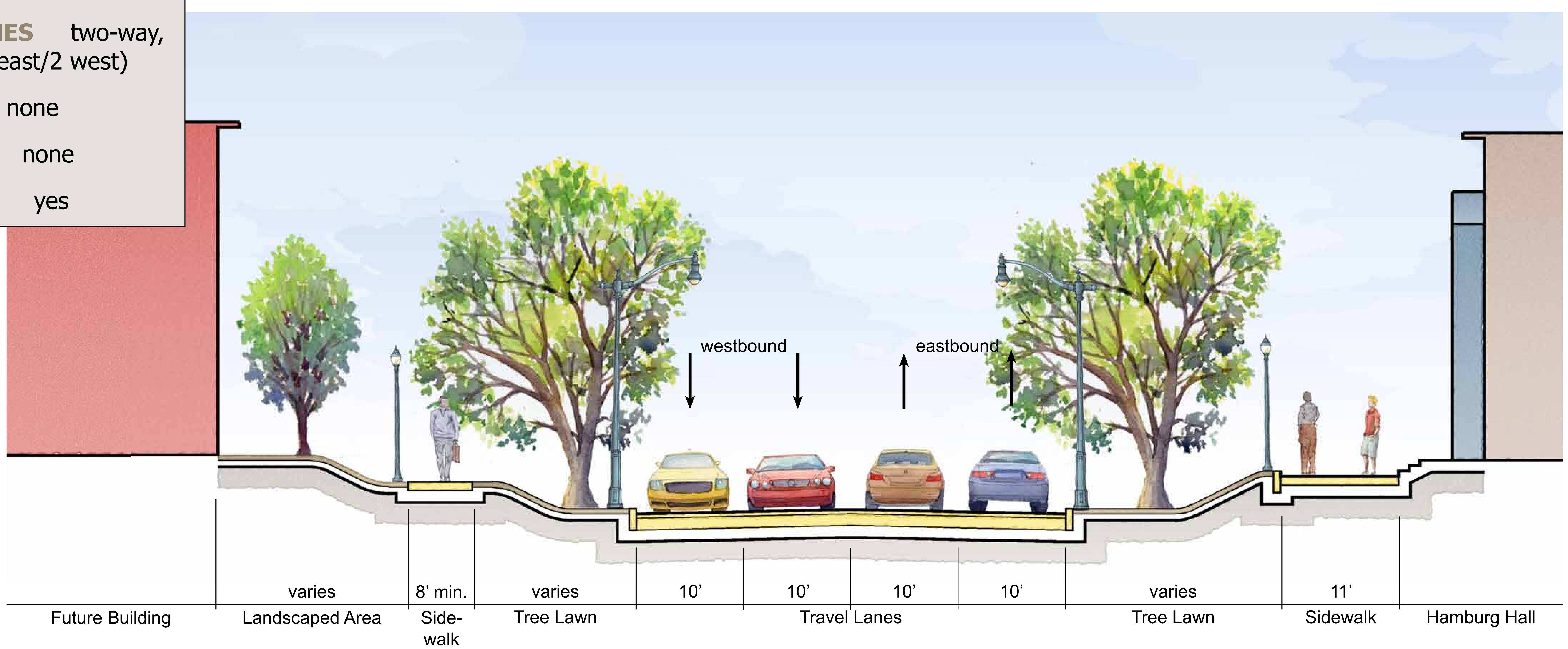
SPEED LIMIT 25 mph

TRAVEL LANES two-way, four lanes (2 east/2 west)

PARKING none

BIKE LANE none

TREE LAWN yes



Forbes Avenue - Sidewalk Alternative Concept

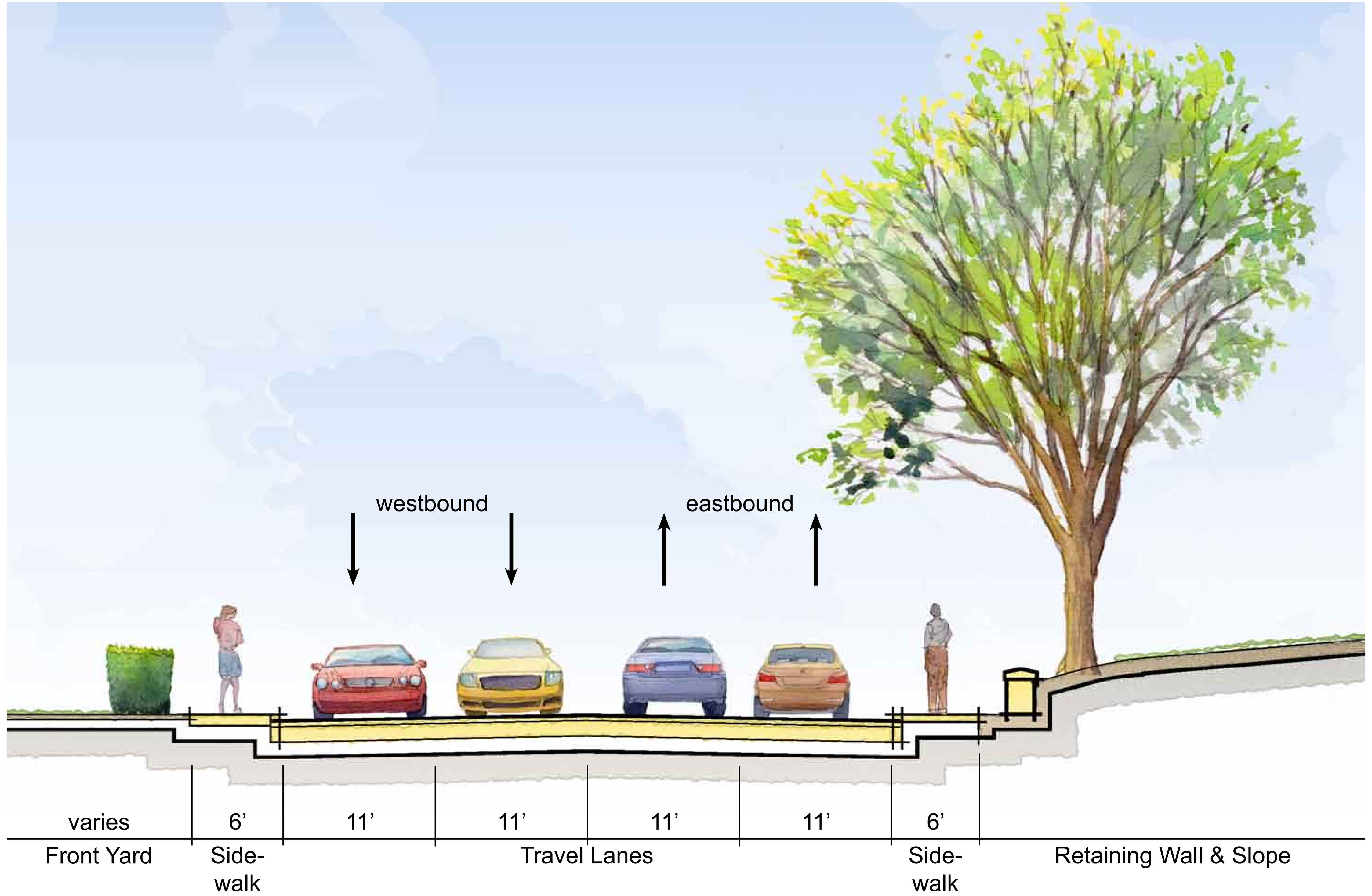
Forbes Avenue - Sidewalk Alternative Concept

This section retains then four existing lanes on Forbes Avenue but provides for a complete separation of pedestrians from the cart way via wide sidewalks separated by substantial tree lawns along both directions of Forbes Avenue.

- Achieves a campus-like look by creating large tree lawns capable of sustaining large trees
- Moves pedestrians away from the street environment
- Enables wide sidewalks to be constructed similar to campus walks in the "Cut" and "Mall"
- Creates some traffic calming due to size of tree lawn and future size of trees

Figure 15
Street Sections
Fifth Avenue

SPEED LIMIT	25 mph
TRAVEL LANES	two-way, four lanes (2 east/2 west)
PARKING	Sundays only
BIKE LANE	none
TREE LAWN	none



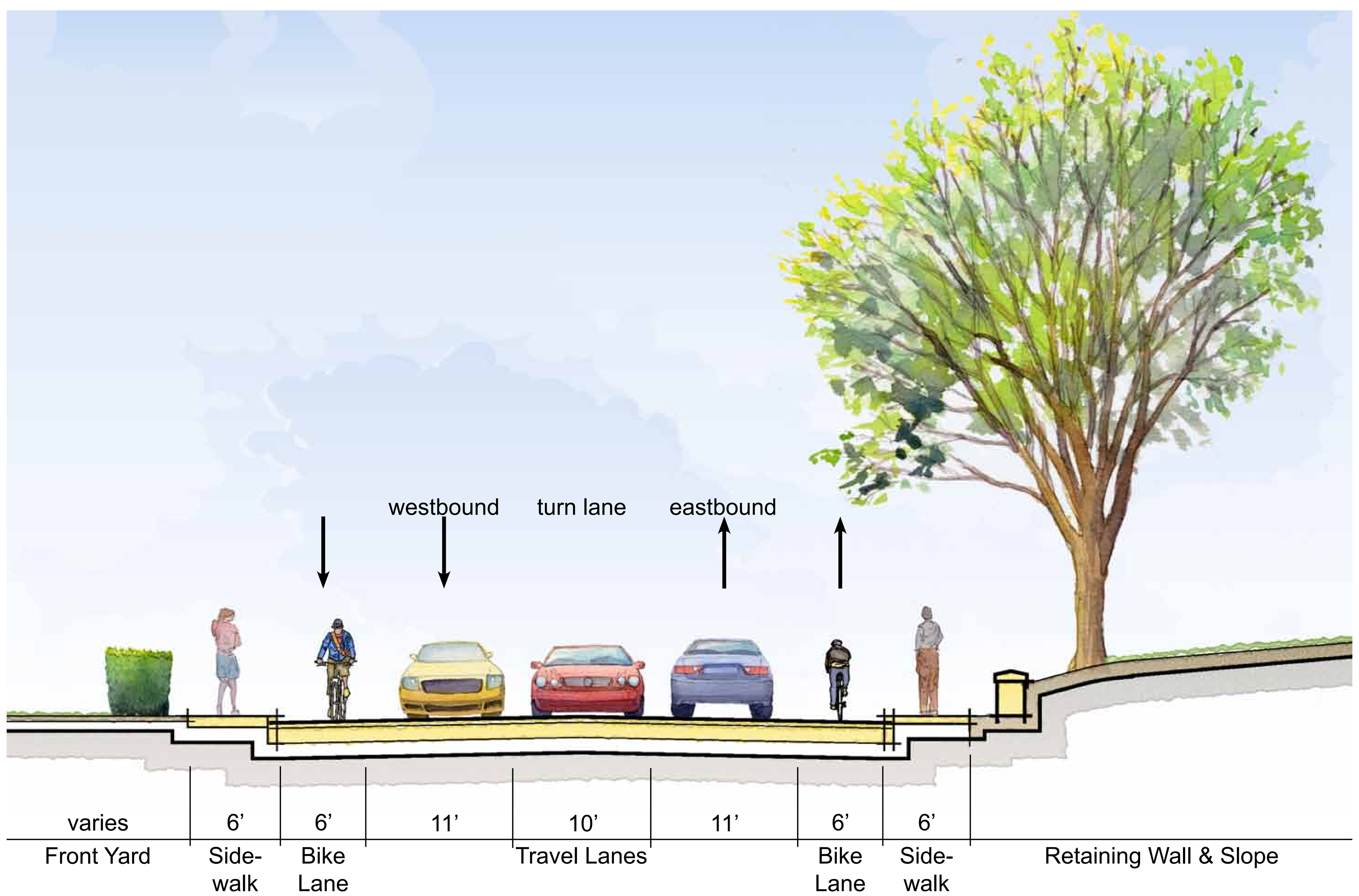
Fifth Avenue - Existing Conditions

Fifth Avenue - Existing Conditions

This section represents Fifth Avenue east of South Neville Street, containing a 44-foot wide cart way of four lane traffic. West of South Neville Street, the cart way widens with the addition of parking on both side of Fifth Avenue but the vehicle lanes remain at 11 feet wide.

- High speeds exceeding 40 mph at times
- Very narrow sidewalks adjacent to street, below ADA standards in some areas
- No bicycle lanes or sharrows
- No turning lanes

SPEED LIMIT	25 mph
TRAVEL LANES	two-way, two lanes w/ turning lane
PARKING	Sundays only
BIKE LANE	two-way
TREE LAWN	none



Fifth Avenue - Bike Lane Alternative Concept

Fifth Avenue - Bike Lane Alternative Concept

This section consist of three lanes of vehicle traffic and two bike lanes. The center lane becomes a bi-directional continuous left turn lane with dedicated left turn lanes at Morewood Avenue and South Neville Street as well as South Craig and South Dithridge Streets.

- Creates a center left turn lane in midblock areas for access to multiple uses
- Creates a separate turning lane at all major intersections
- Economical to achieve

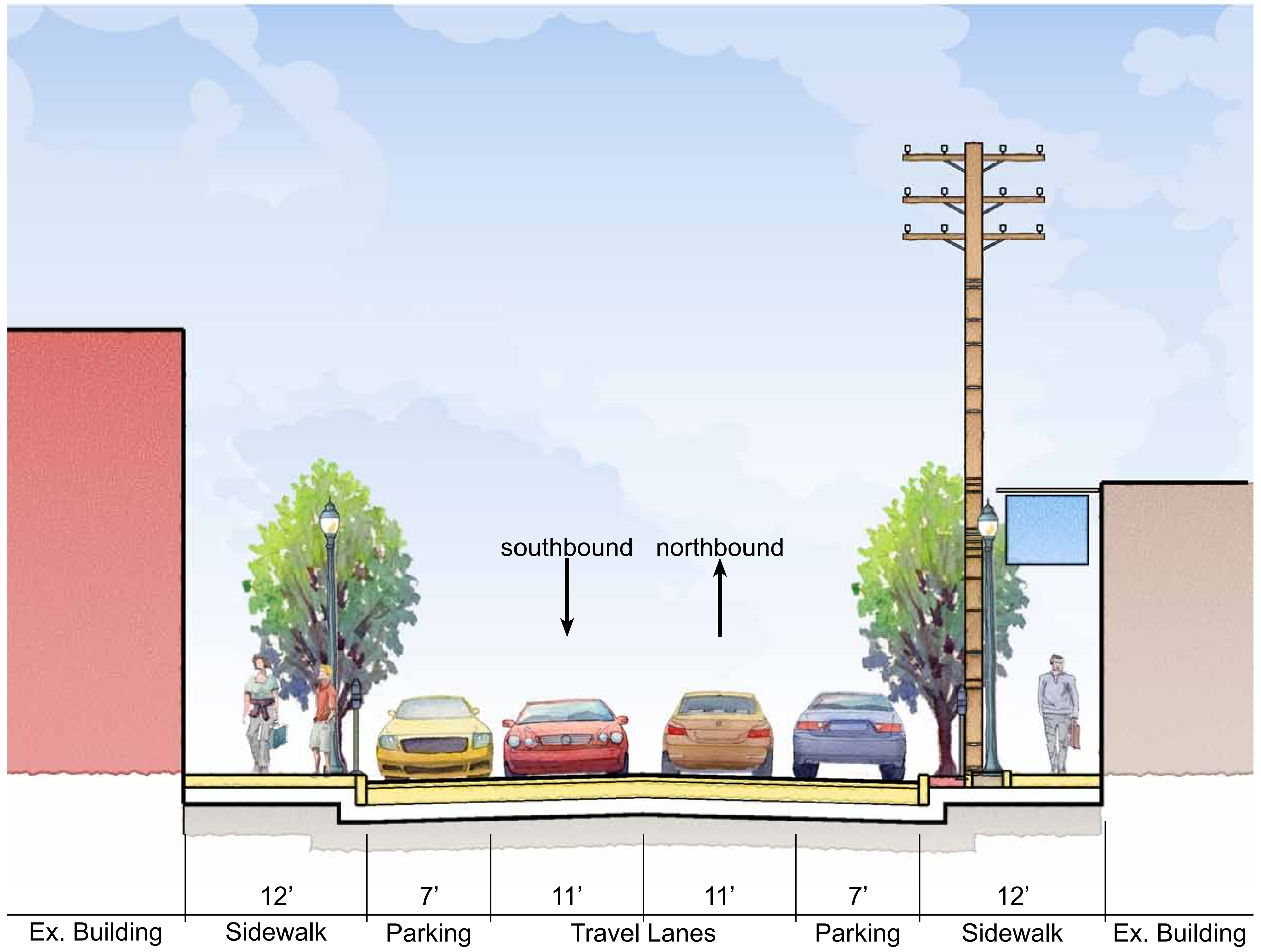
SPEED LIMIT 25 mph

TRAVEL LANES two-way, two lanes (1 north/1 south)

PARKING both sides

BIKE LANE none

TREE LAWN yes



South Craig Street - Existing Conditions

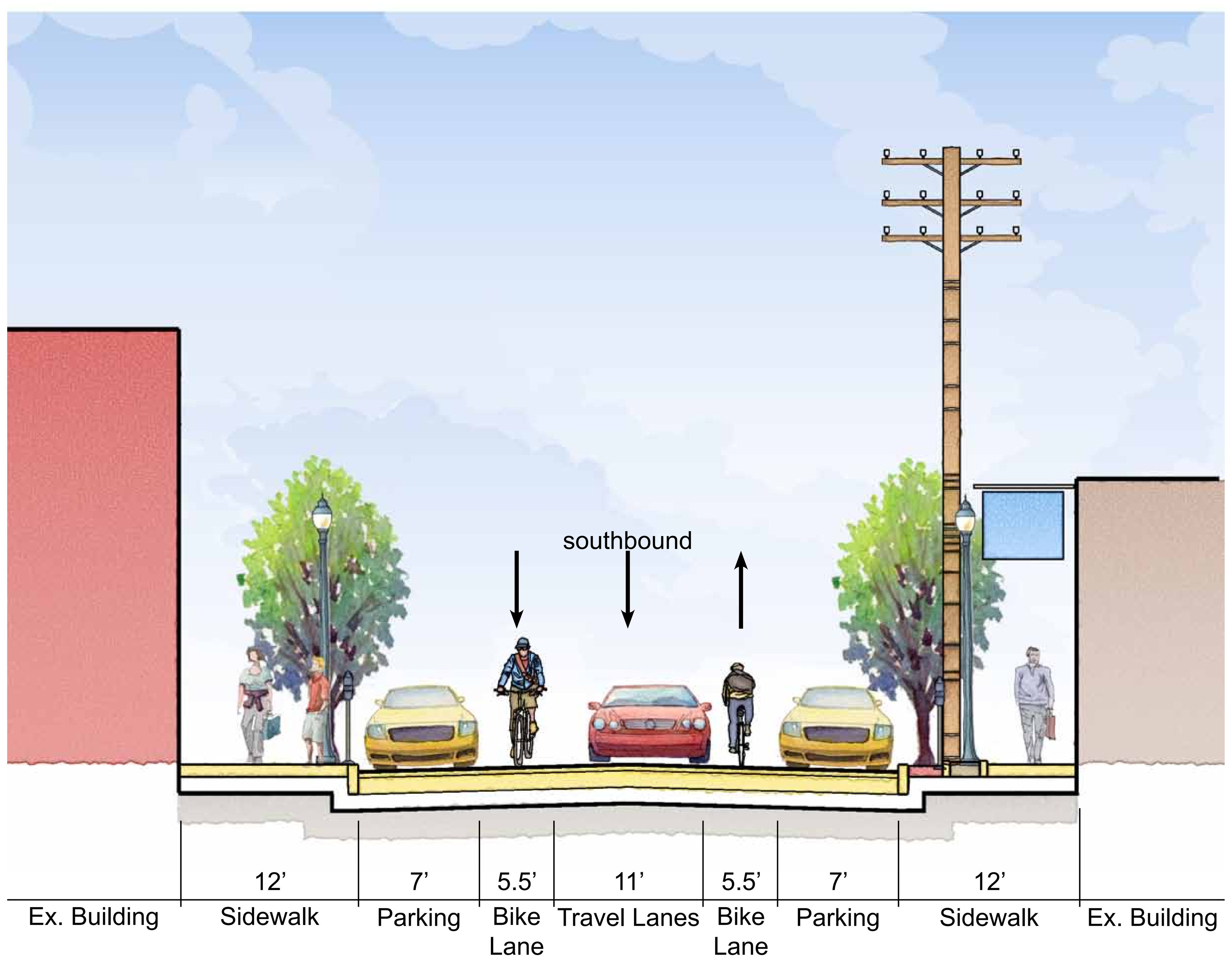
SPEED LIMIT 25 mph

TRAVEL LANES two-way, one lane (1 south)

PARKING both sides

BIKE LANE two-way

TREE LAWN yes



South Craig Street - Bike Lane Alternative Concept

Figure 16
Street Sections
South Craig Street

South Craig Street - Existing Conditions

This section consists of a narrow cart way containing single lane two-way traffic and two lanes of parking within a total width only 36 feet.

- Existing street functions well as a low speed connection between Forbes and Fifth Avenues
- Congestion exists on many levels, within movements of vehicles, pedestrians and cyclists
- In spite of traffic, the street supports an abundance of commercial activities

South Craig Street - Bike Lane Alternative Concept

This section depicts a bike lane in each direction created by the elimination of northbound traffic on South Craig Street from Forbes Avenue to Fifth Avenue.

- Creates a one way street southbound
- Creates a two way bicycle street
- Retains existing parking
- Rerouting of former northbound traffic can be handled within two blocks, all within the Study Area
- Removes bicycle traffic from sidewalks

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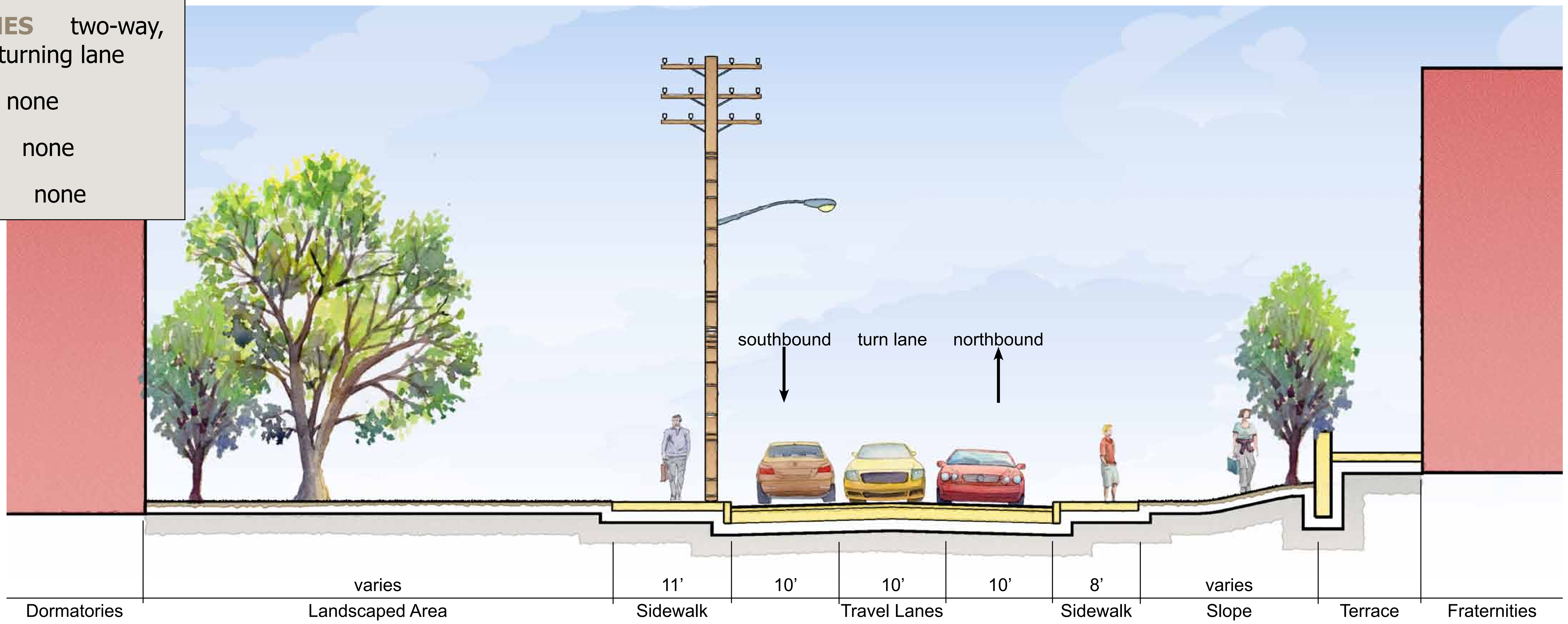
Figure 17
Street Sections
Morewood Avenue

SPEED LIMIT 25 mph
TRAVEL LANES two-way, two lanes w/ turning lane
PARKING none
BIKE LANE none
TREE LAWN none



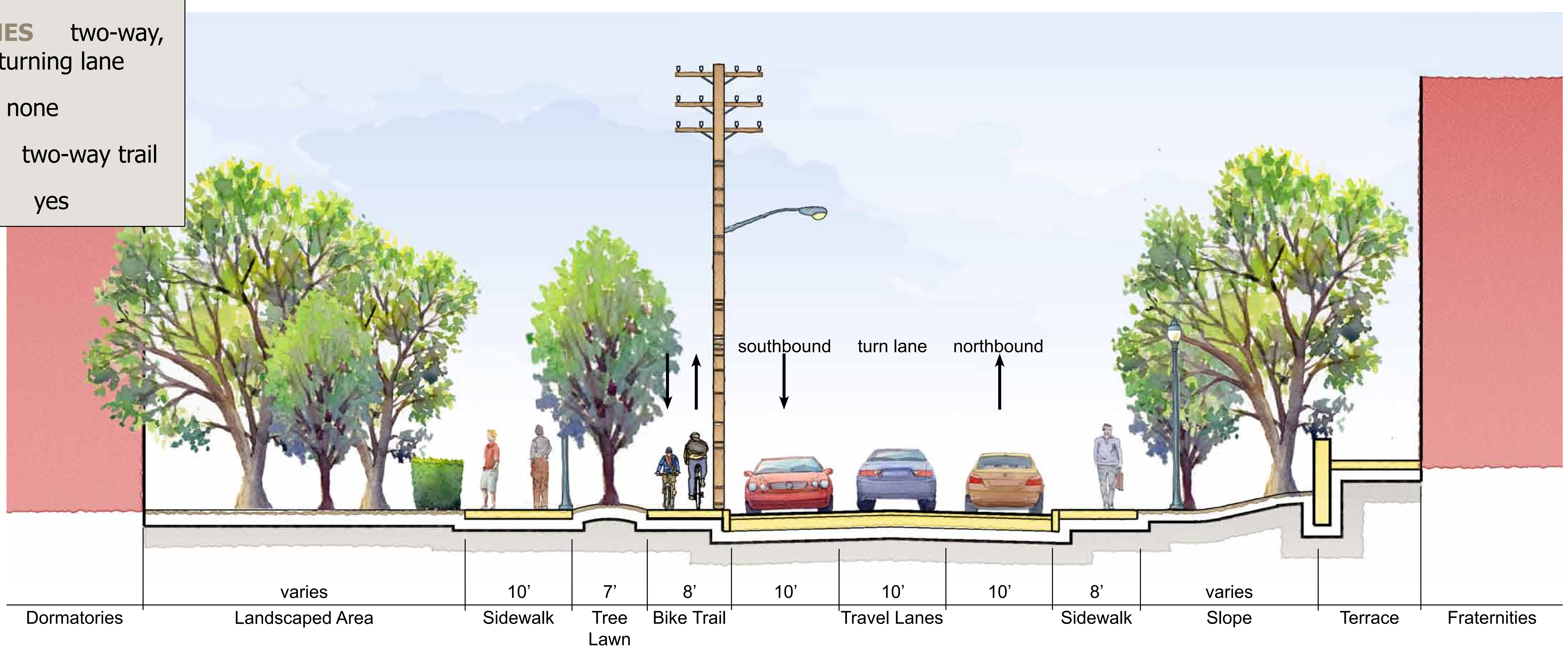
Morewood Avenue - Existing Conditions

Morewood Avenue - Existing Conditions

This section depicts the exiting three lane section contained in only a 30-foot wide cart way with side-walks immediately adjacent to the cart way.

- Narrow vehicle travel lanes
- Sidewalks adjacent to street
- Narrow sidewalks
- No bicycle lanes

SPEED LIMIT 25 mph
TRAVEL LANES two-way, two lanes w/ turning lane
PARKING none
BIKE LANE two-way trail
TREE LAWN yes



Morewood Avenue - Sidewalk Alternative Concept

Morewood Avenue - Sidewalk Alternative Concept

This section depicts the exiting cart way remaining to the northern driveway of the fraternity section, whereupon the sidewalk along the eastern side of Morewood is eliminated and the street widened to Fifth Avenue. The pedestrian movement would be accommodated via a 10-foot wide sidewalk placed behind a tree lawn along the western frontage of the street. The existing sidewalk would remain be-coming a two-way bike lane.

- 10-foot wide sidewalks and separate bike trail
- Tree lawn created along western curb line
- Potential for street widening via sidewalk elimina-tion midblock north of fraternity house driveway
- Eliminate sidewalk along eastern curb north of fraternity driveway

1 Fifth Avenue & South Bellefield Avenue

2 Fifth Avenue & South Dithridge Street

3 Fifth Avenue & South Craig Street

Figure 18
Intersection Panoramas

1 Fifth Avenue & South Bellefield Avenue
2 Fifth Avenue & South Dithridge Street
3 Fifth Avenue & South Craig Street

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Figure 19
Intersection Panoramas

4 Fifth Avenue & South Neville Street
5 Fifth Avenue & Morewood Avenue

4 Fifth Avenue & South Neville Street

5 Fifth Avenue & Morewood Avenue

Oakland/CMU
Pedestrian Safety Mobility Study

October 15, 2010

PCTI PENNSYLVANIA COMMUNITY TRANSPORTATION INITIATIVE

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6 **Forbes Avenue & South Craig Street**

7 **Forbes Avenue & Hamburg Hall**

8 **Forbes Avenue & Morewood Avenue**

Figure 20

Intersection Panoramas

6 Forbes Avenue & South Craig Street
7 Forbes Avenue & Hamburg Hall
8 Forbes Avenue & Morewood Avenue

Oakland/CMU
Pedestrian Safety Mobility Study

October 15, 2010

PCTI PENNSYLVANIA COMMUNITY TRANSPORTATION INITIATIVE

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Figure 21
Intersection Panoramas

9 Forbes Avenue & Beeler Street
10 Forbes Avenue & Margaret Morrison Street

9 Forbes Avenue & Beeler Street

10 Forbes Avenue & Margaret Morrison Street

Oakland/CMU
Pedestrian Safety Mobility Study

October 15, 2010

PCTI PENNSYLVANIA COMMUNITY TRANSPORTATION INITIATIVE
Oakland Transportation Management Association
Carnegie Mellon

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Pennsylvania Community Transportation Initiative (PCTI)
Oakland/CMU Pedestrian Safety Mobility Study

Scope of Work

Issue Defined:

The Oakland community has the highest concentration of academic and medical institutions in the region and state. It has a daytime population of over 100,000 workers, students and visitors mingling with over 60,000 automobiles passing through on its two main arterials – Fifth Avenue and Forbes Avenue. The Oakland Transportation Management Association (OTMA) and Carnegie Mellon University (CMU) recognize that a smart transportation system should consider the infrastructure necessary to support multi-modal access, including walking, bicycling, transit, and private automobiles. Safety and mobility for all pedestrians, motorists, transit users and bikers have been constant concerns in the Oakland community.

Scope of the Project:

1. Review and analyze Accident data
    a. PennDOT will supply 5 year accident data for GAI.
       (As Fifth Avenue is a city road and Forbes Avenue is a state road; PennDOT will request both city and state data).
    b. KAI will analyze the accident data and document patterns and trends, and identify target locations for potential modifications. GAI will review and confirm findings.
    c. GAI will submit information to add to the PCTI public comment website to solicit information from students, employees, and other interested parties regarding potential improvement locations and pedestrian needs within the study area.
2. Inventory University parking supply (number of spaces)document needs
    a. Carnegie Mellon University Parking and Transportation will provide an inventory of all on campus parking lots and spaces.
    b. The Pittsburgh Parking Authority will provide an inventory of on street metered parking spaces in the study area.
    c. GAI will identify all on-street non metered parking and restrictions in the study area (see the attached map). GAI will not identify legally and illegally parked vehicles, but GAI will identify locations where parked vehicles interfere with traffic flow of any mode.
    d. GAI will provide analysis of the current parking capacity and demand within the study area. Parking occupancy counts will be taken midday between 10 AM and 2 PM. CMU will provide commuting population figures for all undergraduate and graduate full time and part time enrolments.
    e. GAI will provide parking management recommendations for the approved future growth scenario provided by Ayers Saint Gross, the CMU master planning consulting team.

3. Identify campus destinations and bike/pedestrian corridors
    a. GAI and KAI will meet with University and Ayers Saint Gross to identify current pedestrian and bicycle corridors.
    b. GAI and KAI will interview members of the steering committee including CMU, OTMA and City of Pittsburgh staff to establish campus and community planning trends and land use patterns.
    c. GAI will provide an urban design analysis and will provide a land use analysis for the study area corridors.
4. Concept designs
    a. GAI will provide conceptual diagrams, in both plan and section, of possible Complete Street configurations within existing Rights-of way.
    b. GAI and KAI will create options and make recommendations on the configurations.
    c. GAI and KAI will provide analysis of impacts on capacity of recommended options.
    d. GAI will create detailed concept designs for improvements at each intersection, and typical "Complete Streets" sections for all connecting streets.
5. Counts and Data Gathering
    a. TWE will collect pedestrian and cyclist, through traffic and turning movement counts at the ten (10) intersections in the study area (see map).
    b. Counts will be made during peak hours (7:00am – 10:00am and 3:00pm – 6:00pm).
    c. Counts will be conducted on regular business days (Tuesday, Wednesday and Thursday).
    d. Counts will be conducted while classes are in session – the 2010/2011 school year begins on August 30, 2010.
    e. Counts will be summarized every 15min.
    f. CMU will explore the option of working with graduate level Civil and Environmental Engineering students to assist in conducting manual counts.
    g. KAI will provide capacity analysis and signal phasing and timing changes for the entire study area.
    h. GAI will obtain details on the recently completed bicycle plan component of the "Pittsburgh Plan" Comprehensive Plan, currently underway.
    i. GAI will obtain current Port Authority Bus routings and stops and planned changes to routings due in June and September of 2010, as available.
    j. GAI will document typical street cross sections within the ten (10) intersection study areas.
    k. GAI will identify existing ADA ramps and traffic signal related components within the ten (10) study area intersections only, which obviously do not comply with current standards and guidelines.

6. Meetings and Presentations
    a. GAI will attend bi-weekly with the Steering Committee provide progress updates and to gather input and authorization on next steps from the Committee, KAI will attend via phone.
    b. GAI and KAI will meet with Ayers Saint Gross on June 3, 2010 regarding coordination with the University's Master Plan
    c. GAI and KAI will conduct one half-day open workshop (date and time to be determined) for members of the campus and city community to participate in the planning process
    d. GAI and KAI will interview up to 10 individuals as identified by the steering committee
    e. GAI will present all findings and recommendations to the steering committee before November 30, 2010

Deliverables:

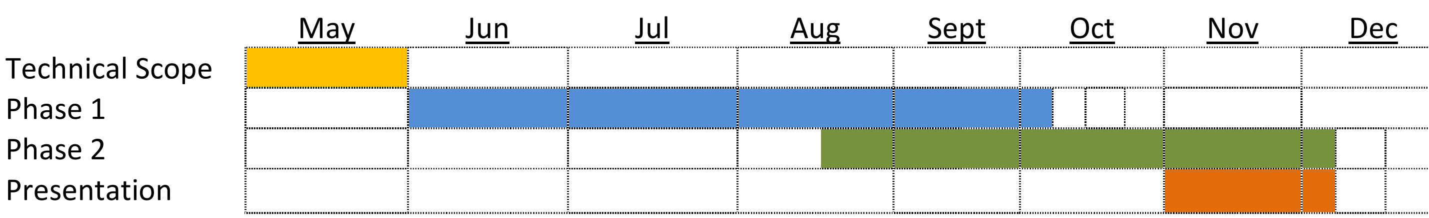
1. **Phase 1: A macro level report** to be used as an Appendix to the Carnegie Mellon University Institutional Master Plan 2010. This report will accomplish the following:
    a. Identify the major transportation, safety and mobility issues in the study area.
    b. Graphically represent accidents in the study corridor that provide detail about the type of accident, location and time of day.
    c. Provide a needs / demands assessment that includes an inventory of parking lots, number of spaces and overall capacity of the University's parking reservoir.
    d. Analyze current parking utilization and provide recommendations for future parking management and development strategies.
    e. Identify pedestrian and bicycle corridors and desired destinations.
    f. Provide an urban design and land use analysis for the study area that assesses the relationship between planning and transportation issues.
    g. Provide Draft concept designs and schematics for potential improvements. throughout the study area utilizing "Complete Streets" design theories and best practices.

    DUE DATE: October 5, 2010.

2. **Phase 2: A micro level report** to be used to guide future design and construction activities and to pursue funding for physical infrastructure improvements by the Oakland Transportation Management Association. This report will include the following items:
    a. Pedestrian and cyclist counts at each intersection and throughout the study area.
    b. Traffic counts at each intersection and throughout the corridors.
    c. Turning movements at each intersection.
    d. Capacity analysis and cycle changes of roadways.
    e. Options for corridor improvements to enhance safety, movement and aesthetics.
    f. Options for pedestrian enhancements.
    g. Options for improved bicycle facilities.
    h. Options for bus stop relocations or eliminations.
    i. Recommendations on proposed options and feasibility of options on two or three key project initiatives.
    j. Refine Concept designs and schematics for the two or three recommended improvements.

DUE DATE: December 3, 2010.

Schedule



Appendix B: Non-Motorized Safety Toolbox

Oakland / CMU Pedestrian Safety Mobility Study

The Toolbox of Potential Strategies contains descriptions and examples of possible pedestrian and bicycle improvements to implement in the area around Carnegie Mellon University. These tools are based on some of the best practices across the country and are applicable to many locations in the study area. The Carnegie Mellon University Pedestrian Safety study will focus on near-term improvements that can be implemented at specific locations. Additional future considerations are presented at the end of this section, intended to serve as guidance as development occurs and/or additional funding becomes available.

The strategies presented in this section serve as countermeasures to many of the deficiencies and challenges that exist in the area. While each strategy is only applicable in certain locations, the combination of systematic pedestrian improvements throughout a given area has been shown to create significant improvements to pedestrian safety. For instance, a study contained in the 2010 Transportation Research Record, entitled "Reduction of Pedestrian Fatalities, Injuries, Conflicts, and Other Surrogate Measures in Miami-Dade, Florida" (Reference 5), documents the positive impact of inexpensive pedestrian safety measures. Several small-scale pedestrian improvements were implemented on eight high-crash corridors, following a public education and enforcement program on pedestrian safety. The two years following the installation of improvements resulted in a 41 percent reduction in the number of crashes.

The strategies contained in the next few pages are low-cost pedestrian and bicycle improvements that could be implemented in the next 1 to 5 years, depending on available funding. Projects include new installations or changes to existing pedestrian crossings, minor signal timing changes, and additional amenities for pedestrians. The treatments presented on the following pages are organized into five categories:

- Bicycle Improvements – aimed facilitating safe cycling behavior as well as encouraging cycling by creating more comfortable facilities
- Signal Timing Changes – aimed at promoting safety at intersection by making various changes in signal phase lengths and signal amenities
- Pedestrian Crossing Improvements – aimed at improving safety at locations where pedestrians cross roadways, including intersections
- Comfort and Convenience – aimed at improving the pedestrian and bicyclist experience with improved amenities, as well as better orienting travelers toward area destinations
- Other Improvements

The treatments presented under the category Comfort and Convenience serve to encourage travel by foot and by bicycle, which, particularly in the case of bicyclists, can lead to improved safety through increased number of users.

The treatments described below are organized to address deficiencies that were documented during our field visit and a review of historical crashes. The specific treatments within each category represent options for improvements.

This information is intended to provide an overview of each treatment, with information on its intended application. Many of the summaries also provide one or more examples of a recommended project in the project study area. Each example in the study area provides additional context for the development of the complete recommendation list for this plan.

Each treatment is presented on a half page with the following basic information:

- Typical cost provided by the Pedestrian and Bicycle Information Center (Reference 6)
- Description
- Effectiveness
- Implementation considerations
- Compliance with standards contained in the Manual on Uniform Traffic Control Devices (MUTCD) and Public Rights-of-Way Accessibility Guidelines (PROWAG)
- Photo or graphic

For each of the treatments, there may be specific locations within the study area that are identified for possible application. However, there are a number of treatments presented here for which a specific application has not been identified. More specific location recommendations will be made in the fall pending further data collection and analysis.

Several references were used to compile the information in the following sections, including the *Desktop Reference for Crash Reduction Factors* (Reference 8), "Pedestrian Countdown Signals: Experience with an Extensive Pilot Installation" (Reference 9), *NCHRP Report 562: Improving Pedestrian Safety at Unsignalized Crossings* (Reference 10), *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach* (Reference 11), and other references cited throughout this report.

Signal Timing Changes

Signal timing changes at intersections range from minor changes in the amount of time for crossing pedestrians to the addition of pedestrian signals and push-buttons. These intersection improvements provide walkers with the time and awareness to cross approaches of the intersection, increasing safety for pedestrians and drivers.

LEADING PEDESTRIAN INTERVAL

Cost: Minimal staff time for signal re-timing

Description: Pedestrians are allowed to begin crossing at the crosswalk before conflicting vehicles start moving. For example, right-turning vehicles may have a red light for 5 to 7 seconds while pedestrians and through vehicles are allowed to begin through the intersection.

Effectiveness: Pedestrians get a head start on vehicles in crossing the roadway, increasing the percentage of turning drivers yielding to pedestrians. Note that right-turn-on-red is often prohibited in conjunction with leading pedestrian intervals (5).

Implementation Considerations: Adding a leading pedestrian interval reduces the amount of green time available for conflicting vehicle movements.

Compliance with Standards: Pedestrian Walk intervals should be a minimum of 4 to 7 seconds in duration. The Flash Don't Walk phase, according to the 2009 MUTCD, is based on the amount of time it takes a pedestrian to cross with a walk speed of 3.5 feet per second.

Application in Study Area: Intersections with heavy turning volumes could benefit from leading pedestrian intervals. No specific locations identified at this time, but may be identified pending data collection and analysis.

PEDESTRIAN COUNTDOWN SIGNALS

Cost: $20,000 to $40,000 for all four legs

Description: All new pedestrian signal heads, contrasted with static Walk/Flash Don't Walk signals, inform pedestrians of the time remaining to cross the street with a countdown on the signal head.

Effectiveness: Fewer pedestrians crossing the street late in the countdown, as compared to signal heads with only the Flash Don't Walk light. Fewer pedestrians left in crosswalk in steady don't walk phase (9).

Implementation Considerations: Pedestrian signal heads should be clearly visible while pedestrians are waiting and crossing the street.

Compliance with Standards: The 2009 MUTCD requires all new pedestrian signals, and any retrofitted signals, to include countdown pedestrian signals. Per MUTCD guidance, the countdown should include enough time for pedestrians to cross the full width of the street or, in rare cases, reach a refuge island.

Application in Study Area: The highest priority locations are at intersections that lack pedestrian signal heads altogether, such as along Fifth Avenue. All other pedestrian signals should be considered for retrofit to become compliant under the new MUTCD guidelines.

PROHIBIT RIGHT-TURNS ON RED

Cost: $300 to $500 per sign; $1,000 to $3,000 for electronic signs

Description: Reduces conflicts between cars and pedestrians by prohibiting cars to turn right, into the path of crossing pedestrians. This treatment may be deployed on a full-time or restricted basis.

Effectiveness: Electronic NRTOR signs have been shown to decrease pedestrian/vehicle conflicts significantly (5). According to the forthcoming AASHTO Highway Safety Manual, NRTOR also significantly reduces pedestrian crashes.

Implementation Considerations: Restricting right-turns at an intersection may increase delay for drivers.

Compliance with Standards: Prohibiting right-turns at intersections during the red phase complies with MUTCD standards

Application in Study Area: A number of intersections in the study area currently make use of NRTOR signs. Additional applications TBD.

CYCLE LENGTH ADJUSTMENTS

Cost: Minimal

Description: Reduce the amount of green time, and therefore overall cycle length, at intersections to decrease the amount of time pedestrians wait to cross the street.

Effectiveness: By reducing the average amount of time pedestrians wait to cross the street, pedestrians are more likely to cross during the Walk phase.

Implementation Considerations: May reduce capacity for vehicles and require coordination with jurisdictions operating signals on a corridor

Compliance with Standards: Signal timing changes comply with MUTCD standards as long as the minimum Walk and clearance times for the intersection are met.

Application in Study Area: TBD

PUSH-BUTTON RETROFITS

Cost: $5,000 to $10,000 for all four legs

Description: Signs above the pedestrian push-button indicate direction of crossing. “Confirm” press buttons acknowledge activation through a light or sound after called by a pedestrian.

Effectiveness: Confirm press buttons have been shown to increase the number of pedestrians using the push-button, and more pedestrians wait for the Walk phase at the signal (5).

Implementation Considerations: New confirm press pedestrian push-buttons are easily exchanged with existing ones. New installations at intersections without existing push-buttons are more costly. Intersections with high pedestrian delay, such as where there is an exclusive pedestrian phase, can benefit from the increased wait tolerance induced by push-buttons.

Compliance with Standards: The MUTCD specifies that separate poles, located at least 10 feet apart, should be used for pedestrian push-buttons unless physical constraints make use of two poles impractical.

Application in Study Area: All locations without confirm press push-buttons are candidates for installation. Priority should be given to locations with high pedestrian volumes or existing trends of low compliance. For example, the Forbes Avenue/Morewood Avenue intersection should likely be outfitted with push-buttons. Other new pedestrian signal installations along Fifth Avenue should also include confirm press push-buttons.

Crossing Improvements

Crossing improvements include upgrading intersection and mid-block crosswalks, reducing crossing distances for pedestrians, and adding new crossings locations. The strategies contained in this section improve safety at pedestrian crossing by reducing the amount of time they are exposed to vehicle traffic. Several of the complete street principles identified in the Countywide Mater Plan relate to crossing improvements:

- Encourage medians as pedestrian refuge islands.
- Design turning radii to slow turning vehicles.
- Reduce crossing distances.
- Increase crossing opportunities.

HIGH VISIBILITY CROSSWALKS

Cost: $1,200 for all four legs

Description: High visibility crosswalks better warn motorists to expect pedestrian crossings and indicate preferred crossing locations.

Effectiveness: At non-intersection locations, crosswalks are safest on roadways with lower traffic volumes and where drivers might expect pedestrians.

Implementation Considerations: Marked crosswalks should be used in conjunction with other improvements that help physically reinforce crosswalks and reduce vehicle speeds, especially at uncontrolled locations and on multi-lane or high-volume roadways. It is important that maintenance and durability are considered to ensure that crosswalks retain visibility.

Compliance with Standards: The MUTCD allows for various crosswalk marking patterns, but the “international” (or “ladder”) markings are strongly preferred due to increased visibility.

Application in Study Area: When restriping faded crosswalks at intersections and other crossings in the study area, more visible crosswalk patterns and/or more durable striping technology can be implemented.

RAISED MEDIAN ISLANDS

Interim striping/flex-bollards cost: $1,300 to $2,000 per crossing;
full construction cost: $4,000 to $30,000 per crossing

Description: Provide a protected area in the middle of a crosswalk for pedestrians to stop while crossing. Interim islands consist of striping on the pavement to identify pedestrian space, while fully constructed islands typically include curbs and signs notifying drivers to avoid the location.

Effectiveness: Installing raised medians have been shown to reduce the number of crashes at marked and unmarked crosswalks, as documented in the *Desktop Reference for Crash Reduction Factors* (8).

Implementation Considerations: Raised islands should notify crossing pedestrians that they are exiting a safe place by including detectable warning surfaces or changes in direction (for example, directing pedestrians towards oncoming traffic) in the design.

Compliance with Standards: At a minimum, raised islands should be 6 feet wide to accommodate persons in wheelchairs. Wider islands are often preferred, particularly when included on multilane facilities.

Application in Study Area: Refuge islands could be used in conjunction with a road diet and other pedestrian crossing improvements along Forbes Avenue and other roadway segments where the addition of a signalized intersection is impractical.

IN-STREET "YIELD FOR PEDESTRIANS" SIGNS

Cost: $300 to $500 per sign

Description: Signs placed in the middle of crosswalks to increase driver awareness of pedestrians and the legal responsibility to yield right-of-way to pedestrians in crosswalks

Effectiveness: Increases the number of drivers that yield to pedestrians in the crosswalk (10).

Implementation Considerations: Signs are placed in the middle of the roadway and are subject to possible damage from cars and trucks. In-street signs usually require more maintenance due to more frequent replacement.

Compliance with Standards: Signs comply with the latest guidance contained in the MUTCD.

Application in Study Area: A sign could be used in conjunction with other improvements, such as high-visibility crosswalk markings, beacons, or a hybrid signal at the midblock crossing on Forbes Avenue in front of the Hamburg building.

RECTANGULAR RAPID FLASH BEACON

Cost: $10,000 to $15,000 for both directions

Description: Signs with a pedestrian-activated "strobe-light" flashing pattern attracts attention and notifies the driver that pedestrians are at the crosswalk.

Effectiveness: RRFBs on the side of the road increase driver yielding behavior significantly (to around 80% typically). Additional signs can be included on a center island or median, although these have a lower marginal benefit as compared to roadside signs (10).

Implementation Considerations: Flashing pattern can be activated with manual push-buttons or automated passive (e.g., video or infrared) pedestrian detection, and should be unlit when not activated.

Compliance with Standards: The MUTCD gave interim approval to RRFBs for optional use in limited circumstances in July 2008. The interim approval allows for usage as a warning beacon to supplement standard pedestrian crossing warning signs and markings at either a pedestrian or school crossing, where the crosswalk approach is not controlled by a YIELD sign, STOP sign, traffic-control signal, or at a roundabout.

Application in Study Area: A Rectangular Rapid Flash Beacon should be considered at the midblock crossing on Forbes Avenue in front of the Hamburg building to increase pedestrian visibility and remind drivers to stop for crossing pedestrians.

PEDESTRIAN HYBRID SIGNAL

Cost: $50,000 to $75,000 per installation

Description: The pedestrian activated signal (also known as a HAWK signal), unlit when not in use, begins with a flashing yellow light altering drivers to slow. A solid red light requires drivers to stop while pedestrians have the right-of-way to cross the street. While the pedestrian signal is in the Flash Don't Walk Phase, the overhead signal flashes red, and drivers may proceed if the crosswalk is clear.

Effectiveness: Studies show that hybrid signals result in over 95 percent of drivers yielding to pedestrians. Moreover, drivers experience less delay at hybrid signals compared to other signalized intersections (10).

Implementation Considerations: Pedestrian Hybrid Signals should only be installed at marked crosswalk locations with additional signs to warn drivers about the pedestrian crossing. Maintenance is similar to a full signal.

Compliance with Standards: Included in the 2009 MUTCD

Application in Study Area: The long distances between intersection crossings on Forbes Avenue and Fifth Avenue could be reduced with the installation of a pedestrian hybrid signal.

CURB EXTENSIONS

Interim striping cost: $1,300 to $2,000 per corner;
full construction cost: $5,000 to $25,000 per curb

Description: Extend the sidewalk into the street (typically a parking lane) to create additional space for pedestrians

Effectiveness: Allow pedestrians and vehicles to see each other at the crosswalk. Curb extensions (or pedestrian bulb-outs) also reduce crossing distance for pedestrians, reducing the amount of exposure to traffic.

Implementation Considerations: Curb extensions are more easily installed along roadways with on-street parking since not all lanes are used for through traffic. They may be installed at intersections or mid-block crossings.

Compliance with Standards: Curb extensions comply with the MUTCD and PROWAG. Note that PROWAG provides design specifications associated with curb ramps (at curb extensions and elsewhere).

Application in Study Area: Curb extensions should be considered along roadways in the study area that have on-street parking, such as S Craig Street and portions of Fifth Avenue.

REDUCED CURB RADII

Interim striping cost: $2,500 to $4,000 per corner; **full construction cost:** $5,000 to $25,000 per curb

Description: Reconstructing a street corner with a smaller radius to reduce vehicle speeds while turning.

Effectiveness: Smaller curb radii can improve the safety for pedestrians at intersections by reducing crossing width, providing additional space for pedestrians to wait before crossing, and slowing turning vehicles.

Implementation Considerations: The design of the curb radius is a function of the angle between the intersecting streets, typical size of vehicles at the intersection, and maintenance. For example, intersections with several large trucks may need to have a slightly larger curb radius than local streets, typically 15 to 25 feet. However, streets with on-street parking or bicycle lanes can have smaller radii since vehicles have more space to negotiate turns.

Compliance with Standards: Curb radius modifications comply with the MUTCD and PROWAG. Note that PROWAG provides design specifications associated with curb ramps (at curb extensions and elsewhere).

Application in Study Area: Most of the intersections along Fifth Avenue would benefit from reduced curb radii and/or curb extensions. The Forbes Avenue/Morewood Avenue intersection is also recommended for a curb radii reduction and accompanying crosswalk realignment.

Comfort and Convenience

Strategies to improve comfort and convenience for pedestrians enhance the pedestrian environment, encouraging people to walk between destinations. Types of improvements include pedestrian-scaled amenities such as wayfinding signs, parks, lighting, and benches. The strategies contained in this section focus on creating a comfortable and safe pedestrian environment that increases the number of pedestrians in the area. These strategies primarily fulfill needs to "Encourage pedestrian-scaled land use and urban design," as included in the Countywide Master Plan of Transportation.

IMPROVED WAYFINDING

Cost: $500 for signs, more for complete network

Description: Signs directing pedestrians towards destinations in the area, typically including distances or average walk times.

Effectiveness: Wayfinding signs make it easier for residents and visitors to navigate the station area.

Implementation Considerations: Signing should be uniform and consistent through the area, and should complement existing wayfinding signs implemented by other agencies.

Compliance with Standards: Pedestrian wayfinding is not covered by the MUTCD. The MUTCD provides standard guidance signs for bicycle wayfinding applications.

Application in Study Area: Provide guidance along major pedestrian routes for reaching area attractions including university facilities. Complement wayfinding signs for drivers with cyclist-oriented information.

LANDSCAPING

Cost: Wide range based on treatment

Description: Landscaping treatments range from planted strips on roadways to small “pocket” parks on corners to improve aesthetics.

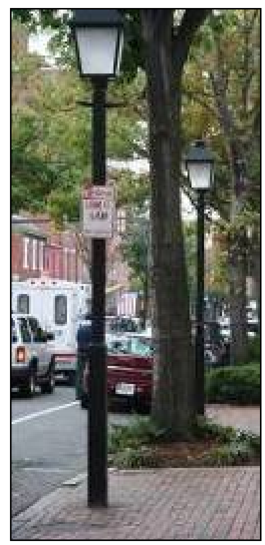
Effectiveness: Not applicable

Implementation Considerations: Depending on the application, landscaping costs vary substantially based on the type of amenities provided. The amount of space available for landscaping will influence the extents. Landscaping such as shrubs, trees, and flowers should be regularly maintained to preserve the quality of public space.

Compliance with Standards: Landscaping is not a traffic control device, and is not covered by the MUTCD.

Application in Study Area: The sidewalk along Forbes Avenue west of Morewood Avenue could be made more comfortable by scaling back the landscaping.

LIGHTING



Cost: $10,000 to $15,000 per light

Description: Pedestrian-scaled lighting along sidewalks and pathways

Effectiveness: Street lighting enhances pedestrian safety and security by lighting areas at night, making walkers visible to drivers and others. Lighting is particularly beneficial in commercial districts or frequently traveled routes.

Implementation Considerations: The physical structure (pole) should not obstruct sidewalks and all pathways, particularly crosswalks, should be well lit. Lighting levels should be uniform as to not distract drivers on the roadway.

Compliance with Standards: The Illuminating Engineering Society of North America provides specific guidance for walkways and bikeways (12).

Application in Study Area: TBD

BENCHES AND TRASH RECEPTACLES

Cost: $500 to $1,500 for benches and $500 to $1,000 for trash receptacles

Description: Benches are typically placed along sidewalks or multiuse pathways for pedestrians to rest, while trash receptacles provide a location for waste along frequented paths.

Effectiveness: Benches enhance pedestrian areas, particularly commercial districts, by allowing people to socialize and linger.

Implementation Considerations: These investments should be made where there is currently, or expected, heavy pedestrian activity. In order to preserve park and open spaces, trash cans should be provided to reduce the likelihood of littering in these more sensitive areas. Trash cans need to be emptied regularly to prevent overflowing.

Compliance with Standards: Street furniture should not reduce the minimum clear distances required for adjacent pedestrian walkways.

Application in Study Area: Both treatments are recommended throughout the study area.

Bicycle Improvements

Bicycle improvements include a range of treatments that can be installed along sections of roadway or at intersections in order to foster safe bicyclist behavior and to improve visibility of bicycle users among other roadway users. The treatments contained in this section focus on using existing roadway space for bicyclists. On-street facilities can also be combined with other mentioned treatments, such as improved wayfinding.

BIKE LANE MARKINGS

Cost: $1,000 to $5,000 per mile

Description: Bike lanes are the area of a roadway designated for non-motorized bicycle use, separated from vehicles by pavement markings.

Effectiveness: Bike lanes improve safety and comfort by increasing visibility and awareness of cyclists, in addition to providing adequate facilities for biking.

Implementation Considerations: Bike lanes are typically 5 feet or wider on roadways with a curb and gutter. Consideration should be given for a wider bike lane depending on the amount space consumed by existing gutters and other obstructions.

Compliance with Standards: The AASHTO Guide for the Development of Bicycle Facilities recommends a minimum width of 5 feet for bike lanes adjacent to parking, curbs, or guardrails (6).

Application in Study Area: Bike lanes could incorporated into a road diet along Forbes Avenue.

BICYCLE SHARROWS

Cost: $200 to $300 per stencil

Description: A shared-lane marking, or sharrow, is a pavement marking that can be used where space does not allow for a bike lane. Sharrows remind motorists of the presence of bicycles and indicate to cyclists where to safely ride within the roadway.

Effectiveness: Studies in San Francisco and in Florida have found that sharrows significantly reduce wrong-way and sidewalk riding, as well as improve cyclist positioning in the roadway.

Implementation Considerations: Sharrow are placed inside of a travel lane and should be located so as to position riders safely outside of the “door zone.” Sharrows can be useful on busier roads when speeds are not too high.

Compliance with Standards: Included in the 2009 MUTCD.

Application in Study Area: Craig Street may be a good candidate for sharrows.

ENHANCED SHARROWS

Cost: Uncertain; $10,000 to $50,000 per mile

Description: An enhanced sharrrow combines the sharrow marking with a colored stripe that further emphasizes the presence and likely riding location of cyclists.

Effectiveness: Enhanced sharrows can theoretically further the benefits provided by normal sharrows.

Implementation Considerations: Same as for sharrows. Enhanced sharrows have been installed in only a few locations. Ongoing costs to maintain color may be a concern.

Compliance with Standards: Like colored bike lanes, enhanced sharrows are not yet MUTCD compliant.

Application in Study Area: Enhanced sharrows could be used in areas where sharrows work to add extra visibility and awareness. Craig Street may be a good candidate for sharrows or enhanced sharrows.

BIKE BOX

Cost: Varies based on materials and related signage or signal needs. Up to $10,000 or more per box.

Description: A bike box is a marked area in front of the stop bar at a signalized intersection that allows cyclists to correctly position themselves for turning movements during the red signal phase by pulling ahead of the queue.

Effectiveness: Bike boxes have been shown to decrease conflicts and accidents between cars and bicycles. They have been found to be most effective when combined with a colored bike lane that continues straight into the intersection.

Implementation Considerations: Bike boxes should be located in a right-hand lane where on-street bike treatments exist. A bike box should be implemented in conjunction with a No Right Turn On Red sign and regulation. On-going costs to maintain color may be a concern.

Compliance with Standards: Not yet MUTCD compliant.

Application in Study Area: TBD

Other Improvements

This last type of treatments included in this section are improvements that include installing new walkways, consolidating or relocating bus stops to improve transit times, and establishing waiting space for transit riders at stops. The strategies contained in this section improve pedestrian comfort and safety by defining space for walkers, while improving access to transit.

BUS STOP CONSOLIDATION/ RELOCATION

Cost: minimal cost to remove existing stops; new shelters cost $10,000 to $15,000

Description: Bus stops located close to one another can be consolidated into a single stop, reducing the total number of stops the bus has to make and concentrating boardings/alightings at one location. Bus stops can also be relocated to improve access to existing sidewalks, crosswalks, or destinations.

Effectiveness: Reducing the number of stops from 10 per mile to 8 per mile increases average bus speeds by 1.5 minutes/mile or more, depending on average dwell time at stops.

Implementation Considerations: The placement of bus stops depends on the existing transit network and operator. Coordination with The Port Authority is necessary to determine if or where potential stops could be moved. Consideration should also be given to the available right-of-way and/or willingness of adjacent property owners to have stop amenities on their property.

Compliance with Standards: N/A

Application in Study Area: TBD

MULTIUSE PATHWAYS

Cost: $11 to $15 per square foot

Description: Sidewalks and multiuse pathways are the primary facilities for pedestrians to travel and provide mobility to various destinations. They can also serve as additional facilities for bicyclists.

Effectiveness: Safe and comfortable walkways have been shown to increase pedestrian use.

Implementation Considerations: Walkways should be part of every new roadway and retrofitted in locations without them to complete a network of pedestrian facilities. Where possible, a buffer (4 to 6 feet) should be provided to separate pedestrians from vehicle traffic.

Compliance with Standards: For ADA compliance, the minimum clear width of a sidewalk is 4 feet, but the FHWA and the Institute of Transportation Engineers (ITE) recommend a 5-foot minimum for pedestrians to pass one another or walk side-by-side.

Application in Study Area: No specific locations identified.

ACCESS MANAGEMENT

Cost: N/A

Description: Access management represents a long-term strategy focused on reducing conflicts at access points Excessive curb cuts along sidewalks contribute to an uncomfortable and unsafe pedestrian environment.

Effectiveness: N/A

Implementation Considerations: As redevelopment and reconstruction occurs, driveway access should be consolidated among properties where possible and curb cuts should be reduced to the minimum distance needed for safe ingress/egress.

Compliance with Standards: N/A

Application in Study Area: Several driveways with full or partial access exist along Forbes Road. As redevelopment opportunities arise, driveways should be consolidated and/or shrunk to minimize conflicts between turning vehicles and pedestrians. Where feasible, building accesses should be on minor streets or in the rear of buildings to improve pedestrian safety.

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