


Pittsburgh | Oakland | East End
TRANSIT STUDY

Definition of Alternatives

December 2014
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WSP

Submitted to: Port Authority of Allegheny County

EXECUTIVE SUMMARY

In response to requests from community stakeholders and members of the public, the Port Authority initiated this alternatives analysis of Bus Rapid Transit (BRT) in the Downtown-Oakland corridor, beginning in 2011 and concluding in 2014. Previous studies had considered light rail in this corridor as well as BRT. The 2009 Transit Development Plan recommended implementation of Rapid Bus Service on the 61- and 71-series routes, as well as on route 28X.

The study corridor between downtown and Oakland is richly served by multiple transit routes, including the 8 61- and 71- series routes, Route 28X with semi-express service to the Airport, route P3 connecting to the East Busway, and a number of other local and crosstown routes. 2011 daily ridership on the combined 61 and 71-series routes exceed 46,000. Travel patterns on these routes is centered on Oakland, not downtown, with heavy ridership from East End neighborhoods to Oakland. A high level of bus service is provided in the corridor, with high frequencies, but service is often overwhelmed by demand. Headways are unpredictable, with significant platooning or bunching observed. Dwell times at stops can be high, particularly in Oakland, due to a combination of high patron volumes and the "pay exit" fare collection strategy. Actual moving time is also highly variable, with buses operating in mixed traffic and subject to congestion delays in many parts of the corridor at many times of day.

Seven critical needs were identified for transit improvements in the Downtown-Oakland-East End area. These include improving travel choices, improving quality of service and amenities at transit stops, improving utilization of existing transportation resources, enhancing environmental quality and improving energy efficiency, reducing congestion with effective transportation solutions, coordinating transit and community planning, and coordinating transit planning and economic development initiatives.

An extensive public involvement process was conducted. Eight meetings were conducted with a Stakeholder Advisory Committee organized by Sustainable Pittsburgh, comprising more than 40 organizations, institutions, and community groups. A public meeting was held in Oakland on January 12, 2012 to introduce the public to the concept of BRT and to the study. This was followed by two rounds of four community meetings held in Oakland, Uptown, the Hill District, and the East End in spring and fall 2012. A total of 131 additional meetings were conducted with agencies, officials, individual stakeholders, and organizations. The public involvement process also included developing a video demonstrating application of BRT to the study area, and a computer simulation allowing users to model different station and roadway configurations for BRT. Both of these were hosted on GetTherePGH.org, a website hosted by Sustainable Pittsburgh.

The consultant team conducted a preliminary assessment of ridership and costs for different possible service configurations, including a core BRT service between Downtown and Oakland, an extended BRT service beyond this core to East Liberty and Wilkinsburg, an alternate extended BRT service beyond the core to Squirrel Hill, and a combined alignment of two routes serving the common core and branches extending to Wilkinsburg and to Squirrel Hill. The last of these appeared to have the potential to serve the most riders at the lowest cost per rider.

Stations are an important element of the image and function of the BRT system, and preliminary concepts of station design were developed. This included identifying a typology of BRT station types including bus stop, freestanding bus station, storefront station and major transit center. Sketch concepts were developed to illustrate design elements which could be incorporated into station design. A workshop was conducted with stakeholders to provide input into the station design process on January 31, 2013. Participants identified a number of features that could be included in stations, and also identified a number of design elements for further development. From this input, a refined concept sketch was developed which could serve as a basis for further design work. Some preliminary analysis was conducted of station spacing and location, but this was not shared with the public and is incorporated into the alternatives being advanced.

A broad range of alternatives was developed for BRT alignments in the corridor. These were developed at the neighborhood level, recognizing the widely varying conditions and needs throughout the study area. Typically, four to seven alternatives were developed for each neighborhood combining BRT operations, bicycle and pedestrian facilities, general traffic, and parking needs. These concepts were presented as typical cross sections and sketch mapping.

The broad range of initial corridor alternatives could not be practically evaluated to the level required for environmental clearance and design development. A preliminary screening process was conducted, involving a qualitative screening on a set of 16 parameters developed in consultation with the Stakeholder Advisory Committee. This allowed for the elimination of some alternatives; the remaining ones were combined into 5-corridor wide concepts, although it was understood that actual alignments would be selected at the neighborhood level. A secondary screening process was then conducted, reviewing each of these concepts to identify issues that may not have been considered in the preliminary screening that would preclude the alternative from approval or implementation.

Two refined alternatives were advanced from the screening process: Fifth/Forbes Concurrent lanes, generally consisting of exclusive bus lanes in the travel direction on Forbes and Fifth Avenues through Uptown and Oakland; and the Fifth Avenue Curb Lanes, generally providing exclusive bus lanes in both directions on Fifth Avenue. Both concepts also included accommodations for parking, bicycles and pedestrians as well as for and general traffic. In the downtown area, two options were advanced: a route through downtown to Gateway Center, and a short look terminating at Steel Plaza subway station. The impacts on Uptown parking were evaluated, as were possible connections to the Hill District. Potential service patterns were identified, which could be operated under either alignment alternative. Projected travel times were calculated, showing approximately 5 minutes' reduction in average travel time between Downtown and Oakland, combined with much greater travel time reliability. Construction costs were estimated to run between $190 million and $210 million in 2012 dollars. Based upon the information and analysis conducted to that point, stakeholders were unable to reach a consensus among these alternatives.

On July 20, 2013, work on the project to date was presented to FTA Region 3 staff, who recommended advancing the two remaining alternatives to the Project Development phase for further analysis to refine and select the preferred alternative. This recommendation was brought to the Stakeholder Advisory Committee, which agreed with moving forward in this manner.

Formal entry into Project Development and further work on the project was delayed as funding was sought to move forward, and as a Memorandum of Understanding (MOU) was negotiated between the Port Authority, the City of Pittsburgh, Allegheny County and the Urban Redevelopment Authority. Due to a change in administrations, this MOU was not executed until November, 2014.

Work resumed early in 2015, and the two alternatives being advanced were presented to the public at scoping meetings on May 5, and May 6, 2015. The two alignments were developed to the corridor level based upon the typical sections advanced from the Alternatives Analysis. Additional analysis was conducted of system configuration, branding, and station locations, Section 106 coordination was begun including a Phase 1 archaeological investigation, and preliminary work was begun on NEPA evaluations including environmental justice and noise and vibration analysis.

The two detailed corridor alignments were presented to the City of Pittsburgh, which determined that additional planning work was required to understand the relationship of BRT to other City initiatives, including bicycle lanes and economic development. The City undertook a number of initiatives including the Uptown EcoInnovation District study, the Envision Downtown initiative, and coordination with neighborhood groups in Oakland and the Hill District. Based in part on this work, the Mayor and Allegheny County Executive reached agreement in late 2016 to continue advancing the development and analysis of the BRT alignments and service plan options, and to resume the NEPA analysis.

A series of public meetings are planned for early 2017 to share the results of the two refined alternatives and to select an LPA. LPA selection is anticipated in late April, 2017, and that PAAC expects to enter the project into FTA's Capital Investment Grant program. This will involve additional environmental analysis and more detailed project engineering.

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1.0 INTRODUCTION

1.1 Background and Overview

Proposals for rapid transit linking Pittsburgh's Central Business District (CBD) with Oakland and other eastern neighborhoods date back to the early 1900s. From the 1980s through 2006, a series of corridor studies considered various options for extending Port Authority's Light Rail System from Downtown to Oakland, Squirrel Hill and other eastern communities. Due to projected very high capital costs, these efforts never advanced beyond initial alternatives analyses and environmental reviews.

In the mid-2000s, with on-street Bus Rapid Transit (BRT) being built in several North American cities, BRT was viewed as being a much less expensive solution to improve transit in the Corridor. In 2005, an Oakland citizen transit advocate led the effort to convene two forums on BRT in the Downtown – Oakland Corridor. The positive response to these forums led the Port Authority to commission an alternatives analysis beginning in 2011 which concluded in 2014.

1.2 Previous Studies

Spine Line

The Spine Line Corridor study began in 1988 and was completed in 1993. This study looked at options for extending light rail from Downtown Pittsburgh, and also considered a transportation systems management alternative to provide express bus service to Oakland via the East Busway.

Three light rail alternatives were considered between Downtown Pittsburgh and Oakland:

- Centre Avenue: In subway from the existing T near Forbes Avenue under Centre Avenue to Soho Street, and then connecting to Oakland at Craft Avenue.
- Colwell Street: In subway or at grade, extending generally along the existing Colwell Street alignment from the existing T near Forbes Avenue to Oakland.
- Pittsburgh Technology Center: At grade along the former B&O alignment (now the Eliza Furnace Trail, extending from the existing T near First Avenue and then elevated crossing the Parkway East to Oakland.

Within Oakland, the LRT would be constructed in subway under either Forbes or Fifth Avenue to a terminus at Morewood Avenue near Carnegie Mellon University.

Daily ridership was estimated to range from 51,000 to 61,000, and construction costs were estimated to range from $864 million to $1.086 billion in 1992 dollars. This is for a line from the existing T to Morewood Avenue. The3 study identified capacity constraints and geometric issues with connecting to the existing T, and noted that a separate downtown subway may be necessary but the cost of this was not included.

The TSM option was estimated to attract about 4,200 additional daily riders, and to cost $50M in 1992 dollars.

A potential extension to Squirrel Hill was identified in subway under Forbes Avenue from Morewood Avenue to near Dallas Avenue, and another potential extension was identified from Downtown to the North Side.

No clear alternative was identified as preferred from this study, with tradeoffs between construction cost, ridership, travel time, and economic development potential.

Eastern Corridor Transit Study

The Eastern Corridor Transit Study, Transitional Analysis to Locally Preferred Alternatives was completed in 2006 to update the recommendations from the original Eastern Corridor Transit Study and conduct the public involvement to select Locally Preferred Alternatives to place on the Long-Range Plan for the region. Six potential transit investments in five corridors were evaluated. This study considered three different alternatives for a Downtown Pittsburgh to Oakland transit investment. The first alternative would be to provide a light rail connection from the existing Steel Plaza Station in Pittsburgh to Oakland via the Strip District. The second would link Downtown and Oakland via Centre Avenue in the Hill District with options to extend beyond Oakland to either Homestead or Wilkinsburg. The third alternative would be to provide a Bus Rapid Transit system utilizing the existing Port Authority bus routes on Forbes Avenue and Fifth Avenue.

Constructing the Spine Line light rail to Wilkinsburg would reduce travel time from Wilkinsburg to Downtown by 43% compared to local buses, but would not improve on driving or existing express buses. Travel time from Wilkinsburg to Oakland would reduce by 45% over existing local buses and 39% compared to driving. Total daily boardings would be 39,400, at a capital cost estimated at $2.7 billion to $3.2 billion. An alternate configuration to Homestead was also evaluated, which would have similar benefits but a slightly lower capital cost.

A Downtown to Oakland Bus Rapid Transit system was evaluated, with an estimated 5% improvement in travel time over conventional buses. Ridership and capital cost were not estimated.

No alternative was advanced, but the next step recommended was to enter the alternatives into the Southwestern Pennsylvania Commission's (SPC) Long Range Plan. This would allow for the next study phases for each alternative to be initiated.

1.3 Transit Development Plan

In 2007-2009, Port Authority conducted the Transit Development Plan (TDP), a comprehensive assessment of its transit system to determine how to reorganize its bus route network to provide more effective, efficient and improved service within available financial resources. One of the TDP's major recommendations was to implement a Rapid Bus service between Downtown Pittsburgh and Oakland and City of Pittsburgh neighborhoods to the east of Oakland. This recommendation applied to the primary routes between Oakland and Downtown, as well as Route 28X with service to Pittsburgh International Airport.

1.4 Opening of the Cleveland Health Line and BRT Symposium

In 2009, the Greater Cleveland Regional Transit Authority opened the Health Line, a BRT project linking Cleveland's CBD with its university and medical center district. Several

delegations of Pittsburgh stakeholders toured the Health Line. As the project is in a corridor with several functional, economic and development similarities to the Downtown – Oakland – East End Corridor, the stakeholders were inspired by their tours and became very interested in a similar project for Pittsburgh.

On September 20, 2010, Port Authority, along with many of these stakeholders convened a day-long BRT informational forum for local officials, stakeholders and interested members of the public not familiar with BRT. A National Bus Rapid Transit Institute representative provided an overview of BRT and transit agency representatives from Cleveland, Kansas City and Los Angeles discussed their cities' BRT systems. Break-out discussions were convened in the afternoon to provide an opportunity for the forum attendees to consider the implications of BRT for Pittsburgh.

1.5 Current Study

Based upon the needs, opportunities, and support identified at this Forum, the Port Authority along with key stakeholders including the City of Pittsburgh and Allegheny County, elected to move forward with a formal study of Bus Rapid Transit in the Downtown-Oakland-East End Corridor. Funding was identified for an Alternatives Analysis and preparation of NEPA documentation, and the Port Authority advertised for and selected a consultant team headed by PB Americas to advance this project.

The purpose of this study is to develop a Downtown-Oakland-East End Bus Rapid Transit (BRT) project which would qualify for funding under the Federal Transit Administration (FTA) Small Starts Program. The study involves an Alternatives Analysis (AA) and a National Environmental Policy Act (NEPA) review for a BRT project linking Downtown, Oakland and other East End neighborhoods in the City of Pittsburgh along the Fifth and Forbes Avenues Corridor.

2.0 EXISTING CONDITIONS

2.1 Transit Service

Core Corridor Routes

The study area is richly served by the existing transit network, as shown in Figure 1.

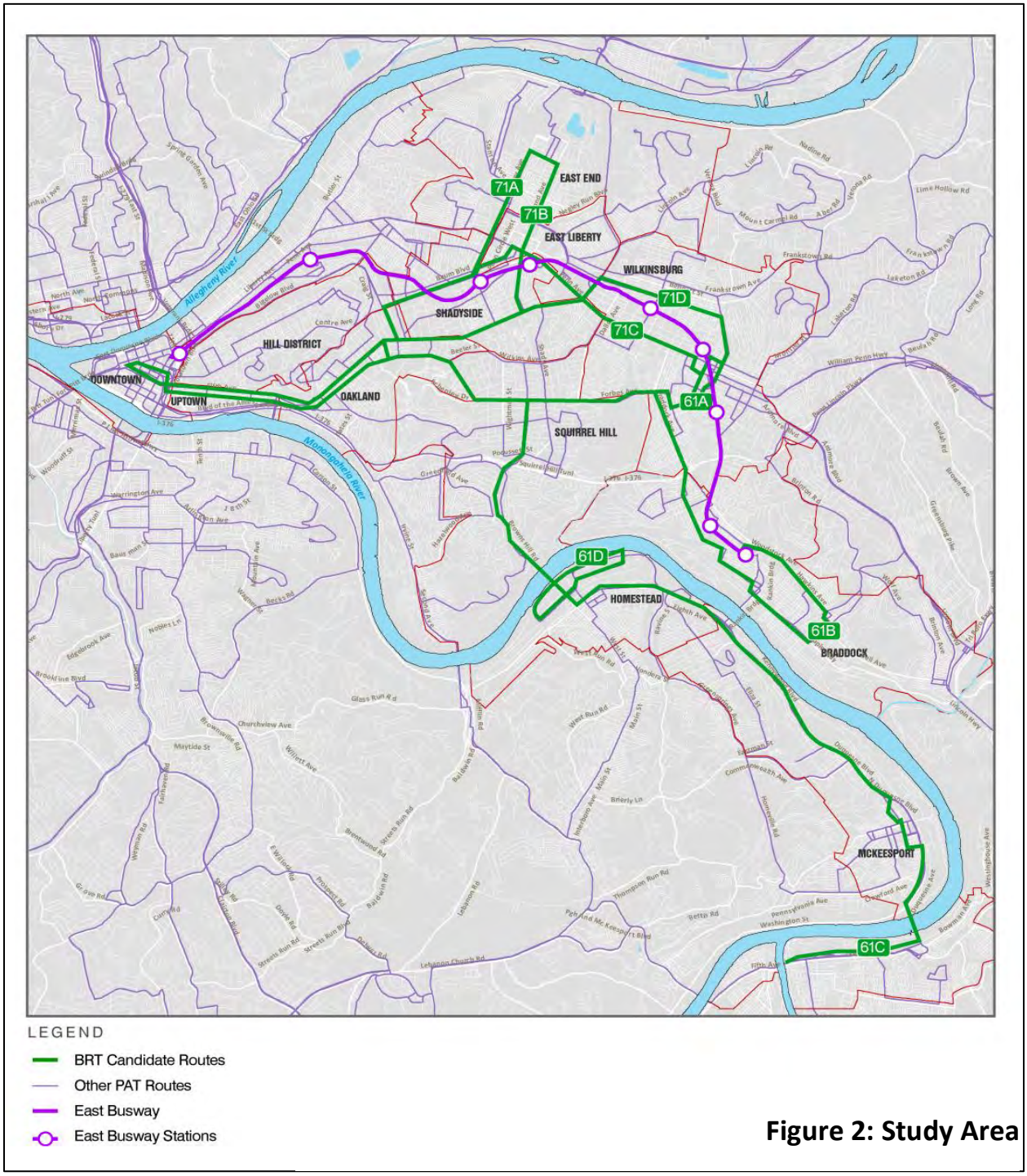

Figure 2: Study Area

The heart of the corridor is the eight 61- and 71 series routes, which serve a common routing between Oakland and Downtown. These are the routes that were identified by the TDP as candidates for conversion to BRT.

The 61-series routes operate eastbound through Oakland on Forbes Avenue, and extend to the east along Forbes Avenue to Squirrel Hill before branching to serve locations including Regent Square, Wilkinsburg, Braddock, McKeesport and Homestead.

The 71-series routes operate eastbound through Oakland on Fifth Avenue, and extend to the east along Fifth Avenue to North Oakland and Shadyside before branching to serve locations including East Liberty, Highland Park, Point Breeze, Homewood and Wilkinsburg.

The combined 61- and 71-series routes operate westbound through Oakland and Uptown on Fifth Avenue and enter downtown via Sixth Avenue. They loop via Liberty Avenue and travel eastbound through Downtown on Fifth Avenue, then travel eastbound on Forbes Avenue. At Jumonville Street, the 71-series routes transition to Fifth Avenue towards Oakland, while the 61 series routes remain on Forbes Avenue.

Other Corridor Routes

Service overlapping the core corridor routes is provided between Oakland and Downtown by routes 28X, 65, 67, 69 and P3.

Route 28X provides semi-express service between Oakland and Downtown to the Airport and Robinson Town Center. This route travels between Oakland and Downtown via the Boulevard of the Allies.

Route 65 provides service between Downtown and Squirrel Hill, traveling through Uptown and Oakland on the Boulevard of the Allies.

Routes 67 and 69 travel from Downtown to Oakland via the Boulevard of the Allies, then travel on the same route as the 61-series routes to Beeler Street where they then serve Point Breeze and Wilkinsburg before diverging through the eastern suburbs to termini in Trafford and Monroeville.

Route P3 integrates the East Busway with the corridor with a service beginning at the busways eastern terminus in Swissvale, continuing along the East Busway to the Neville Ramp, where it enters Oakland, and then traverses Oakland along Fifth Avenue to Craft Avenue.

Crosstown Routes

Oakland serves a secondary hub of the transit system, with several routes serving Oakland that do not go to Downtown Pittsburgh. These include Route 75 from East Liberty to South Side, Route 54 from North Side and Strip District to the South Side and Mount Oliver, and Route 93 from Lawrenceville to Hazelwood.

Other Routes Serving the Corridor

A number of other routes serve parallel corridors in the eastern portion of the city of Pittsburgh, and overlap at least some portion of the core corridor routes. Some of these routes also pass

through or terminate in Oakland. These routes include: 58 Greenfield, 77 Penn Hills, 81 Oak Hill, 81 B Lincoln, 83 Webster.

Transit Ridership

Ridership on the corridor routes is robust. Based on 2011 data (the latest available at the time this analysis was conducted) average weekday ridership on the combined 61- and 71-series routes exceeds 46,000. This accounts for 20% of total Port Authority system ridership. With the other corridor routes included, total average weekday ridership reaches 78,000, or a third of total system ridership.

39% of the ridership on the core 61-and 71-series routes is made by people riding with passes from local universities including University of Pittsburgh, Carnegie Mellon University and Chatham University through arrangements made with Port Authority.

Table 1: 2011 Transit Ridership

September 2011 Transit Ridership			
	Average Weekday	Average Saturday	Average Sunday
61A Wilkinsburg	4,121	2,880	2,064
61B Braddock	5,076	3,702	2,062
61C McKeesport	6,505	4,504	3,048
61D Murray	5,731	3,989	2,257
71A Negley	9,277	2,988	2,067
71B Highland Park	5,252	2,314	1,504
71C Point Breeze	4,733	3,945	1,914
71D Hamilton	5,344	2,789	1,735
Total	**46,039**	**27,111**	**16,651**
System Total	**234,212**	**108,231**	**65,177**

2.2 Travel Patterns

Existing travel demand patterns in the corridor were evaluated, both based on current ridership patterns on the 61- and 71-series routes, and also on the 2007 Transit Survey conducted by Southwestern Pennsylvania Commission. Based on this data, shown in Figure 2, several patterns can be observed which are significant for development and design of a BRT system.

The most noteworthy pattern is that ridership on these routes is centered on Oakland, not on Downtown. Roughly equal numbers of trips travel between Oakland and Downtown, Oakland and Shadyside/East Liberty/Highland Park, and Oakland and Squirrel Hill. Comparatively low

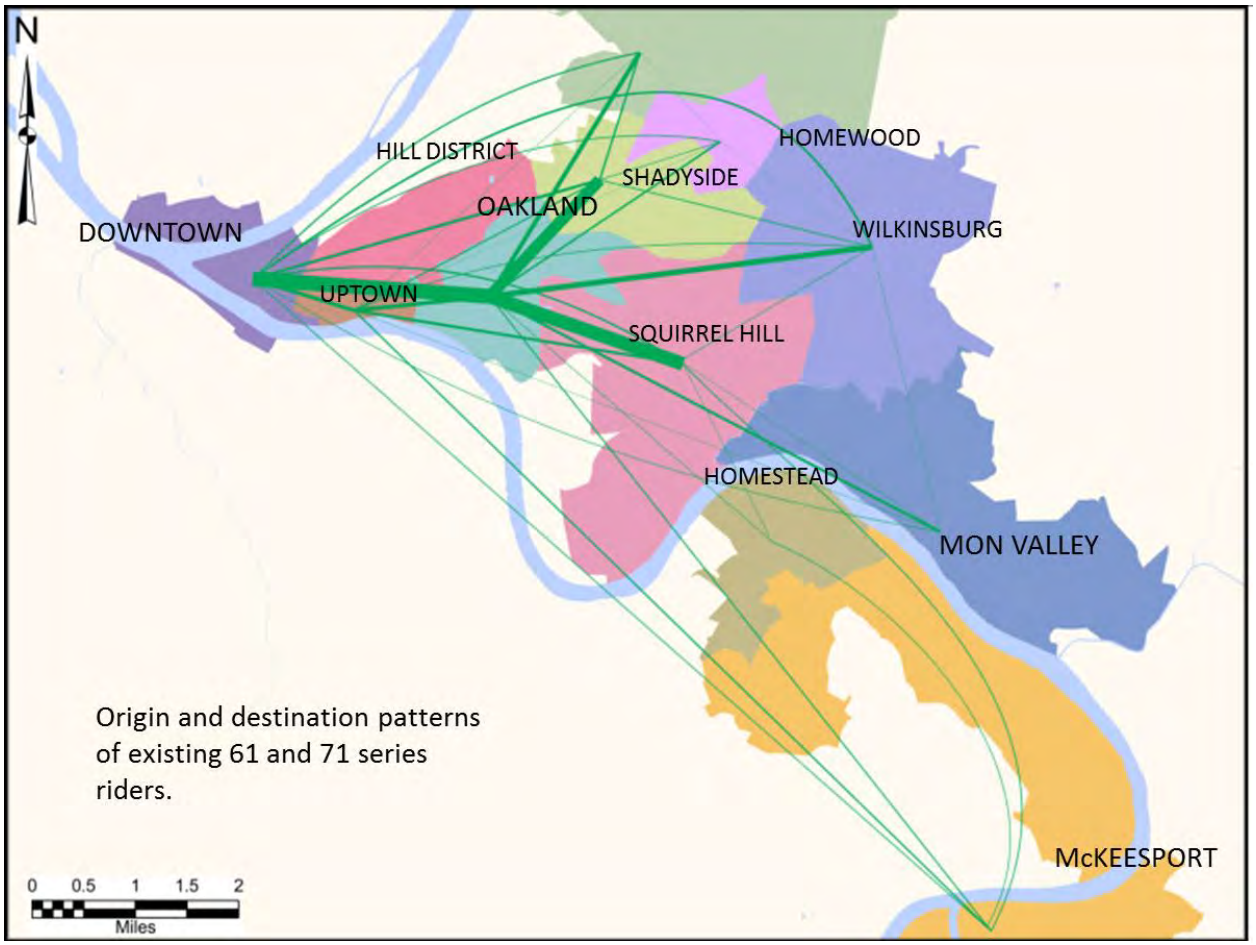

Figure 3: Travel Patterns

numbers of trips are made on these routes between Downtown and the eastern neighborhoods by traveling through Oakland.

Another aspect of this data is that most trips on these routes are relatively short distance, between Downtown, Squirrel Hill or Shadyside and Oakland.

To a certain extent, these ridership patterns reflect both the severe congestion of the transit network in Oakland, as well as the provision of alternate routes between the eastern neighborhoods and downtown, most notably via the East Busway but by numerous other routes as well.

However, these patterns also reflect the emergence of Oakland as a regional hub in its own right. Many university students and employees of Oakland institutions reside in the adjacent Squirrel Hill and Shadyside neighborhoods, and make use of the extensive transit service and institutional passes to commute. Transit has an extremely high penetration in these corridors. Many other institutional employees and visitors live in parts of the region without direct transit service to Oakland, and many of the commute using the T or other bus routes to downtown, connecting to the 61-and 91 series routes to Oakland.

Designing an effective BRT service for the corridor based upon these travel patterns could lead to a network similar to that shown schematically in Figure 5. This includes high levels of BRT

service on branches to Shadyside and to Squirrel Hill, and potential extensions further to the east.

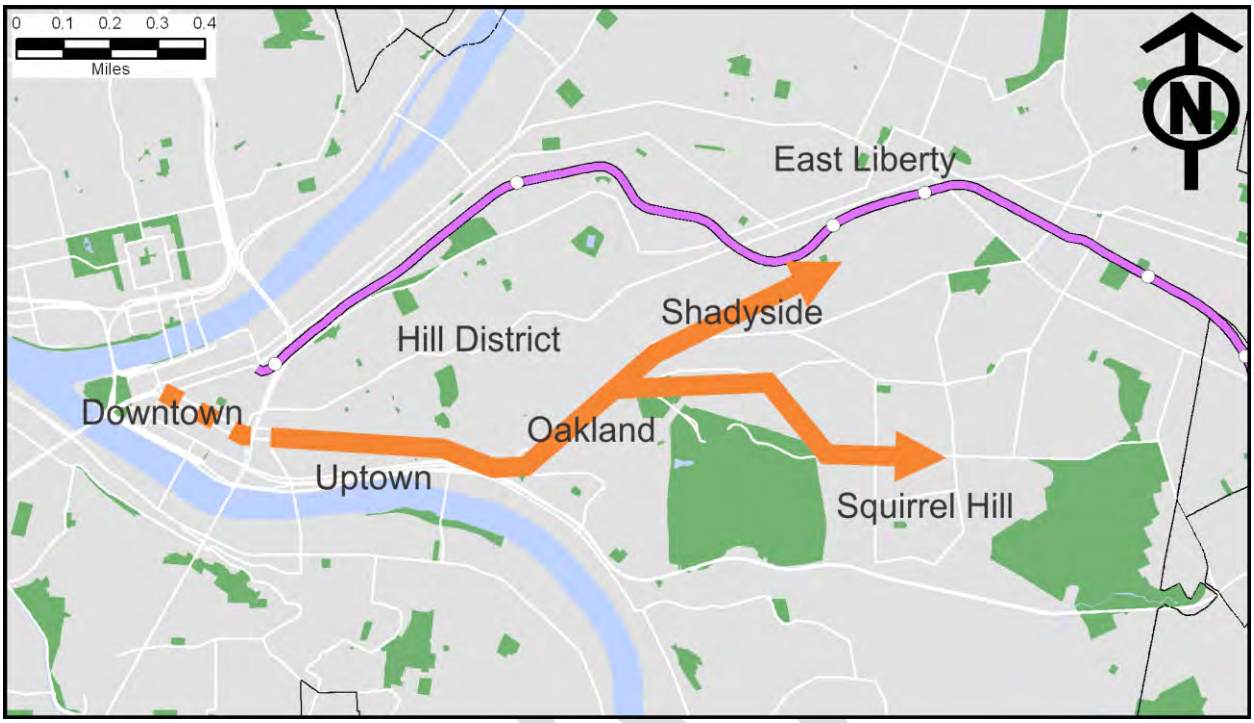

Figure 5: Schematic BRT Demand Pattern

2.3 Service Quality

As befits the high level of transit ridership in the corridor, transit service is extensive, with bus frequencies unmatched in any other corridor in the system. However even this extensive service is overwhelmed by the ridership demand, particularly in Oakland and neighborhoods east of Oakland and the service quality is often less than optimal.

In particular, the routes in the corridor suffer from unpredictable headways variable travel times, and long dwell times. These combine to make bus travel times in the corridor extremely unpredictable, and at times quite slow.

Headways

Existing combined headways for the 61- and 71-series routes at Fifth Avenue and Smithfield Street in Downtown Pittsburgh are shown in Figure 6. Because the combined service is a confluence of eight major routes, scheduled headway averages about two minutes, varying little between peak and off-peak periods. However, a significant amount of platooning occurs, a function of the degree of congestion in the corridor, uneven boarding and unloading times and the amount of mixed-traffic running. Due to the platooning, the effective weighted headway observed by patrons is just over three minutes, Significant fluctuations can occur. During the AM peak period, headways greater than 8 minutes were observed, and headways of near five minutes were not uncommon. These headways are for combined service; headways on individual routes may be even less predictable.

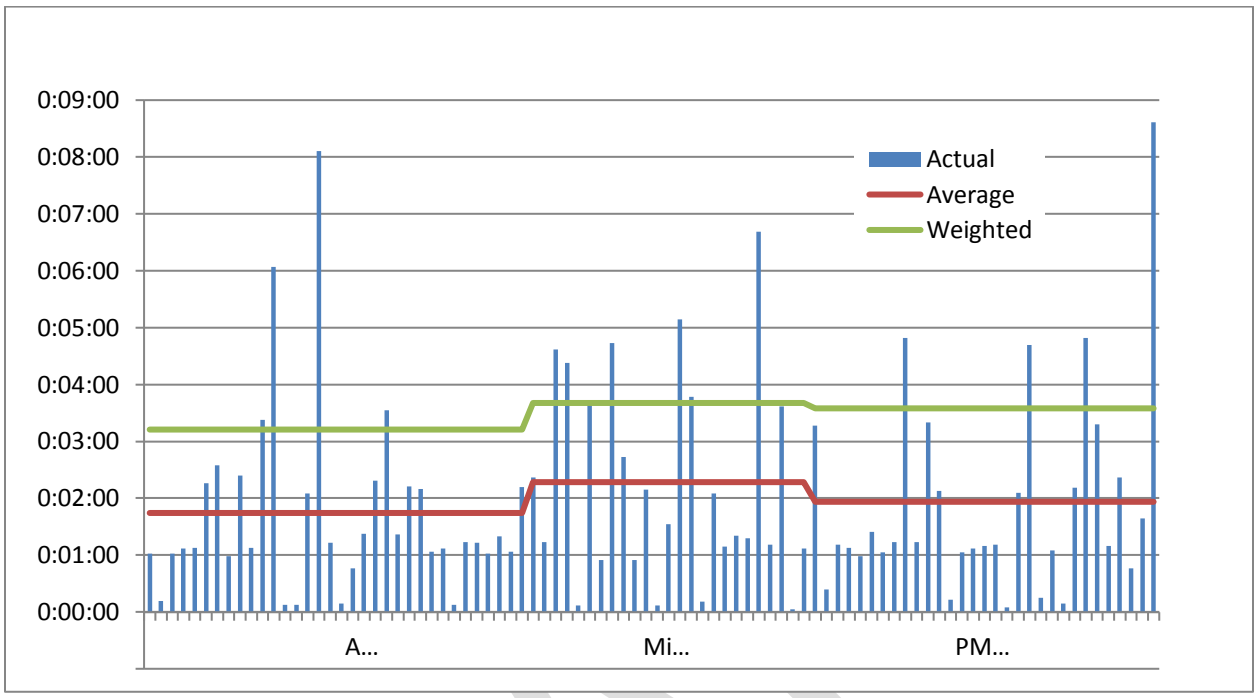

Figure 6: Existing Transit Headways

Dwell Time

A second factor contributing to variable travel times is variation in dwell times at stops. Based upon an analysis of dwell time and passenger counts from Automatic Passenger Count data on routes in the corridor as shown in Figure 7, the mean dwell time is 5 seconds per passenger in the eastbound direction and 3 seconds per passenger in the westbound direction. This compares to the national average of 2.5 seconds per passenger.

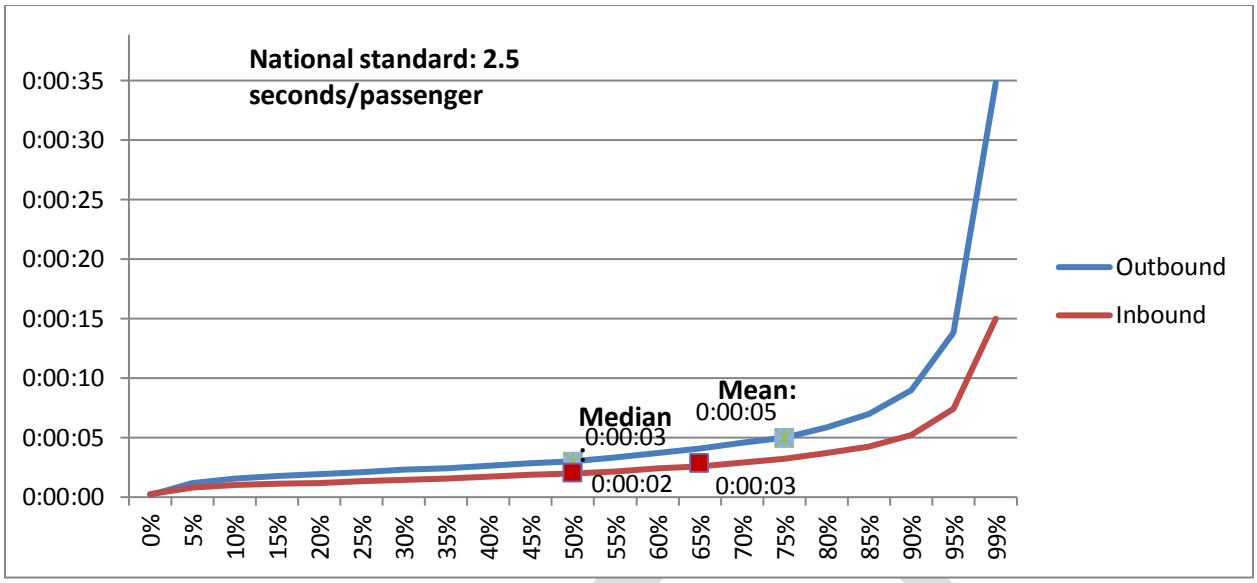

Figure 7: Dwell Times

The median observed values of 2 and 3 seconds closely track the national data, and reflect the high proportion of patrons using passes in the corridor. However, the distribution of dwell times shows a number of trips with substantially slower rates. This can stem from a combination of factors, including placing and removing bicycles from racks and boarding and alighting of persons with disabilities, but also relates to fare collection issues. While most patrons use passes, many riders pay with cash. . Even with modern electronic farebox equipment, paying the standard $2.50 fare with cash requires numerous operations with paper bills and coins. Adding to the challenges is a fare collection strategy that, while effective in many parts of the system, essentially requires all boardings and alightings in Oakland to take place through the buses' front doors.

Moving Time

The last major factor contributing to variable travel times is the actual moving time. With vehicles operating in mixed traffic, and with significant congestion recurring in Downtown, Oakland and Uptown during peak periods, as well as during off-peak periods due to special events and other factors, observed moving time per trip between downtown and Oakland was observed to range from a low of 12 minutes to a high exceeding 36 minutes. As shown in Figure 8, this is moving time alone, exclusive of vehicle headways and dwell time at stops.

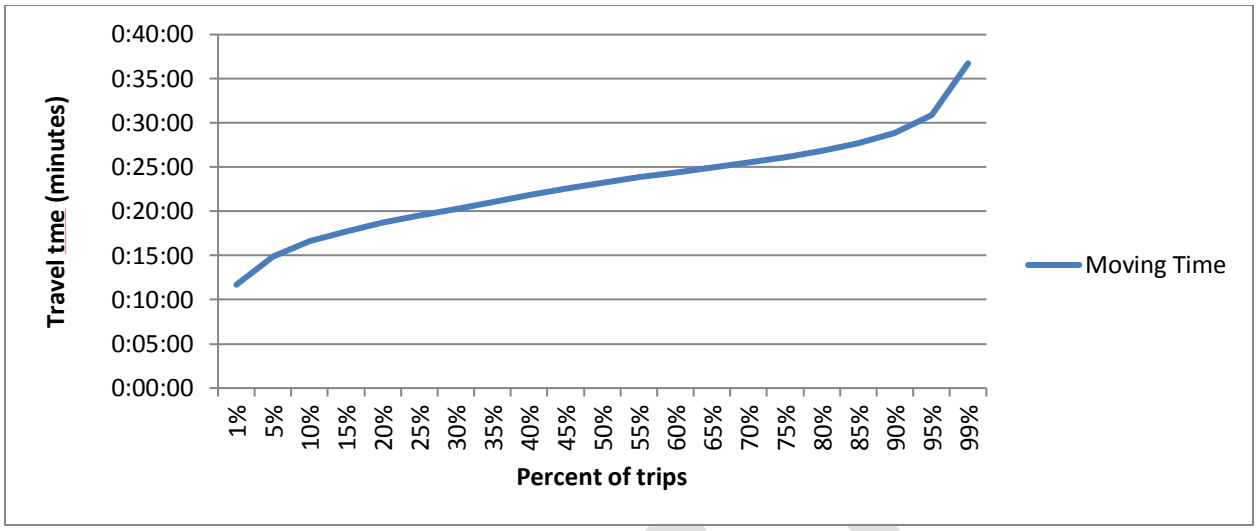

Figure 8: Moving Time

Variable Travel Time

Taking into consideration the range of variability in headways, dwell time and moving time, the variable range of travel time can be shown in Table 2 and Table 3.

While the existing travel time between Downtown and Oakland averages 19 minutes 33 seconds, under typical variation this can reach 33 minutes 51 seconds, a total time that few users experience regularly, but which must be accounted for in planning travel. A similar variation exists for travel between Downtown and Morewood Avenue, where the average is 25 minutes 27 seconds, but a maximum of 41 minutes 51 seconds has been observed.

Table 2: Existing Travel Times to Oakland

Downtown to Atwood Street		
	Average	**Worst Case**
Wait Time	2:17	8:37
Travel Time	17:16	25:14
Total Trip	19:33	33:51

Table 3: Existing Travel Times to Morewood Ave

Downtown to Morewood Avenue		
	Average	Worst Case
Wait Time	2:17	8:37
Travel Time	23:10	33:14
Total Trip	25:27	41:51

3.0 PURPOSE AND NEED

Pittsburgh has pioneered a number of arterial-based bus transit improvements, including contra-flow bus lanes and passive signal priority at key intersections. With the South, West and Martin Luther King, Jr. East Busways, Pittsburgh has been a national leader in development and operation of Bus Rapid Transit systems since 1977. However pioneering, Pittsburgh's Bus Rapid Transit systems have failed to keep up with the rapid advances in BRT implementation in the past decade, and the service generally lacks a clear identity, In addition, these facilities generally serve radial travel to and from the Central Business District, and only peripherally serve the dynamic area centered on Oakland.

Downtown Pittsburgh and Oakland are, respectively, the second and third largest generators of traffic in the Commonwealth of Pennsylvania. Both areas are intensely developed with multi-story buildings accommodating office, educational, medical, residential, retail and government uses. Other neighborhoods in the eastern corridor are also intensely developed with similar uses.

The dense employment and residential development in combination with the universities and hospitals in Oakland and the Downtown office development make the Downtown – Oakland – East End area one of the most significant travel sheds in Southwestern Pennsylvania. In September, 2011, Port Authority's eight routes traversing the study area carried an average 46,039 riders, nearly 20% of total system ridership. Other routes provide service through segments of the corridor carried an additional 24,641 riders, although these may not all be within the study area.

The intensity of development in the Downtown – Oakland – East End corridor places a very high level of demand on the street and highway network serving the corridor. As a result local roadways are frequently congested, even during non-peak periods. The high level of development specifically in Downtown and Oakland limits the amount of land available for parking which results in high parking rates. On-street parking is also limited and expensive.

Although the Port Authority currently operates a very high level of service to and within the eastern corridor, buses are often overcrowded. The high level of service in combination with congestion frequently results in "bunching" of buses resulting in gaps in service, overcrowding of the first two or three buses in a bunch as well as delayed and unreliable service. The uneven distribution of loads reduces customer satisfaction and operational efficiency while increasing Port Authority's operating costs.

Transit service in the eastern corridor of Pittsburgh serves several distinct user and geographic markets. Commuters destined to Downtown Pittsburgh begin their trips in communities located east of the city as well as in eastern neighborhoods within the city. These riders follow typical commuter travel patterns of commuting to work during the morning peak period (6:00 to 9:00 am) and return home during the afternoon peak period (4:00 – 6:00 pm).

Travelers to Oakland are more diverse in terms of trip purpose and time of travel. They include university faculty, staff and students, high school students and medical center employees and patients. While many Oakland commuters travel during typical commute times, the nature of hospital shifts and university class schedules involves travel during mid-day and evening and late night periods, too.

Both Downtown and Oakland commuters experience overcrowding on routes which, combined with slow bus service, provide uncomfortable rides. "Bunching" of buses contributes to uneven loading of buses throughout much of the day. [Repetitive with second paragraph]

Many Oakland commuters begin and end their trips within eastern neighborhoods within the city or in communities to the east of Pittsburgh. However, as Oakland is a regional employment hub, there are many other commuters who travel from other areas of Allegheny County. For most of these commuters, a transfer to Oakland-destined transit service is required in Downtown Pittsburgh. Waiting times for transfers are exacerbated by bus "bunching."

Oakland is the location of several cultural attractions such as the Carnegie Museums of Art and Natural History, Carnegie Library, Carnegie Music Hall, Cathedral of Learning/Nationality Rooms, Soldiers and Sailors Memorial Hall and the Stephen Foster Memorial. Visitors, particularly those from outside of the Pittsburgh Region, would desire more easily understood service to the area, particularly from Downtown Pittsburgh where most Port Authority routes converge.

Changes in bus stop locations have been made on an *ad hoc* basis to accommodate new development in the Downtown-Oakland-East End area, but to date, there has been no comprehensive assessment to determine the optimal locations of stops with respect to maximizing customer access from origins and to destinations, increasing operating efficiency and ensuring greatest compatibility with existing and proposed new development.

The system of fare collection involves payment upon entry for inbound buses traveling from the east to Oakland and Downtown Pittsburgh and payment upon exit for outbound buses leaving from Downtown Pittsburgh to Oakland and other eastern communities until 7 pm. After 7 pm and for crosstown routes, riders pay upon entry regardless of direction. This system causes considerable delays in Oakland where bus drivers first must collect fares from alighting passengers and then board outbound (eastbound) riders. Additionally, this system of fare collection is confusing and can discourage occasional users such as visitors.

These problems make it difficult for the region's residents to access employment sites, educational institutions, medical facilities and retail development in Oakland and Downtown. Improvements in transit service are necessary to maintain and enhance mobility to and within the Downtown-Oakland-East End area as well as to ensure that ongoing and future development in the area does not overwhelm the area's transportation system. Additionally, better transit service is critical for maintaining and improving the area's ability to be a livable community for workers, students, residents and visitors.

Seven critical needs have been identified associated with the development of premium transit service and facilities in the Downtown-Oakland-East End area:

Need 1: Improve Travel Choices

- More travel choices.
- Improved transit service.
- Better bicycle and pedestrian facilities.
- Better integration of bicycle and pedestrian access to transit.

Need 2: Improve Quality of Service and Amenities at Transit Stops

- More reliable transit service.
- Transit service operated on more even intervals.
- Increased capacity to relieve overcrowding on transit vehicles.
- Provision of real time schedule information for transit users.
- More attractive transit stops to improve understanding of the transit system and increase its appeal for existing and prospective new riders.

- Need for amenities such as more shelters, benches and other enhancements.
- Better integration of stops and stations with existing and future development.

Need 3: Improve Utilization of Existing Transportation Resources

- Optimize utilization of Fifth and Forbes Avenues and other major streets in the area including incorporation of Complete Streets treatments.
- More effective integration of pedestrian and bicycle access into the existing street and sidewalk network and eliminating gaps in the network.
- Increase capacity and quality of transit service without increasing operating costs.
- Add more transit lanes and other transit prioritization treatments to reduce transit travel times.
- Incorporate Intelligent Transportation System improvements to improve speed, reliability and operating efficiency of transit service and to provide travel information as well as balance the needs of all modes.

Need 4: Enhance Environmental Quality and Improve Energy Efficiency

- Relieve air and noise pollution through usage of more environmentally-benign transit vehicles and modes.
- Reduce transportation generated CO2 and other greenhouse gasses in coordination with the City of Pittsburgh's greenhouse gas reduction initiatives.
- Incorporate transit priority treatments to improve energy efficiency of transit vehicles.
- Increase investments in bicycle and pedestrian facilities to enhance zero-emission zero-fossil fuel travel choices.
- Improve aesthetics of transit stops through design, branding and, where appropriate, landscaping treatments.
- Increase attractiveness of transit service to reduce air and noise pollution and energy consumption associated with automobile travel to and within the area.

Need 5: Reduce Congestion with Effective Transportation Solutions

- Forbes and Fifth Avenues and major arterials feeding into Oakland and Downtown from other areas such as the Parkway East, Bigelow Boulevard and Boulevard of the Allies are now and are projected to be severely congested.
- A multimodal approach is needed to maximize improving alternatives to single-occupant automobiles in order to ameliorate intense congestion in the area.

Need 6: Coordinate Transit and Community Planning to Enhance Quality of Life

- Coordinate with the City of Pittsburgh's MovePGH plan to be consistent with the transportation element of its developing Comprehensive Plan.
- Enhance collaboration with community planning initiatives such as the Oakland 2025 Plan to ensure that transit improvements are compatible with community plans and to ensure that community plans support transit, pedestrian and bicycle improvements.
- Achieve consistency with Allegheny County's comprehensive plan, Allegheny Places and Active Allegheny, the County's pedestrian and bicycle plan.
- Maintain consistency with the Pennsylvania Department of Transportation Smart Transportation principles.

- Improve transit service to help ensure that disadvantaged communities benefit from economic development and community revitalization efforts.
- Improve transit services and facilities so that area residents, businesses, students, institutions and visitors see them as assets.
- Consider providing of public spaces at transit stops and stations to encourage social interaction.
- Use urban design principles for stations and stops to promote neighborhood identity.
- Use enhanced techniques to engage the public and stakeholders in the planning process.

Need 7: Coordinate Transit Planning and Economic Development Initiatives

- Improve collaboration with existing business and institutions as well as interested developers to ensure that transit improvements support existing and future development and to ensure that new developments are compatible with proposed transit, pedestrian and bicycle improvements.
- Promote infill development to promote more compact and walkable communities and reduce vehicle-miles traveled.
- Implement mechanisms to capture the increased value of property at and near transit facilities to help fund transit investments and support transit service.
- Implement an effective transit system to increase the attractiveness of the area to developers.
- Utilize branding and marketing strategies to facilitate integration of transportation investments with development.
- Encourage land uses along stations and stops which generate activity and transit usage throughout the day and week.

4.0 PUBLIC INVOLVEMENT

4.1 Stakeholder Advisory Committee

Composition

While this study is being led by the Port Authority of Allegheny County, its genesis came from a grass-roots movement of local leaders and institutions who saw the potential for bus rapid transit to play a role in regional transportation and economic development. These stakeholders organized the BRT symposium in September, 2010, which directly led to the current study.

Building upon that initial leadership, stakeholder organizations have continued to play an active role in the BRT project, and it has been widely recognized that broad support from these organizations will be necessary if the project is to advance.

The initial group of stakeholders has been joined by a number of other organizations and institutions who are endorsing the study and it now constitutes more than 40 members as shown in Table 4. These groups have been organized as the Stakeholder Advisory Committee by Sustainable Pittsburgh.

Table 4: Stakeholders

• ACTION Housing, Inc. • Allegheny Conference on Community Development • Allegheny County Department of Economic Development • Allegheny County Transportation Action Partnership • Allegheny County Labor Council • Allegheny County Transit Council • Bike Pittsburgh • Carnegie Mellon University • Carlow University • City of Pittsburgh Dept. of City Planning • Committee for Accessible Transportation • Duquesne University • East Liberty Development, Inc. • Federal Transit Administration • Local Government Academy • Hill District Community Development Corporation • Hill District Consensus Group • Hill House Association • NAIOP, Pittsburgh Chapter • Oakland Planning & Development Corporation • Oakland Transportation Management Association	• Oakland Task Force • PA Department of Transportation • PA Interfaith Impact Network • Pittsburgh Central Keystone Innovation Zone • Pittsburgh Community Reinvestment Group • Pittsburgh Downtown Community Development Corp. • Pittsburgh Downtown Neighborhood Association • Pittsburgh Downtown Partnership • Pittsburgh Parking Authority • Pittsburgh Partnership for Neighborhood Development • Pittsburgh Penguins • Pittsburgh Sports & Exhibition Authority • Pittsburgh United • Port Authority of Allegheny County • Southwestern Pennsylvania Commission • Squirrel Hill Urban Coalition • Sustainable Pittsburgh • University of Pittsburgh • UPMC • Uptown Partners of Pittsburgh • Urban Innovation21 • Urban Land Institute, Pittsburgh Chapter • Urban Redevelopment Authority of Pittsburgh

Meetings

The Stakeholder Advisory Committee met eight times during the course of the study to review technical analysis, provide input into decision making, and to share information on the project to and from their constituents. These meetings are summarized in Table 5.

Table 5: Stakeholder Meetings

Mtg.	Date	Location	Major Topics
1	9/28/2011	Port Authority *Holmes Room*	Project background, key issues, corridor study methodology and study, stakeholder committee involvement.
2	12/15/2011	Regional Enterprise Tower *McNeill Room*	Public involvement plan, system configuration analysis, ITDP BRT "Gold Standard."
3	3/29/2012	Regional Enterprise Tower *McNeill Room*	Conceptual alignment alternatives, upcoming community meetings, BRT simulation and visualization.
4	6/5/2012	University of Pittsburgh *Alumni Hall*	BRT simulation, review of community meetings, stakeholder survey, proposed screening methodology, conceptual service alternatives.
5	9/5/2012	City of Pittsburgh *Citi-Stats Room*	Presentation of visualization, simulation, results of screening, BRT connections to surrounding neighborhoods, upcoming newsletter, and upcoming community meetings.
6	October 22, 2012	Pittsburgh Downtown Partnership	Review of technical analysis, update on community meetings, and discussion of process going forward.
7	3/21/2013	Port Authority *Holmes Room*	Rockefeller Foundation, BRT benefits, travel time analysis, Uptown parking study, traffic impacts, construction cost estimates, station design workshop.
8	9/25/2013	Carnegie Mellon University *Gates Center*	Review of Health Line Corridor tour, update on FTA briefing, next steps in Project Development phase, station concept and development, system configuration, downtown circulation options, next steps.

Health Line Tour

On June 20, 2013, a tour, sponsored by Allegheny County Executive Rich Fitzgerald, was conducted of the Health Line BRT in Cleveland. . Nearly 70 stakeholders and elected officials travelled to Cleveland for an all-day event which included presentations from CGRTA and Cuyahoga County economic development officials followed by as a tour of the BRT system between Public Square in Downtown Cleveland and East 120th Street. Participants had the opportunity to view different station types, observe exclusive bus lanes, and to see what had

been touted as $4.3 billion in economic development along the corridor, which was as high as $5 billion by some estimates.

4.2 Public Meeting

The first public meeting for the study was held on January 12, 2012 at the University of Pittsburgh's Alumni Hall Grand Ballroom, to introduce the public to the project and to the bus rapid transit concept. Two sessions were held, from 12:00 to 2:00 PM and from 6:00 to 8:00 PM. A total of 85 people signed in.

The meeting began with an open house, with 27 informational boards explaining bus rapid transit concepts, providing information on bus rapid transit implementation in other cities, and providing information on the upcoming study. A brief presentation was made highlighting the same points, followed by an opportunity to ask questions. During the open house, a video describing the Fort Collins, Colorado MAX BRT in implementing BRT was shown. Participants were given the opportunity to complete comment forms or to comment on a study area map.

4.3 Community Meetings

First Round

The first round of community meetings was conducted in spring 2012. Separate meetings were conducted in individual neighborhoods to allow the presentation and discussion to be tailored to the specific needs of each community, as well as to make it easier for people to attend. During the first round, meetings were held as listed in Table 6.

Table 6: First Round Community Meetings

Neighborhood	Date	Time	Location
Hill District	April 24, 2012	6:00 to 8:00 PM	Hill House
Oakland	April 25, 2012	6:00 to 8:00 PM	Carnegie Mellon University
East End	April 26, 2012	6:00 to 8:00 PM	East Liberty Presbyterian Church
Uptown	May 8, 2012	6:00 to 8:00 PM	UPMC Mercy Hospital

At these meetings, a PowerPoint presentation was given beginning with a brief overview of BRT. This was followed by a discussion of the approach used to develop potential alignments for the BRT system, with the alternatives tailored to each individual neighborhood in the corridor. This was followed by a more detailed presentation of the specific alternatives identified for the neighborhood targeted for that meeting. The meetings concluded with a discussion of upcoming steps. Participants were given the opportunity to ask questions during the meetings, and to submit comment forms at the conclusion.

Second Round

The second round of community meetings was held in fall 2012. Separate meetings were conducted in individual neighborhoods to allow the presentation and discussion to be tailored to

the specific needs of each community, as well as to make it easier for people to attend. During the first round, meetings were held as listed in Table 7.

Table 7: Second Round Community Meetings

Neighborhood	Date	Time	Location
Hill District	October 11, 2012	6:00 to 8:00 PM	Hill House
Oakland	April 25, 2012	6:00 to 8:00 PM	Carnegie Mellon University
East End	April 26, 2012	6:00 to 8:00 PM	East Liberty Presbyterian Church
Uptown	May 8, 2012	6:00 to 8:00 PM	UPMC Mercy Hospital

Each of these meetings began with a presentation of the Pittsburgh BRT video. This was followed by an overview of the work underway on the project. The revised alternative alignments being advanced for the respective neighborhoods were presented in detail. The presentation concluded with an introduction to the BRT simulation and a discussion of next steps, and was followed by a period of questions. Participants were then given the opportunity to post comments on large maps of the corridor showing each of the alignments.

4.4 Other Meetings

During the course of the initial phase of the project, the project team engaged in an extensive effort of additional meetings with agencies, officials, individual stakeholders and organizations to discuss the BRT project. Between August, 2010 and February, 2014, a total of 131 such meetings were held. Most of these meetings were conducted by Port Authority staff, and participants ranged from elected officials to community organizations and advocacy groups such as the Committee for Accessible Transportation.

4.5 Video

The firm of Etcetera Edutainment was engaged to develop a video demonstrating the concepts of bus rapid transit and its potential for applicability to the project corridor. The 2 minute, 38 second visualization uses a combination of live action video and computer generated graphics to present concepts. The video uses a series of vignettes tracing hypothetical trips in the corridor, showing a wide range of people using the BRT to travel for shopping, work and pleasure. It demonstrates the potential for BRT to serve as a catalyst for economic development, particularly in Uptown, and demonstrates key BRT features such as branding, off-board fare collection, real-time information, dedicated bus lanes and signal priority.

The visualization was presented at the fifth stakeholder meeting and at the second round of community meetings. It was also posted on the GetTherePGH.org website.

Figure 9: Image from BRT Visualization

4.6 Simulation

The firm of Etcetera Edutainment was also engaged to develop a BRT simulation intended to familiarize the public with BRT concepts, and to develop an understanding of the challenges in developing designated bus lanes and complete streets in a constrained corridor.

The simulation allows users to look at BRT stations and configurations at five locations: a typical downtown location, a typical uptown location, a location of Forbes Avenue in Oakland, a location on Fifth Avenue in Oakland, and a typical residential neighborhood station location. For each location, the user is shown a perspective rendering of the location, and is given the opportunity to customize the station with BRT elements such as branding, station branding, and off-board fare collection. These elements are incorporated into the station rendering, and also are used to provide the user with an estimate of their impact on metrics such as system cost, ridership, and economic development in the corridor.

The user is also given the opportunity to experiment with street configuration at the station locations, with the opportunity to add or remove elements including sidewalks, general traffic lanes, exclusive bus lanes and bicycle lanes, and to provide these lanes in either one-way or two-way traffic flow patterns. These “complete street” layout options are constrained by the width of the available right of way at the station locations, providing an example of the tradeoffs that must be considered to implement bus and cycle lanes in the congested study corridor. This is shown in Figure 10.

Figure 10: Street Configuration in Simulation

4.7 Web Site

A website was established by Sustainable Pittsburgh to coordinate communication between the stakeholders and to provide information on bus rapid transit to the general public. The firm Fireman Creative was engaged to develop the website, GetTherePGH.org, hosted by Sustainable Pittsburgh. Although not specifically a project website, project-related information including meeting minutes and handouts were posted.

The website features the BRT simulation and visualization developed for the project, and also incorporates a large amount of information on bus rapid transit concepts and other cities' experiences. A screenshot from the website is shown in Figure 11.

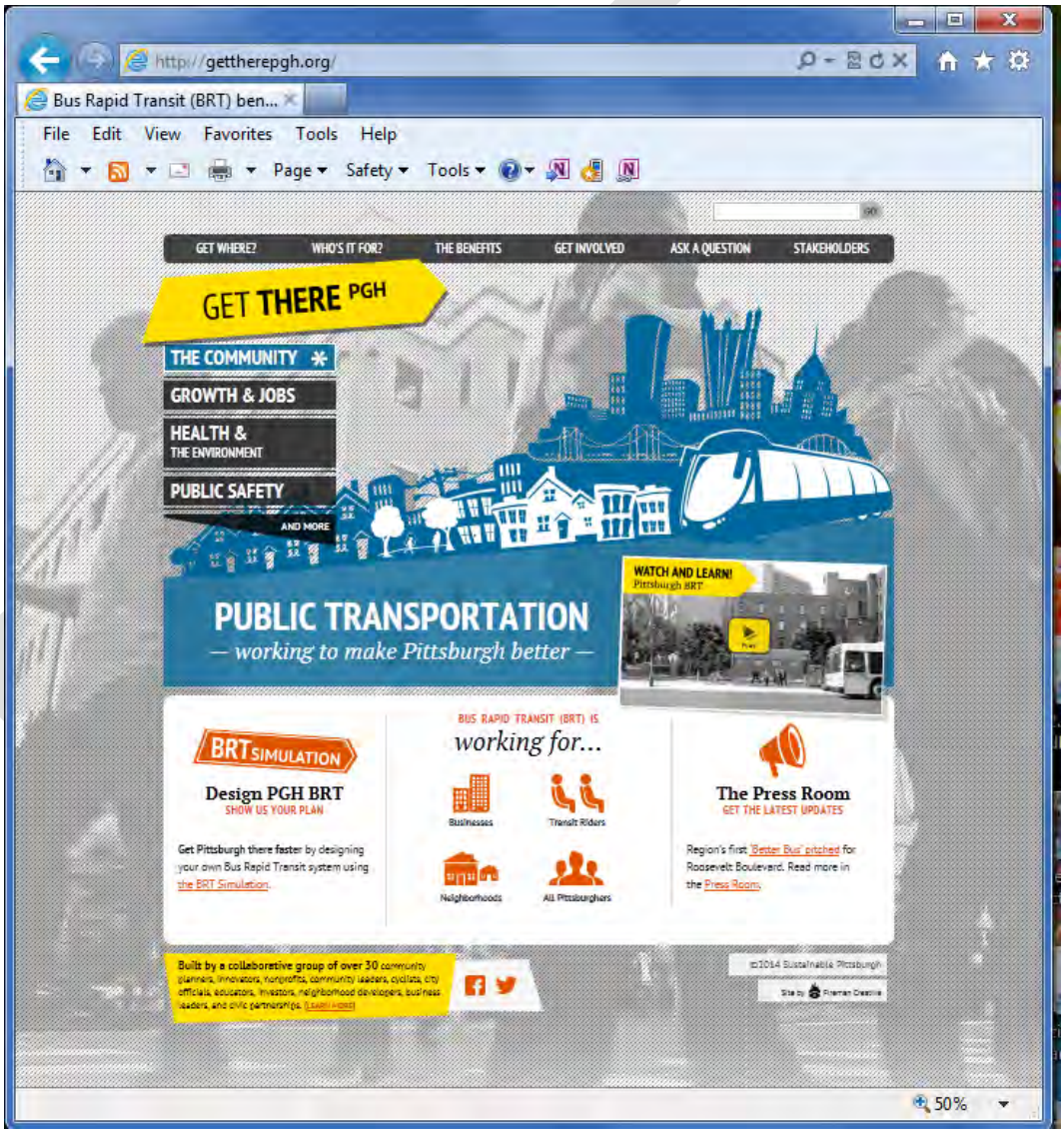

Figure 11: Screenshot from Website

5.0 SYSTEM CONFIGURATION

5.1 Preliminary Concepts and Analysis

The consultant team conducted a preliminary assessment of ridership and costs for different system service configurations. The first alternative was for a tightly focused linear BRT corridor system, with a network of feeder routes, as shown in Figure 12. The second alternative was for an extended linear corridor, extending beyond Oakland the East Liberty and Wilkinsburg. The third alternative was an extended linear corridor, extending beyond Oakland to Squirrel Hill, Homestead and potentially McKeesport. The fourth alternative was a combination of the second and third alternatives, with a common corridor between Downtown and Oakland and two BRT branches, one extending east to Shadyside, East Liberty and Wilkinsburg, and the second extending east to Squirrel Hill, Homestead and McKeesport.

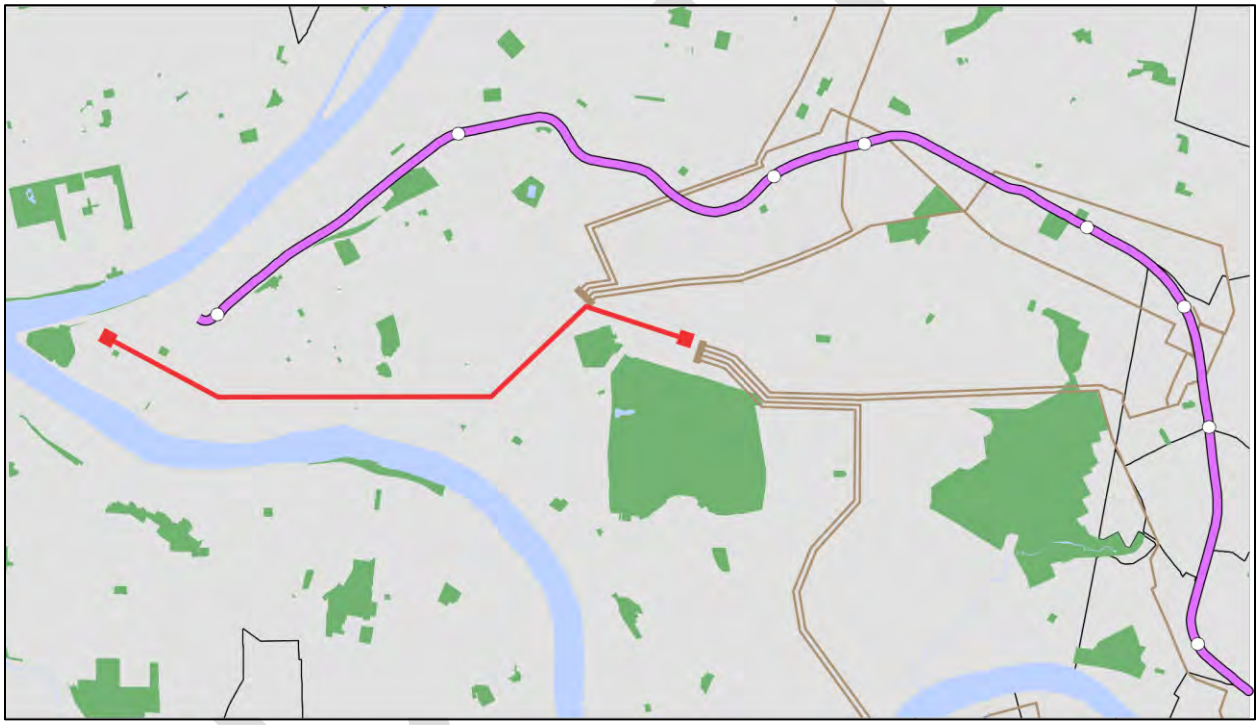

Figure 12: BRT Core System

The analysis indicated that the fourth alternative appears to benefit the most riders and to provide the lowest operating cost per rider. The ridership numbers shown in Table 8 are based on existing ridership, and are intended only for comparison between alternatives. More detailed analysis will be required for ridership forecasts and detailed service plan development, but the branched BRT core alignment appears to be the most appropriate for this corridor.

Table 8: Ridership on Different Service Alignments

Measure of Effectiveness	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Average Weekday Ridership				
Riders on BRT	25,091	39,230	37,898	46,117
Riders on Local Buses	28,645	21,566	18,241	11,162
Forced Transfers	3,347	2,519	2,519	2,519
Annual Ridership				
BRT	7.7 M	12.0 M	11.6 M	14.1 M
Local	8.8 M	6.6 M	5.6 M	3.4 M
Transfers	1.0 M	0.8 M	0.8 M	0.79M
Total Boardings	16.5 M	18.6 M	17.2 M	17.6 M
Total Trips	15.4 M	17.9 M	16.4 M	16.8 M

6.0 STATION DEVELOPMENT

6.1 Station Programming

Stations are a very important element to both the image and the function of a BRT system. They serve as the "front door" both the transit system as well as to the neighborhoods it serves. The experience at the stations shapes the perception of both the neighborhoods and the transit system as a whole.

From the beginning of the study, stations were presented as an element of the BRT system, which could include amenities such as off-board fare collection, real-time passenger information systems, system maps, shelter and seating for waiting patrons, and potentially high-level boarding. Stations are an important element in branding the system, with a distinctive architecture that allows for ready identification. Ideally, this architecture can be compatible with the range of neighborhoods and the diverse architectural styles found throughout the corridor.

It's important to note that in a diverse corridor, it may not be possible to develop a single station design that will work for all conditions. A typology was identified early in the study, consisting of the following station types:

- Bus stop
- Freestanding bus station
- Storefront station
- Major transit center.

This range is intended to allow the stations to be incorporated into areas ranging from low-volume stops in neighborhoods, through higher-volume BRT stations, up to the volume stops which may accommodate route termini and transfers between routes. The storefront station involves incorporating a passenger waiting area into an unused street-level space in a commercial district. This station type was identified as a unique response to the conditions in business areas in the corridor, where a narrow sidewalk width is not capable of accommodating pedestrian traffic, waiting passengers as well as BRT station structure with amenities. .

These station elements and branding possibilities were presented to the public and the stakeholders at the initial public meeting, reemphasized during subsequent meetings, and presented prominently both in the BRT visualization video and in the BRT simulation.

6.2 Sketch Concepts

Maynes Associates Architects (MAA) was engaged to develop architectural concepts for station design. As a starting point, MAA developed six concept "sketches" to illustrate design elements which could be incorporated in station design. These sketches in no way represented final station designs, but were to serve as a starting point for discussion of design. These sketches are shown in Figure 13.

Key to each of these elements was the need to provide a degree of shelter to waiting patrons and the need to accommodate fare collection equipment and other amenities within a limited sidewalk width. Some of the concept sketches incorporated materials associated with Pittsburgh's industrial past, especially stone, steel and glass; and others incorporated design elements to reflect Pittsburgh's Three Rivers and other local icons.

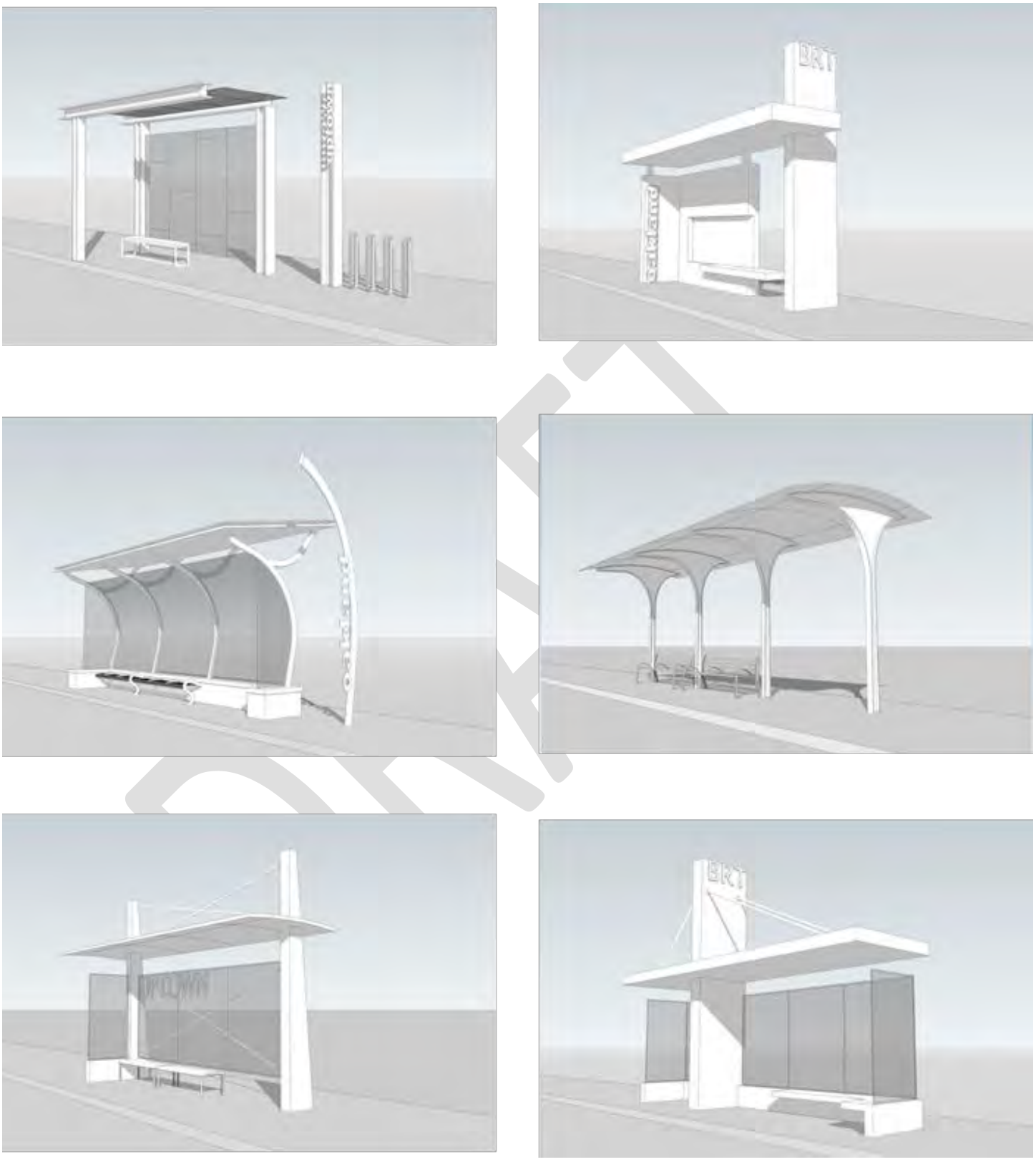

Figure 13: Station Concept Sketches

6.3 Station Design Workshop

On January 31, 2013, MAA led a workshop for stakeholders to provide input into the station design process, held at the William Pitt Union at the University of Pittsburgh. Twenty-one stakeholder representatives attended.

Paula Maynes of MAA presented an overview, including a photo essay, of the character and constraints of context in the widely varied neighborhoods of the corridor. She then presented an illustration of factors that shape BRT stations, including architectural identity, branding, platform height and access, bus patron usage and service frequency, connecting to other modes of transportation, and sustainable green design. These were illustrated with photographic examples from BRT installations across the country, and including relevant examples from the project corridor and Pittsburgh's busway system. Potential BRT station amenities were similarly presented, including shelter from weather, accessibility lighting, information systems, fare systems, furnishings, and functional art.

Following the presentation, participants broke out into three groups to discuss station design elements and the design concepts. Following the meeting, participants were also invited to complete comment forms.

Participants identified the following station features:

Essential station features

- Uniform, identifiable design
- Accessibility design for all users
- Transparency and visibility for safety
- Off-board fare collection
- Real-time information
- Accommodating advertising
- Informational signage / Wayfinding

Desirable station features

- Bike facilities in nearby parking garages
- Unique pavement
- USB power ports
- Park and ride at nearby lots, e.g. churches
- Sound to identify stations
- Interactive technology

Innovative station features

- Bike facilities in nearby parking garages
- Unique pavement
- USB power ports
- Park and ride at nearby lots, e.g. churches
- Sound to identify stations
- Interactive technology

Patrons were asked to identify the elements that the most liked in the design concepts. Key elements that were identified include:

- Light design that retraces the distinct architectural greatness of Pittsburgh--dynamic and leiki *[sic]* thoughts of movement
- Minimal structure, materials can be altered easily with a distinct style against size constraints
- Transparency, simple design
- Open concept-good visibility, distinctive design
- transparency, design unique to Pittsburgh
- lighting, transparency
- 3 sided protection lots of glass vernacular design
- straight lines--visible, distinctive structure
- height, bridge reference, enclosure
- it echoes something about the city and is distinctive and visually striking
- Should make sense it belongs in Pittsburgh [illegible]
- Permanence, visibility, lots of glass, ease of recognition from far away

6.4 Refined Concept Sketch

With the input from the stakeholders, MAA developed a refined station concept sketch, shown in Figure 14. This concept is illustrated on Fifth Avenue opposite Atwood Street, one of the busiest in the system, but the proposed design concept is modular and could be scaled to small, smaller stations and stops.

Figure 14: Refined Station Concept Sketch.

6.5 Station Location and Spacing

Preliminary analysis was conducted of stop spacing, comparing stop spacing of 1 mile 1/2 mile, 1/4 mile and 1/12 mile (approximately one block) to the existing development patterns in the corridor neighborhoods, as shown in Figure 15 for the Oakland example. While some BRT systems use 1-mile or half-mile stop spacing to reduce stop delays and corresponding travel time, such spacing appears to be limited for the shorter trips made in this corridor. Some consolidation of stops has occurred in Oakland, and major stops range from 700 feet to 1200 feet. In Uptown, stops are generally located every block, often as close as 300 to 400 feet, although many are infrequently used because of low passenger demand.

For the BRT alignment alternatives presented to the public and the stakeholders, hypothetical stop locations were shown, typically based on the location of busier stops and available right-of-way, and generally approximating a 1/4 mile spacing. Ho These stop locations are for initial planning purposes only, are not yet part of the alternatives and have not yet been subject to public comment. .

Figure 15: Stop Spacing in Oakland

7.0 INITIAL ALTERNATIVES

7.1 Neighborhood Basis

A broad range of alternatives was developed for BRT alignments in the corridor. From the outset, it was recognized that because of the widely varying characteristics of the corridor, the BRT alignment would need to be configured on a neighborhood, or even subneighborhood level, to respond to different needs, development patterns, and conditions. While conceptually a number of alternatives applied similar principals across neighborhoods, the actual layout ended up significantly different for each neighborhood due to the limitations of available right of way and other constraints.

Within each neighborhood segment, a typical cross section was developed for each alternative based upon the most common street widths in that neighborhood. As alternative development progresses, these typical sections will need to be adjusted to accommodate locations where the street widths vary from the typical section. Each alternative was also laid out in plan view at the neighborhood level, showing locations of exclusive bus lanes, exclusive bike lanes, and areas of mixed flow. Potential station locations were also shown for illustrative purposes. While many alternatives show bike lanes and parking lanes, the relative configuration of these elements is flexible.

It is expected, that at the end of the project, a preferred alternative would be developed based upon the most appropriate configuration in each neighborhood, with modifications as necessary to connect the different segments into a coherent, functional corridor. Further development may also be needed to develop turn lanes and resolve interaction between exclusive bus lanes, mixed-flow traffic lanes and bicycle lanes.

7.2 Downtown

When the study got underway, the City of Pittsburgh considered several concepts to significantly restructure bus circulation in Downtown. Some of the concepts that had been proposed would radically affect the BRT routing, including proposals to operate all bus routes at the periphery of the Golden Triangle, or even to terminate bus routes at T stations.

For the purpose of the BRT alternatives study, it was assumed that BRT would operate through Downtown Pittsburgh in both directions on Fifth Avenue between Liberty Avenue and Uptown. Bidirectional operation was preferred over a one-way couplet because it would provide greater visibility and legibility for the BRT operation, with inbound and outbound stations clearly separated but visible from one another. This bidirectional option was used for a number of other alternatives in other neighborhoods, where the simplicity of bidirectional operation was also acknowledged.

A central corridor through downtown provides transit service to the largest employment centers downtown, along Grant Street and at Gateway Center. It also provides good connections to the T and to most downtown bus loops.

Fifth Avenue was selected as a representative downtown route because of its logical connection to the BRT alternatives in Uptown. Most Uptown alignments were defined along Fifth Avenue

and/or Forbes Avenue. The Fifth Avenue alignment is a logical continuation of a Fifth Avenue routing in Uptown, and has a simple connection to Forbes Avenue via Sixth Avenue. Fifth Avenue serves low general traffic volumes, and has a long history of transit operations serving the Oakland routes. While Forbes Avenue could also provide a continuation of the Uptown BRT alignments, with connections to Fifth Avenue via Diamond Street, it was not considered as an alternative for BRT operations due to its narrow width and the City of Pittsburgh policy directive which resulted in routing buses out of Market Square.

One issue with bidirectional bus operation in Downtown is the need to turn buses from inbound to outbound operation. This need is a major factor in the development of the one way loops currently operated by most buses in Downtown. Five different loop alignments were identified within downtown to turn BRT buses operating on Fifth Avenue. These alignments are:

- Fifth Avenue Extension, left on Penn Avenue, left on Stanwix Street, left on Liberty Avenue to Fifth Avenue,
- Left turn to Liberty Avenue, right to Commonwealth Place, right to Fort Duquesne Boulevard, left on Liberty Avenue to Fifth Avenue.
- Left turn to Liberty Avenue, U turn on Liberty Avenue at Gateway Center or at Commonwealth Place, and return on Liberty Avenue to Fifth Avenue.
- Left turn to Liberty Avenue, left on Stanwix Street, right on Boulevard of the Allies, Right turn on Commonwealth Place, right turn on Liberty Avenue and return on Liberty Avenue to Fifth Avenue.
- Left turn to Liberty Avenue, right turn onto Stanwix Street, left turn onto Fort Duquesne Boulevard, hairpin loop to Fort Duquesne Boulevard eastbound, right turn on Stanwix Street, left turn on Liberty Avenue, and return on Liberty Avenue to Fifth Avenue.

A fatal flaw analysis was conducted of these options, considering possible stop locations, geometric constraints, and areas of recurrent congestion. Based upon this evaluation, the loop via Stanwix Street, Commonwealth Place, and Liberty Avenue was advanced.

7.3 Uptown Alignments

U1 Fifth Avenue Bus Lanes

This alignment was developed from the concept of a center, two-way transitway, similar to portions of the Health Line near downtown Cleveland. However, due to the narrow, 36-foot wide typical cartway on Fifth Avenue, a true center-of-street alignment was not possible.

On Fifth Avenue, the proposed section has an exclusive bus lane eastbound, along the south curb lane, an exclusive bus lane westbound in the center lane immediately adjacent to the eastbound lane, and a westbound general traffic lane adjacent to the north curb. There is no on-street parking permitted on Fifth Avenue in this alternative. At stations, Fifth Avenue will need to be widened to permit relocation of travel lanes to accommodate a center platform between the two exclusive bus lanes.

This option would require specially-equipped buses with doors on the left side.

On Forbes Avenue, the proposed cross section includes a two-way cycle track along the north curb line, separated by a narrow median from a single eastbound general traffic lane in the center, with parking permitted along the south curb line. At particular locations, the parking lane may be replaced with a second eastbound general traffic lane to accommodate turning vehicles or heavy traffic volumes.

U2 Fifth Avenue Bus Lanes

On Fifth Avenue, the proposed section has an exclusive bus lane eastbound, along the south curb lane, a westbound general traffic lane adjacent in the center lane immediately adjacent to the eastbound bus lane, and an exclusive bus lane westbound lane adjacent to the north curb. There is no on-street parking shown on Fifth Avenue in this alternative, although if conditions warrant it could be accommodated in the westbound bus lane during certain off-peak hours.

On Forbes Avenue, the proposed cross section includes a two-way cycle track along the north curb line, separated by a narrow median from a single eastbound general traffic lane in the center, with parking permitted along the south curb line. At particular locations, the parking lane replaced with a second eastbound general traffic lane to accommodate turning vehicles or heavy traffic volumes.

U3 Right Side Bus Lanes

On Fifth Avenue, the proposed section has an exclusive westbound bus lane along the north curb line, a westbound bike lane, and two westbound general traffic lanes. While there is no on-street parking shown on Fifth Avenue in this alternative, if conditions warrant it could be accommodated in the south curb lane during certain off-peak hours

On Forbes Avenue, the proposed section has an exclusive eastbound bus lane along the south curb line, an eastbound bike lane, and two eastbound general traffic lanes. While there is no on-street parking shown on Forbes Avenue in this alternative, if conditions warrant it could be accommodated in the south curb lane during certain off-peak hours

U4 Left Side Bus Lanes

On Fifth Avenue, the proposed section has an exclusive westbound bus lane along the south curb line, a westbound bike lane, and two westbound general traffic lanes. While there is no on-street parking shown on Fifth Avenue in this alternative, if conditions warrant it could be accommodated in the north curb lane during certain off-peak hours

On Forbes Avenue, the proposed section has an exclusive eastbound bus lane along the north curb line, an eastbound bike lane, and two eastbound general traffic lanes. While there is no on-street parking shown on Forbes Avenue in this alternative, if conditions warrant it could be accommodated in the south curb lane during certain off-peak hours.

This option would require specially-equipped buses with doors on the left side.

U5 Contra Flow Bus Lanes

On Fifth Avenue, the proposed section has an exclusive eastbound contra-flow bus lane along the south curb line, a westbound bike lane, and two westbound general traffic lanes. While

there is no on-street parking shown on Fifth Avenue in this alternative, if conditions warrant it could be accommodated in the north curb lane during certain off-peak hours

On Forbes Avenue, the proposed section has an exclusive westbound contra-flow bus lane along the north curb line, an eastbound bike lane, and two eastbound general traffic lanes. While there is no on-street parking shown on Forbes Avenue in this alternative, if conditions warrant it could be accommodated in the south curb lane during certain off-peak hours.

U6 Colwell Street Busway

This option consists of a grade-separated busway constructed along the Colwell Street alignment from Stevenson Street and extending across Kirkpatrick Street along or near De Ruad Street and Beelen Street. West of Stevenson Street, a direct busway alignment connecting to downtown is precluded by the Consol Energy Center; bus connections to downtown would need to either follow Stevenson Street to Fifth Avenue or Crawford Street to Centre Avenue. The proposed configuration shows busway stations at Marion Street, Jumonville Street and Kirkpatrick Street. A cycle path could be constructed along the busway.

In this alignment, no changes are proposed to the configuration of either Fifth Avenue or Forbes Avenue. Both streets could be reconfigured to provide bike lanes or changes to parking or travel lanes, but this is not required to support the busway.

U7 Boulevard of the Allies

This option consists of operating buses in semi-express mode along the Boulevard of the Allies between Downtown and Oakland, similar to current routes 65, 67 and 69. Because of the heavy peak-period traffic flows on the Boulevard of the Allies, it would not be practical to designate exclusive bus lanes, and all transit operations would be in mixed traffic.

The only feasible location for stations would be the existing eastbound platform at the Duquesne University footbridge, and westbound at Stevenson Street. Widening for pull-of lanes or additional stations appears to be impractical because of the limited right of way to the north and the steep slope to the south.

In this alignment, no changes are proposed to the configuration of either Fifth Avenue or Forbes Avenue. Both streets could be reconfigured to provide bike lanes or changes to parking or travel lanes, but this is not required to support the BRT.

7.4 Soho

S1 Fifth Avenue Mixed Flow

In this option, Fifth Avenue operates from Robinson Street to Kirkpatrick Street as an eastbound contra-flow exclusive bus lane, and two westbound general traffic lanes, with westbound buses in mixed traffic.

Forbes Avenue operates as a single eastbound general traffic lane from the Birmingham Bridge ramps, with added lanes from the Boulevard of the Allies and the Parkway East.

This option essentially duplicates the existing conditions of Forbes and Fifth Avenues through Soho, and can be implemented without widening any roadways.

S2 Fifth Avenue Curb Lanes

In this option, Fifth Avenue operates from Robinson Street to Kirkpatrick Street as an eastbound contra-flow exclusive bus lane, with two westbound general traffic lanes, and a separate westbound exclusive bus lane along the north curb. The cartway will be widened as necessary, and no parking will be permitted along Fifth Avenue in this area.

Forbes Avenue operates as a single eastbound general traffic lane from the Birmingham Bridge ramps, with added lanes from the Boulevard of the Allies and the Parkway East.

S3 Fifth Forbes Exclusive Lanes

In this option, an exclusive bus lane would be provided in the westbound direction on Fifth Avenue, and another in the eastbound direction on Forbes Avenue. However, it does not appear to be physically possible to provide a continuous bus lane on Forbes Avenue between past the Boulevard of the Allies and Parkway East ramps. Bus operations would require at least a short direction of operation in heavily congested general traffic lanes, and thus this option was not pursued further.

S4 Colwell Street Busway

This option consists of a grade-separated busway along the Beelen Street alignment and continuing along the hillside above Fifth Avenue, This is an extension of the Colwelll Street Busway alignment in Uptown. A cycle path could be constructed along the busway.

In this alignment, no changes are proposed to the configuration of either Fifth Avenue or Forbes Avenue. Fifth Avenue could be reconfigured to provide bike lanes or changes to parking or travel lanes, but this is not required to support the busway.

S5 Boulevard of the Allies

This option consists of operating buses in semi-express mode along the Boulevard of the Allies between Uptown and Craft Avenue, similar to current routes 65, 67 and 69. Because of the heavy peak-period traffic flows on the Boulevard of the Allies, it would not be practical to designate exclusive bus lanes, and all transit operations would be in mixed traffic.

In this alignment, no changes are proposed to the configuration of either Fifth Avenue or Forbes Avenue. Fifth Avenue could be reconfigured to provide bike lanes or changes to parking or travel lanes, but this is not required to support the BRT configuration.

7.5 Hill District

H1 Centre Craig

This option is similar to the existing Route 82, following Centre Avenue from Downtown through the Hill District to Craig Street, then to the BRT alignment in Oakland towards downtown. This could operate as a loop route, a separate route terminating in Oakland, or could be interlined with service on other routes between Oakland and Downtown.

H2 Centre Dinwiddie

This option is similar to existing route 82, but would travel from Downtown through Uptown on the BRT alignment to Dinwiddie Street, would traverse the Hill District on Centre Avenue to Craig Street, then to the BRT alignment in Oakland towards downtown. This could operate as a loop route between Oakland, Uptown and the Hill; as a separate route terminating in Oakland, or could be interlined with service on other routes between Oakland and Downtown.

H3 Bentley/Robinson

This option is similar to existing route 81, and would operate from Downtown via Centre Avenue, and would serve areas in Oak Hill and along Bentley Drive, and connecting to Oakland via Robinson Street, Terrace Street and Desoto Street to the BRT alignment. This could operate as a loop route, a separate route terminating in Oakland, maintain the existing extension to the South Side, or could be interlined with service on other routes between Oakland and Downtown.

H4 Webster/Allequippa

This option is similar to existing Route 83, and would operate from Downtown via Centre Avenue, and would communities along Bedford Avenue and in the Upper Hill, and connecting to Oakland via Robinson Street, Terrace Street and Desoto Street to the BRT alignment. This could operate as a loop route, a separate route terminating in Oakland, maintain the existing extension to the South Side, or could be interlined with service on other routes between Oakland and Downtown.

H5 Hill Circulator

This option is, in some ways, a hybrid of the others, and would consist of a loop from the BRT alignment in Uptown, through the Hill District communities along Bedford Avenue, the Upper Hill, Oak Hill and Bentley Drive, and returning to the BRT alignment in Uptown via Kirkpatrick Street.

7.6 Oakland

O1 Fifth Avenue Center Lanes

This alignment was developed from the concept of a center, two-way transitway, similar to portions of the Health Line near downtown Cleveland. However, due to the narrow, variable width cartway on Fifth Avenue, a true center alignment was not possible.

On Fifth Avenue, the proposed section has an exclusive bus lane eastbound, along the south curb lane, an exclusive bus lane westbound in the center lane immediately adjacent to the eastbound lane, two to three westbound general traffic lanes, and a westbound bike lane adjacent to the north curb. There is no on-street parking permitted on Fifth Avenue in this alternative. At stations, Fifth Avenue will need to be widened to permit relocation of travel lanes to accommodate a center platform between the two exclusive bus lanes.

This option would require specially-equipped buses with doors on the left side.

On Forbes Avenue, the proposed cross section includes an eastbound bike lane along the south curb line, two eastbound general traffic lanes in the center, and parking along the north curb line.

O2 Fifth Avenue Curb Lanes

On Fifth Avenue, the proposed section has an exclusive bus lane eastbound along the south curb lane, two or three westbound general traffic lane in the center lane immediately adjacent to the eastbound bus lane, and an exclusive bus lane westbound lane adjacent to the north curb. There is no on-street parking shown on Fifth Avenue in this alternative, although if conditions warrant it could be accommodated in the westbound bus lane during certain off-peak hours.

On Forbes Avenue, the proposed cross section includes an eastbound bike lane along the south curb line, two eastbound general traffic lanes in the center, and parking along the north curb line.

O3 Contra Flow Lanes

On Fifth Avenue, the proposed section has an exclusive eastbound contra-flow bus lane along the south curb line, a westbound bike lane, and three westbound general traffic lanes. Bike lanes and on-street parking could be accommodated in wider sections.

On Forbes Avenue, the proposed section has an exclusive westbound contra-flow bus lane along the north curb line, an eastbound bike lane, and two eastbound general traffic lanes. There is no on-street parking shown on Forbes Avenue in this alternative.

O4 Left Side Curb Lanes

On Fifth Avenue, the proposed section has an exclusive westbound bus lane along the south curb line, two to three westbound general traffic lanes, and a bike lane in wider sections.

On Forbes Avenue, the proposed section has an exclusive eastbound bus lane along the north curb line, an eastbound bike lane, and two eastbound general traffic lanes.

This option would require specially-equipped buses with doors on the left side.

O5 Forbes Avenue Transit Street

In this option, Fifth and Forbes Avenues would be restored to their historic operation as two-way streets.

Fifth Avenue would become a bidirectional arterial roadway with an emphasis on accommodating automobile and truck traffic, with two to three general traffic lanes in either direction. Left turns may be restricted to certain locations.

Forbes Avenue would become a bidirectional local street, with an emphasis on a pedestrian, walkable scale. Buses would operate in mixed traffic in a single lane in each direction. Short segments of exclusive bus lanes would prevent use by commuter traffic, allowing the street to remain uncongested to permit efficient bus movement. Bicycle traffic would share the general traffic lanes, and parking would be permitted in both curb lanes.

O6 Bus Tunnel

In this option, all bus traffic would be reassigned to a transit tunnel to be constructed under Fifth Avenues, with portals west of Craft Avenue and near Morewood Avenue. In the future, the tunnel could be constructed to accommodate shared use or conversion to light rail.

On Fifth Avenue, this would allow for removal of the existing contra-flow bus lane, and could potential permit reduction of an additional traffic lane, allowing for installation of bike lanes or widened sidewalks.

On Forbes Avenue, this may allow for reduction of a traffic lane, allowing for installation of bike lanes or wider sidewalks.

7.7 East End

E1 On-Street Bus Lanes

In this option, BRT service would be extended to the east in exclusive, on-street bus lanes. Service would generally follow the routings and service patterns of the existing 61- and 71-series routes.

Service to the east of Oakland on these routes operates on streets including Fifth Avenue, Centre Avenue, and Forbes Avenue. Fifth Avenue is a four-lane arterial roadway with very heavy traffic volumes, while Centre Avenue and Forbes Avenue are both two-lane roadways with on-street parking on both sides. The combination of current high levels of traffic and limited street space preclude designating any of the existing traffic lanes for exclusive BRT use, and the adjacent residential and commercial development would preclude converting the existing parking lanes to bus lanes or to traffic lanes. Therefore, this option was not advanced.

E2 On-Street BRT Extensions

In this option, BRT service would be extended to the east in mixed flow in existing traffic lanes, similar to the current operation. Service would generally follow the routings and service patterns of the existing 61- and 71-series routes.

E3 East Busway Connections

This option would extend BRT service to the east using the Martin Luther King, Jr. East Busway. Buses would travel from the BRT alignment on Fifth Avenue to the Neville Street busway ramp via Neville Street in mixed traffic. This is similar to the existing P3 route, although likely with significantly increased service. If new stations were constructed on the Busway in the vicinity of South Aiken Avenue and Bakery Square, the majority of the Centre Avenue corridor currently could be served by this option, thus relieving overcrowding on routes 71A and 71C currently operating on Centre Avenue.

E4 Local Route/BRT Feeder

The East End route options described above would generally follow existing Port Authority routes. For each of these options, there is the option of different service patterns which would either operate these routes as extensions of BRT routes onto local streets, or as separate feeder routes with transfers to the BRT at key locations.

8.0 SCREENING OF ALTERNATIVES

8.1 Screening Methodology

The broad range of initial corridor alternatives described above could not practically be evaluated in the level of detail required for environmental clearance and design development. Accordingly, a screening process was proposed, based upon a technical analysis of the alternatives, a review of the analysis results with public and stakeholder input to develop a smaller, refined set of alternatives, followed by a more detailed technical analysis and review with public and stakeholder input to define the locally preferred alternative. This process is shown conceptually in Figure 16.

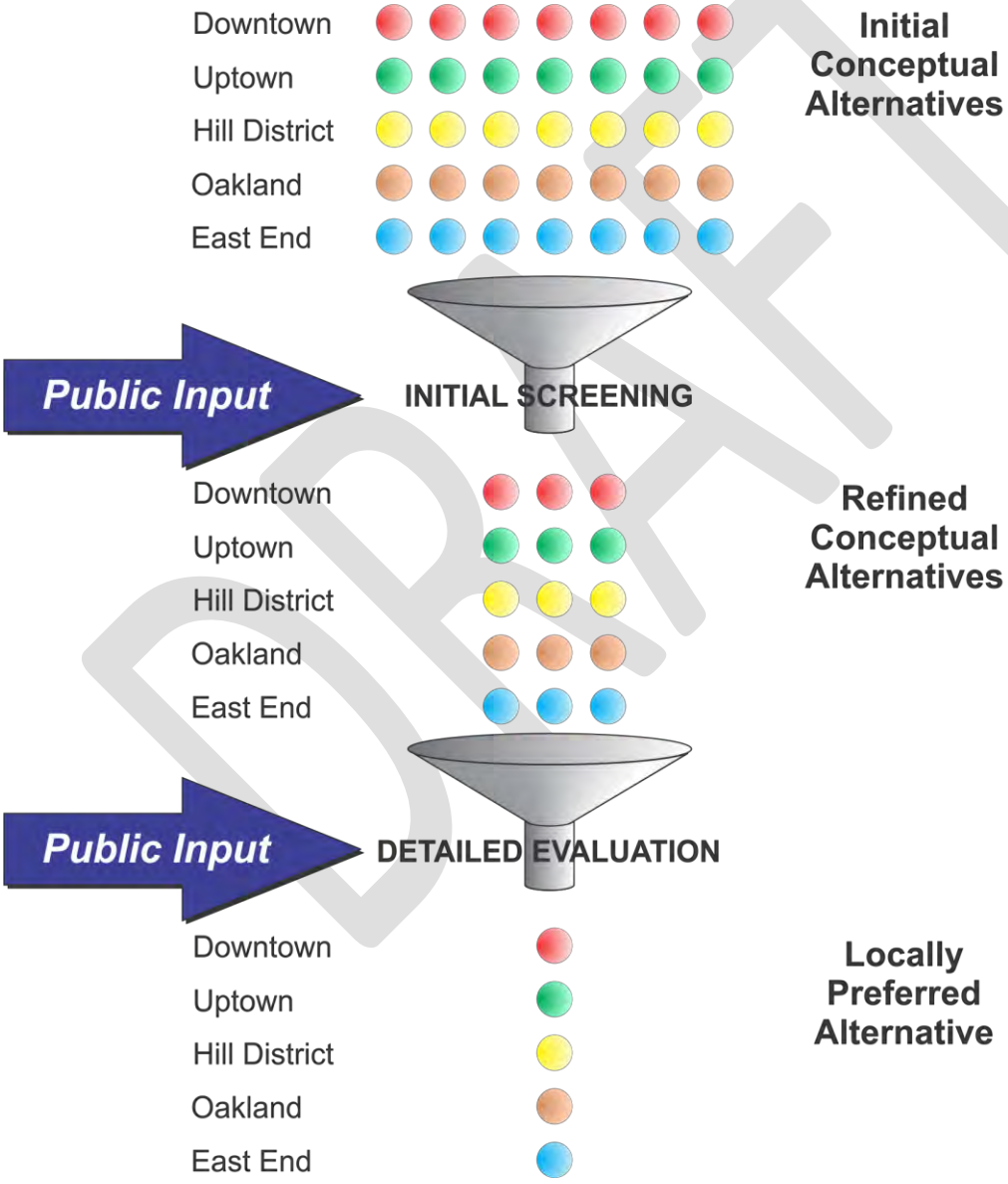

Figure 16: Conceptual Screening Process

8.2 Preliminary Screening

Process

The project team, in consultation with the stakeholders, defined a set of 16 parameters to be used for screening the alternatives. These parameters included demographic, cost, access and multimodal transportation. Stakeholders were surveyed and contributed to developing a weighting of the factors.

The consultant team developed metrics and methodology to evaluate the results of each metric. These metrics were calculated using existing ridership numbers, Geographic Information Systems (GIS) evaluation of the transportation network and cultural institutions, and demographic impacts. The calculated ratings were normalized to facilitate comparison between measures with very different baselines, with a score of 1 being assigned to those rated below average on that measure, a score of 2 assigned to those rated somewhat above average, and a score of 3 assigned to those rated significantly above average. These normalized scores were then multiplied by the weightings developed with stakeholder input to give composite scores.

Uptown

In Uptown, the preliminary screening showed a strong advantage to alternatives U1 Fifth Avenue Center Bus Lane and U2 Fifth Avenue Curb Bus Lanes. In consultation with the stakeholders, it was determined to also retain alternatives U3 Right Side Bus Lanes and U5 Contra Flow bus lanes because of their similarity to the existing operations and thus the potential for easier implementation. Alternatives U6 Colwell Street Busway and U7 Boulevard of the Allies scored poorly in the preliminary screening in part because they provided poorer service to Fifth and Forbes Avenues in Uptown, and they did not support the vision of BRT being a catalyst for revitalization of the Fifth/Forbes corridor in the neighborhood.

Soho

In Soho, the preliminary screening showed a strong advantage to the alternatives SO1 Fifth Avenue Mixed Flow and SO2 Fifth Avenue Bus lanes. The first is essentially the existing conditions, and the second would appear to be a preferable option, although proposed area development could make implementation of this option impractical. SO2 was advanced as the preferred alternative, with SO1 remaining as an option.

Oakland

In Oakland, the screening was somewhat inconclusive. Option 06 Bus Tunnel was clearly excluded, and option O5 Forbes Avenue Transit Street scored highest, but the remaining options all scored equally well and at a high level, and were thus retained.

East End and Hill District

The preliminary screening of alternatives for these areas outside of the core was inconclusive. Widespread support has been expressed for integrating East Busway service into the BRT system. However, aside from the elimination of designated bus routes from consideration east of Morewood Avenue, the routing of service to the surrounding neighborhoods remains open

and may be to some extent an operational issue rather than a specific characteristic of the BRT configuration.

8.3 Refined Corridor Alternatives

Following the preliminary screening, the number of alternatives had been reduced slightly. However, with four alternatives remaining under consideration in Uptown, two in Soho, and five in Oakland, the decision was made to assemble the alternatives into corridor alternatives to simplify presentation and discussion. The refined corridor alternatives were as follows:

1 Fifth Avenue Center Lanes consisting of:

U1 Uptown Fifth Avenue Center Bus Lanes

S2 Soho Fifth Avenue Curb Lanes

O1 Oakland Fifth Avenue Center Bus Lanes

2 Fifth Avenue Curb Lanes consisting of:

U2 Fifth Avenue Bus Lanes

S2 Fifth Avenue Curb Lanes

O2 Oakland Fifth Avenue Curb Bus Lanes

3 Contra Flow Lanes consisting of:

U5 Uptown Contra Flow Lanes

S2 Fifth Avenue Curb Lanes

O3 Oakland Contra Flow Lanes

4 Fifth/Forbes Concurrent Lanes: consisting of:

U3 Uptown Right Side Curb Lanes

S2 Fifth Avenue Curb Lanes

Oakland Fifth Forbes Concurrent Lanes

5 Forbes Avenue Transit Street: consisting of

U2 Fifth Avenue Bus Lanes

S2 Fifth Avenue Curb Lanes

O5 Forbes Avenue Transit Street

While the neighborhood-level alternatives were joined to create these refined corridor alternatives, it was considered important that the evaluation and selection of alternative be conducted at the neighborhood level. The locally preferred alternative to be selected at the conclusion of the study could be a combination of these alternatives. For the Soho section, all five of the alternatives incorporated the Fifth Avenue Curb Bus Lanes, but the actual configuration will depend on more detailed development in preliminary engineering.

8.4 Secondary Screening

Following presentation of the refined corridor alternatives to the stakeholders, a number of questions were raised regarding BRT configuration and impacts that could not be answered at the current level of analysis. However, it was not practical to advance all five alternatives to the level of preliminary engineering and detailed evaluation. It was necessary to further reduce the number of alternatives under consideration. Accordingly, a secondary screening process was conducted.

For this secondary screening, the project team and the stakeholders were asked to review the Refined Corridor Alternatives to identify issues that may have been external to the preliminary screening process methodology, but that would preclude the that alternative from approval or implementation.

Upon review, it was determined that the Fifth Avenue Center Lane Alternative would require acquiring significant right of way. At stations, the right of way would need to be increased to accommodate the width of the station platform, plus lane tapers and transitions. Given the extensive level of existing development in the corridor, acquiring this right of way could be extremely difficult, disruptive and costly. Additionally, a center platform would need to accommodate bus patrons travelling in both directions, potentially needing double the capacity of curbside stations, and thus potentially requiring even greater width. For these reasons, the Fifth Avenue Center Lane alternative was eliminated from further consideration.

The contra-flow lane configuration also led to a number of concerns. While the existing contra-flow lane on Fifth Avenue safely and successfully accommodates a large volume of bus traffic, its initial implementation was extremely controversial, with perceived safety issues. With the need accommodate including bike lanes and general traffic in addition to BRT in narrow cartways, the resulting lane widths could pose challenges to contraflow traffic. Based on experience with the existing Fifth Avenue contra-flow lane, stakeholders, including the Pennsylvania Department of Transportation, were concerned about the acceptance and operation of a new contra-flow lane on the narrower Forbes Avenue, and were concerned that this could lead to delays in BRT implementation and could prove to be insurmountable. For these reasons, the Contra Flow Lanes alternative was eliminated from further consideration.

The Forbes Avenue Transit Street alternative was highly controversial. While its genesis came from a longstanding community desire for restoration of bidirectional traffic, the proposal was not well received. It would require major disruption to existing traffic and transit patterns and local access, and the local business community felt that the existing patterns served them well. In addition, there were concerns over the speed and reliability of bus rapid transit in the mixed traffic lanes. While all of these issues may have been solvable, the benefits of this configuration were not apparent. For these reasons, the Forbes Avenue Transit Street alternative was eliminated from further consideration.

Based upon this secondary screening, two alternatives remained under consideration: the Fifth Avenue Curbside Lanes and the Fifth/Forbes Concurrent Lanes. The alternatives being advanced into future phases of development are described in greater in the next section.

9.0 REFINED ALTERNATIVES

9.1 Fifth Avenue Curb Lanes

This alternative provides exclusive bus lanes from Downtown to Bellefield Avenue, with both directions operating on Fifth Avenue. At this conceptual level, the alternative also provides a continuous bicycle corridor through the same area.

In Uptown on Fifth Avenue, the proposed section has an exclusive westbound bus lane along the north curb line, a westbound bike lane, and two westbound general traffic lanes. While there is no on-street parking shown on Fifth Avenue in this alternative, if conditions warrant it could be accommodated in the south curb lane during certain off-peak hours

In Uptown on Forbes Avenue, the proposed section has an exclusive eastbound bus lane along the south curb line, an eastbound bike lane, and two eastbound general traffic lanes. While there is no on-street parking shown on Forbes Avenue in this alternative, if conditions warrant it could be accommodated in the south curb lane during certain off-peak hours. An example of Uptown alignments is shown in .

Figure 17: Fifth Avenue Curb Lanes in Uptown

In the Soho area, eastbound buses would transition to an exclusive lane on Fifth Avenue, possibly on a widened Moultrie Street or a new alignment in the vicinity of the Birmingham Bridge. A cycle track would connect the cycle track on Forbes Avenue to an alignment paralleling Fifth Avenue.

On Fifth Avenue, the proposed section has an exclusive bus lane eastbound along the south curb lane, two or three westbound general traffic lanes in the center lane immediately adjacent to the eastbound bus lane, and an exclusive bus lane westbound lane adjacent to the north curb. There is no on-street parking shown on Fifth Avenue in this alternative, although if conditions warrant it could be accommodated in the westbound bus lane during certain off-peak hours.

On Forbes Avenue, the proposed cross section includes an eastbound bike lane along the south curb line, two eastbound general traffic lanes in the center, and parking along the north curb line. An example of the Oakland alignment is shown in .

East of Bellefield Avenue, buses to Fifth Avenue will be able to continue between the exclusive bus lanes in the BRT corridor and operation in mixed traffic. However, for buses connecting to Forbes Avenue, the transition from the exclusive bus lanes has not been resolved. Only a few streets are available for this connection: Bigelow Boulevard, Bellefield Avenue, Dithridge Street, Craig Street and Morewood Avenue. All have significant issues which make them undesirable, but Morewood Avenue may be the most practical, although there are issues with roadway width, geometric alignments, and poor service to the Forbes/Craig area that would need to be resolved.

Figure 18: Fifth Avenue Curb Lanes in Oakland

9.2 Fifth/Forbes Concurrent Lanes

This alternative provides exclusive bus lanes from Downtown to Bellefield Avenue, typically in a split alignment with eastbound buses on Forbes Avenue and Westbound buses on Fifth Avenue. At the conceptual level, the alternative also provides a continuous bicycle corridor through the same areas.

In Uptown on Fifth Avenue, the proposed section has an exclusive westbound bus lane along the north curb line, a westbound bike lane, and two westbound general traffic lanes. While there is no on-street parking shown on Fifth Avenue in this alternative, if conditions warrant it could be accommodated in the south curb lane during certain off-peak hours

In Uptown on Forbes Avenue, the proposed section has an exclusive eastbound bus lane along the south curb line, an eastbound bike lane, and two eastbound general traffic lanes. While there is no on-street parking shown on Forbes Avenue in this alternative, if conditions warrant it could be accommodated in the south curb lane during certain off-peak hours. An example of the Uptown alignments is shown in Figure 19.

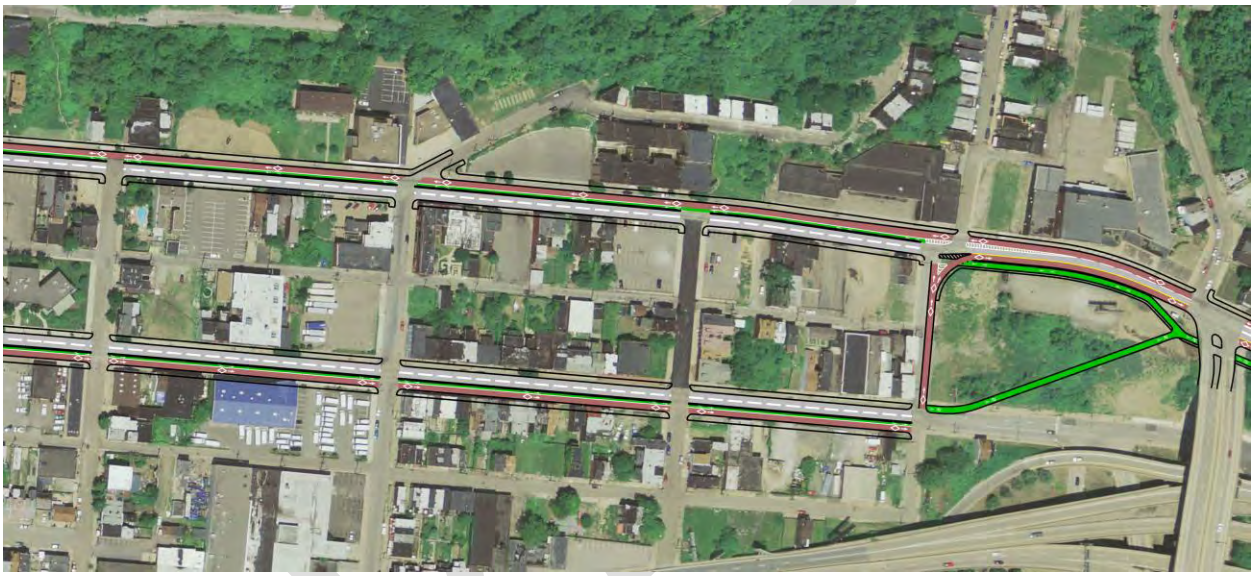

Figure 19: Fifth/Forbes Concurrent Lanes in Uptown

In the Soho area, eastbound buses would transition to an exclusive lane on Fifth Avenue, possibly on a widened Moultrie Street or a new alignment in the vicinity of the Birmingham Bridge. A cycle track would connect the cycle lanes on Fifth and Forbes Avenue to an alignment paralleling Fifth Avenue.

In Oakland on Fifth Avenue, the proposed section has an exclusive westbound bus lane generally along the north curb line, two to three westbound general traffic lanes, and a bidirectional cycle track along the south curb line. The exact configuration of the bus lane and its interaction with heavy right turns at the UPMC driveways and at McKee place remain to be addressed, as does the issue of left turns at Craft Avenue.

In Oakland on Forbes Avenue, the proposed section has an exclusive eastbound bus lane along the south curb line, two eastbound general traffic lanes, and a parking lane along the north cub line. An example of Oakland alignments is shown in Figure 20.

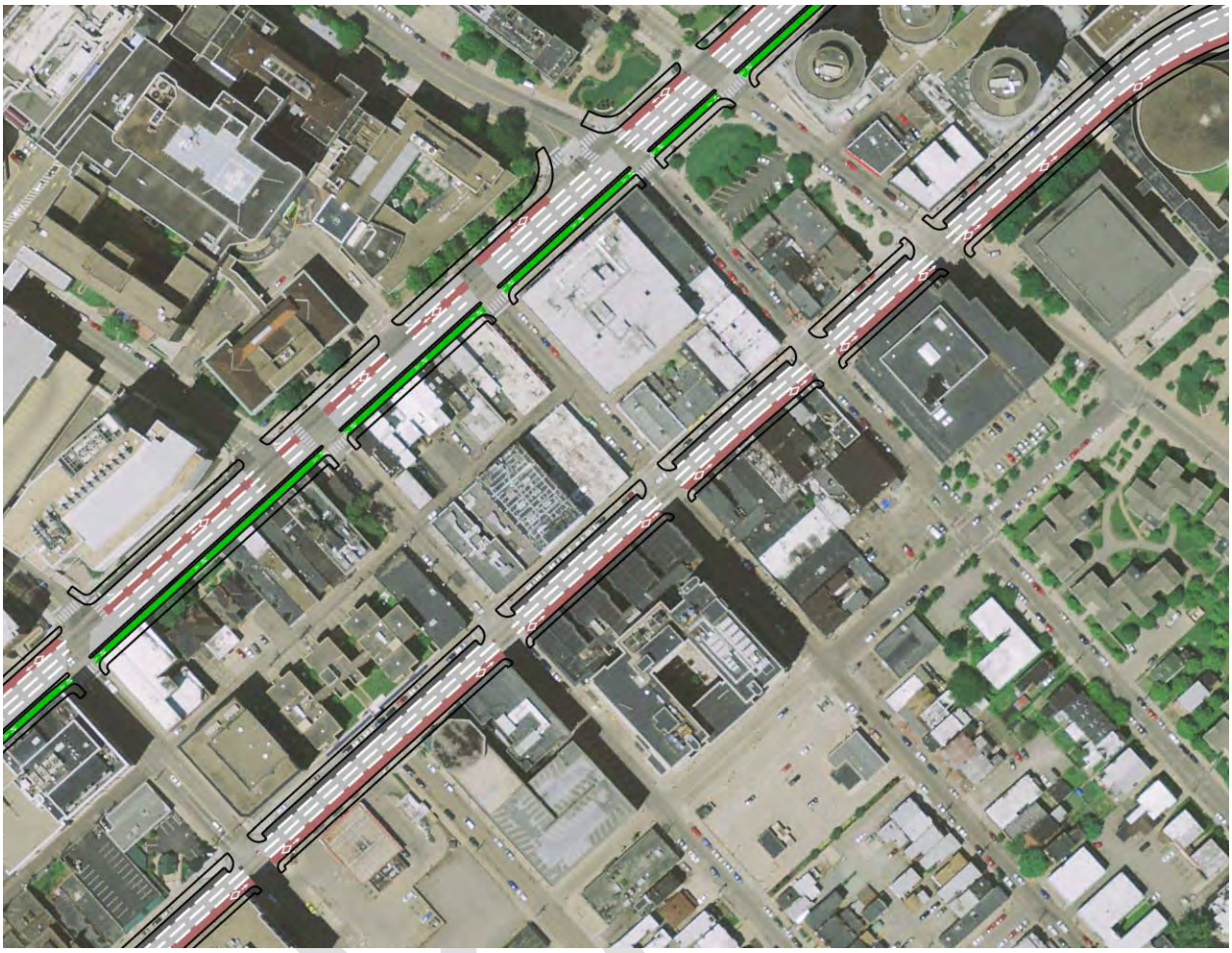

Figure 20: Fifth/Forbes Concurrent lanes in Oakland

East of Bellefield Avenue, eastbound buses will be able to continue on Forbes Avenue or to transition to Fifth Avenue via Bellefield Avenue, while westbound buses from Forbes Avenue will also transition to Fifth Avenue and the BRT alignment via Bellefield Avenue. This is similar to current operations.

9.3 Downtown Alignment Options

For each of the alternatives the downtown alignment was assumed to include bidirectional BRT operation on Fifth Avenue to Liberty Avenue, and a terminal loop via Stanwix Street, Boulevard of the Allies Commonwealth Place and Liberty Avenue, as shown in Figure 21.

This alignment conceptually shows stops/stations in the Gateway Center, Smithfield/Wood and Grant/Ross areas, although the exact number and locations of the stations have not been finalized.

Also remaining to be determined is whether BRT along this alignment would operate in exclusive lanes, mixed traffic, or a combination, although it is assumed that a degree of signal prioritization will be provided in any configuration.

Some stakeholders have also proposed an alternative downtown alignment which would terminate BRT service in a loop on Ross Street at Steel Plaza T station. This alternative would reduce bus operations and connections within the Golden Triangle, and BRT riders would be able to transfer to the T for connections to Gateway Center and beyond. This is shown in Figure 22.

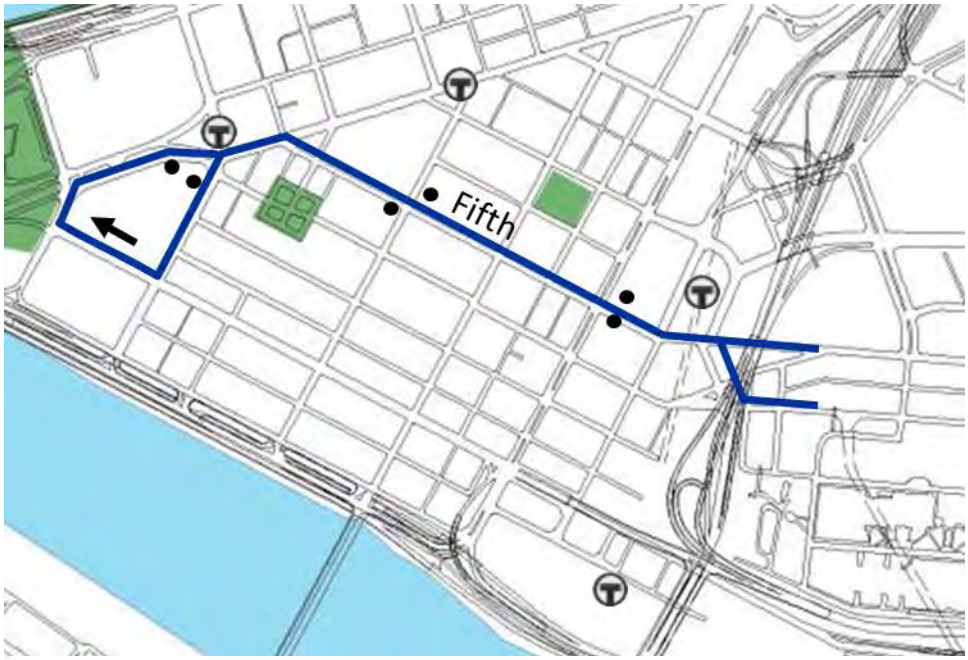

Figure 21: Fifth Avenue Downtown Alignment

Figure 22: Steel Plaza Downtown Alignment

9.4 Uptown Parking Study

At the initiation of the study, it was recognized that providing exclusive bus lanes and bicycle lanes in Uptown could only be accommodated by reducing the number of general traffic lanes or the amount of on-street parking. During the stakeholder interviews and community meetings, it became clear that on-street parking was a critical concern of the Uptown community. This parking serves residents and local businesses, although it was noted that commuters to Oakland, Downtown and even Uptown institutions. With potential redevelopment at the Civic Arena site and growth on the Duquesne University and UPMC Mercy campuses, residents were concerned about the BRT having an adverse impact on the parking situation.

The consultant team conducted a parking study of Uptown during November, 2012. This study focused on on-street parking on Fifth and Forbes Avenues between the Crosstown Boulevard and Robinson Street and on intersecting streets within once block of these areas. This study included observation of parked vehicles at several times during the day and evening, and calculating the duration of parking occupancy. With the assistance of the Pennsylvania Department of Transportation, it was determined whether parked vehicles were registered to addresses within this immediate study area, elsewhere in Uptown or the Hill District, or outside the study area.

The study found that of the 766 parking spaces in the defined Uptown study area, 278 or 36% of the spaces were vacant at the peak parking time. 211 or 28% were short-term parkers, who were only present during the morning. These could perhaps be attributed in part to students at Duquesne University or patients at UPMC Mercy. An additional 183 or 23% were all-day parkers, most likely commuters. This is shown in Figure 23.

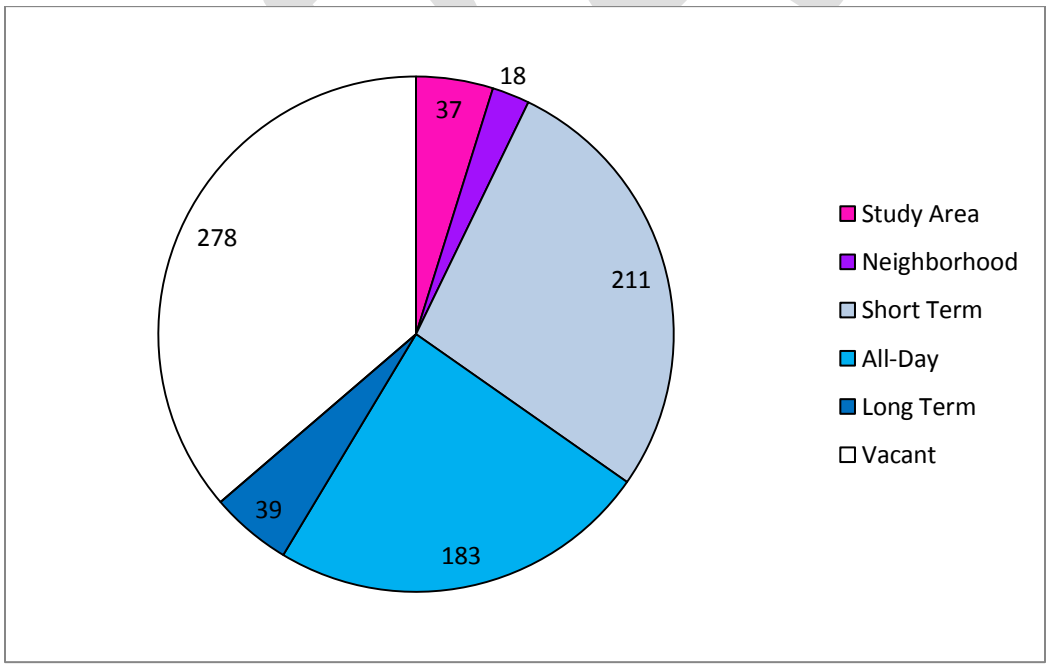

Figure 23: AM On-Street Parking Utilization in Uptown

Of particular note were 37 vehicles registered to Uptown addresses, 18 registered elsewhere in the neighborhood, and 39 vehicles identified as long-term parkers. These vehicles were observed throughout the entire observation period, but were not registered within the study area. These could be vehicles owned by students on nearby campuses who use them infrequently, or they could be vehicles owned by local residents with their vehicles registered at a previous address.

During the afternoon period, the general parking situation is similar to that shown in the morning, but with a drop in the number of short-term parkers. Just slightly more than half of the on-street spaces are used at this time.

During the evening, the parking situation changes dramatically. Only 37 percent of the on-street parking spaces are utilized, and the number of short-term parkers has dropped to 162, with only 35 all-day parkers. During this time period, 31 vehicles were identified on-street belonging to study area residents, 11 to residents elsewhere in the neighborhood, and 39 long-term parkers. This is shown in Figure 24

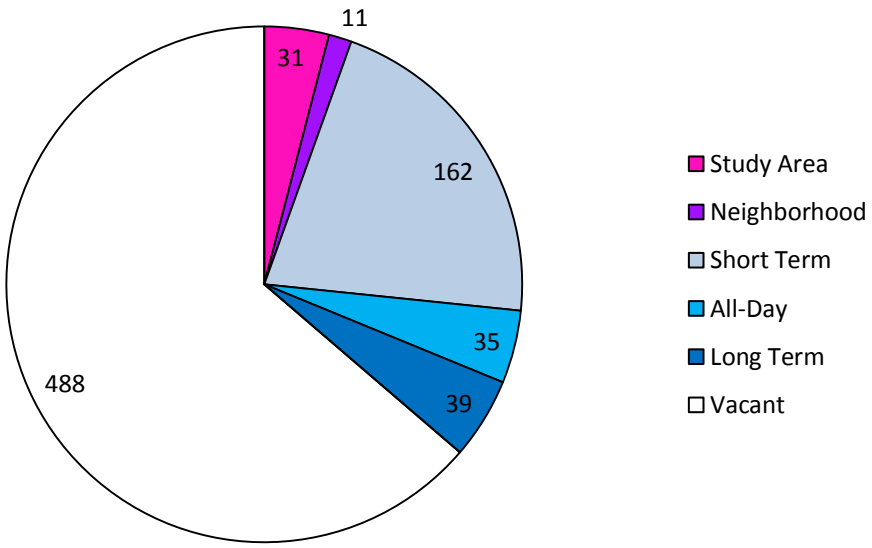

Figure 24: Evening On-Street Parking Utilization in Uptown

This data suggests that the parking demand and supply in Uptown is complex, and needs to be analyzed at a much closer level. Analysis of the data on a block-by-block basis in cooperation with local residents may identify ways in which the neighborhood parking demand can be accommodated in conjunction with the BRT alignments. This may include permitting on-street parking in certain blocks or at certain times of the day.

9.5 Hill District Connections

The community and the stakeholders have expressed a clear desire for good transit connections between the Hill District and the BRT corridor. Specific routes have not yet been identified. Support was voiced for bus routes that connect different parts of the Hill District, as the former Hill Loop route did, although this is not directly related to the BRT service. Support was also given to the Centre-Dinwiddie route, or to other routes which would connect the Hill District to Uptown, two adjacent neighborhoods that currently have no direct transit connection. Other needs were identified were continued and improved service from the Hill District to the employment services and other opportunities in Downtown, Oakland and South Side. In response to the concerns raised at one of the Hill District community meetings, the Port Authority met with Hill District representatives and rerouted the 83 route from Webster Avenue to Bedford Avenue to address their concerns.

9.6 Service Patterns

The alternatives advanced to this point are geometric alignments which provide a continuous network of designated transit lanes extending from Downtown Pittsburgh through Uptown and Oakland. This provides a framework for building a high quality bus rapid transit service. However, equally important to the effectiveness of BRT is the operational plan. This will include elements such as bus frequencies and routings.

The simplest BRT service pattern is corridor BRT, shown schematically in the study area in Figure 25. This service plan consists of BRT service operated in a linear, well defined corridor. This is the simplest form of operation, and is easily understandable to people unfamiliar with the system. However, in the study corridor, it is only capable of directly serving a fraction of the total trips, and would require either overlapping local service or transfers to local feeder routes to serve all riders. Most riders destined to Oakland from communities located east of Oakland would be required to either transfer to the BRT route for the last segment of their route or walk a considerably longer to reach their destinations. Either option represents a decrease in mobility for many riders commuting to and from Oakland. Additionally, this option would require a large area for staging of buses and accommodating transferring riders which could not be established without displacing existing development.

Figure 25: Corridor BRT Service

An alternative service plan is the modified collector BRT shown in Figure 26. In this plan, BRT service would extend beyond the core corridor of exclusive lanes into the surrounding neighborhoods. This will enable people in the surrounding neighborhoods to access the BRT without the need to transfer to feeder routes. Some local feeder routes would connect to the BRT, and may provide direct service to key destinations. While somewhat more complex than the corridor BRT service, this would allow more riders to benefit from the BRT and the corridor improvements.

Collector service extending from the BRT core corridor into the surrounding neighborhoods can be branded as BRT service, with identifiable stations, service using branded vehicles, off-board fare collection and the like. This is demonstrated by the Health Line BRT in Cleveland.

In order to balance service with demand in different parts of the corridor, it may be necessary to short turn some routes, particularly in Oakland, as existing ridership demand does not require the existing service levels in this segment. This will require transit station facilities in Oakland, both to provide locations where patrons can transfer, and to provide locations where buses can turn and layover. These functions do not need to occur at the same location, and many of these functions could be accommodated either on street or in a separate transit facility. To avoid requiring patrons on short-turned routes to transfer to reach Oakland destinations, these routes should continue through to the western end of Oakland, with a turnaround location preferably near Craft Avenue.

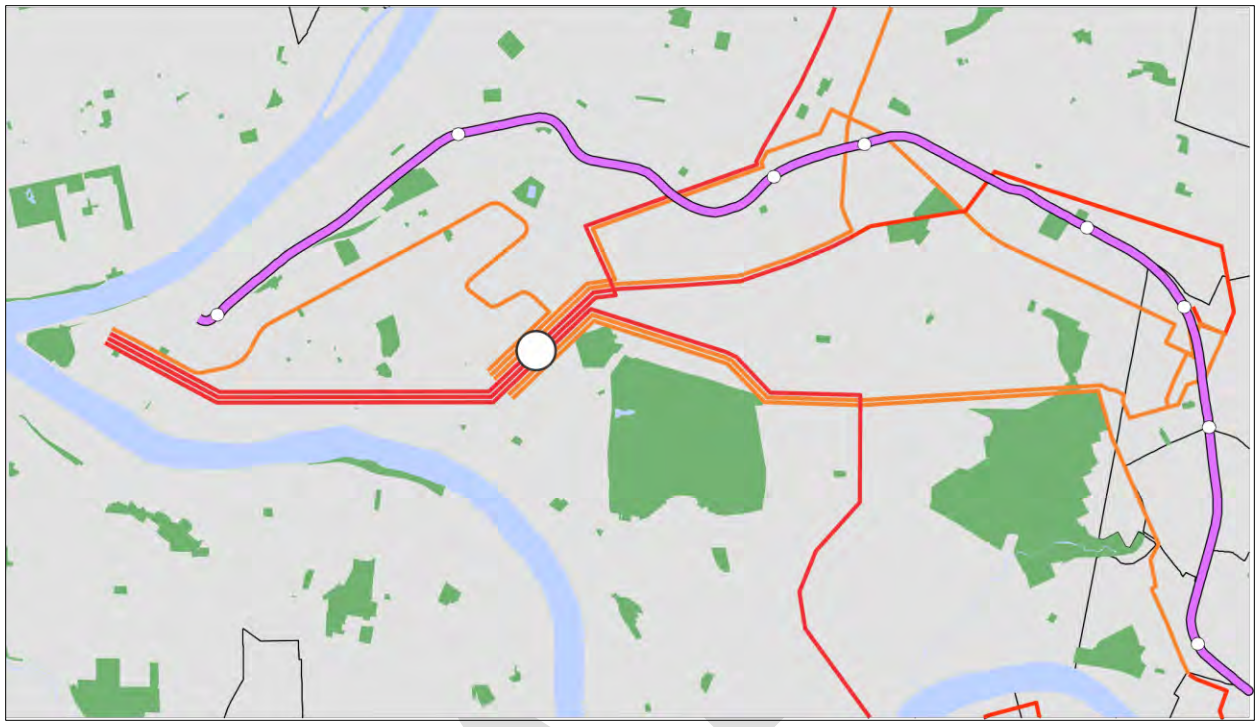

Figure 26: Modified Collector BRT Service

9.7 Travel Times

Bus rapid transit service on the exclusive facilities proposed in these alternatives has the potential to significantly improve travel time in the corridor. Much of the existing delay and variability in the corridor stems from two sources: traffic congestion and dwell times at stations. As noted previously, these are both highly variable and can be significant and unpredictable.

By providing exclusive bus lanes throughout the core corridor, the BRT will reduce the delays that result from interaction with traffic congestion. For preliminary analysis, potential BRT travel times were estimated by existing travel times in the corridor during uncongested periods. These reflect actual, not hypothetical examples, of travel between points in the corridor with existing signal timings and stop locations. With signal prioritization and optimized stop locations, further travel time improvements are likely.

The second major factor in bus delays and variability stems from stop delays. As noted above, these delays can be significant. For the preliminary estimate of BRT travel times, existing stop locations and number of boardings were used, with revised delay estimates based on the assumption of adopting an off-board fare collection system which would permit barrier-free boarding of buses through three sets of doors.

For the preliminary BRT travel time estimates, a headway of 5:00 minutes was assumed. While this is less than the current average travel times, it reflects a possible reduction of service frequency in the Downtown to Oakland segment to balance service levels throughout the corridor.

Table 9 and Table 10 show the potential travel time improvements due to BRT. With the anticipated headway reductions taken into account, estimated average travel times between Wood Street Downtown and Atwood Street in Oakland is projected to improve from a current 16 minutes 33 seconds to 14 minutes and 43 seconds. While significant in percentage terms, this represents only about a five-minute improvement in what is a relatively short trip at present. However, the potential benefits of BRT become more significant when compared to the existing range of variability.

Table 9: Downtown to Oakland Travel Times with BRT

Downtown to Atwood Street			
	Average	**Worst Case**	**BRT**
Headway	2:17	8:37	5:00
Travel Time	17:16	25:14	9:43
Total Trip	19:33	33:51	14:43

While the average travel time between Downtown and Atwood Street is 19 minutes 33 seconds, under current conditions, this can increase, in the worst cases, to 33 minutes 15 seconds. In this scenario, the faster, reliable BRT travel time of 14 minutes 33 seconds becomes far more significant, potentially cutting over 19 minutes off the trip. As congestion in the corridor can be unpredictable, the BRT investments have the potential to provide a reliable, predictable travel time from Downtown to Oakland of just under 15 minutes.

Table 10: Downtown to Morewood Travel Times with BRT

Downtown to Morewood Avenue			
	Average	**Worst Case**	**BRT**
Headway	2:17	8:37	5:00
Travel Time	23:10	33:14	14:07
Total Trip	25:27	41:51	19:07

Similar improvements are also seen looking at the broader corridor from Downtown to Morewood Avenue. The estimated BRT reduction in travel time from 25 minutes 27 seconds to 19 minutes 7 seconds is significant, although a relatively small time savings on a relatively short trip. But compared to the existing range of travel time variability, BRT has the potential to cut in half the amount of time that needs to be allowed for any particular trip by reducing variability.

Additional analysis with a simulation model and the proposed BRT service plans will be needed to confirm these findings.

9.8 Construction Costs

Construction cost estimates were developed for the five refined corridor alternatives under consideration following the preliminary screening. These estimates assume a relatively extensive BRT system and implementation including: complete reconstruction of Fifth and Forbes Avenues in Uptown and in Oakland, including sidewalks, streetscaping, and complete street treatments; branded BRT stations throughout the core corridor and extending into the surrounding neighborhoods; branded, high-capacity, alternate fuel BRT vehicles, and signal upgrades and BRT priority throughout the core corridor.

As shown in Table 11 the construction cost of these alternatives is estimated to range between $190 million and $210 million in 2012 dollars, with the variation between alternatives relatively modest. These cost estimates could be subject to variation based upon further refinements in the extent and scope of the BRT system.

Table 11: Construction Cost Estimates

	Alternative 1 Fifth Ave Transitway	Alternative 2 Fifth Avenue Curb Lanes	Alternative 3 Fifth/Forbes Contra Flow	Alternative 4 Fifth/Forbes Concurrent Lanes	Alternative 5 Forbes Ave Transit Street
Complete Streets	$42,200,000	$41,200,000	$44,200,000	$44,00,000	$40,900,000
Traffic Signals	$6,500,000	$5,500,000	$7,400,000	$8,400,000	$7,900,000
Stations	$56,700,000	$57,500,000	$51,700,000	$56,900,000	$57,100,000
AVL System	$4,100,000	$4,100,000	$4,100,000	$4,100,000	$4,100,000
Right of Way	$2,700,000	$1,400,000	$2,000,000	$2,000,000	$19,300,000
Subtotal	$110,200,000	$108,300,000	$107,400,000	$113,600,000	$110,300,000
Vehicles	$50,600,000	$50,600,000	$50,600,000	$50,600,000	$50,600,000
Design and CM	$31,600,000	$30,200,000	$30,800,000	$32,200,000	$30,900,000
Total	**$194,500,000**	**$190,500,000**	**$190,800,000**	**$198,400,000**	**$210,800,000**

10.0 NEXT STEPS

10.1 MAP-21

On July 6, 2012 the Moving Ahead for Progress in the 21st Century Act (MAP-21) was signed into law, providing funding for surface transportation programs for Federal fiscal years 2013 and 2014. In addition to providing the first long-term transportation authorization enacted since 2005, MAP-21 included a number of changes designed to streamline the approval and funding process.

Of particular relevance to this project, MAP-21 removed the previous requirement for a formal stand-alone Alternatives Analysis phase to select a Locally Preferred Alternative prior to moving into preliminary engineering. MAP-21 defines a Project Development phase which incorporates preliminary engineering and NEPA documentation. Project Development can be entered at any time the project sponsors feel the planning work has advanced adequately to define the alternatives. This allows for the more detailed analysis and design conducted as part of Project Development to inform the selection of the Locally Preferred Alternative.

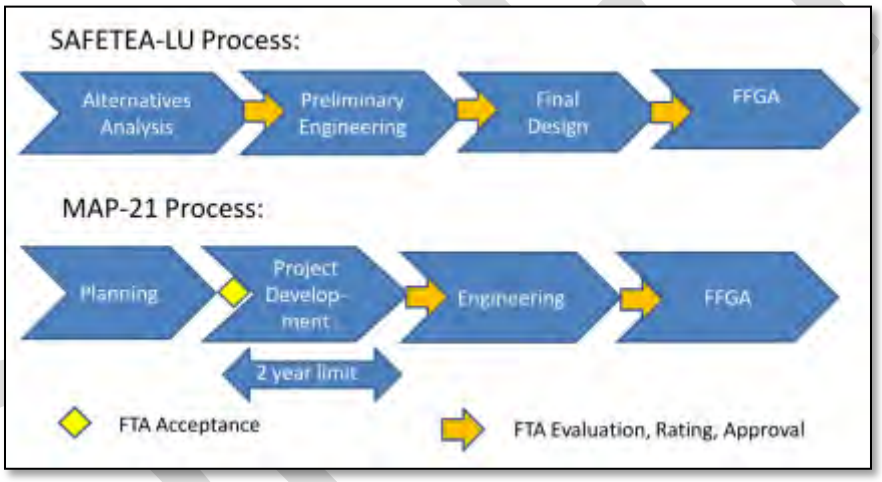

Figure 27: MAP-21 Project Process

10.2 FTA Briefing

On July 20, 2013, the Port Authority and consultant staff met with FTA Region 3 staff in Philadelphia to present work on the project to date. The extensive program of stakeholder and public involvement was noted, as was the extensive screening process used to narrow the number of alternative alignments down to the two still under consideration. It was noted that at that point, there was no consensus among stakeholders to select one of the two alternatives based on the level of analysis that had been done.

FTA staff noted that the alternatives analysis work done to date appeared to be solid. While a Locally Preferred Alternative had not yet been selected, in many ways the alternative had been defined as bus rapid transit between Downtown and Oakland, operating on some combination of Forbes and Fifth Avenues. FTA also encouraged incorporation of East Busway service into

the BRT alternative. The remaining issues needed to refine and select a final alternative were appropriate to be considered as part of the NEPA and engineering analysis in Project Development. Accordingly, FTA staff recommended that the Authority consider advancing the project to the Project Development phase. In this phase, additional technical analysis could be conducted on the two remaining alternatives, and additional opportunities could be provided for public review and input prior to selecting the Locally Preferred Alternative.

10.3 Stakeholder and Agency Coordination

Following the FTA meeting, the proposal to advance into Project Development was presented to the Stakeholder Advisory Committee,. The stakeholders responded positively, and the Port Authority, City of Pittsburgh and Allegheny County began identifying funding and negotiating agreements that would be necessary to support the Project Development phase.

One significant constraint that MAP-21 places on the Project Development phase is a two year timeline to complete the NEPA phase along with the engineering necessary to complete NEPA. While adequate for the technical requirements, this timeline constrains the sponsoring agencies to ensure that support and financing are in place, and that no significant issues remain which could delay decision making. Accordingly, a formal request to FTA to enter Project Development was deferred until these issues could be resolved.

Recognizing that cooperation between agencies would be necessary to advance the project further, a Memorandum of Understanding was negotiated between the Port Authority, Allegheny County, the City of Pittsburgh and the Urban Redevelopment Agency. Negotiations of the agreement was delayed due to a change of administration for the City of Pittsburgh, and the agreement was executed in November, 2014.

10.4 Project Development

Upon execution of the Memorandum of Understanding, notice to proceed was given to the consultant team to resume technical analysis and public involvement to advance the development of the project. A stakeholder meeting was held on March 3, 2015 to reacquaint the group with the project and the alternatives being advanced.

The project was reintroduced to the public at a series of scoping meetings held at Duquesne University in Uptown on May 5, 2015, and at the University of Pittsburgh. At these meetings information was presented on the project process and on the alternatives being advanced, including cross sections and corridor maps. A scoping booklet summarizing this information was distributed as well.

Following the scoping meetings, work began on advancing the concepts and the NEPA analysis.

The two alternatives were developed from typical sections at the neighborhood level to full corridor-level alignments including dedicated bus lanes, general travel lanes, and bicycle facilities. These were shared with the City of Pittsburgh for review prior to advancing to detailed analysis. At the request of the City of Pittsburgh, additional downtown routing options were identified. Field views were conducted with representatives from PAAC, the City, Allegheny County, the URA and SPC to identify potential station locations. Ridership forecasting

methodology was coordinated with SPC. Preliminary system configuration concepts and branding concepts were identified.

Section 106 consultation was initiated through FTA. A preliminary Area of Potential Effects was identified, and used to identify potential historic and cultural resources in the core area for further investigation. A Phase 1 archaeological investigation, and identified areas of potential concern. Sensitive receptors for noise and vibration analysis were identified. Background data for Environmental Justice evaluation was collated.

However, technical work was not able to advance further without resolution of alignment and system configuration issues. The City of Pittsburgh determined that the BRT project would potentially have wide-ranging impacts on affected neighborhoods, and further planning was needed to understand the needs visions of these neighborhoods beyond the lens of BRT.

10.5 Additional Planning Initiatives

The City of Pittsburgh undertook an extensive program of planning with neighborhoods to understand their needs and visions. This was led by an understanding that a broader context was required to consider BRT in light of other needs including economic development, housing, bicycle infrastructure, stormwater management and energy efficiency. This planning work was not able to move ahead until the new City administration took office in January, 2015, and the subsequent addition of new leadership and staff to the Department of City Planning.

In Uptown, the City undertook planning and development of an ecoinnovation district, with the goal of developing a plan for the community that was environmentally and economically innovative and that enhance equitable land use, mobility, energy, and infrastructure that will embody sustainability in all aspects of development. A public kick-off of the project was held in February 2016, and the plan is expected to be completed in early 2017. The plan is expected to provide a framework to attract and guide new investment and to reduce the City's environmental footprint. During the planning process, the community reached consensus on ways in which BRT could serve as a catalyst to reaching these goals, and could be incorporated into the streetscape on Forbes and Fifth Avenues.

In Downtown, the City of Pittsburgh created Envision Downtown, a public-private partnership with the Pittsburgh Downtown Partnership. This group was established to accelerate Downtown's economic growth and competitiveness, and advancing mobility and liability in Pittsburgh's central neighborhoods. Key initiatives are focused on improving pedestrian safety, removing barriers for persons with disabilities, investing in transit rider amenities, and reducing traffic congestion.

In Oakland, City Planning has coordinated with established organizations and agencies including the Oakland Business Improvement District, the Oakland Transportation Management Association, and the Oakland Planning and Development Corporation. Many of the community's needs and goals were addressed in the Oakland 2025 Plan.

Based in part on this work, the Mayor and Allegheny County Executive reached agreement in late 2016 to continue advancing the development and analysis of the BRT alignments and service plan options, and to resume the NEPA analysis.

10.6 Planned Work

A series of public meetings are planned for early 2017 to share the results of the two refined alternatives and to select an LPA. LPA selection is anticipated in late April, 2017, and that PAAC expects to enter the project into FTA's Capital Investment Grant program. This will involve additional environmental analysis and more detailed project engineering.