BROOKLYN STREETCAR
FEASIBILITY STUDY




NEW YORK CITY DOT

URS

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1.0 EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The New York City Department of Transportation (DOT) embarked on a study to determine the feasibility of running a streetcar route in the Borough of Brooklyn, New York, specifically serving the neighborhood of Red Hook. The intent of the study was to determine the current and future transportation needs of Red Hook and identify whether a streetcar can effectively meet these needs. The Brooklyn Streetcar Feasibility Study (BSFS) included a technical analysis of the area's demographics and transit needs. Streetcar routing options were identified, followed by an initial assessment of potential alignments. The engineering advantages and limitations led to delineation of the one basic potential alignment with options for particular segments. The BSFS analyzed the alignment options, including constructability, costs, and benefits. Using the results of this analysis, DOT was able to make a policy decision on the potential for re-introducing the streetcar mode in Red Hook and also develop alternative short-term solutions for transportation access needs in the area.

This final report is a culmination of the feasibility study. During this extensive study, several documents were prepared. They include: Existing Conditions Report, Case Study Report, Transit Demand Report, Operations Planning Technical Memorandum, Alignment Evaluation and Feasibility Considerations Technical Memorandum, and Feasibility Report. Each of these documents is summarized below, and the full documents are appended following this Executive Summary. In addition, this study included three Community Advisory Committee meetings, a public meeting, and a project webpage to provide an opportunity for stakeholders and the general public to comment and give feedback. Summaries of the Community Advisory Committee meetings and Public Meeting are included in Appendix A. A summary of the BSFS process and the associated reports and technical memoranda is described below.

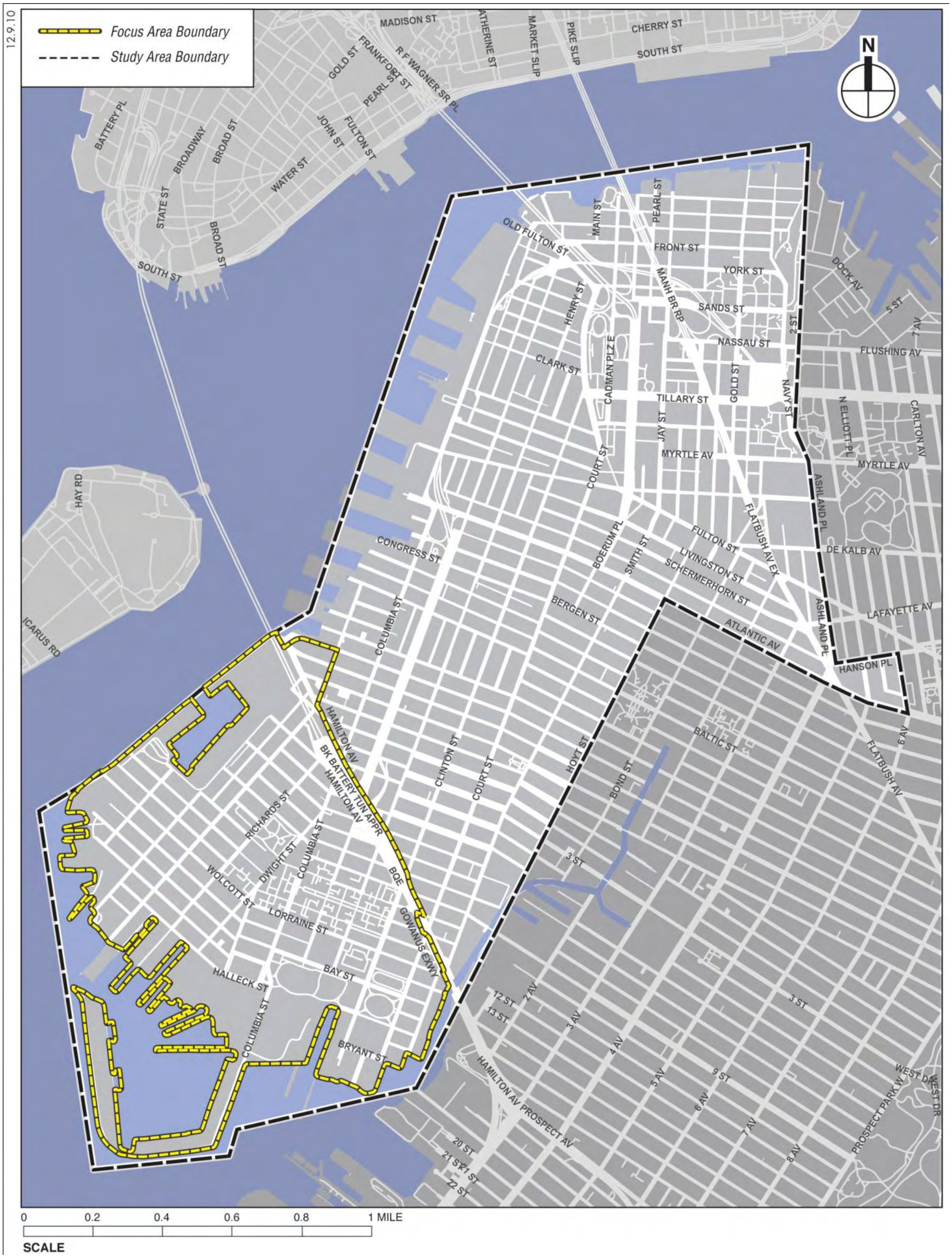
Based on the selection and evaluation of the alignment options, streetcar feasibility considerations, capital and operating costs, public input, zoning and land use policies in Red Hook, and expected benefits, DOT arrived at policy decision for a future streetcar service in Red Hook, Brooklyn. DOT has determined a streetcar system would be better suited in a neighborhood with fewer physical constraints and potential conflicts (i.e. wider streets). In addition, in implementing a comprehensive planning approach, the neighborhood should be a higher density mixed-use zone, or have the potential for accommodating these supportive land uses. At the present time, these conditions do not exist in Red Hook.

EXISTING CONDITIONS REPORT

The Existing Conditions Report provided the context for assessing the transportation needs of Red Hook, Brooklyn and identified potential transit solutions. Specifically, land use, demographic, and community characteristics of Red Hook and adjacent areas were presented, as well as an overview of the existing transportation options for current Red Hook residents, workers, and visitors.

To evaluate the potential transit needs of Red Hook as well as the feasibility of connections to existing transit services, a Focus Area and a Study Area were established. The Focus Area (Red Hook) is located in Community District 6. It is bounded by the Buttermilk Channel to the west, Hamilton Avenue, the Brooklyn-Queens Expressway, and the Brooklyn-Battery Tunnel to the north, the Gowanus Canal to the east, and the Gowanus Bay to the south, as shown in Figure 1.

Figure 1: Focus Area and Study Area



The Study Area is much larger and encompasses the transit hubs of Downtown Brooklyn and adjacent neighborhoods. The Study Area incorporates the Focus Area extending to include the blocks between the Buttermilk Channel and the East River waterfront to the west and north and Hoyt Street, Ashland Place, and Navy Street to the east. The Study Area includes the neighborhoods of Carroll Gardens, Cobble Hill, Brooklyn Heights, Downtown Brooklyn, DUMBO, Vinegar Hill, Boerum Hill, and Gowanus.

Land Use and Community Character

The Existing Conditions Report presents demographic, economic, and travel characteristics for the Focus Area and the Study Area, based on geographic information system (GIS), field survey, and U.S. Census Bureau data, as well as a literature review. This reconnaissance provided an understanding of the land use and community character of Red Hook, as well as its surrounding neighborhoods that comprise the Study Area.

Over the past 20 years, the Focus Area has begun to recover from historic economic decline, and has seen an increase in residential and commercial development. However, despite the consequent increase in residential and employee densities, the Focus Area continues to experience population and employment levels below the historical peaks. The Study Area has also seen an increase in residential and employment populations over the last 20 years. Outside of the dense Downtown Brooklyn area, neighborhoods in the Study Area have residential and employee densities similar to those of the Focus Area.

The Focus Area and Study Area differ greatly in terms of income. According to Census forecasts, the 2010 median household income for the Focus Area is $19,417. A substantial portion of households in the Focus Area earn less than $15,000 per year (48 percent), and few earn more than $50,000 per year (10 percent). Related to the lower incomes in Red Hook, vehicular ownership is similarly low. Much of the working-age population in Red Hook is dependent upon transit. Therefore, it is critical that transit improvements be considered.

Transportation

In addition to providing an understanding of the land use and community characteristics in the Focus and Study Areas, the Existing Conditions Report describes the current transportation system. Due to the highway network, the Focus Area is physically isolated from surrounding areas of Brooklyn, resulting in limited north-south and east-west access to and from Red Hook.

The Focus Area has no direct subway service and is served by only one bus route, the B61. Although the B61 offers frequent peak period service in Red Hook (every eight to nine minutes), reliability was a major concern raised by study participants. The nearest subway station is Smith-9th Street, which is served by the F and G subway lines. Access to the subway involves a lengthy walk or a transfer from the B61.

Despite limited transit service, the largest share of the Focus Area's residents relies on the bus or subway for their commute. However, Red Hook employees heavily rely on their automobiles to travel to the Focus Area for work. In both cases, the poor access to Red Hook contributes to long commutes for its residents and employees. Nearly 50 percent of residents commute more than 45 minutes to work. More than 50 percent of its employees also commute more than 45 minutes to work. Even for residents that commute relatively short distances (for example, to Downtown Brooklyn, Lower Manhattan, or Midtown Manhattan) travel times are long compared to other areas that are better served by transit.

Principal Conclusions

The Focus Area's residential and worker populations have grown in recent years, but the area remains poorly served by transit. Only one bus route serves the Focus Area even though many of its residents rely on public transportation. In addition to limited transit service, the Brooklyn highway network isolates the Focus Area from adjoining areas. Much of the Study Area is well served by public transportation. However, there has been rapid redevelopment along its waterfront with new recreational, residential, and commercial uses. These waterfront sites, particularly those south of Atlantic Avenue, are not well served by public transportation.

CASE STUDY REPORT

A Case Study Report was prepared to illustrate relevant streetcar components and experiences in the United States that are applicable to the Brooklyn Streetcar Feasibility Study. The report was used as a reference for the subsequent tasks in the study, as well as determining DOT's policy decision on a future streetcar in Red Hook.

DOT selected three streetcar systems to be further studied for their applicability to a Brooklyn Streetcar: Portland Streetcar, Seattle's South Lake Union Streetcar, and Philadelphia's Route 15/Girard Avenue Trolley.

Portland Streetcar

The Portland Streetcar demonstrates the use of modern streetcar technology in mixed street-running operation along urban streets. In addition, the Portland Streetcar offers multiple examples of utility impact mitigation techniques and well-documented economic development impacts. Other relevant lessons for Brooklyn include the system expansion process, use of non-Federal funding, use of one-way pairs for operations, and strategies to integrate with bike lanes and pedestrian pathways.

Seattle South Lake Union Streetcar

The South Lake Union Streetcar is a new modern streetcar system in full revenue service, similar to Portland, in a larger urban setting. The process to develop this system provides relevant information and lessons learned for Brooklyn. For example, to fund the South Lake Union Streetcar, waterfront businesses formed a Local Improvement District to contribute $1.1 million for construction costs. The adoption of the LID worked well because the South Lake Union area has several major property owners participating with the city of Seattle on revitalization, including private developers and the University of Washington.

Philadelphia Girard Avenue/Route 15 Trolley

Philadelphia's Route 15 trolley demonstrates the re-use of PCC heritage streetcar vehicles and existing infrastructure. In addition, the Route 15 Trolley is located in a northern climate, similar to Brooklyn, and in relatively close proximity to New York allowing study team site visits. While this system is not the only example of PCC cars in operation today, it does demonstrate the lessons learned, both positive and negative, of returning a former streetcar line into regular revenue service using heritage streetcar equipment.

For example, the Route 15 trolley line has experienced reliability issues due to limited rights-of-way. Most of the line runs within mixed traffic, along narrow streets. In years past, Girard Avenue's roadway cross sections were of sufficient width to allow simultaneous operation of both streetcar vehicles and automobiles. However, as the prevalence of larger vehicles such as sport utility vehicles has grown, the corridor's narrow streets are no longer as accommodating. Operating space is further compromised during the winter months when there is snowfall. Along Route 15's narrow streets it is not uncommon for a trolley to be blocked by a double parked vehicle, as streetcars can only travel along the provided tracks. Frequently, streetcar operators must stop the streetcar and exit the vehicle to move a parked vehicle's mirror that is blocking the streetcar ROW. In addition, SEPTA has used vehicles equipped with bumpers designed to move double-parked vehicles out of the way.

Examination of the case studies demonstrated the multitude of planning components that comprise a streetcar system. These factors collectively determine the future success or demise of a streetcar operation. Throughout the BSFS, the examples provided in this Case Study Report were considered. Streetcars provide a historic, romantic appeal and have transformed blighted districts into vibrant areas. However, in these success stories contributing factors were implemented in a master planning approach. As such, it is critical that a holistic approach be applied to the planning and design of a Red Hook streetcar.

TRANSIT DEMAND ANALYSIS TECHNICAL MEMORANDUM

The Transit Demand Analysis Technical Memorandum projected future demand for higher capacity transit service in Red Hook. Existing met and unmet demands (existing transit riders and those not currently riding, respectively) were first determined using available information and travel patterns in peer New York City neighborhoods. Future demand was based on the calculated existing demands, current transit level of service, and proposed increase in transit level of service. The projection also considered any future additional demands generated by already-planned developments within Red Hook and the areas directly between Red Hook and Downtown Brooklyn. (These developments increase transit demand, but the demand is not attributable to a future streetcar service, as they are already in the approval process.)

Table 1 presents the number of new riders that would be attributable to a new streetcar service. The table also presents the number of boardings generated by new developments within the Focus Area and Study Area. In total, these factors combine for a total projected number of boardings of 5,521 from the Focus Area and 12,544 from the Study Area.

Table 1: Projected Transit Boardings

	TOTAL CURRENT TRANSIT BOARDINGS	NEW RIDERS	BOARDINGS FROM PLANNED DEVELOPMENTS WITH STREETCAR	TOTAL BOARDINGS WITH PLANNED DEVELOPMENTS AND STREETCAR
Focus Area	3,852	474	1,195	5,521
Study Area	9,902	1,218	1,424	12,544

OPERATIONS PLANNING TECHNICAL MEMORANDUM

The Operations Planning Technical Memorandum presents a proposed operating plan for a future Brooklyn streetcar, outlining the key variables that typically affect streetcar service. These variables include the following:

Service Operations

In determining the hours of operation and frequency of a future Brooklyn streetcar system, consideration was given to the existing Red Hook transit service, consistency with the Metropolitan Transportation Authority New York City Transit (MTA NYCT) services, and future transit needs. These elements would allow the streetcar system to seamlessly connect with other transit services (subway, bus, and commuter rail). A summary of service operations is as follows:

- Operating hours:
  - Alternative 1 – 24-hour streetcar service; or
  - Alternative 2 – 6 AM to midnight streetcar service and midnight to 6 AM bus service;
- Service frequency: 8 to 40 minute headways, depending on time of day (similar to existing bus service); and
- System integration: integration with the MTA NYCT existing transit system, including fare collection and intermodal transfer points.

Vehicle Characteristics

A general assumption is that a future Brooklyn streetcar system would operate at speeds similar to the existing MTA NYCT bus service in the Study Area. Although streetcar vehicles have faster acceleration rates than buses and boarding times are generally faster due to low-floor operations and all-door boarding capabilities, it is assumed a future Brooklyn streetcar would operate in mixed traffic (non-exclusive lanes), which would restrict travel speeds to those generally experienced by buses.

The number of vehicles required for a streetcar system is driven by the frequency of service and spare vehicle requirements. Streetcar vehicle layover requirements are typically similar to those required for bus service, which is 15 to 20 percent of the total travel time.

A summary of vehicle characteristics is as follows:

- Average speed: 10.5 miles per hour;
- Layover requirements: 15 to 20 percent of trip time, approximately 6 minutes; and
- Number of vehicles: 8 vehicles plus additional spare vehicles, as required.

Maintenance Requirements

Streetcar systems require a storage and maintenance facility, or ‘car barns’ for servicing and storing the vehicle fleet, administering system operations, and supporting employees. As such, the servicing and storage of the streetcar fleet should be considered as an integral part of streetcar operations. The storage and maintenance facility should be located within close proximity to the streetcar route and outfitted to maintain the streetcar fleet, both now and in the future.

The requirements for the vehicle maintenance facility are:

- 150 feet x 150 feet facility with six tracks;

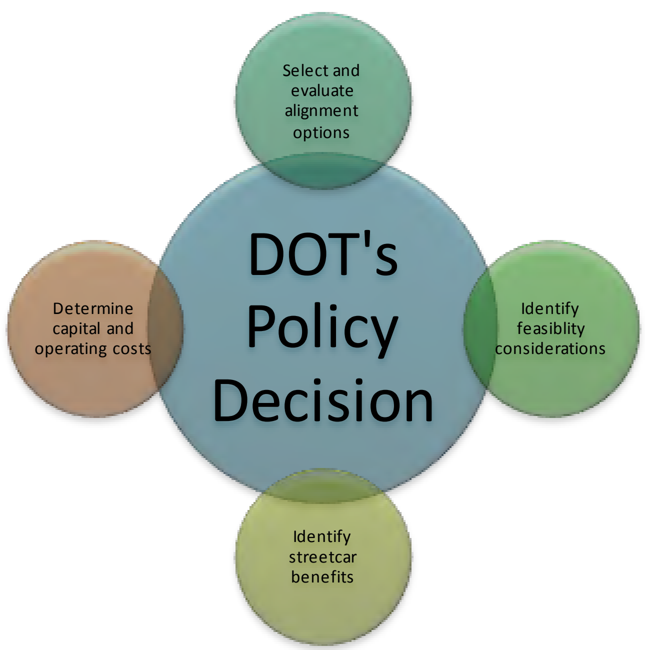
- 1 to 2 acre site; and
- Manufacturing zoned district.

These key variables (service operations, vehicle characteristics, and maintenance requirements) comprise the operations plan of a future Brooklyn Streetcar. Development of these operating parameters were used to guide several components of the Brooklyn Streetcar Feasibility Study, including the potential vehicle labor requirements and energy costs, preliminary operating and vehicle costs, and an estimate of overall capital costs.

FEASIBILITY REPORT

The Feasibility Report presents the results of a detailed evaluation of the feasibility of implementing a streetcar system in Brooklyn. Based on the approach outlined in the Alignment Evaluation Methodology and Feasibility Considerations Technical Memorandum, this analysis considered constructability issues, vehicle options, and overall costs to implement and operate a starter system in Brooklyn. In addition to feasibility from an engineering standpoint, this report also includes DOT's policy decisions related to a future streetcar in Red Hook. The process for developing a policy decision for a future streetcar in Brooklyn includes selecting and evaluating the alignment options, identifying feasibility considerations, and determining capital and operating costs. DOT's policy decision also incorporates streetcar benefits, as shown in Figure 2.

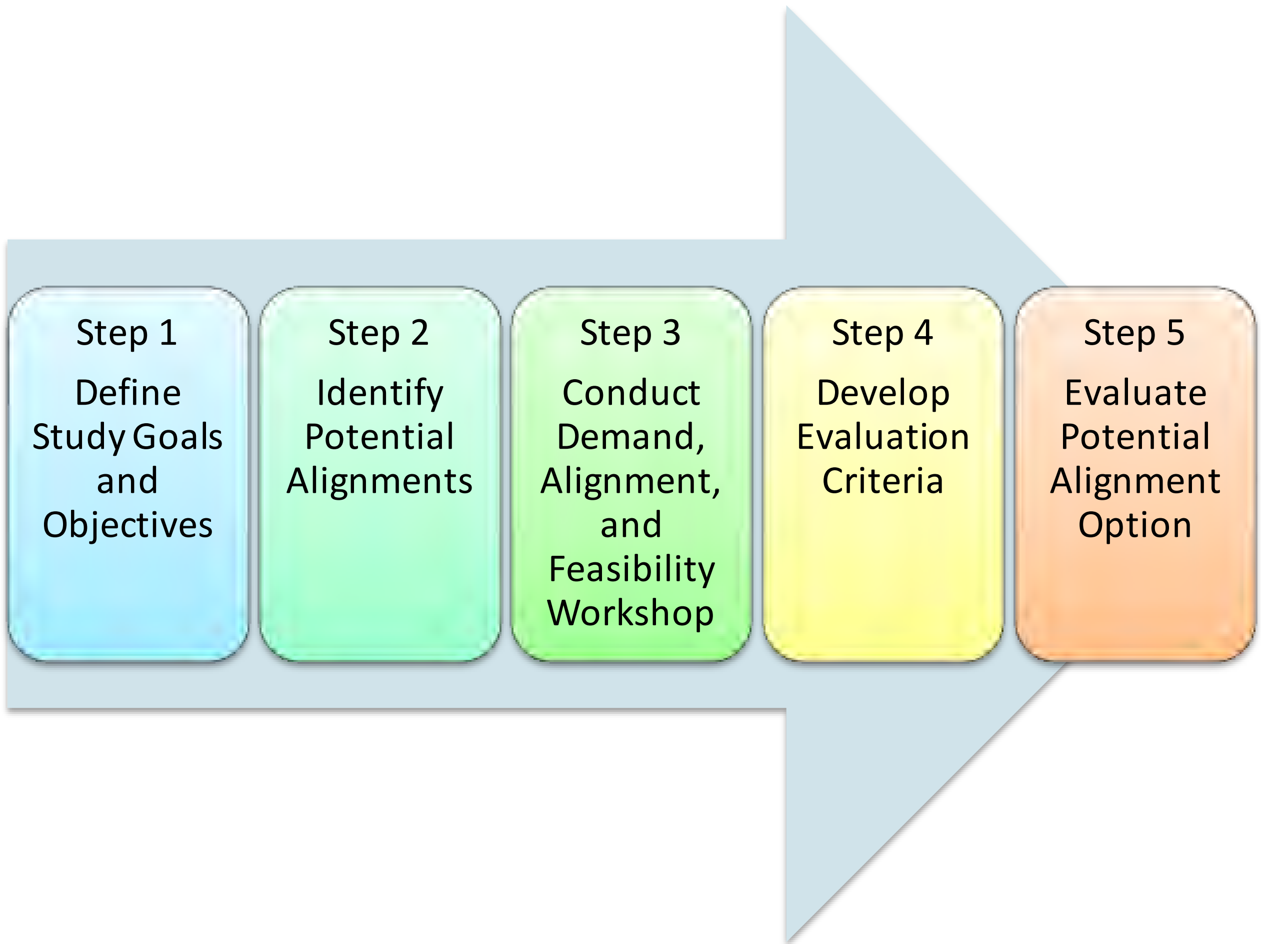
Figure 2: DOT Policy Decision Components



Alignment Selection

The process for selecting and evaluating potential alignments for a streetcar service in Brooklyn included defining the study's goals and objectives, identifying potential streetcar alignments, developing evaluation criteria to measure how well the alignment options satisfy the study's goals and objectives, and evaluating various alignment options in comparison to each other. This multi-step process is graphically shown in Figure 3.

Figure 3: Alignment Selection and Evaluation Process



In Step 1, study goals and objectives were discussed and developed during the initial study meetings. In Step 2, conceptual alignments were identified based on a combination of factors, including land uses that generate significant person trips, employment densities that concentrate these trip generating uses, connecting existing transit that allows for citywide access, and input from the Community Advisory Committee.

In Step 3, additional streetcar alignments were identified and reviewed during a Demand, Alignment, and Feasibility Workshop attended by DOT and members of the consultant team. Based on the input received at this workshop and considering planning factors such as existing land use, employment density, existing transit, and the roadway network, the alignments were refined to include one basic potential alignment with various options for particular segments. This potential alignment with options was presented at the second Community Advisory Committee meeting on December 13, 2010 for public feedback.

Using this methodology, potential alignments for each segment of streetcar service in Brooklyn were selected, evaluated, and ranked, with the highest ranking given to those that best satisfied the goals and objectives of the project. This resulted in an individual preferred alignment. The highest ranking alignment options are shown in Figure 4and as follows:

- Focus Area East – Centre Street;
- Focus Area West – Van Brunt Street;
- Middle Section – Columbia Street / President Street and Carroll Street; and
- Northern Section – Borough Hall / Boerum Place.

Feasibility Considerations

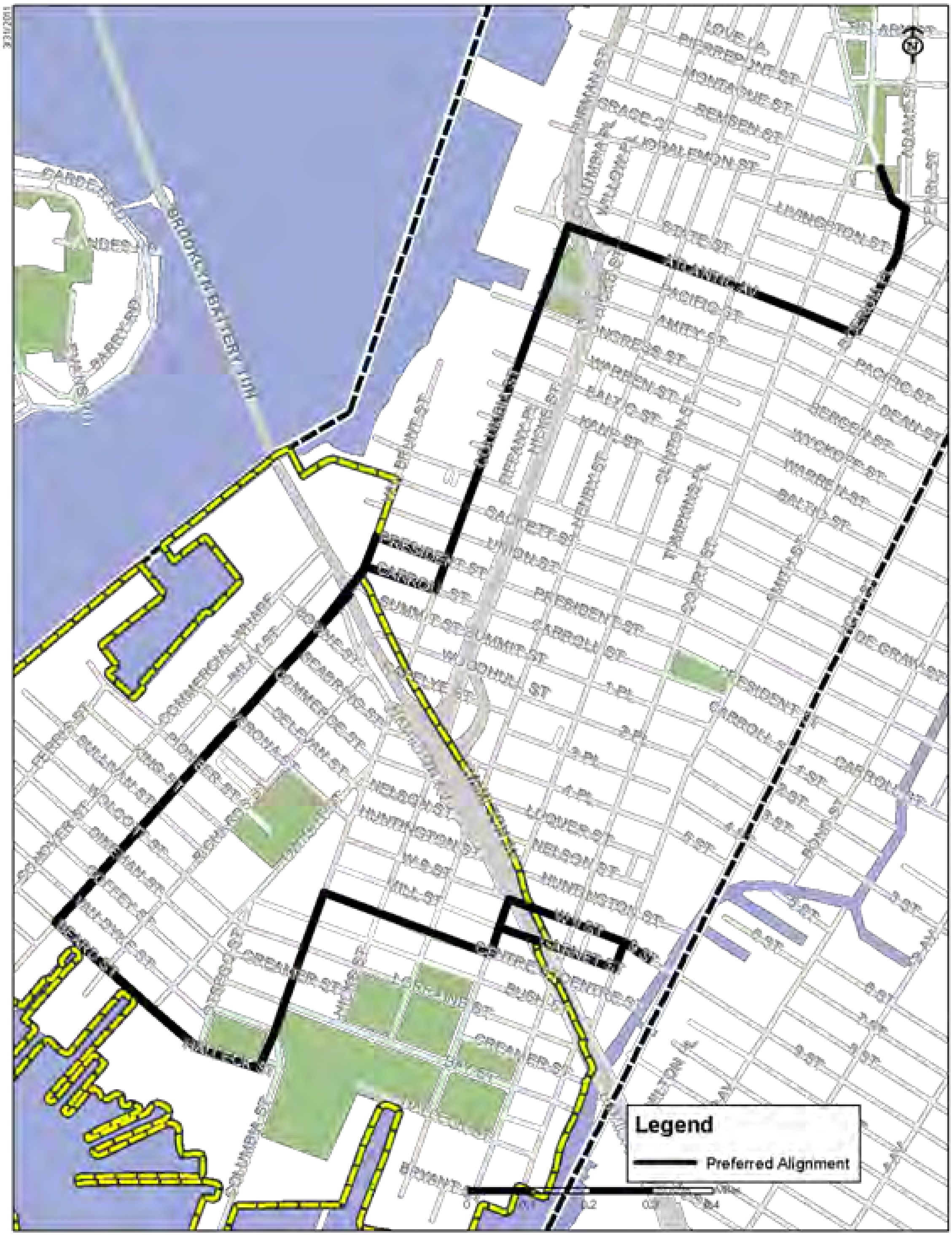
Feasibility considerations typical of a streetcar operating in an urban environment that could affect the viability of the alignment options were identified. These general considerations, derived from the Case Study Report, include the geometric constraints or physical conditions necessary to provide reasonable operations (i.e. width, height, slope, grade, weight, and existing utilities). Specifically, the following feasibility considerations were examined:

- Horizontal alignment and curvature
- Grades
- Station platforms
- Vertical clearance
- Roadway cross slopes
- Right-of-way
- Structural operations
- Traffic operation / signals
- Bicycle integration
- Utilities
- Track structure / pavement reconstruction

As the evaluation process demonstrated, all of the alignments are technically feasible. All of the feasibility considerations of implementing a streetcar system could be addressed during the planning, design, and construction phases of a future streetcar. However, when considering factors such as the cost effectiveness of each alignment option, there are distinct differences in the options. The evaluation process produced a ranking of the alignment options to determine the most feasible alignment.

Although the Centre Street, Van Brunt Street, Columbia Street / President Street and Carroll Street, and Borough Hall / Boerum Place alignment is most feasible from an engineering standpoint, other factors, including right-of-way and intersection geometric modifications, property acquisitions, parking reductions, and signal modifications would need to be addressed. For example, the narrow right-of-ways along Van Brunt Street could impact the operation of a future streetcar, as well as associated vehicular, bicyclist, and pedestrian movements.

Figure 4: Preferred Streetcar Alignment



NYCDOT - BROOKLYN STREETCAR FEASIBILITY STUDY

Vehicle Operating and Maintenance Facilities

Cost

A new transit service in Red Hook would require a substantial capital investment. The estimated cost based on the conceptual design of the preferred alignment amounts to approximately $176 million in 2011 dollars. Given the current economic environment, it is questionable whether the City could raise the funds for this substantial capital investment. Moreover, in light of the unfavorable feasibility considerations related to the actual operation of such a system, it is uncertain that a streetcar, while technically feasible, is the most efficient and effective option for meeting Red Hook's transit goals.

Additional Factors

As reported in the Case Study Report, there are a multitude of planning and land use components that work together to create a successful streetcar system. Streetcars have transformed blighted districts into vibrant areas in a number of U.S. cities, specifically in two of the systems studied (Portland and Seattle). However, other factors likely contributed to this growth, including local land use policies, the construction of a complementary light rail system, urban renewal, and the ability to use tax district funds to subsidize infrastructure costs. In contrast, Philadelphia's streetcar corridor has not experienced similar growth. Although the return of the Route 15 trolley was partially justified for economic redevelopment reasons, the planning process lacked a land use component, and redevelopment has not progressed as hoped.

Although Red Hook has experienced recent growth, the City of New York has no plans to change zoning, or use other planning tools necessary to spur further residential or mixed-use development. In fact, the NYC Department of City Planning has identified the Red Hook waterfront as a working waterfront, to be maintained in its current industrial state. Manufacturing land use conflicts with the mixed-use development recommended to support a streetcar system and encourage redevelopment. In addition, based on feedback received from the Community Advisory Committee, there does not appear to be community consensus on whether increased density of mixed use development is desired.

Policy Decision

Based on the selection and evaluation of the alignment options, streetcar feasibility considerations, capital and operating costs, public support, zoning and land use policies in Red Hook, and expected benefits, DOT developed a policy decision for a future streetcar service in Red Hook, Brooklyn. DOT has determined that a streetcar system is not appropriate in the study area at this time. A streetcar would be better suited in a neighborhood with fewer physical constraints and potential conflicts (i.e. wider streets). In addition, in implementing a comprehensive planning approach, the neighborhood should be a higher density mixed-use zone, or have the potential for being redeveloped with supportive land uses. At the present time, these conditions do not exist in Red Hook.

If in the future, consensus for development becomes apparent, the neighborhood planning goals change, and/or as economic recovery continues, a streetcar could become feasible. This document would then provide a resource for future planning and design of a streetcar. In the interim, DOT and MTA NYCT are investigating other opportunities to improve transit mobility and accessibility in Red Hook that would be feasible in the short-term, less costly to implement, and would provide the needed transit benefits.

2.0 EXISTING CONDITIONS REPORT

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1.0 INTRODUCTION

1.1 *PURPOSE OF THE STUDY*

DOT is investigating the potential of a streetcar to, from, and within the Red Hook neighborhood of Brooklyn. The intent of the study is to determine the current and future transportation needs of the Red Hook neighborhood and identify whether a streetcar can effectively meet these needs. In addition, the study will analyze streetcar routings and will provide an initial assessment of potential streetcar alternatives, analyzing alignment, constructability, costs, and benefits. This study is a first step in developing solutions to transportation access needs for Red Hook and provides an opportunity to evaluate the potential for re-introducing the streetcar mode in Brooklyn. It will be followed by more detailed analysis if solutions are determined feasible.

This Existing Conditions Report provides a context for assessing the transportation needs of Red Hook and evaluating streetcar as a potential transit solution. It describes the land use, demographic, and community characteristics of Red Hook and adjacent areas and provides an overview of the existing transportation options for Red Hook's residents, workers, and visitors.

1.2 *IDENTIFICATION OF FOCUS AREA AND STUDY AREA*

To evaluate the potential transit needs of Red Hook as well as potential connections to existing transit services in the Borough of Brooklyn, a Focus Area and a Study Area were established. The Focus Area is defined specifically as the neighborhood of Red Hook. The Study Area is much larger and encompasses the transit hubs of Downtown Brooklyn and adjacent neighborhoods.

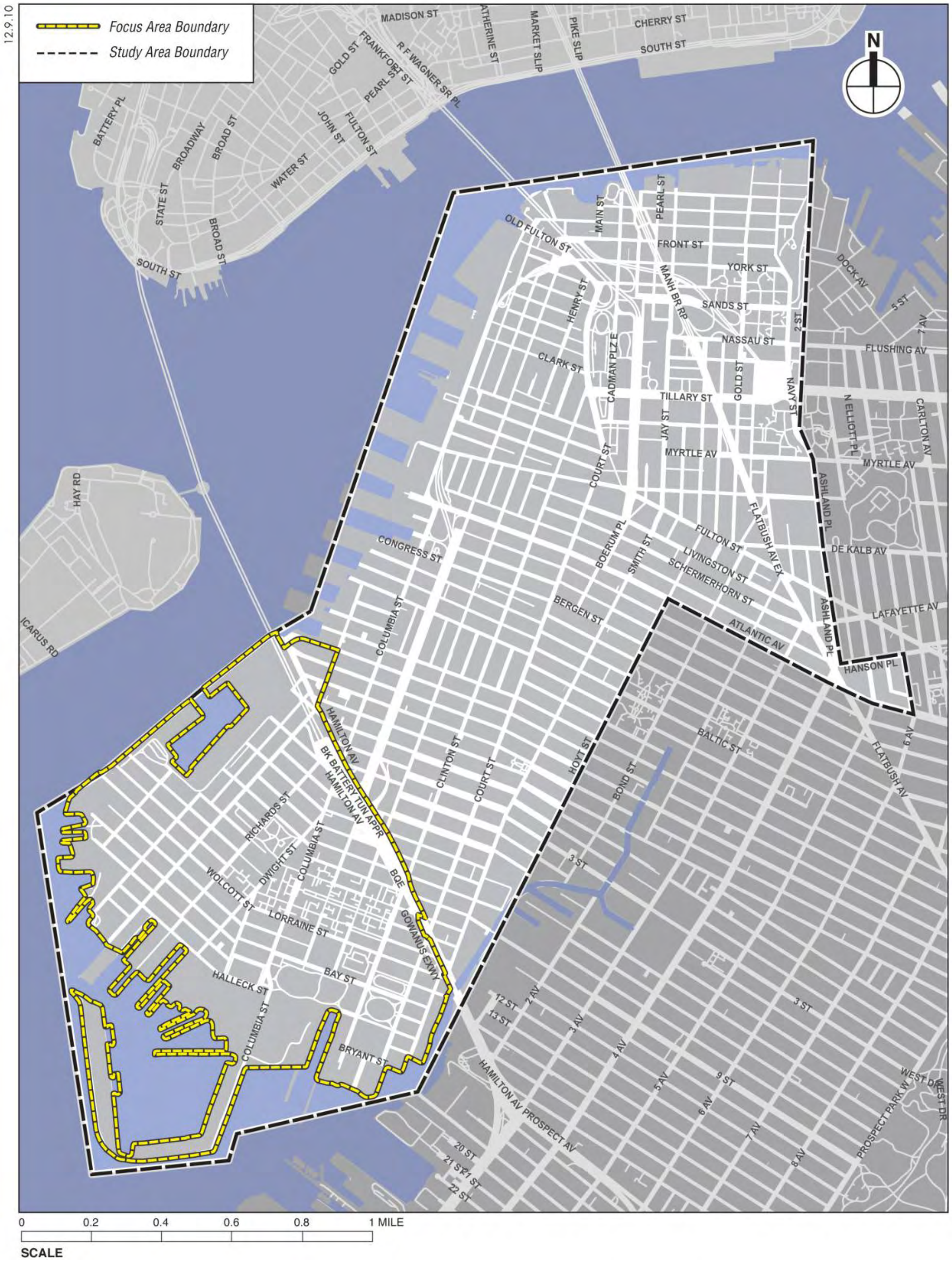
The Focus Area (Red Hook) is located in Community District 6 of the Borough of Brooklyn. It is bounded by the Buttermilk Channel to the west, Hamilton Avenue, the Brooklyn-Queens Expressway, and the Brooklyn-Battery Tunnel to the north, the Gowanus Canal to the east, and the Gowanus Bay to the south (see Figure 1-1). The Study Area borders the Focus Area to the north and includes the blocks between the Buttermilk Channel and East River waterfront to the west and north and Hoyt Street, Ashland Place and Navy Street to the east. The Study Area includes the neighborhoods of Carroll Gardens, Cobble Hill, Brooklyn Heights, Downtown Brooklyn, DUMBO, Vinegar Hill, Boerum Hill, and Gowanus.

1.3 *METHODOLOGY*

This report summarizes data from a number of sources, including geographic information system data, field surveys, the U.S. Census, and a literature review. The Downtown Brooklyn Surface Transit Circulation Study was also used to identify land use and demographics for a large portion of the Study Area.

Demographic, economic, and travel characteristics are presented both for the Focus Area and the Study Area. The Focus Area statistics are the composite of data for the U.S. Census block groups within Red Hook as defined by the boundary shown in Figure 1-1. Statistics for the Study Area are comprised of all of the Census block groups within the Study Area boundary shown in Figure 1-1, including the Focus Area. Therefore, the Focus Area statistics are a subset of the factors presented for the Study Area.

FIGURE 1-1:
STUDY AREA AND FOCUS AREA



2.0 LAND USE AND COMMUNITY CHARACTER

2.1 DEVELOPMENT HISTORY

The City of Brooklyn was established in 1834. At this time, it comprised individual settlements along its waterfront, including Downtown Brooklyn, Brooklyn Heights, Cobble Hill, Boerum Hill, and the Navy Yard area, including Vinegar Hill. The City of Brooklyn annexed other sections of the present-day borough at various points throughout the 1800s.

In 1893, the first electric streetcar ran in Brooklyn. The introduction of these streetcars and other rail modes would change the borough from a collection of small towns into the City's most populous borough. Originally comprised of ten independent operating companies, many lines were incorporated into the Brooklyn Rapid Transit Company (BRT). The BRT was one of the largest streetcar operators in the United States. In its peak, it had 80 lines and 3,000 streetcars. The BRT would eventually take over the elevated lines that had developed in the 1880's and the various steam railroads that ran to Coney Island. The BRT had the vision to implement fast and far reaching transit service in Brooklyn. The combined BRT rail and streetcar system allowed the public to easily travel between Manhattan and the far reaches of Brooklyn. As service was instituted in new areas, empty lots along the lines rapidly became homes and shopping areas. Consequently, the population of the borough grew.

STREETCAR AT SMITH AND SACKETT STREETS

STREETCAR CROSSING THE GOWANUS CANAL

James Greller

Several streetcar lines ran through Red Hook. The Furman Street, Erie Basin, and Crosstown Lines ran along Columbia Street. The Hamilton Avenue Line ran between Red Hook and Bay Ridge.

Prior to World War II, streetcars were prominent in the Brooklyn landscape. However, the automobile became increasingly more available and popular, and in the 1940's, the City began an aggressive initiative to replace streetcars with buses. Starting in 1949, Brooklyn's streetcar lines were converted to new buses with the Borough's last streetcar running in 1956. Remnants of the former system remain in parts of Brooklyn, including track and electrical poles.

FOCUS AREA

The Focus Area has a long history of industrial and maritime uses, taking advantage of its location on the Buttermilk Channel and its proximity to the population centers of Brooklyn and Manhattan. In the 1840's, the Atlantic Dock Company developed piers in the Atlantic Basin and soon thereafter, William Beard developed the wharves at the Erie Basin. The Red Hook Peninsula then quickly became one of the busiest shipping ports in the United States. By the beginning of the Civil War, ships from all over the world docked at Red Hook, and through the mid-20th century, the neighborhood bustled with shipping and related industries, employing over 7,000 people.

Originally built for the families of dockworkers, the Red Hook Houses opened in 1939 and was the first public housing complex in the City. Red Hook Houses is now the largest New York City Housing Authority (NYCHA) development in Brooklyn. It consists of Red Hook (East) and Red Hook (West). The combined 39-acre development includes 33 buildings, 30 residential buildings and three non-residential buildings. The residential buildings range in height from two to 14 stories and have a total of over 2,800 apartments. Since their completion, the Red Hook Houses have comprised the largest portion of Red Hook's residential population and occupy much of its interior blocks.

The development of Red Hook Houses occurred in concert with the construction of Red Hook Park. In 1934, the City assigned former industrial sites that it owned to the New York City Department of Parks and Recreation (DPR). Other parcels that are now part of Red Hook Park came under DPR's jurisdiction between 1935 and 1947. Gilmore D. Clarke, a prominent landscape designer, laid out its original development plan during the tenure of Robert Moses. Today, Red Hook Park occupies nearly 59 acres, and includes a recreation center, a pool, athletic facilities, a jogging path, and picnic areas.

Red Hook's population peaked in about 1950. However, changes in the shipping industry, the construction of Interstate 278 (also referred to as the Brooklyn-Queens Expressway and Gowonus Expressway in the Focus Area and Study Area) and Brooklyn-Battery Tunnel, and the removal of its streetcar service would quickly deteriorate and isolate the community, resulting in a drastic decline in its residential and employment populations.

After 1950, the shipping and manufacturing trades weakened substantially in Red Hook and New York City in general. Overland transport of goods increasingly replaced maritime shipping and cargo companies began to favor alternative ports along the East Coast. Red Hook's primary industry and population declined substantially as a result. However, in the 1960s, the Port Authority of New York and New Jersey opened a new container port—the Red Hook Marine Terminal—to provide a modern cargo facility that met new standards in marine commerce. Although helping to foster Red Hook's traditional economic base, the facility required much less labor than previous facilities.

BROOKLYN-BATTERY TUNNEL ENTRANCE

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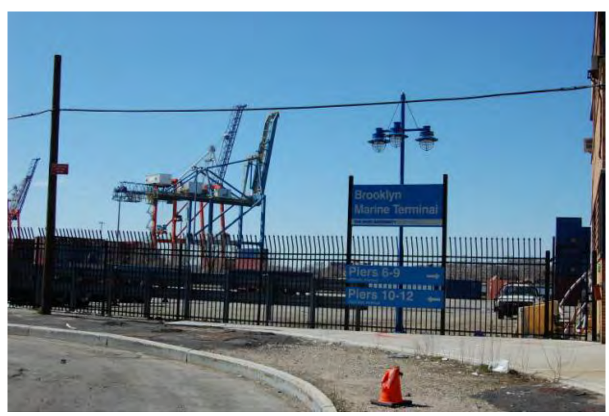


BROOKLYN MARINE TERMINAML

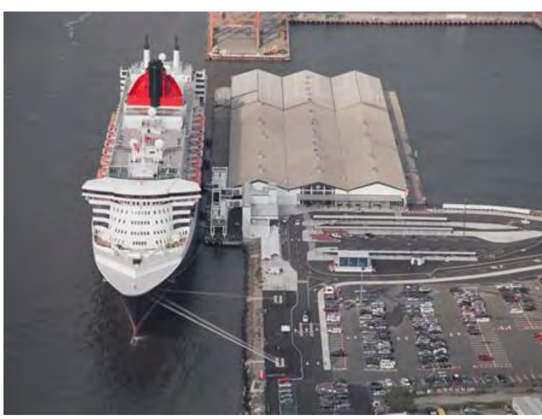
URS Corporation

Interstate 278 and Brooklyn Battery Tunnel were built in the Focus Area following World War II. Interstate 278 is a major east-west highway that runs from New Jersey to the Bronx via Staten Island, Brooklyn, and Queens. In the Focus Area, Interstate 278 runs along Red Hook's eastern and northern edges. Entrances to the Brooklyn Battery Tunnel, which runs under the East River and connects Brooklyn and Manhattan, are situated at Red Hook's northern edge. These transportation facilities quickly established *de-facto* neighborhood borders for Red Hook and effectively cut it off physically and socially from adjacent neighborhoods.

Red Hook's economic base and population continued to decline through the 1980s. Numerous residential, commercial, and industrial buildings were abandoned. By 1990, the population of Red Hook dropped to 10,500, a 50 percent decline from its 1950 population.

In 1994, Community Board 6 and local stakeholders developed a comprehensive strategic plan (197-a Plan) to spur the revitalization of Red Hook's population and economy with improvements to housing, social services, and business and industrial activities. In that same year, New York State Governor Mario Cuomo designated Red Hook and the nearby Sunset Park and Gowanus neighborhoods as the Southwest Brooklyn Economic Development Zone (now the Southwest Brooklyn Empire Zone). Combined, the 197-a Plan and the economic incentives provided by the State have resulted in substantial reinvestment in the area. Projects have included the refurbishment and new construction of neighborhood parks, the opening of the Red Hook Community Justice Center, and the renovation of the Sullivan Street Hotel as affordable housing.

The New York City Economic Development Corporation has pursued efforts to revitalize the Atlantic Basin. In April 2006, Carnival Cruise Lines inaugurated the Brooklyn Cruise Terminal with the arrival of the *RMS Queen Mary 2*. The terminal occupies Pier 12. It consists of an 180,000 square foot terminal that can handle 4,000 passengers. It includes a rebuilt port building, new slips, a 500-space parking lot, and taxi and bus drop-off areas. In 2008, the Terminal was called on by nearly 60 vessels and served more than 282,000 passengers.



BROOKLYN CRUISE TERMINAL
http://www.nycruise.com/terminalBKN.html

IKEA
http://www.nydailynews.com

In 2006, Fairway Market opened a 52,000 square foot store on Van Brunt Street. The chain had a long-established and popular location on Manhattan's Upper West Side, and its presence in Red Hook symbolized an upswing in the neighborhood's economic vitality. Two years later, IKEA opened a 346,000 square foot store on Beard Street between Otsengo and Columbia Streets. The store replaced a 19th Century dry dock and is IKEA's only location within New York City.

Recent and proposed loft conversions and new construction projects in Red Hook will help to revitalize its housing stock. Although the pace of this development has been less robust than in DUMBO, Williamsburg, and other historically, industrial areas of Brooklyn, these projects demonstrate a renewed interest in the area and its potential for growth.

STUDY AREA

The Brooklyn Bridge opened in 1883, bringing vehicular, trolley, and pedestrian traffic to Downtown Brooklyn and its surrounding neighborhoods. This triggered substantial growth in municipal, commercial, and residential land use in the downtown area and its surrounding commuter neighborhoods. In 1908, the Interborough Rapid Transit (IRT) subway line was extended from Manhattan to Brooklyn, with stations at Borough Hall, Hoyt Street, Nevins Street, and Atlantic Avenue. This accelerated development in the borough and generated a drive for larger and denser development in Downtown Brooklyn and surrounding areas. The rapid pace of development continued until the Great Depression.

Following World War II, the nation's industries began moving out of inner cities, with negative consequences for manufacturing centers like Brooklyn. Middle-class households also fled the inner cities, affecting most of the neighborhoods in the Study Area. As a result, many apartment buildings were abandoned, and many of the active industrial and commercial uses in the Study Area became low performance commercial uses (auto-repair shops, gas stations, parking lots) or vacant lots. Several policies were enacted by New York City agencies including the New York City Department of Housing Preservation and Development (HPD) and the New York City Planning Commission (CPC) to counteract the deterioration of Brooklyn's neighborhoods. These initiatives included the Atlantic Terminal Urban Renewal Area (ATURA) in 1968, the Schermerhorn-Pacific Urban Renewal Area (SPURA) in Boerum Hill in 1974, and the Brooklyn Center Urban Renewal Plan (BCURP). In the 1970's ATURA spurred the development of the Atlantic Terminal Houses, and the Atlantic Center Mall and SPURA sought to redevelop an area of Boerum Hill for affordable housing.

METROTECH CENTER
http://www.forestcity.net

The City's urban renewal efforts and a 1980s real estate boom fueled an economic revival for many communities in the Study Area, which continues today. The MetroTech Center was developed in 1986 as a result of the MetroTech Urban Renewal Plan (MURP). Currently, MetroTech is a sixteen-acre corporate and academic complex with more than five million square feet of commercial and municipal office space in twelve buildings ranging in height from eight to thirty-two stories. Other high-rise office buildings have followed, and Downtown Brooklyn is now a major employment center in the City. Brownstones in Cobble Hill, Vinegar Hill, and Carroll Gardens were refurbished and many new retailers, restaurants, and bars opened on the commercials strips of these neighborhoods. The many industrial loft buildings in DUMBO were redeveloped as luxury housing. To preserve the historic character of the Study Area amidst this flurry of development, the City designated many areas as landmark districts. Much of Brooklyn Heights was designated as a Historic District (New York City's first) in 1965, followed by sections of Cobble Hill (1969, expanded in 1988), Boerum Hill (1973), Carroll Gardens (1973), Vinegar Hill (1997), and DUMBO (2007).

New development continues to occur in the Study Area guided by new planning initiatives. Downtown Brooklyn has been the focus of City planning efforts including the establishment of the Special Downtown Brooklyn District (2001) and the Downtown Brooklyn Development project (2004). These initiatives seek to focus development in Downtown Brooklyn to strengthen business, preserve historic architectural resources, provide a buffer between large-scale business uses of the Downtown core and surrounding low- to medium-density residential neighborhoods, and to improve transit access through the area.

The area around Long Island Rail Road's (LIRR) Atlantic Terminal is also rapidly redeveloping. In 2004, the Atlantic Terminal/Bank of New York Tower, which includes retail and office uses, opened above the LIRR Atlantic Terminal on the northeast corner of Flatbush and Atlantic Avenues. The areas across Flatbush and Atlantic Avenue from the LIRR Terminal and above the LIRR Atlantic Yards are in the process of a major redevelopment, including a basketball arena, high-rise residential buildings, office and retail uses, a school, and open space.

Abandoned waterfront sites in the Study Area have also been the focus of recent public initiatives. The City and State are building Brooklyn Bridge Park, a multi-use recreational facility that will occupy piers and upland parcels between Atlantic Avenue and the Brooklyn Bridge. The Brooklyn Navy Yard and adjacent sites also continue to be developed with light industrial and commercial uses, including movie studies, workshops, and small, niche industrial production companies.

ATLANTIC YARDS REDEVELOPMENT PLAN

AKRF

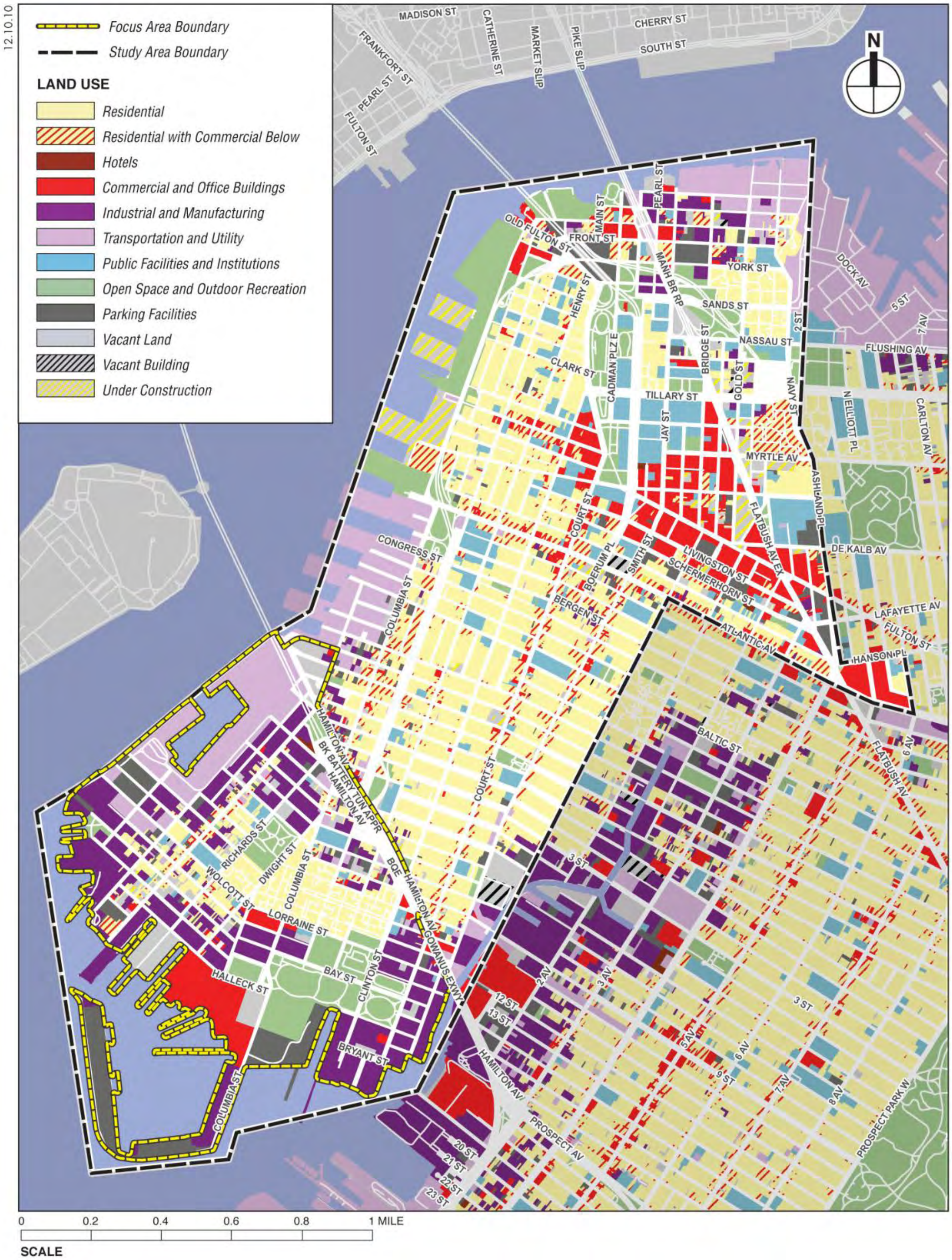
2.2 *LAND USE*

Figure 2-1 shows land uses in the Focus Area and Study Area.

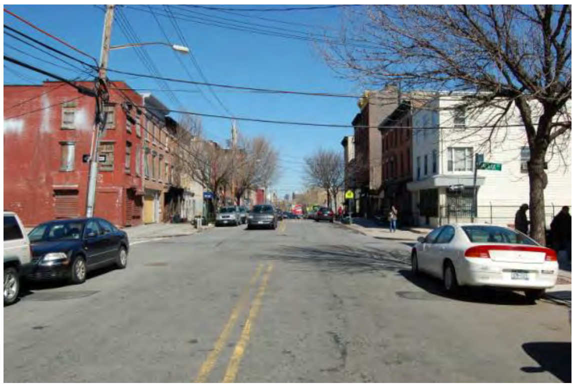
FOCUS AREA

The Focus Area is defined primarily by industrial and manufacturing uses along the waterfront and residential uses in its interior (see Figure 2-1). Its primary commercial corridor is Van Brunt Street.

FIGURE 2-1:
LAND USE



The most common residential building types in the focus are small-to-medium sized three-to-six story apartment buildings, particularly in the area bordered by Van Brunt Street to the west, Verona Street to the north, Richards Street to the east, and Coffey Street to the south. High-rise residential buildings, notably the Red Hook Houses, predominate east of Richards Street. The Red Hook Houses stretch from Richards Street to Clinton Street and 9th Street to Lorraine Street. Approximately 8,000 people live in the Red Hook Houses, comprising almost 80 percent of the Focus Area's population.



RESIDENTIAL STREET IN RED HOOK
URS Corporation

MIXED RESIDENTIAL AND INDUSTRIAL STREET IN RED HOOK
URS Corporation

RED HOOK HOUSES

DOITT

Commercial retail uses, catering to the local community, are found throughout the Focus Area. The largest concentration of such uses is along Van Brunt Street and are primarily housed on the ground floors of medium sized (three-to six-story) residential buildings. A handful of restaurants, bars, bakeries, check cashing stores, beauty salons, variety stores, small grocery stores, and delis can be found along the length of Van Brunt Street. Large retail uses in the Focus Area include IKEA at Richards and Beard Streets and the Fairway Supermarket at Van Brunt and Reed Streets.

The Focus Area has a number of institutional and public facilities. Educational facilities include P.S. 15, the South Brooklyn Community High School, and the Agnes Y. Humphrey School for Leadership. It is also served by FDNY Engine Company 202, Ladder Company 101, a branch of the Brooklyn Public Library at 7 Wolcott Street, and a U.S. Post Office at 615 Clinton Street. The Red Hook Community Justice Center, opened in 2000 and located at 88 Visitation Place, serves as a neighborhood court house. The Focus Area also has various social service and religious institutions such as the South Brooklyn Health Center, the Mercy Home for Children, and churches of various denominations.

The largest open space in the Focus Area is Red Hook Park. It is a 59-acre public park, bordered by Otsego, Bay, Hicks, Lorraine, Court, and Halleck Streets, and includes a pool, running track, and recreation center. Other parks include Coffey Park, between King, Verona, Richards, and Dwight Streets; and Louis Valentino, Jr. Park, on the waterfront at Coffey Street. The Red Hook Houses also provide open space, including play areas and other amenities.

STUDY AREA

The Study Area is historically characterized by industrial uses along its waterfront, commercial uses in Downtown Brooklyn and along neighborhood thoroughfares, and residential uses in most other locations. Interstate 278, which sweeps through the western and northern portions of the Study Area, has divided the industrial waterfront from the upland residential and commercial areas since the 1960's. However, recent redevelopment efforts have and will continue to transform the waterfront.

Just north of Red Hook is the Columbia Street Waterfront, located along the East River and Buttermilk Channel, west of Interstate 278 and south of Atlantic Avenue. This area contains a mix of residential and light industrial uses with working waterfront activities along its western edge. Vacant lots are scattered throughout this area, some of which are used for surface parking. The area is undergoing growth, with new restaurants, art galleries, and residential development. Columbia Street, the main thoroughfare in the neighborhood, contains local retail uses that are generally found on the ground floor of three- or four-story residential buildings. The side streets are lined with rowhouses, with some new apartment conversions such as those centered along Tiffany Place. The waterfront includes the Red Hook Marine Terminal and Van Voorhees Park. Long Island College Hospital occupies a complex of buildings around Hicks and Amity Streets.

East and north of the Columbia Street Waterfront, the Carroll Gardens, Cobble Hill, Boerum Hill, and Brooklyn Heights neighborhoods are characterized by medium density residential (three- to six-story) apartment buildings on local streets, with commercial activities concentrated along major corridors such as Smith Street, Court Street, and Montague Street. Along these corridors, commercial activities are primarily housed on the ground floors of medium sized residential apartment buildings, and comprise restaurants, delis, small grocery stores, and other businesses catering to the local community. In addition to the three- and four-story rowhouses, there are also modern mid-rise apartment buildings, including Clark Cadman Tower and Whitman Close

Townhouses, on the west side of Cadman Plaza West north of Tillary Street, and large NYCHA complexes adjacent to the industrial areas bordering the Gowanus Canal (Warren Street Houses, Gowanus Houses, and Wyckoff Gardens). A prominent destination in Brooklyn Heights is the Brooklyn Heights Promenade, a public open space at the western edge of the neighborhood situated on an elevated platform over Interstate 278. The promenade, which features a walkway, benches, and a small playground, extends from Orange Street south to Remsen Street. The piers and adjacent waterfront areas west of Interstate 278 and north of Atlantic Avenue are being redeveloped as Brooklyn Bridge Park.

RESIDENTIAL STREET IN COBBLE HILL
AKRF

RENDERING OF BROOKLYN BRIDGE PARK
http://www.brooklynbridgeparknyc.org

Atlantic Avenue is the main arterial dividing Cobble Hill and Boerum Hill and Brooklyn Heights and Downtown Brooklyn. It is a two-way, east-west thoroughfare with two travel lanes in each direction, relatively heavy traffic, and parking typically along both sides of the street. Atlantic Avenue is designated a truck route by DOT. Along Atlantic Avenue in the Cobble Hill and Brooklyn Heights sections, buildings are typically four- to eight-story residential apartment buildings with ground-level commercial uses, including restaurants, bars, antique stores, a supermarket, and smaller grocery stores. Further east, it supports higher density uses mixed with older mid-rise buildings and newer free-standing commercial structures. The Brooklyn House of Detention, at Atlantic Avenue and Boerum Place, is a 750-bed prison. It was closed since 2003, but is slated to reopen in 2011. The intersection of Atlantic Avenue, Fourth Avenue, and Flatbush Avenue brings together some of the highest volume arterials in Brooklyn. It is surrounded by big box retail uses including two malls, and is the northwest boundary of the Atlantic Yards redevelopment, which is currently underway.

Downtown Brooklyn is New York City’s third largest central business district (CBD) after Midtown and Downtown Manhattan, and it also serves as a government center. A large complex of City, State, and Federal institutions is located in buildings in and around Cadman Plaza, including the U.S. Federal Courthouse, Brooklyn Criminal Court, Brooklyn Family Court, the New York State Supreme Court, and the New York City Housing Court. The central post office for Brooklyn is also located on Cadman Plaza, between Johnson and Tillary Streets. MetroTech is a sixteen-acre corporate and academic complex with more than five million square feet of office space in twelve buildings ranging in height from eight to thirty-two stories. There are also several educational institutions in Downtown Brooklyn, including New York University’s Polytech campus, the New York City College of Technology, Long Island University’s Brooklyn campus, St. Francis College, Brooklyn Law School, and a number of public and private primary and secondary schools.

The largest retail area in Downtown Brooklyn is the Fulton Street Mall, which extends along Fulton Street between Adams Street and Flatbush Avenue. Fulton Street is restricted to bus and pedestrian traffic. This area contains mostly 3- to 5-story commercial structures with ground-floor retail uses. Typical ground-floor uses include clothing, department, and electronic stores as well as fast food chains. While the ground-floor uses on Fulton Street are very active, the upper floors of buildings have traditionally had little activity, though new uses are beginning to emerge.

Multiple new mid- and high-rise residential buildings have risen throughout Downtown Brooklyn, including along Schermerhorn Street, Livingston Street, and Flatbush Avenue. These developments have replaced surface parking lots and older, lower density buildings.

LIVINGSTON
NYCDOT

DOWNTOWN BROOKLYN SKYLINE
AKRF

STREET IN DUMBO
URS Corporation

Flatbush Avenue is a major two-way north-south arterial running the entire length of Brooklyn and leading to the Manhattan Bridge in the Study Area. It has heavy traffic volumes and is characterized by large-scale institutional and large national chain retail uses. Atlantic Terminal and the Atlantic Center Mall are located at Atlantic Avenue and Flatbush Avenue. Atlantic Terminal is a transportation hub with access to several New York City Transit subway lines and the LIRR.

The DUMBO neighborhood is characterized by large residential loft buildings converted from industrial uses, with ground-floor commercial. Vinegar Hill is a smaller-scale residential neighborhood with two- to three-story apartment buildings and a waterfront dominated by the Hudson Avenue Generating Station, a Consolidated Edison power plant along almost the entire Vinegar Hill waterfront, from Gold Street to Jay Street.

There are several small parks scattered throughout the Study Area, and a handful of larger open spaces including Cadman Plaza, bordered by Cadman Plaza East and West, Tillary Street, and the Brooklyn Bridge and Brooklyn Bridge Park, which is currently being developed.

2.3 *FUTURE DEVELOPMENT PLANS*

As shown in Table 2-1, a number of development projects were recently completed or are planned in and near the Focus Area and Study Area. Figure 2-2 shows the developments in the Focus Area.

FIGURE 2-2:
RECENTLY COMPLETED AND PLANNED DEVELOPMENT PROJECTS WITHIN AND NEAR THE FOCUS AREA

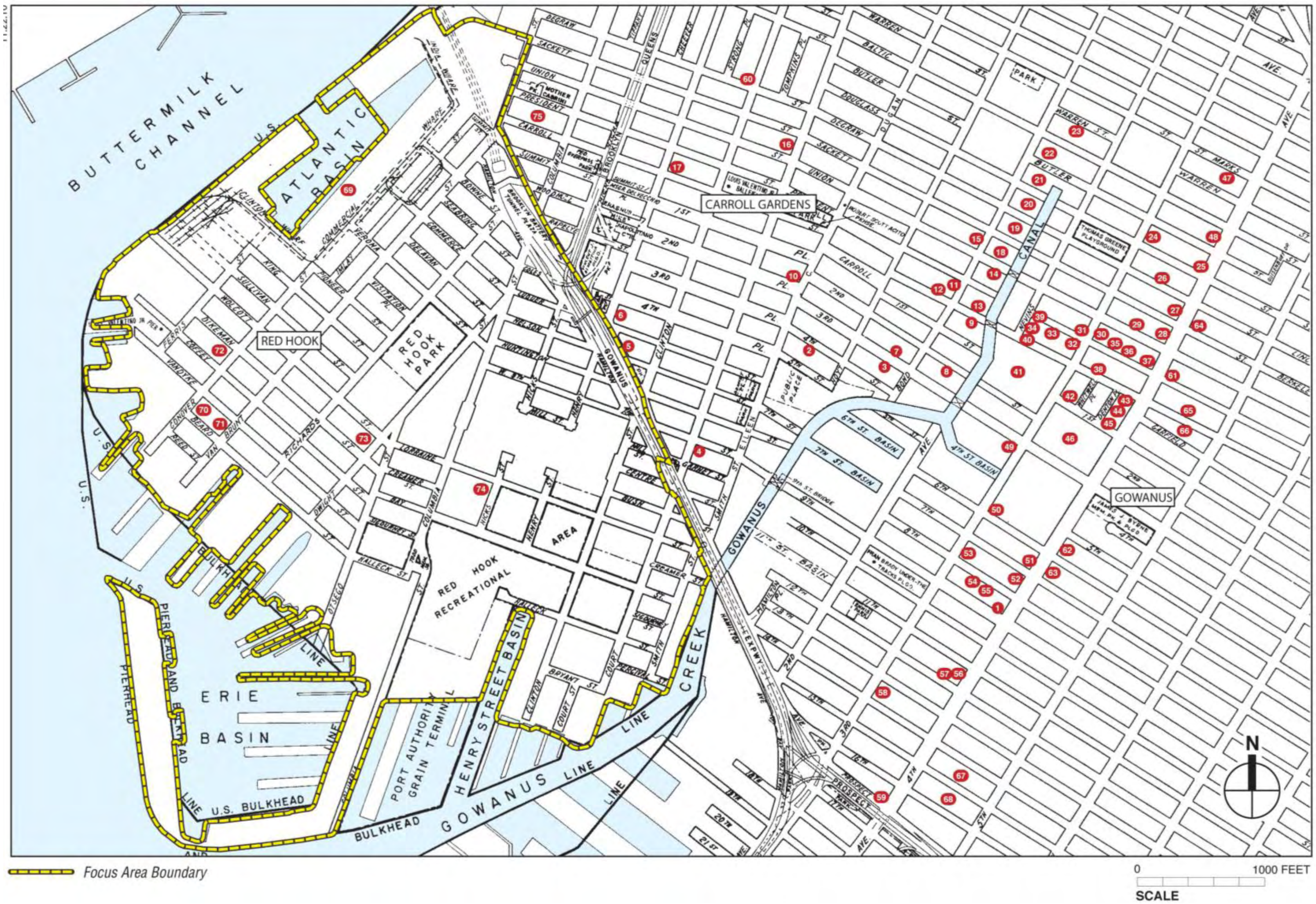


TABLE 2-1:
RECENTLY-COMPLETED AND PLANNED DEVELOPMENT PROJECTS WITHIN AND NEAR THE FOCUS AREA

MAP NO.	NAME/ADDRESS	USE	UNITS/ ROOMS/ FLOOR AREA
WITHIN FOCUS AREA			
69	160 Imlay Street	Residential, office, parking	153 units, 153 parking spaces, 9,000 sf office, 1 floor office conforming to existing zoning
70	162-166 Beard Street	Residential	4 dwelling units
71	440 Van Brunt Street	Residential, Office	9,149 sf mixed-use building with art studio on first floor, office on second floor, and one dwelling unit on third
72	216 Conover Street	Industrial	6,000 sf
73	141 Dwight Street	Synagogue	4,500 sf
74	96 Lorraine Street	Residential	11,000 sf building with 8 dwelling units
75	25-33 Carroll Street	Residential	Rezone M1-1 to R6B to Construct an 8-unit Residential Building
NEAR FOCUS AREA			
1	436 4th Avenue	Residential	Information unknown; construction activity observed no records available at DOB
2	26 4th Street	Residential	11 dwelling units
3	92 Third Street	Hotel/Office	33,000 sf
4	517 Court Street	Residential/Community Facility	6 dwelling units, ground-floor retail, and diagnostic & treatment facility
5	245 Hamilton Avenue	Residential	20 dwelling units
6	671 Henry Street	Residential	5 dwelling units
7	103-113 3rd Street	Residential	45 dwelling units
8	141 3rd Street	Residential, office	152 dwelling units (122 market rate, 30 affordable), 11,361 sf of office
9	363-365 Bond Street	Residential, retail, community facility, open space	447 dwelling units (317 market rate, 130 affordable), 2,000 sf of community facility, 2,000 sf of retail, and a portion of the total 0.6-acres of open space
10	360 Smith Street	Residential	46 dwelling units
11	340-346 Bond Street (at Carroll Street)	Residential	24 dwelling units
12	361 Carroll Street	Residential	15 dwelling units
13	313-325, 327-333 Bond Street; 383 Carroll Street	Residential, retail	297 dwelling units (238 market rate, 59 affordable), 14,810 sf of retail
14	307 Bond Street	Residential, retail	87 dwelling units (70 market rate, 17 affordable), 7,125 sf of retail
15	306 Bond Street	Residential	11 dwelling units
16	290 Sackett Street	Residential, retail, community facility	32 dwelling units
17	151 Carroll Street	Residential	8 dwelling units
18	287 Bond Street, 498-510 Sackett Street	Residential	148 dwelling units (118 market rate, 30 affordable)
19	285 Bond Street, 495 Sackett Street	Residential, retail	186 dwelling units (149 market, 37 affordable), 11,875 sf of retail
20	253-261 Bond Street	Residential	90 dwelling units (72 market, 18 affordable)
21	191 Douglass Street	Residential	10 dwelling units
22	213 Bond Street	Residential	21 dwelling units
23	462 Baltic Street	Office	35,551 sf

TABLE 2-1 (CONTINUED)
RECENTLY-COMPLETED AND PLANNED DEVELOPMENT PROJECTS WITHIN AND NEAR THE FOCUS AREA

MAP NO.	NAME/ADDRESS	USE	UNITS/ ROOMS/ FLOOR AREA
24	181 3rd Avenue	Hotel	65,785 sf
25	150 4th Avenue	Residential	95 dwelling units
26	611 DeGraw Street	Hotel	10,000 sf
27	184 4th Avenue	Residential, retail	30 dwelling units (24 market rate, 6 affordable), 4,786 sf of retail
28	204 4th Avenue	Residential, retail	134 dwelling units (107 market rate, 27 affordable), 2,920 sf of retail
29	643-651 Union Street	Residential, retail	54 dwelling units (43 market rate, 11 affordable), 5,582 sf of retail
30	265 3rd Avenue	Hotel	18,130 sf
31	577 Union Street, 586 Sackett Street	Residential, retail, community facility	139 dwelling units (111 market rate, 28 affordable), 13,485 sf of retail, 1,532 sf of community facility
32	503 President Street	Residential	5 dwelling units
33	532-542 Union Street, 495-499 President Street	Residential, retail	65 dwelling units (52 market rate, 13 affordable), 5,755 sf of retail
34	469 President Street, 305 Nevins Street, 514 Union Street	Residential	185 dwelling units (148 market, 37 affordable)
35	543 President Street	Residential	31 dwelling units
36	545 President Street	Residential	10 dwelling units
37	561 President Street	Residential	50 dwelling units (48 market, 2 affordable)
38	509 Carroll Street, 530 President Street	Residential	95 dwelling units
39	325-337 Nevins Street	Residential	34 dwelling units
40	341 Nevins Street, 431 Carroll Street	Residential	8 dwelling units
41	420-458 Carroll Street, 322 3rd Avenue	Residential, community facility	612 dwelling units (509 market rate, 103 affordable), 30,000 sf of community facility
42	305 3rd Avenue	Residential, office	31 dwelling units (25 market rate, 6 affordable), 8,592 sf of office
43	9 Denton Place, 272 4th Avenue, 538 Carroll Street	Residential, retail	86 dwelling units (71 market rate, 17 affordable), 2,896 sf of retail
44	284-290 4th Avenue, 21 Denton Place	Residential, retail	76 dwelling units (62 market rate, 14 affordable), 1,330 sf of retail
45	27 Denton Place	Residential, office	152 dwelling units (122 market rate, 30 affordable), 11,361 sf of office
46	Con Edison/ block bounded by 1st and 3rd Streets, 3rd and 4th Avenues	Office	49, 552 sq. ft.
47	567 Warren Street	Residential	20 dwelling units
48	126 Fourth Avenue	Residential	50 dwelling units
49	Whole Foods Market/220 Third Street (at 3rd Avenue)	Commercial retail (supermarket)	52,000 sq. ft.
50	399 3rd Avenue	Office	78,251 sf
51	410 4th Avenue	Residential	59 dwelling units

TABLE 2-1 (CONTINUED)
RECENTLY-COMPLETED AND PLANNED DEVELOPMENT PROJECTS WITHIN AND NEAR THE FOCUS AREA

MAP NO.	NAME/ADDRESS	USE	UNITS/ ROOMS/ FLOOR AREA
52	232 7th Street	Residential	7 dwelling units
53	433 3rd Avenue	Residential, commercial	26 dwelling units, 4,956 sf of retail
54	186 8th Street	Residential	8 dwelling units
55	202 8th Street	Residential	43 dwelling units
56	500 4th Avenue	Residential	132 dwelling units
57	187 13th Street	Residential	13 dwelling units
58	531 3rd Avenue	Hotel	24,771 sf
59	574 4th Avenue	Residential	80 dwelling units
60	56 Strong Place	Residential	3 dwelling units (Conversion)
61	225 4th Avenue	Residential, Retail	40 dwelling units, 3,131 sf of retail
62	267 6th Street	Residential, Retail, Community Facility	107 dwelling units, 3,938 sf of retail, 3,938 sf of community facility space
63	385 4th Avenue	Residential, Community Facility	51 dwelling units, 6,513 sf ambulatory care facility
64	675 Sackett Street	Residential	38 dwelling units
65	571 Carroll Street	Residential	18 dwelling units
66	580 Carroll Street	Residential	7 dwelling units
67	155 15th Street	Residential	31 dwelling units
68	182 15th Street	Residential	31 dwelling units

FOCUS AREA

Within the Focus Area, there are seven recently-completed or proposed projects. Three are small residential projects, generally resulting in three to five new units per building. One is a small industrial property, and another is a synagogue. The largest proposed development is at 160 Imlay Street. This project has been approved by the New York City Board of Standards and Appeals but is presently on-hold. Once completed, the project will convert a former industrial warehouse to 153 residential units and 10,000 square feet of office space.

STUDY AREA

A number of development projects are proposed in the areas north and east of the Focus Area. Major residential redevelopment is proposed along and surrounding the Gowanus Canal. These projects range in size. The largest new developments would be 363-365 Bond Street (427 units), 312-333 Bond Street (297 units), and 420-450 Carroll Street (612 units). Several other developments include more than 100 new dwelling units.

Very few commercial projects were identified in the Focus Area and surrounding neighborhoods. Most commercial development would be local retail. However, three office projects, the largest of which would be about 78,000 square feet, and five hotels are planned. The largest new retail project would be a Whole Foods located at 220 3rd Street.

In Downtown Brooklyn, DUMBO, and Vinegar Hill, there has been and continues to be extensive growth in residential units and office space. These include a mix of building conversions and new construction. Just outside the study area, the Atlantic Yards redevelopment is taking shape. This project will result in a new sports arena, office towers, more than 5,000 residential units, and retail and community facility space.

2.4 ZONING

Generally, Downtown Brooklyn is zoned high density as it is a commercial center and has ample transit access. The residential areas outside Downtown Brooklyn are generally medium density, except for new construction near Atlantic Avenue and public housing developments at other locations. These medium density districts are also well-served by transit. The Focus Area, however, is primarily zoned for manufacturing and lower density residential uses. Much of its zoning reflects the historic industrial character of the Focus Area. The combination of this zoning policy and lack of easy access to high capacity transit service has likely contributed to comparatively lower growth in Red Hook. Table 2-2 identifies the zoning districts in the Focus Area and the Study Area. The New York City zoning maps for the Focus Area and Study Area are provided in Appendix A.

FOCUS AREA

The Red Hook waterfront is generally zoned as manufacturing with M1-1, M2-1, and M3-1 districts. The northeast portion of Red Hook is also zoned manufacturing. M1-1 districts are manufacturing districts with high performance standards that typically serve as a buffer between lower-performance manufacturing districts and adjacent commercial or residential districts. Performance standards are minimum requirements or maximum allowable limits on noise, vibration, smoke, odor, and other effects of industrial uses. M1-1 districts typically include warehouses, woodworking shops, auto storage and repair shops, and wholesale service and storage facilities. M2-1 districts allow manufacturing uses that fall between light and heavy industrial areas. Performance standards for these districts are lower than those in M1 districts. M3-1 districts are intended for heavy industries that generate noise, traffic, or pollutants. Typical uses include power plants, solid waste transfer facilities, recycling plants, and fuel supply depots.

The interior blocks of the Focus Area are R5 and R6 zoning districts. R5 districts are medium density general residence districts typified by three- to four-story apartment buildings and rowhouses. R6 districts are also medium density general residence districts. Apartment houses in R6 districts can range from low-rise three-story buildings to mid-rise, eight- to 10-story buildings.

Commercial zoning districts in the Focus Area include a C1-1 overlay along Van Brunt Street, C1-3 districts along two blocks of Lorraine Street, and a C1-2 district on the south side of 9th Street. There are also small commercial zoning districts along portions of Hamilton Avenue. C1 districts are generally local retail districts in residential neighborhoods and are often overlaid on residential zones to allow ground-level retail. Typical uses in C1 districts include grocery stores, small dry cleaning establishments, restaurants, and barber shops.

TABLE 2-2:
FOCUS AREA AND STUDY AREA ZONING DISTRICTS

DISTRICT	MAXIMUM FLOOR AREA RATIO (FAR)	USES/ZONE TYPE
R5	1.25 RES; 2.0 CF	General residence district
R6	2.43 RES; 4.8 CF	General residence district
R6A	3.0 RES and CF	General residence district; contextual
R6B	2.0 RES and CF	General residence district; contextual
R7A	4.0 RES and CF	General residence district; contextual
R7-1	3.44 RES; 4.8 CF	General residence district
R8	6.02 RES; 6.5 CF	General residence district
R8A	6.02 RES; 6.5 CF	General residence district; contextual
R8B	4.0 RES; 4.0 CF	General residence district; contextual
R9-1	7.52 RES; 10.0 CF	General residence district
C1-1	2.0 COM ; 2.43 RES	Commercial overlay within a residential district
C2-1	2.0 COM ; 2.43 RES	Commercial overlay within a residential district
C2-4	2.0 COM ; 2.43 RES	Commercial overlay within a residential district
C4-3	3.4 COM; 2.43 RES; 4.8 CF	Regional commercial center outside the central business district
C5-2A	10.0 COM; 10.0 (12.0 w/ bonus) RES; 10.0 CF	Restricted Central Commercial District intended primarily for retail uses serving metropolitan region; high-density residential
C5-4	10.0 (12.0 w/ bonus) COM, RES, and CF	Central commercial district serving wider metropolitan region
C6-1	6.0 (7.2 w/ bonus) COM; 3.44 RES; 6.5 (7.8 w/ bonus) CF	High bulk commercial district
C6-1A	6.0 COM; 2.43 (2.2 on narrow streets) RES; 6.0 (7.2 w/ bonus) CF	High bulk commercial district
C6-2	6.0 (7.2 w/ bonus) COM; 6.02 (7.2 on wide streets) RES; 6.5 (7.8 w/ bonus) CF	High bulk commercial district
C6-2A	6.0 COM; 6.02 RES; 6.5 CF	High bulk commercial district
C6-4	10.0 (12.0 w/ bonus) COM; 10.0 (12.0 w/ bonus) RES; 10.0 (12.0 w/ bonus) CF	High bulk commercial district
C6-4.5	12.0 (14.4 w/ bonus) COM; 10.0 (12.0 w/ bonus) RES; 10.0 (12.0 w/ bonus) CF	High bulk commercial district
M1-1	1.0 MAN or COM; 2.4 CF	Light industrial district bordering residential or commercial district
M1-2	2.0 MAN or COM; 4.8 CF	Light industrial district bordering residential or commercial district
M1-4	2.0 MAN or COM; 6.5 CF	Light industrial district bordering residential or commercial district
M1-5	5.0 MAN or COM; 6.5 CF	Light industrial district bordering residential or commercial district
M1-6	10 MAN, COM or CF	Light industrial district bordering residential or commercial district
M2-1	2.0 MAN or COM	High performance medium scale industrial district
M3-1	2.0 MAN or COM	Low performance heavy manufacturing
MX-2	2.0 MAN or COM; 6.5 CF; 6.02 RES	Mixed use light industrial and medium density residential
MX-5	1.25 RES; 1.0 MAN or COM; 2.0 CF	Mixed use light industrial and medium density residential
DB	Varies	Downtown Brooklyn Special Zoning District
LH-1	Not Applicable	Limited Height overlay district
SV-1	Not Applicable	Brooklyn Heights Scenic View district

Notes: RES = Residential; COM = Commercial; MAN = Manufacturing; CF = Community Facility
Sources: NYC Zoning Resolution; Zoning Handbook, DCP January, 2006.

An MX-5 special use district (M1-1/R5) was mapped in 2002 in the area south of Coffey Street between Conover and Van Brunt Streets. Targeted for industrial areas, this district allows for the development of residential, commercial, community facilities, and light manufacturing/industrial by combining manufacturing zoning (M1) with residential zoning (R3-R10). Commercial, residential, and light manufacturing uses can occupy the same lot side by side or use the same building. Under conventional zoning, residential uses are not permitted in manufacturing districts and vice versa.

STUDY AREA

Zoning districts in the Study Area include: R6, R6A, R6B, R7A, R7-1, R8A, and R9-1 residential districts; C4-3, C5-2A, C5-4, C6-1, C6-1A, C6-2, C6-2A, C6-4, and C6-4.5 commercial districts; C1-1, C2-1, and C2-4 commercial overlay districts; M1-1, M1-2, M1-4, M1-5, M2-1, and M3-1 manufacturing districts; MX-2 mixed-use district; and LH-1 limited height overlay districts. In addition, portions of Downtown Brooklyn fall within the Special Downtown Brooklyn District (DB), and as noted below, a number of areas are designated historic districts.

The waterfront of Clinton Hill and Carroll Gardens is zoned manufacturing (M1-1) and residential (R6A, R6B, and R7A). Interior blocks have medium density residential zoning (R6, R6A, and R6B). Commercial overlay districts (C1-1, C1-4, C2-1, and C2-4) line Columbia, Smith, and Court Streets as well as Atlantic Avenue. There are also a small number of M3-1 zones along Smith Street near the boundary between Carroll Gardens and Red Hook.

Along its waterfront, Brooklyn Heights is zoned M2-1. Its waterfront is designated the SV-1 Brooklyn Heights Scenic View District, which regulates development in a view plane from Brooklyn Heights to the waterfront. The interior of Brooklyn Heights west of Court Street is primarily zoned residential R6 and R7. A C1-3 commercial overlay district lines several blocks of Montague Street and a C1-5 overlay is provided along Henry Street near the Clark Street Subway Station.

DUMBO and Vinegar Hill contain a mix of residential and manufacturing zoning districts, including multiple mixed-use designations. Generally, the manufacturing designations are along the East River waterfront and in the area between the Brooklyn and Manhattan Bridges. Other areas are generally residential districts (R6 and R7). There are also commercial zones and commercial overlay zones peppered throughout these neighborhoods.

Most of Downtown Brooklyn is mapped with medium and high-density commercial districts. The area is also designated as the Special Downtown Brooklyn (DB) District. Developments within this district are required to conform to special height and setback regulations, ground floor retail requirements, and zones of transition between commercial and residential areas.

2.5 PUBLIC POLICY

There are a number of public policy initiatives that apply to the Focus Area and/or the Study Area. Some policies, such as PlaNYC, are citywide initiatives while others are more localized undertakings. The following sections describe some of the policies that are specific to the focus area and general citywide initiatives that apply to both the Focus Area and the Study Area.

RED HOOK 197-A PLAN

In 1996, the New York City Council approved a 197-a Plan for Red Hook, Brooklyn. *Red Hook: A Plan for Community Regeneration* is a community-based plan that serves as a framework for the area's future development. The 197-a Plan proposed to: improve the existing residential community and promote affordable residential development; promote economic development, including opportunities for residents; preserve and expand industrial and maritime activity; improve services to residents, including education and healthcare; improve transportation access and internal circulation for businesses and residents; improve public waterfront access; promote Red Hook's cultural and historic resources; and rezone areas to promote development and maintain context.

While many plan initiatives would improve the ability to live and work in Red Hook and were widely supported, there were conflicting views on the introduction of new housing to the area. In particular, the business community objected to a wide-scale, mixed-use rezoning of the Red Hook and the introduction of residential uses at certain locations.

The 197-a Plan recommended a change from industrial to mixed-use zoning for many interior blocks of the Focus Area. While such zoning would allow for the continued operation of industrial uses, it would also provide for the as-of-right development of housing. The business community felt that the introduction of housing in these areas would not be appropriate and could impede their operations. The City Planning Commission agreed and narrowed the scope of the proposed mixed use zoning to a smaller number of blocks.

The 197-a Plan reflected a commitment to increase the area's population by providing for new affordable housing. The plan recommended the residential rezoning of industrial sites and the conversion of underused buildings. Although the 197-a Plan acknowledged the retention of Red Hook's maritime uses as one of its primary goals, the rezoning of industrial sites or publicly-sponsored reoccupation of industrial buildings was considered by the business community to undermine the long-time operation of industries in the area.

Some initiatives of the 197-a Plan have been realized such as the opening of Red Hook's first full-service bank branch in 1997, the refurbishment and new construction of neighborhood parks, the opening of the Red Hook Community Justice Center, and the renovation of the Sullivan Street Hotel as an affordable housing project. In 2006, the Fairway Market opened at 480-500 Van Brunt Street in a former industrial building that was identified for new mixed-use development in the 197-a Plan.

SOUTHWEST BROOKLYN ECONOMIC DEVELOPMENT ZONE AND NYC INDUSTRIAL BUSINESS ZONE

In 1994, New York State Governor Mario Cuomo designated Red Hook and the nearby Sunset Park and Gowanus neighborhoods as the Southwest Brooklyn Economic Development Zone (now the Southwest Brooklyn Empire Zone). This initiative was launched to provide tax credit incentives to spur business expansion and the creation of jobs. It is funded by the State and administered by the Southwest Brooklyn Industrial Development Corporation, a group of business owners, community leaders, and elected officials formed in 1978 to bolster the local economy.

Most of the waterfront in the Focus Area also falls within the Southwest Brooklyn Industrial Business Zone (IBZ), which also includes the waterfronts of the adjacent neighborhoods of Gowanus and Sunset Park. An IBZ is defined as a manufacturing area that reflects the commitment by the City to not implement zoning changes or variances that would allow a change from manufacturing use to residential use. The City is also committed to providing technical and financial assistance to industrial businesses within IBZs and making tax credits available to firms that relocate to IBZs.

Following implementation of the IBZ, a number of vacant waterfront sites were reoccupied. The Brooklyn Cruise Terminal and a large beverage distributor (Phoenix Beverage) are maritime and industrial uses that recently began operations within the Empire Zone and the IBZ.

LOCAL WATERFRONT REVITALIZATION PROGRAM

All of the Focus Area as well as DUMBO, Vinegar Hill, the Brooklyn Heights, Cobble Hill, and Carroll Gardens waterfront, and areas along the Gowanus Canal are within the City and State's designated coastal zone. New York City and State have adopted policies aimed at protecting resources in the coastal zone. The City's Waterfront Revitalization Program (WRP) contains 10 major policies focused on improving public access to the waterfront; reducing damage from flooding and other water-related disasters; protecting water quality, sensitive habitats (such as wetlands), and the aquatic ecosystem; reusing abandoned waterfront structures; and promoting development with appropriate land uses. The principles of the WRP formed the basis for a New York City Department of City Planning study and the resulting adoption of new waterfront zoning. The New York City Planning Commission certifies whether a proposed action is in compliance with the city's WRP. The New York State Department of State has this responsibility on the state level.

The Red Hook waterfront is designated a Significant Maritime and Industrial Area. These working waterfront areas have location advantages that make portions of the coastal zone especially valuable as industrial areas. Public investment within the Significant Maritime and Industrial Area is intended to improve transportation access and maritime and industrial operations. The designation of Red Hook as a Significant Maritime and Industrial Area reflects the City's commitment to maintain its maritime history and discourage the replacement of water-dependent industry with high-rise housing, office space, and other such uses.

BROOKLYN WATERFRONT GREENWAY MASTER PLAN

DOT is developing a master plan to focus the implementation of the Brooklyn Waterfront Greenway, a 14-mile, waterfront bicycle and pedestrian path, stretching from Sunset Park to Greenpoint. The goal of the project is to open underutilized stretches of the Brooklyn waterfront to recreation, and to provide a safe and attractive space for walking and cycling. Portions of the waterfront greenway have opened in the Study Area: between Old Fulton Street and Atlantic Avenue within the newly-constructed Brooklyn Bridge Park, and along Columbia Street from Atlantic Avenue to DeGraw Street, just outside of the Focus Area. DOT is currently evaluating options for the Greenway's alignment through the Focus Area.

TRANSIT-ORIENTED DEVELOPMENT

Transit-oriented development (TOD) is characterized by a high-density mix of residential and commercial uses anchored by a transit center (typically a rail station or terminal) designed to increase mass transit use and provide places for people to live, work, relax, and shop. In TOD communities, concentrated development is generally located within ¼ to ½ miles-walking distance-of a transit station, with the density of development decreasing outwards from the transit center. The New York City Zoning Resolution reflects the City's policy of encouraging high density development in areas with significant mass transit access, with the goal of promoting the opportunity for people to work in the vicinity of their residences. Within the Study Area, the 2009 DUMBO rezoning furthers the City's TOD goal.

NEW YORK CITY BICYCLE MASTER PLAN

The New York City Bicycle Master Plan was produced in the first phase of the Bicycle Network Development Project (BND), a joint Department of City Planning, Department of Parks and Recreation, and Department of Transportation project. The BND goals are to implement and maintain the city's on- and off-street bicycle network, to improve cycling safety, to improve bicycle access on bridges and mass transit, and to encourage cycling in public and private organizations. The Bicycle Master Plan identifies portions of Clinton, Henry, Bergen, and Dean Streets in the Study Area as "priority routes" for improving and expanding the city's on-street network of cycling amenities.

PLANYC

In 2007, the Mayor's Office of Long Term Planning and Sustainability released PlaNYC: A Greener, Greater New York. PlaNYC represents a comprehensive and integrated approach to planning for New York City's future. It includes policies to address three key challenges that the City faces over the next 20 years: (1) population growth; (2) aging infrastructure; and (3) global climate change. Elements of the plan are organized into six categories—land, water, transportation, energy, air quality, and climate change—with corresponding goals and initiatives. Some of the general PlaNYC policy initiatives have been or are in the process of being implemented throughout the city, including both the Focus Area and the Study Area. PlaNYC developments specific to the study area include: a new public plaza opened in DUMBO in 2007; and the implementation or enhancement of bicycle lanes in Cobble Hill, Boerum Hill, Downtown Brooklyn, and along the Columbia Street waterfront. No specific PlaNYC initiatives were identified for the Focus Area in the Mayor's Office of Strategic Planning 2010 PlaNYC progress report.

Local Law 17 of 2008 established the New York City Office of Long-Term Planning and Sustainability, and the requirement for this office to develop and implement a comprehensive long-term sustainability plan. Local Law 17 of 2008 requires the sustainability plan to be updated by April 2011 and every four years thereafter. PlaNYC is the City's long-term sustainability plan until such time as it is updated by the Office of Long-Term Planning and Sustainability.

2.6 HISTORIC RESOURCES

The Study Area contains a number of historic districts (see Table 2-3) and landmarked buildings and structures (see Table 2-4 and Figures 2-4 and 2-5).

TABLE 2-3:
HISTORIC DISTRICTS

NAME	NHL	LPC	S/NR	S/NR-ELIGIBLE	NYCL-ELIGIBLE
Admirals Row Historic District				X	
Boerum Hill Historic District		X	X		
Brooklyn Heights Historic District	X	X	X		
Brooklyn Navy Yard Historic District				X	
Carroll Gardens Historic District		X	X		
Carroll Gardens Historic District Extension				X	X
Cobble Hill Historic District and Extension		X	X		
DUMBO Historic District		X	X		
Fulton Ferry Historic District		X	X		

TABLE 2-3: HISTORIC DISTRICTS

NAME	NHL	LPC	S/NR	S/NR-ELIGIBLE	NYCL-ELIGIBLE
Gowanus Canal Historic District				X	
Vinegar Hill Historic District		X			

Notes: **NHL = National Historic Landmark; LPC = New York City Landmark or Historic District; S/NR = State and National Register of Historic Places; NYCL = New York City Landmark**

TABLE 2-4: HISTORIC BUILDINGS AND STRUCTURES

MAP NO.	NAME	ADDRESS	NHL	LPC	S/NR	S/NR-ELIGIBLE	NYCL-ELIGIBLE
FOCUS AREA							
58	Pier 41	Van Dyke Street and Ferris Street				X	
59	Red Hook Stores	480-500 Van Brundt Street				X	
60	Beard Stores	421-573 Van Brundt Street				X	
61		99-113 Van Dyke Street				X	X
62	Brooklyn Clay Retort and Fire Brick Works Storehouse	76-86 Van Dyke Street		X		X	
63		106-110 Beard Street				X	X
64	Erie Basin Bulkhead	Surrounding Richards Street south of Beard Street				X	
65	Former Revere Sugar Refinery	Richards Street south of Beard Street				X	
66	Graving Dock No. 1	Erie Basin southwest of Beard Street (Ikea site)				X	
67	Gantry Crane	Erie Basin southwest of Beard Street (Ikea site)				X	
68	Port Authority Grain Terminal	Henry Street Basin, south of Halleck Street				X	
69	Red Hook Play Center and Pool	155 Bay Street		X		X	
70	IND 9th and 10th Street Subway Viaduct	Along 9th and 10th Streets between Smith Street and Fifth Avenue				X	
STUDY AREA							
1	Brooklyn Bridge		X	X	X		
2	Manhattan Bridge				X		
3	Brooklyn City Railroad Company	8 Cadman Plaza West		X	X		
4	Thomson Meter Company Building	100-110 Bridge Street		X	X		
5	Commandant's House, Brooklyn Navy Yard	Evans Street at Little Street		X			
6	Plymouth Church of the Pilgrims	75 Hicks Street	X		X		
7	Brooklyn Historical Society	128 Pierrepont Street			X		
8	St. Ann and the Holy Trinity Church	157 Montague Street	X		X		
9	Brooklyn Trust Company Building	177-179 Montague Street		X	X		

TABLE 2-4:
HISTORIC BUILDINGS AND STRUCTURES

MAP NO.	NAME	ADDRESS	NHL	LPC	S/NR	S/NR-ELIGIBLE	NYCL-ELIGIBLE
10	United States Post Office and Court House, Brooklyn Central Office	271-301 Cadman Plaza East		X	X		
11	Former Public School 5	122 Tillary Street				X	
12	Joseph J. Jacobs Building, Polytechnic University	305-315 Jay Street				X	
13	First Free Congregational Church	311 Bridge Street		X		X	
14	Lefferts-Laidlaw House	136 Clinton Street			X		
15	IRT Borough Hall Subway Station	Junction of Joralemon, Court, and Adams Streets		X	X		
16	Brooklyn City Hall (aka Brooklyn Borough Hall)	209 Joralemon Street		X	X		
17		345 Adams Street				X	X
18	Brooklyn Friends School	375 Pearl Street				X	
19	Brooklyn Fire Headquarters	365-367 Jay Street		X	X		
20	New York and New Jersey Telephone and Telegraph Building	81 Willoughby Street		X		X	
21	Duffield Street Houses	182-188 Duffield Street		X			
22	Long Island Headquarters of the New York Telephone Company	97-105 Willoughby Street		X		X	
23	St. Boniface Church	111 Willoughby Street				X	
24		423 Fulton Street				X	
25	Atlantic Avenue Tunnel	Atlantic Avenue between Boerum Place and Columbia Street			X		
26	Former Board of Education Headquarters	110 Livingston Street				X	X
27	Gage & Tollner Restaurant	372 Fulton Street		X	X		
28		376 Fulton Street				X	X
29	Board of Education Building	131 Livingston Street				X	X
30	Former America Fore Building	141 Livingston Street				X	X
31		386-388 Fulton Street					X
32	Former Abraham & Strauss Buildings	418-430 Fulton Street and 15-29 Gallatin Place				X	X
33		495 Fulton Street				X	
34		233 Duffield Street				X	X
35	Offerman Building	503-513 Fulton Street		X		X	
36		446 Fulton Street				X	
37	A.I. Namm & Son Department Store	450-458 Fulton Street		X			
38	Dime Savings Bank	9 DeKalb Avenue		X			
39	Friends Meeting House and School	110 Schermerhorn Street		X	X		
40	Brooklyn Central Courthouse	120 Schermerhorn Street				X	X
41	State Street Houses	291-299, 290-324 State Street		X	X		

TABLE 2-4:
HISTORIC BUILDINGS AND STRUCTURES

MAP NO.	NAME	ADDRESS	NHL	LPC	S/NR	S/NR-ELIGIBLE	NYCL-ELIGIBLE
42	Former Loesser's Department Store	25 Elm Place				X	
43		565-571 Fulton Street					X
44		308-310 Livingston Street				X	X
45	Pioneer Warehouses	37-53 and 74-92 Rockwell Place				X	X
46	Baptist Temple	360 Schermerhorn Street			X		
47	Former Public School 15	372 Schermerhorn Street				X	
48		522-550 State Street				X	
49	IRT/BMT Atlantic Avenue Subway Station	Intersection of Atlantic, Flatbush, and 4th Avenues			X		
50	Atlantic Avenue Control House	Intersection of Atlantic and Flatbush Avenues			X		
51	Wyckoff Street Rowblocks	74-132 and 196-258 Wyckoff Street				X	X
52	Cobble Hill High School	347 Baltic Street				X	
53	Brooklyn Public Library, Carroll Gardens Branch	396 Clinton Street				X	
54	Brooklyn Union Gas Company Building	180 Union Street		X			
55	John Rankin House	440 Clinton Street		X	X		
56	St. Paul's Protestant Episcopal Church	199 Carroll Street			X		
57	South Congregational Church Complex	358-366 Court Street, 253-269 President Street		X	X		

Notes: **NHL = National Historic Landmark; LPC = New York City Landmark or Historic District; S/NR = State and National Register of Historic Places; NYCL = New York City Landmark**

Large sections of the Study Area are designated historic districts, including much of Brooklyn Heights, DUMBO, Vinegar Hill, and Carroll Gardens. The Brooklyn Heights Historic District, the Brooklyn Bridge, Plymouth Church of the Pilgrims, and St. Ann and the Holy Trinity Church are National Historic Landmarks, which receive the highest level of protection under Federal preservation laws.

Several individual buildings are listed or eligible for listing on the State and National Register of Historic Places or are designated or eligible for designation as New York City Landmarks. In the Focus Area, there is a cluster of such structures along the waterfront between Van Brunt and Dwight Streets. In the Study Area, there are several historic structures in Downtown Brooklyn, particularly along Jay Street and Fulton Street.

FIGURE 2-3:
HISTORIC DISTRICTS, BUILDINGS AND STRUCTURES (NORTHERN HALF OF STUDY AREA)

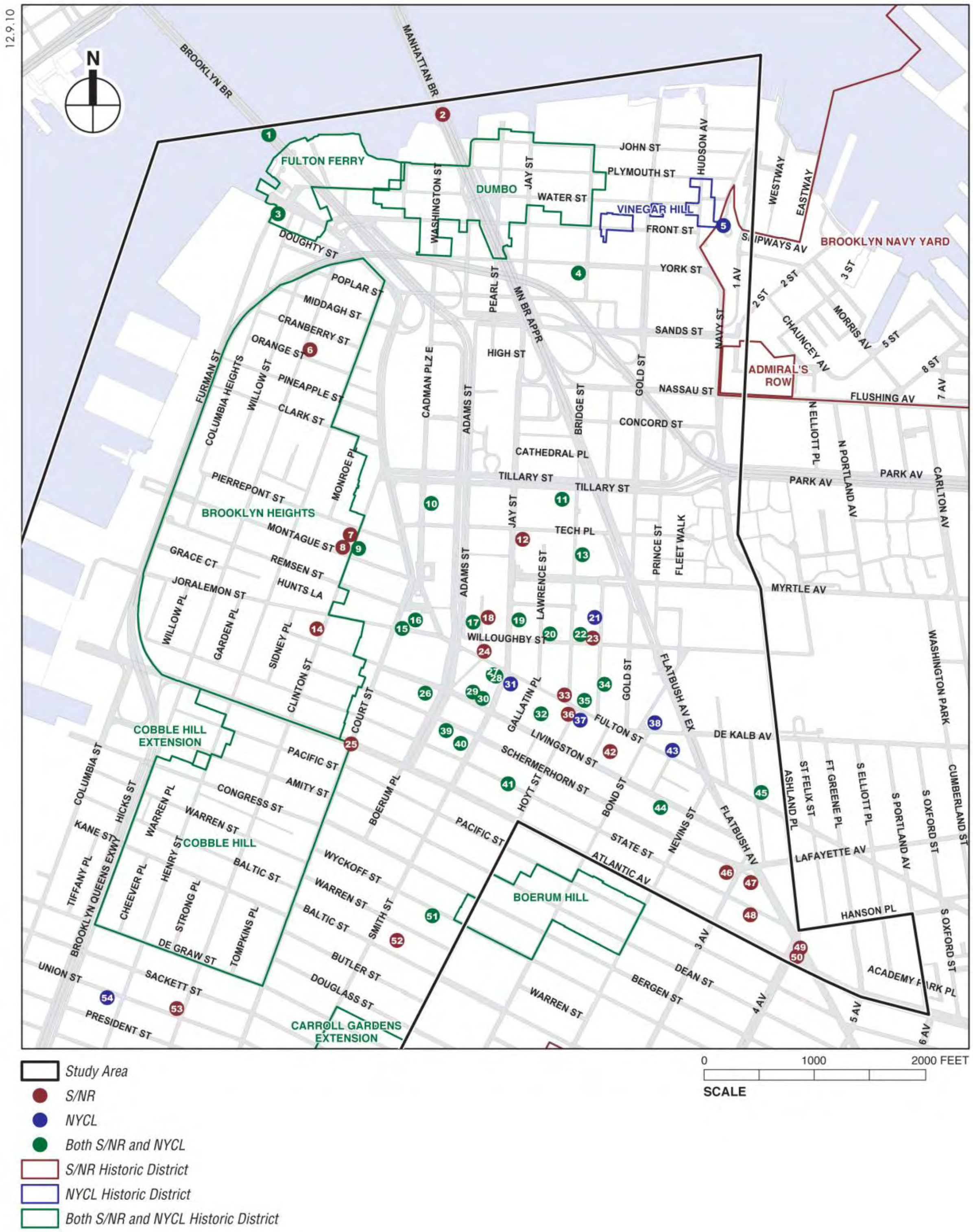
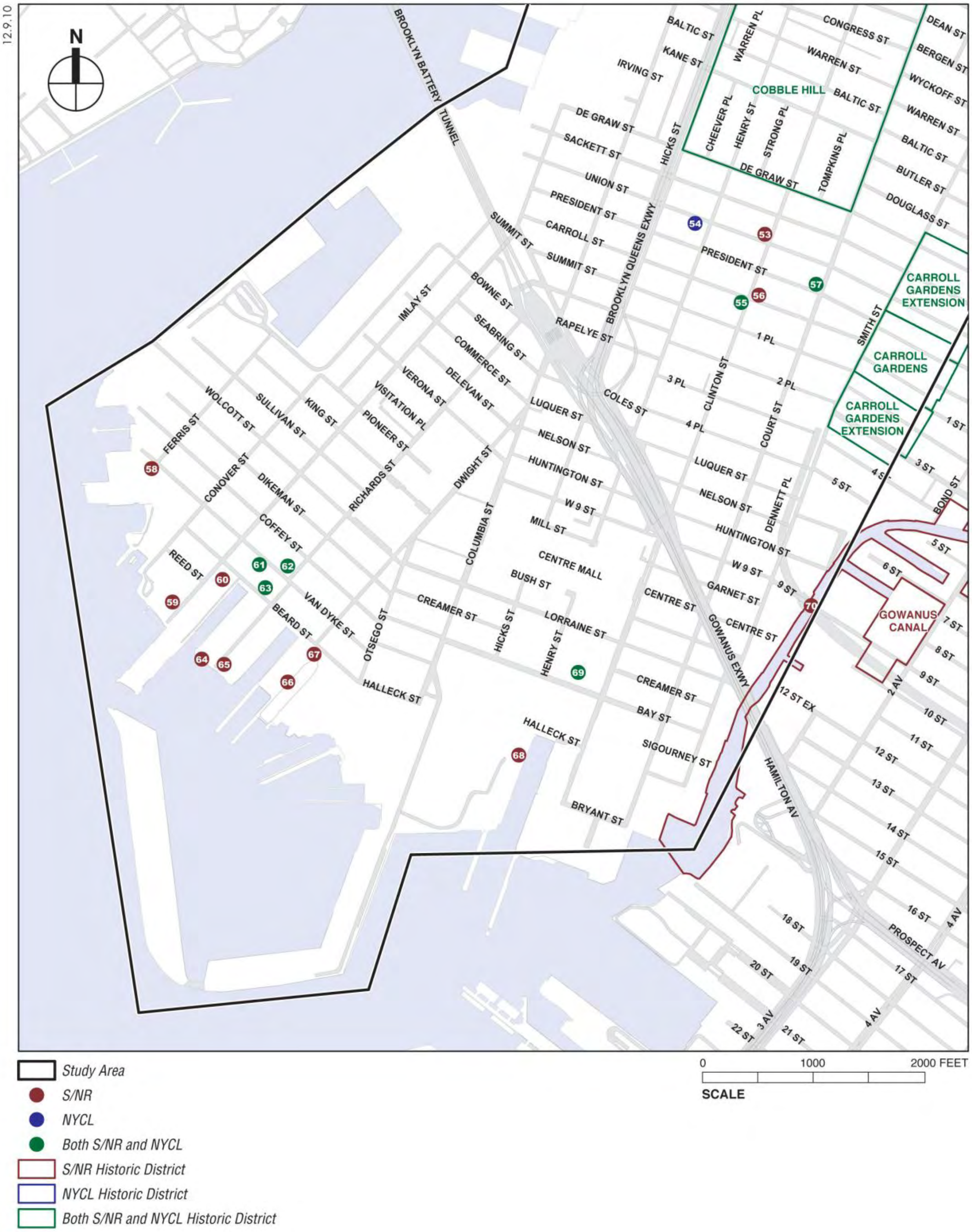


FIGURE 2-4:
HISTORIC DISTRICTS, BUILDINGS, AND STRUCTURES (SOUTHERN HALF OF STUDY AREA / FOCUS AREA)



2.7 CONCLUSION

The Focus Area and Study Area developed rapidly between the mid 1800's and the Great Depression. In the early portion of the period, development was fueled by maritime activities and industrial uses. As transportation, particularly subway and streetcar service, improved access to, from, and within these areas, there was rapid residential and commercial development. Downtown Brooklyn became a hub of municipal and retail uses in the borough, and many of its surrounding neighborhoods became the bedroom communities of its workers.

Following World War II, economic decline in the City's industrial sector devastated the employment bases of Red Hook and other waterfront districts of Brooklyn. At the same time, many middle-class residents fled inner city neighborhoods, resulting in the deterioration and abandonment of the housing stock and subsequent decline in support services.

In the 1980's, portions of the Study Area began to turnaround. A real estate boom resulted in the construction of new high-rise buildings in Downtown Brooklyn, and its surrounding neighborhoods were reoccupied by residents. Through the 1990's this trend extended to DUMBO, where former warehouse and industrial buildings were converted to residential use, and in the first part of this decade new investment has extended to other waterfront areas.

In the Focus Area, the pace of new investment has been less robust than elsewhere in the study area, but the recent development of the Atlantic Basin and large-scale retail uses indicate a renewed interest in the area. These large projects have been complemented by smaller residential conversions and a growing artist community. However, Red Hook remains isolated from surrounding areas and suffers from poor access to the borough's transit infrastructure.

3.0 SOCIAL AND ECONOMIC CHARACTERISTICS

3.1 DEMOGRAPHICS

This section describes the demographic profile of the combined Focus Area and Study Area.[1] When appropriate, local statistics are compared to Brooklyn as a whole.

POPULATION

In 1990, the U.S. Bureau of the Census estimated that 10,846 residents lived in Red Hook. By 2000, the population decreased by approximately six percent to 10,215 residents. The Focus Area population has increased since 2000, and today is estimated at 10,695 people. In comparison, the overall Study Area's population has steadily increased in the past 20 years. In 1990, approximately 79,973 residents lived within the area. By 2000, the population increased by approximately eight percent to 86,602 residents. The Study Area population has continued to increase and today is estimated at 93,457 people (see Table 3-1).

TABLE 3-1:
RESIDENTIAL POPULATION (1990-2010)

LOCATION	TOTAL POPULATION			PERCENT CHANGE	
	1990	2000	2010	1990-2000	2000-2010
Focus Area	10,846	10,215	10,695	-5.8%	4.7%
Study Area	79,973	86,602	93,457	8.3%	7.9%

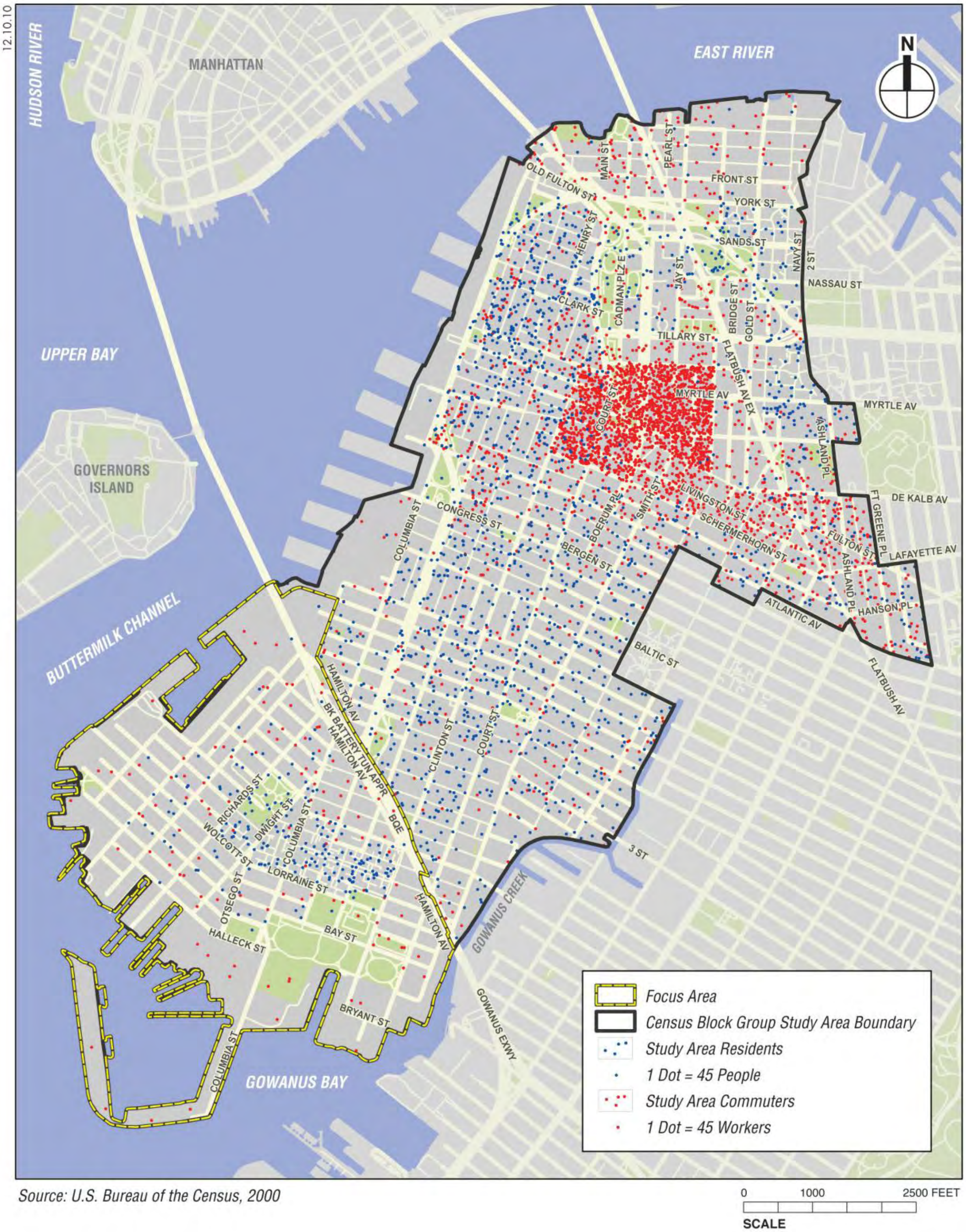
Sources: 1990 and 2000 data from U.S. Bureau of the Census; 2010 estimates from ESRI.

DENSITY

Figure 3-1 shows the geographic distribution of the Focus Area and Study Area residential population density and employment density (discussed in detail later), based on 2000 data from the U.S. Bureau of the Census. As shown, residents are more closely concentrated on interior blocks with fewer people along the waterfront. However, recently-completed development and proposed development in DUMBO, Vinegar Hill, and the Columbia Street Waterfront will increase the population density of those waterfront neighborhoods.

[1] This census profile is based on the 10 block groups that correspond most closely to Red Hook's boundaries, and the 95 block groups that correspond most closely to the Study Area's boundaries. The Study Area is comprised of the following Brooklyn (Kings County) block groups: Census Tract 1, Block Groups 1, 2 and 3; Census Tract 3.01, Block Groups 1, 2, 3, 4 and 5; Census Tract 3.02, Block Group 1; Census Tract 5, Block Groups 1, 2, 3, 4 and 5; Census Tract 7, Block Groups 1, 2 and 3; Census Tract 9, Block Groups 1 and 2; Census Tract 11, Block Group 1; Census Tract 13, Block Groups 1 and 2; Census Tract 21, Block Groups 1, 2, 3 and 4; Census Tract 23, Block Group 1; Census Tract 25, Block Groups 1 and 2; Census Tract 27, Block Groups 1 and 2; Census Tract 31, Block Groups 2 and 3; Census Tract 33, Block Group 2; Census Tract 35, Block Groups 1 and 2; Census Tract 37, Block Groups 1 and 2; Census Tract 39, Block Groups 1 and 2; Census Tract 41, Block Groups 1 and 4; Census Tract 43, Block Groups 1, 2, 3 and 4; Census Tract 45, Block Groups 2, 3 and 4; Census Tract 47, Block Groups 1 and 2; Census Tract 49, Block Groups 1, 2 and 3; Census Tract 51, Block Groups 1, 2 and 3; Census Tract 55, Block Groups 1 and 2; Census Tract 57, Block Groups 1, 2, 3, and 4; Census Tract 59, Block Groups 1, 2 and 3; Census Tract 63, Block Groups 1 and 2; Census Tract 65, Block Groups 1, 2, 3, 4, 5, 6 and 7; Census Tract 67, Block Groups 1, 2, 3, 4 and 5; Census Tract 69, Block Groups 1, 2, 3 and 4; Census Tract 75, Block Groups 2, 3, 4, and 5; Census Tract 77, Block Groups 1, 2, 3 and 4; and Census Tract 85, Block Group 1. Red Hook is comprised of the following block groups: Census Tract 55, Block Groups 1 and 2; Census Tract 57, Block Groups 1, 2, 3, and 4; Census Tract 59, Block Groups 1, 2 and 3; and Census Tract 85, Block Group 1.

FIGURE 3-1:
POPULATION AND EMPLOYMENT DENSITY



Source: U.S. Bureau of the Census, 2000

The Focus Area is approximately 0.87 square miles. Its population density is estimated at 12,323.56 persons per square mile. The overall Study Area is approximately 2.93 square miles. In comparison to the Focus Area, the Study Area is more dense and is estimated at 31,880.37 persons per square mile (see Table 3-2).

TABLE 3-2:
POPULATION DENSITY

LOCATION	PERSONS PER SQUARE MILE			PERCENT CHANGE	
	1990	2000	2010	1990-2000	2000-2010
Focus Area	12,497.55	11,770.47	12,323.56	-5.8%	4.7%
Study Area	27,280.67	29,541.97	31,880.37	8.3%	7.9%
Sources: 1990 and 2000 data from U.S. Bureau of the Census; 2010 estimates from ESRI.					

AGE

As shown in Table 3-3, the majority of residents in the Focus Area are working age (20 to 64 years old), and approximately 30 percent are school aged (5 to 19 years old). About nine percent are under five years old and about nine percent are over 65 years old. In the Study Area, the percentage of working aged persons is much higher (nearly 71 percent) than in the Focus Area. The percentage of senior citizens is also higher (nearly 12 percent), but the percentage of children is lower (5.5 percent under five years and 12.2 percent school-aged).

TABLE 3-3:
AGE DISTRIBUTION

AGE COHORT	FOCUS AREA			STUDY AREA		
	1990	2000	2010	1990	2000	2010
Under 5 Years	10.4%	8.5%	9.1%	5.7%	5.4%	5.5%
5 Years to 19 Years (School Aged)	28.4%	29.7%	25.1%	14.2%	13.7%	12.2%
20 Years to 64 Years (Working Aged)	53.1%	53.4%	57.0%	68.8%	70.3%	70.7%
Over 65 Years	8.1%	8.4%	8.8%	11.3%	10.6%	11.6%
Median Age	26.5	28.1	28.5	32.0	34.8	36.3
Sources: U.S Census, ESRI						

ETHNICITY

As shown in Figure 3-2, Red Hook is a racially diverse community. The Latino population is the largest ethnic group within the Focus Area, representing approximately 47 percent of the population. African Americans represent 42 percent of the Focus Area's population. Whites represent eight percent of the Focus Area population, and Asians represent one percent. About two percent of the population identified themselves as two or more races.

In the Study Area, the largest percentage of the population is White (53 percent). African American and Latino each represent 19 percent of the population. About five percent of the population identified themselves as Asian; three percent identified themselves as two or more races, and 0.5 percent identified themselves as some other race (see Figure 3-3).

FIGURE 3-2:
RACIAL COMPOSITION OF THE FOCUS AREA

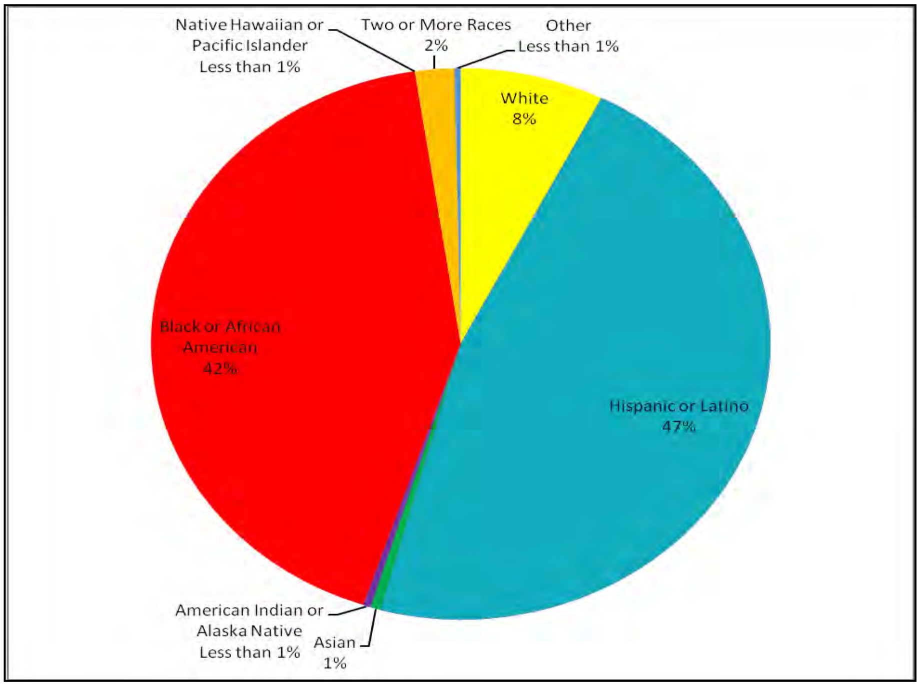
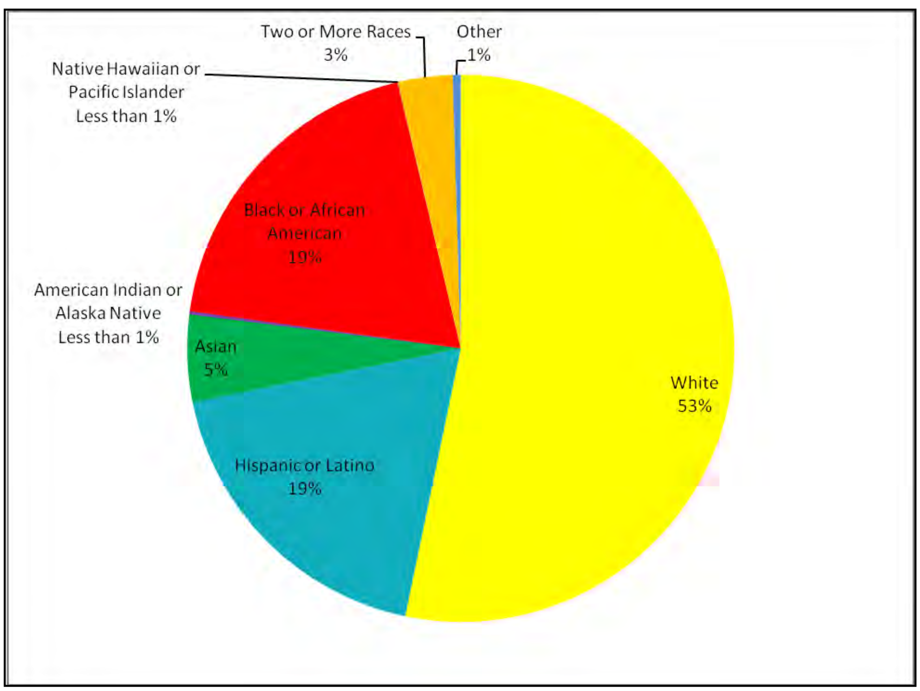


FIGURE 3-3:
RACIAL COMPOSITION OF THE STUDY AREA



EDUCATIONAL ATTAINMENT

Figure 3-4 shows the highest level of educational attainment for Focus Area residents based on 2000 Census data. Over half of the Focus Area's adult populations have completed a high school education. Approximately 10 percent of residents have completed an undergraduate degree program, and nearly three percent have completed a master's or professional degree program. About 49 percent of adult residents have not completed a high school education.

In the Study Area, approximately 82 percent of the area's adult residents have a high school diploma (see Figure 3-5). About 29 percent have completed an undergraduate degree program, and 26 percent have a master's or professional degree. Approximately 18 percent of adult residents the have not completed a high school education.

FIGURE 3-4:
LEVEL OF EDUCATION IN THE FOCUS AREA

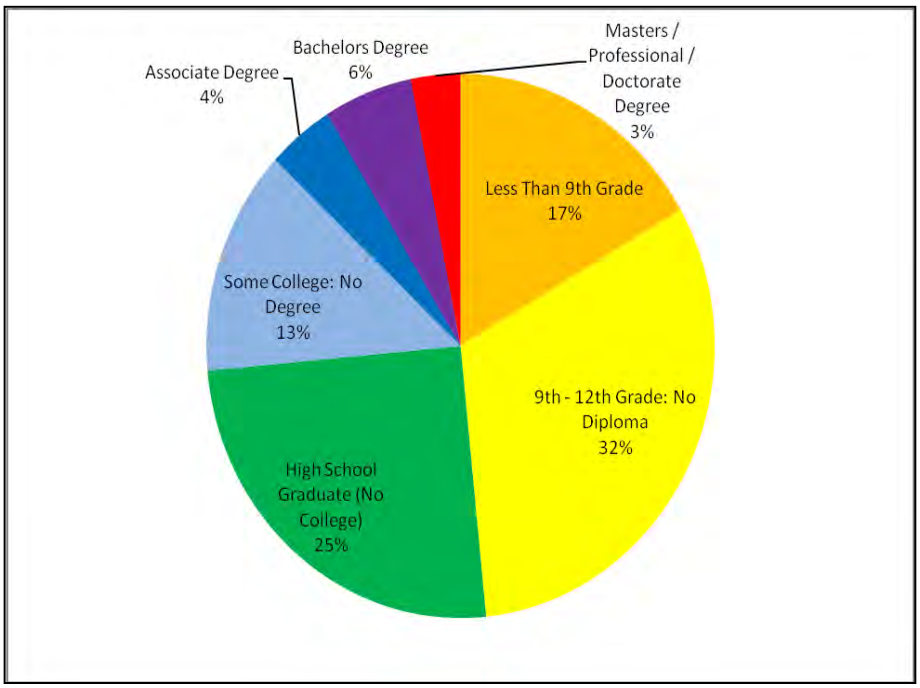
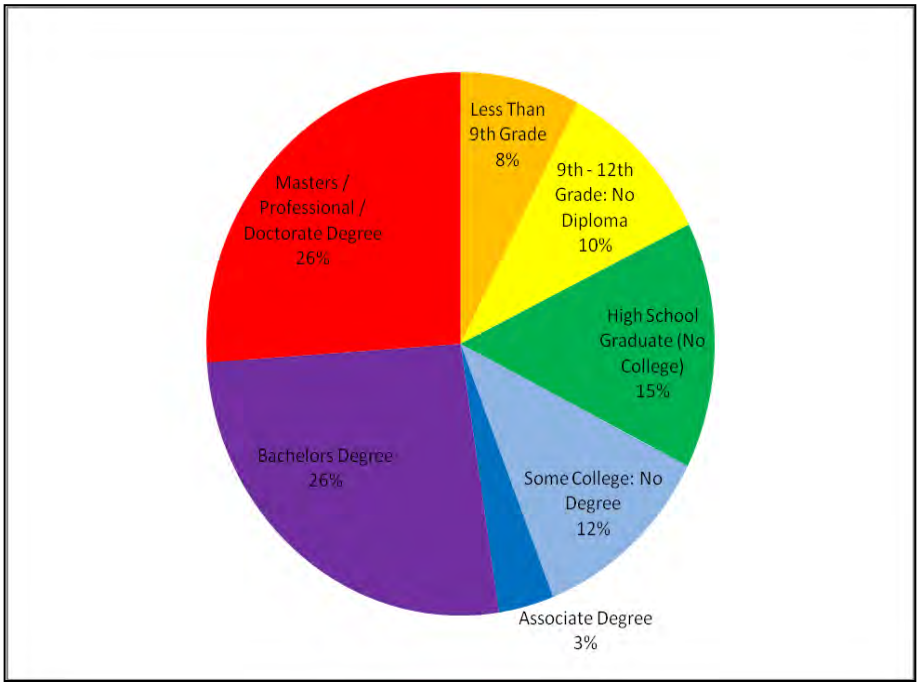


FIGURE 3-5:
LEVEL OF EDUCATION IN THE STUDY AREA



INCOME

According to Census forecasts, the 2010 median household income for the Focus Area is $19,417. As shown in Table 3-4, a substantial number of households (approximately 47.8 percent) earn less than $15,000 per year. Only 10.2 percent of the households earn more than $50,000 per year. By contrast, in the Study Area, approximately 27 percent of households earn less than $25,000 per year, and the majority (52 percent) earns more than $50,000 per year.

TABLE 3-4:
INCOME DISTRIBUTION

ANNUAL INCOME	PERCENT OF FOCUS AREA HOUSEHOLDS	PERCENT OF STUDY AREA HOUSEHOLDS
Less than $15,000	47.8%	18.0%
$15,000 to $24,999	19.6%	8.6%
$25,000 to $34,999	9.0%	8.7%
$35,000 to $49,999	13.4%	13.6%
$50,000 to $74,999	6.2%	17.5%
$75,000 to $99,999	2.2%	9.7%
$100,000 to $149,999	0.9%	11.4%
$150,000 to $199,999	0.3%	5.0%
$200,000 and above	0.6%	7.4%
Source: **2000 Census**		

The median household income for the Focus Area increased slightly between 1989 and 1999, and has continued to increase in recent years. As shown in Table 3-5, the median household income increased by two percent between 1989 and 1999 and increased by 22 percent from 1999 to 2010. The median household income has also increased for the Study Area (by 34 percent between 1989 and 1999 and by 28 percent between 1999 and 2010).

TABLE 3-5:
MEDIAN HOUSEHOLD INCOME

LOCATION	1989	1999	2010	PERCENT CHANGE 1989-1999	PERCENT CHANGE 1999-2010
Focus Area	$15,571	$15,928	$19,417	2%	22%
Study Area	$38,203	$51,164	$65,631	34%	28%

Sources: 2000 U.S. Census; ESRI. All values in 2010 dollars, based on US Bureau of Labor Statistics, Consumer Price Index (CPI)

3.2 HOUSING

As shown in Table 3-6, the Focus Area experienced a net gain of 134 dwelling units between 1990 and 2000, an increase of approximately three percent. This is a much lower increase than the 8 percent gain for the Study Area as a whole. Between 2000 and 2010, the Focus Area had a net gain of 279 dwelling units (6.7 percent). Again, this is lower than the Study Area's increase of 11.2 percent. In addition, the vacancy rate for residential units in the Focus Area is one percent greater than that for the Study Area (see Table 3-6). Overall, however, the Focus Area has seen a greater increase in housing units and has a lower vacancy rate than the borough of Brooklyn.

TABLE 3-6:
HOUSING UNITS AND RESIDENTIAL VACANCY RATES

LOCATION	HOUSING UNITS					VACANCY RATE		
	NUMBER			PERCENT CHANGE				
	1990	2000	2010	1990-2000	2000-2010	1990	2000	2010
Focus Area	4,019	4,153	4,432	3.3%	6.7%	4.7%	6.3%	7.7%
Study Area	37,906	40,813	45,398	7.7%	11.2%	7.8%	4.3%	6.5%
Brooklyn	873,671	930,866	977,590	6.5%	5.0%	5.2%	5.4%	7.9%

Sources: 1990 and 2000 data from U.S. Census; Existing estimates from ESRI, Inc.; 1990 and 2000 data from U.S. Census; Existing estimates from ESRI, Inc and the American Community Survey.

Housing in the Focus Area is predominately renter-occupied (see Table 3-7). In 2000, approximately 93 percent of the housing units were renter-occupied and seven percent were owner-occupied. This rate of renter occupancy is much higher than for the Study Area (68 percent renter-occupied and 32 percent owner-occupied) and for Brooklyn as a whole (69 percent renter-occupied and 31 percent owner-occupied).

TABLE 3-7:
DISTRIBUTION OF RENTER AND OWNER OCCUPIED HOUSING UNITS

LOCATION	OWNER-OCCUPIED UNITS	RENTER-OCCUPIED UNITS
Focus Area	7.2%	92.8%
Study Area	32.3%	67.7%
Brooklyn	31.0%	69.0%
Source: 2000 Census.		

3.3 EMPLOYMENT

Table 3-8 shows employment by category for the Focus Area and Study Area. Residents of the Focus Area are primarily employed in Educational, Health and Social Services (19.3 percent); Professional, Scientific, Management, Administrative, and Waste Management services (13.4 percent); Finance, Insurance, Real Estate, Rental and Leasing (12.4 percent); and Transportation, Warehousing, and Utilities (12.4 percent). Residents of the Study Area are primarily employed in Professional, Scientific, Management, Administrative and Waste Management services (19.8 percent); Educational, Health and Social Services (19.6 percent); Finance, Insurance, Real Estate, Rental and Leasing (13.3 percent); and the Information industry (11.5 percent).

TABLE 3-8:
DISTRIBUTION OF EMPLOYMENT BY CATEGORY

CATEGORY	FOCUS AREA	STUDY AREA
Agriculture/Forestry/Fishing/Hunting/Mining	0.0%	0.1%
Construction	3.3%	2.3%
Manufacturing	8.2%	3.8%
Wholesale Trade	1.3%	2.0%
Retail Trade	8.0%	6.1%
Transportation/Warehousing/Utilities	12.4%	3.1%
Information	6.4%	11.5%
Finance/Insurance/Real Estate/Rental/Leasing	12.4%	13.3%
Professional/Scientific/Mgmt/Admin/Waste Mgmt Services	13.4%	19.8%
Educational/Health/Social Services	19.3%	19.6%
Arts/Entertainment/Recreation/Accommodation/Food Services	6.1%	8.5%
Public Administration	3.3%	4.4%
Other Services	6.0%	5.4%
Source: 2000 Census		

The Focus Area is approximately 0.87 square miles. Its employment density in 2000 was approximately 6,274.13 employees per square mile. The overall Study Area is approximately 2.93 square miles. In comparison to the Focus Area, the Study Area is significantly denser in employment. In 2000, there were approximately 49,071.97 employees per square mile within the Study Area (see Table 3-9 and Figure 3-1).

**Table 3-9:
Employment Density**

Location	Employees per Square Mile 2000
Focus Area	6,274.13
Study Area	49,071.97

Sources: 2000 data from U.S. Bureau of the Census

3.4 Environmental Justice Communities

The environmental justice analysis includes the 10 census block groups in the Focus Area. The ethnic and income characteristics of these block groups were compared to the Study Area, the borough of Brooklyn, and New York City. The ethnic and income characteristics of these areas are shown in Table 3-10.

The U.S. Council on Environmental Quality (CEQ) and the U.S. Department of Transportation (USDOT) provide guidance to determine the presence or absence of environmental justice communities in areas where federal actions are being studied. The guidance defines minority and low-income communities (collectively, environmental justice communities) as follows.

- Minority communities: USDOT Order 5610.2 defines minorities to include American Indians or Alaskan Natives, Asian and Pacific Islanders, African Americans, and Hispanic persons. This environmental justice analysis also considers minority populations to include persons who identified themselves as being either “some other race” or “two or more races” in the Census 2000. Following CEQ guidance, minority populations were identified where either: 1) the minority population of the affected area exceeds 50 percent; or 2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis. For this analysis, the Borough of Brooklyn was used as the project’s primary statistical reference area. Minorities represent 65 percent of the Borough’s population. As this exceeds the CEQ’s minimum threshold, the lower 50 percent number was used to define environmental justice communities in the Focus Area.
- Low-income communities: USDOT Order 6640.23 defines low-income as "a household income at or below the Department of Health and Human Services (HHS) poverty guidelines." The percent of individuals below poverty level in each census block group, also available in Census 2000, was used to identify low-income communities. To determine whether a block group is a low-income community, the percentage of its population below the poverty level was compared to the average for Brooklyn, as a whole. Block groups in the Focus Area that have a population below the poverty level of greater than 25.1 percent, the Brooklyn average, were considered low-income communities.

As shown in Table 3-10 and Figure 3-6, 9 of the 10 block groups in the Focus Area are defined as minority communities based on the CEQ and USDOT guidance described above, and 5 of 10 block groups are considered low-income communities.

TABLE 3-10:
ENVIRONMENTAL JUSTICE CHARACTERISTICS OF THE FOCUS AREA

CENSUS TRACT (CT)/ BLOCK GROUP (BG)	POPULATION PROFILE BY RACE AND ETHNICITY*												INDIVIDUALS BELOW POVERTY LEVEL**
	TOTAL	WHITE	%	BLACK	%	ASIAN	%	OTHER	%	HISPANIC	%	TOTAL MINORITY	
CT 55 BG 1	181	85	47.0%	4	2.2%	2	1.1%	14	7.7%	76	42.0%	53.0%	4.4%
CT 55 BG 2	26	16	61.5%	5	19.2%	0	0.0%	1	3.8%	4	15.4%	38.5%	0.0%
CT 57 BG 1	472	134	28.4%	66	14.0%	7	1.5%	13	2.8%	252	53.4%	71.6%	7.1%
CT 57 BG 2	537	102	19.0%	29	5.4%	8	1.5%	51	9.5%	347	64.6%	81.0%	38.7%
CT 57 BG 3	530	87	16.4%	65	12.3%	0	0.0%	35	6.6%	343	64.7%	83.6%	22.0%
CT 57 BG 4	92	43	46.7%	14	15.2%	1	1.1%	0	0.0%	34	37.0%	53.3%	25.7%
CT 59 BG 1	42	11	26.2%	4	9.5%	0	0.0%	1	2.4%	26	61.9%	73.8%	72.2%
CT 59 BG 2	471	62	13.2%	76	16.1%	4	0.8%	25	5.3%	304	64.5%	86.8%	41.1%
CT 59 BG 3	586	133	22.7%	101	17.2%	9	1.5%	47	8.0%	296	50.5%	77.3%	31.8%
CT 85 BG 1	7278	95	1.3%	3979	54.7%	24	0.3%	96	1.3%	3084	42.4%	98.7%	54.6%
Focus Area (Red Hook)	10,215	768	7.5%	4,343	42.5%	55	0.5%	283	2.8%	4,766	46.7%	92.5%	46.6%
Study Area	86,602	46,124	53.3%	16,547	19.1%	4,454	5.1%	3,378	3.9%	16,099	18.6%	46.7%	19.8%
Brooklyn	2,465,326	854,532	34.7%	848,583	34.4%	184,281	7.5%	90,052	3.6%	487,878	19.8%	65.3%	25.1%
New York City	8,008,278	2,801,267	35.0%	1,962,154	24.5%	780,229	9.7%	304,074	3.8%	2,160,554	27.0%	65.0%	21.0%

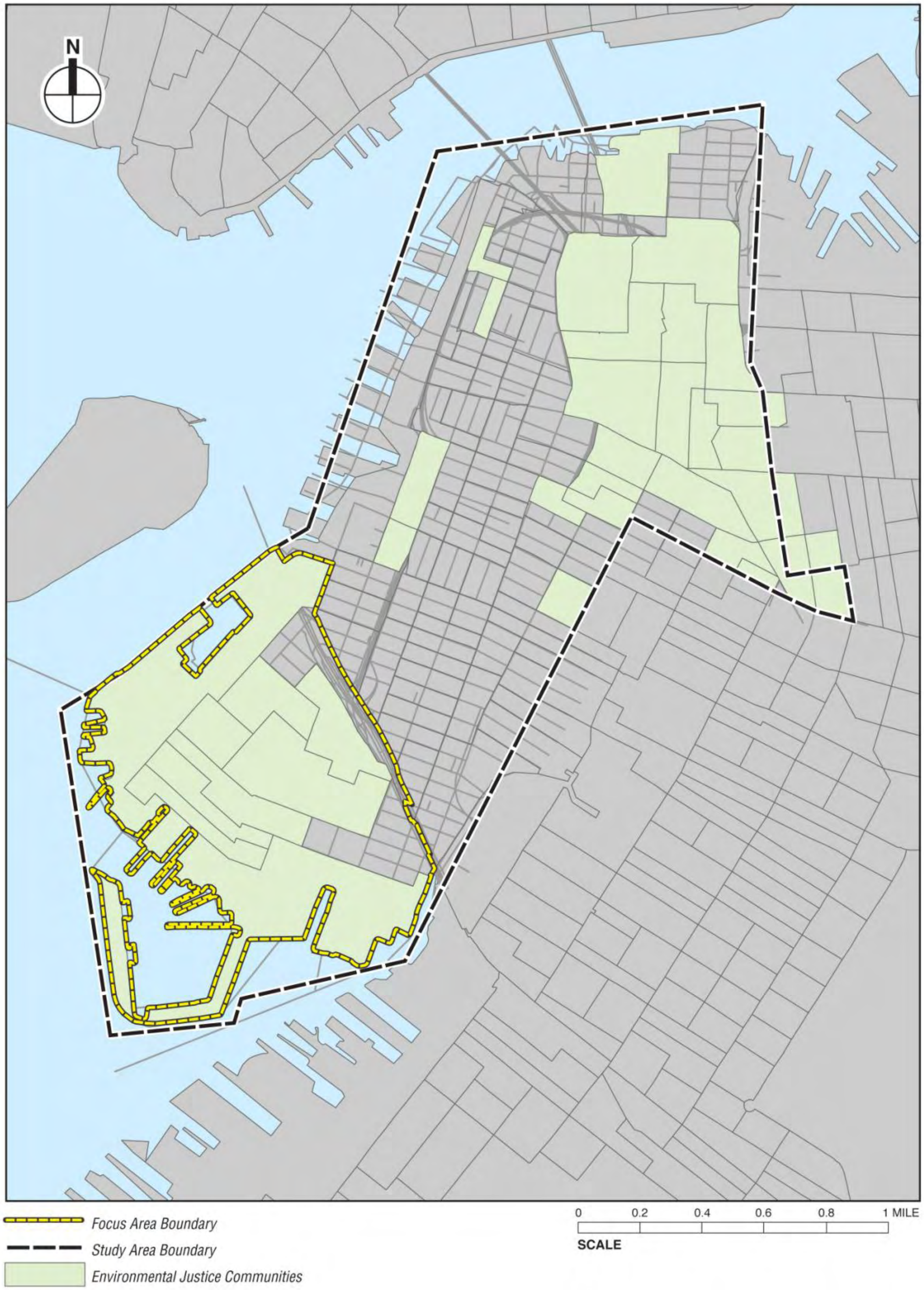
Notes:

*** The racial and ethnic categories provided are further defined as: White (White alone, not Hispanic or Latino); Black (Black or African American alone, not Hispanic or Latino); Asian (Asian alone, not Hispanic or Latino); Other (American Indian and Alaska Native alone, not Hispanic or Latino; Native Hawaiian and Other Pacific Islander alone, not Hispanic or Latino; Some other race alone, not Hispanic or Latino; Two or more races, not Hispanic or Latino); Hispanic (Hispanic or Latino; Persons of Hispanic origin may be of any race).**

**** Percent of individuals with incomes below established poverty level. The U.S. Census Bureau's established income thresholds for poverty level defines poverty level.**

***** Percentages in bold were identified as minority or low-income communities.**

FIGURE 3-6:
ENVIRONMENTAL JUSTICE COMMUNITIES



Approximately 93 percent of the residents of the Focus Area are identified as minority—a substantially larger proportion than in the overall Study Area (46.7 percent), Brooklyn (65 percent), and the City as a whole (65 percent). Slightly less than half of the Focus Area's population (47 percent) identified themselves as Latino, making up the largest racial or ethnic group. African American/black comprised 42.5 percent of the area's population. Asians and other minority groups accounted for approximately 2.5 percent of the population.

The percentage of low-income residents in the Focus Area's block groups range from 25.7 percent to 72.2 percent. Overall, the Focus Area has a low income population of nearly 47 percent. This is substantially higher than the Study Area (19.8 percent), the borough of Brooklyn (25.1 percent), and the City as a whole (21.8 percent).

Thus, the Focus Area is defined as an environmental justice community by the CEQ and USDOT guidance described above.

3.5 CONCLUSION

Over the past 20 years, the Focus Area has begun to recover from historic economic decline, and has seen an increase in residential and commercial development. Despite the consequent increase in residential and employee densities, however, the Focus Area continues to experience population and employment levels below their historic peak.

The Study Area has also seen an increase in residential and employment populations over the last 20 years. Outside of the dense Downtown Brooklyn area, neighborhoods in the Study Area have residential and employee densities similar to those of the Focus Area. However, the Focus Area and Study Area differ greatly in terms of income. According to Census forecasts, the 2010 median household income for the Focus Area is $19,417. A substantial number of households in the Focus Area earn less than $15,000 per year (48 percent), and few earn more than $50,000 per year (10%). By contrast, in the Study Area, approximately 27 percent of households earn less than $25,000 per year, and the majority earns more than $50,000 per year. As a consequence, automobile ownership rates in the Focus Area are significantly lower than in the Study Area, and much of the working-age population of the Focus Area is dependent upon transit for its journey to work (see Section 4.2 below). It is therefore critical that the expanding Focus Area be considered for a substantial improvement to its transit service, and a streetcar is an important option to investigate in this context.

4.0 TRANSPORTATION

4.1 *ACCESS AND CIRCULATION*

VEHICULAR ACCESS AND CIRCULATION

The Study Area consists of several neighborhoods with discrete street networks that connect at individual points. Arterial roadways such as Flatbush Avenue, Tillary Street, Atlantic Avenue, and Hamilton Avenue form neighborhood boundaries and are the roadways that separate differing street grids.

The northeastern portion of the Study Area, from DUMBO to Atlantic Avenue, is traversed by the Brooklyn and Manhattan Bridge ramps that lead to Flatbush Avenue and Adams Street. Flatbush Avenue runs northwest/southeast, creating several irregular block sizes and skewed intersections (such as Flatbush Avenue and Fulton Street). South of Atlantic Avenue and through Brooklyn Heights, the Study Area generally follows rectangular grid pattern.

Interstate 278 also cuts through much of the periphery of the Study Area. The highway is elevated as it runs through the northern limits of Downtown Brooklyn, then it passes under the Brooklyn Bridge, after which the structure is double-decked along the Brooklyn Heights waterfront. At Atlantic Avenue, Interstate 278 descends below grade and becomes an open cut highway through Hicks Street. Access across Interstate 278 to the waterfront is provided at five of the 12 intersections from Atlantic to Hamilton Avenues–Congress, Kane, Sackett, Union, and Summit Streets. The Summit Street crossing is pedestrian-only. Near Clinton Street, Interstate 278 becomes elevated and intersects with the Brooklyn-Battery Tunnel portal and both travel southeasterly to Third Avenue. Hamilton Avenue runs below this portion of the Interstate 278.

Within the Focus Area, streets follow a grid pattern, primarily characterized by one-way paired local streets and a few two-way thoroughfares. Major two-way streets in the Focus Area include Court, Clinton, Columbia, Richards, and Van Brunt Streets. These streets run north-south and span the length of Red Hook, but are cut off from direct access to the Study Area by ramps to and from the Brooklyn Battery Tunnel and changes to street direction north of Hamilton Avenue. Clinton Street provides access to the Study Area via a circuitous series of turns at Hamilton Avenue, however, Clinton becomes a one-lane local street with one-way northbound traffic north of Hamilton Avenue. Some of the Focus Area's east-west running streets, including Wolcott, King, and Pioneer Streets are discontinuous because of the superblocks containing the Red Hook Houses and the adjacent Red Hook Park. Many of the east-west streets in the Focus Area are also cut off from direct access to the Study Area by Interstate 278, the Brooklyn Battery Tunnel, and Hamilton Avenue.

Several Streets in the Study Area are designated by DOT as through truck routes. These include Atlantic Avenue, Flatbush Avenue, and Interstate 278. Local truck routes include segments of Court Street, Smith Street, Schermerhorn Street, Tillary Street, Cadman Plaza West, Jay Street, Front Street, York Street, Sands Street, Navy Street, Furman Street, and Columbia Street. In the Focus Area, local truck routes include Van Brunt Street, Delevan Street, Hicks Street, Clinton Street, Court Street, Bay Street, and Beard Street.

TRANSIT ACCESS AND CIRCULATION

Figure 4-1 shows the subway and bus routes that traverse the Focus Area and Study Area. Transit coverage in the Study Area varies greatly from north to south. North of Atlantic Avenue, several bus and subway routes converge, forming a transit hub. To the south, however, fewer buses and only two subway lines serve the area, with no direct subway service in the Focus Area.

SUBWAYS

Eleven subway routes cross into Brooklyn from Manhattan between Jay Street and Joralemon Streets in Downtown Brooklyn. The G train also crosses Downtown Brooklyn on its route between Queens and south Brooklyn. Most subway routes continue easterly or southeasterly from Downtown Brooklyn and exit the Study Area. However, the F and G trains continue southward to serve Cobble Hill and Carroll Gardens.

From Manhattan, the F train runs southward under Jay Street and Smith Street to Carroll Street. The train becomes elevated at Carroll Street, and turns eastward at 9th Street. It runs over the Gowanus Canal, and then descends below ground again near Fifth Avenue. The G train runs under Hoyt Avenue through downtown Brooklyn. It merges with the F train at Atlantic Avenue and follows the F train route to its terminal at Church Avenue. The F and G subway station at Smith-9th Street is the closest stop to the Focus Area, but accessing the Smith-9th Street Station from Red Hook requires a bus ride or a lengthy and circuitous walk.

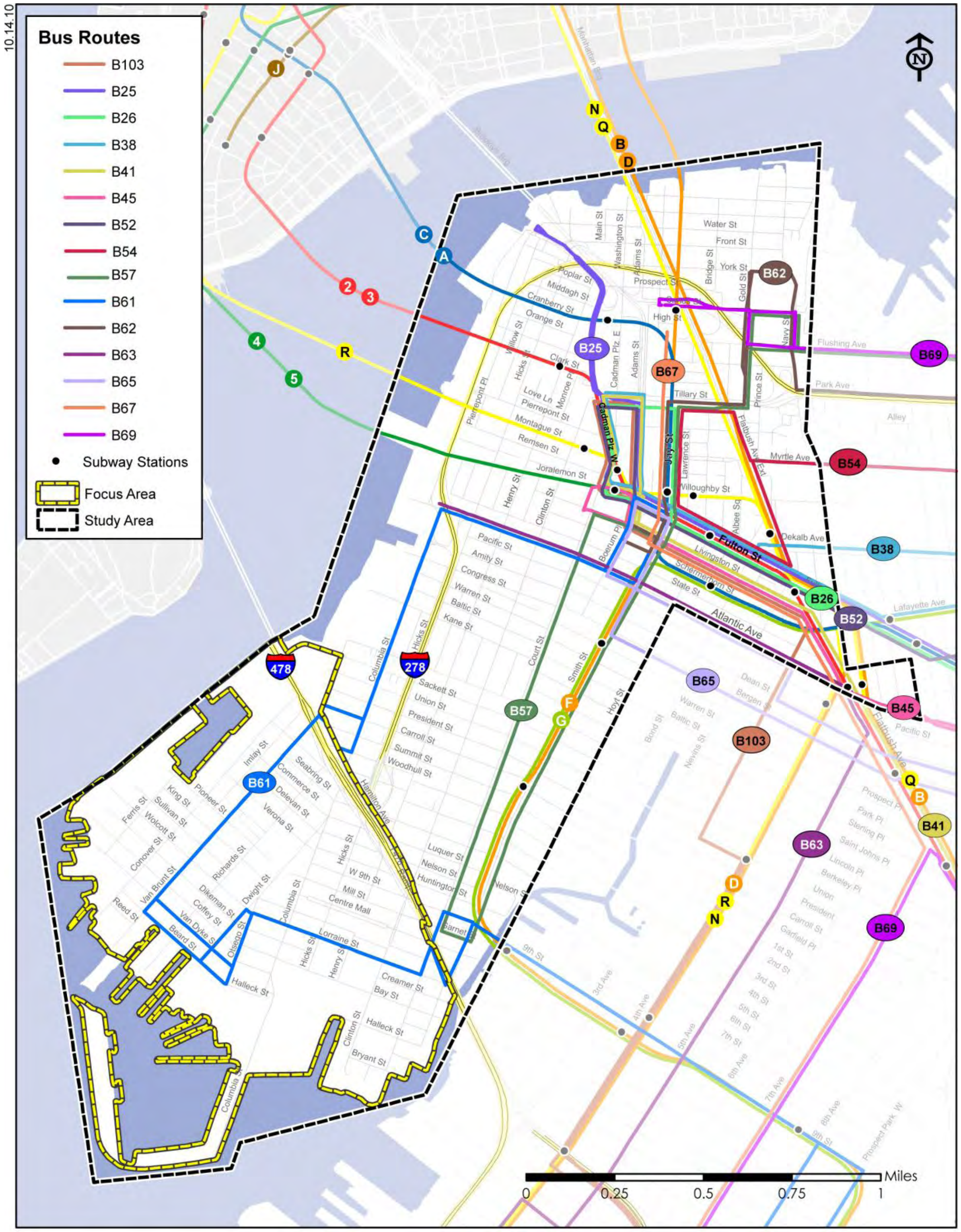
Table 4-1 shows the average weekday, Saturday, Sunday, and annual ridership at subway stations within the Study Area.

TABLE 4-1:
RIDERSHIP AT SUBWAY STATIONS WITHIN THE STUDY AREA

SUBWAY STATION	AVERAGE WEEKDAY	AVERAGE SATURDAY	AVERAGE SUNDAY	ANNUAL
Court St (M*,R)/Borough Hall (2,3,4,5)	37,057	14,597	10,568	10,788,326
Atlantic Av (B,Q,2,3,4,5)/Pacific St (D,M*,N,R)	31,408	21,052	16,575	10,039,490
Jay St-Borough Hall (A,C,F)	30,177	13,080	9,083	8,871,247
DeKalb Av (B,M*,Q,R)	16,835	7,864	5,621	5,014,623
Nevins St (2,3,4,5)	11,579	6,006	3,818	3,479,130
Bergen St (F,G)	10,154	6,594	5,268	3,228,987
Carroll St (F,G)	9,786	5,240	4,021	2,995,068
Hoyt-Schermerhorn Sts (A,C,G)	9,642	4,455	3,075	2,862,942
Hoyt St (2,3)	6,341	3,155	2,197	1,902,962
High St (A,C)	6,045	3,494	2,859	1,888,271
Clark St (2,3)	5,269	3,692	3,020	1,706,174
Smith-9 Sts (F,G)	4,579	2,995	2,466	1,465,834

Note: *M Train Rerouted in 2010
Source: New York City Transit (2009)

FIGURE 4-1:
EXISTING TRANSIT SERVICE



BUSES

Table 4-2 lists the 15 bus routes that serve the Study Area and shows their average weekday, Saturday, and Sunday ridership. Downtown Brooklyn is a major hub for the borough's bus service with nearly all of the 15 routes either terminating or traversing the area. Bus service in the Focus Area is far more limited than in the Study Area in general.

TABLE 4-2:
RIDERSHIP ON BUS ROUTES THAT SERVE THE STUDY AREA

ROUTE	DESCRIPTION	AVERAGE WEEKDAY RIDERSHIP	AVERAGE SATURDAY RIDERSHIP	AVERAGE SUNDAY RIDERSHIP	SYSTEM WIDE RANK*
B25	Broadway Junction to DUMBO along the A/C subway line	12,983	9,666	6,413	66
B26	Ridgewood to Downtown Brooklyn via Halsey and Fulton Streets	10,811	8,690	6,154	82
B38	Ridgewood to Downtown Brooklyn via Kossuth Place and Dekalb Avenue (also runs LTD)	22,043	13,362	9,515	28
B41	Kings Plaza to Downtown Brooklyn via Flatbush	38,658	31,884	20,858	7
B45	Crown Heights to Downtown Brooklyn via St. Johns Pl/Atlantic Ave	8,627	6,629	4,448	97
B54	Ridgewood to Downtown Brooklyn via Myrtle Ave	12,249	7,664	5,489	76
B57	Gowanus to Maspeth via Smith/Court St	5,471	2,688	1,830	132
B61	Park Slope to Red Hook to Downtown Brooklyn**	11,013	7,085	5,105	N/A
B62	Long Island City to Downtown Brooklyn**	11,815	7,162	5,236	N/A
B63	Bay Ridge to Cobble Hill via 5th Ave	13,161	12,050	9,193	56
B52	Ridgewood to Downtown Brooklyn via Gates Ave	14,050	9,467	6,719	60
B65	Crown Heights to Downtown Brooklyn via Dean/Bergen St	4,754	2,923	2,054	142
B67	Kensington to Downtown Brooklyn via 7th Ave	6,560	3,149	2,274	123
B69	Kensington to Downtown Brooklyn via 7th Ave/Vanderbilt	2,286	1,089	830	168
B103	Canarsie to Downtown Brooklyn LTD	6,240	2,003	384	N/A

Notes: *** Ranking of 194 local routes based on 2009 ridership**
**** October 2010**
***** Average ridership for the period of January 2010 to July 2010.**
Some routes have changed since these data have been collected
Sources: **New York City Transit**

In June 2010, NYCT implemented service change that resulted in the restructuring of bus routes in and near Red Hook. These changes discontinued routes and restructured others.

The B75 and B77 routes were discontinued. The B75 previously operated between Downtown Brooklyn (Sands and Jay Streets) and Windsor Terrace (20th Street and Prospect Park West) via Smith Street (northbound), Court Street (southbound), and 9th Street. The B75 generally paralleled the F and G train route. The B77 operated between Red Hook (Conover and Dikeman Streets) and

Park Slope (5 Avenue and 10th Street) via Lorraine and 9th Streets. The B77 provided access between Red Hook and the 4 Avenue/9th Street Subway Station (F, G, N, R).

To provide alternative service for Red Hook customers, NYCT extended the B61 route. The B61 previously operated between Downtown Brooklyn and Red Hook, terminating at Beard and Otsego Streets. NYCT extended the B61 to 19th Street and Prospect Park West in Windsor Terrace. The B57 was also extended from Court and Livingston Streets to the Smith–9 Street (FG) subway station, operating along Court and Smith Streets through Cobble Hill and Carroll Gardens. The extended B57 route replaces the northern portion of the B75 between the Smith–9 Street (FG) subway station and Downtown Brooklyn.

The B61 is the primary bus route serving Red Hook, along Columbia and Van Brunt Streets. As part of the above-described 2010 service changes, the B61, which is a long route and suffered from on-time performance issues, was split into the B61 and B62. The B61 now runs from Park Slope then along 9th Street, through Red Hook, and north on Columbia Street to Downtown Brooklyn. In October 2010, this route registered over 11,000 boardings per weekday. The B62 runs from Downtown Brooklyn to Queens Plaza.

BICYCLES

Bicycle routes crisscross the Study Area. Separated bicycle paths exist at the bridge approaches, along Columbia Street in Cobble Hill, and in the southern portion of Red Hook. Two more separated (Class I) paths are planned or proposed in the Focus Area. On-Street (Class II and III) bicycle routes run nearly the entire length of Clinton Street and Boerum Place/Adams Street. Smith and Henry Streets also have significant lengths of bicycle lanes. In terms of east-west connections, cyclists can connect via 9th, 3rd, Union, Bergen, and Dean Streets. To the north, Myrtle Avenue, Sands Street, and Schermerhorn Street have a mix of dedicated (Class I) and striped, on-street (Class II) bike lanes. Figure 4-2 shows the designated bike routes within the Focus Area and Study Area.

In the Focus Area, east-west, Class III bike paths are provided along Bay Street, Creamer Street, Lorraine Street, and 9th Street. North-south bike paths are provided along Columbia Street (Class II and Class III), Clinton Street (Class II and III), Court Street (Class III), and Smith Street (Class III). Only the 9th Street and Clinton Street bike paths connect to adjoining neighborhoods.

As part of the New York City Bicycle Master Plan, new bike paths are planned in the Focus Area. There is a network of Class II bike paths planned in the western portion of the Focus Area. Also planned are the extension of the Columbia Street Class II bike route from Mill Street to Bowne Street and extension of the Beard Street Class II bike path from Dwight Street to Van Brunt Street.

PARKING REGULATIONS

On-street parking regulations for key north-south and east-west corridors were collected from DOT's STATUS parking database and were field verified. On-street regulations are indicated on blocks where new or enhanced transit service may be possible. Figure 4-3 summarizes on-street regulations. Blocks were generally classified by their dominant regulation (75 percent or more of one regulation). In cases where blocks were split evenly among more than one regulation, multiple regulations are shown.

FIGURE 4-2:
BICYCLE ROUTES

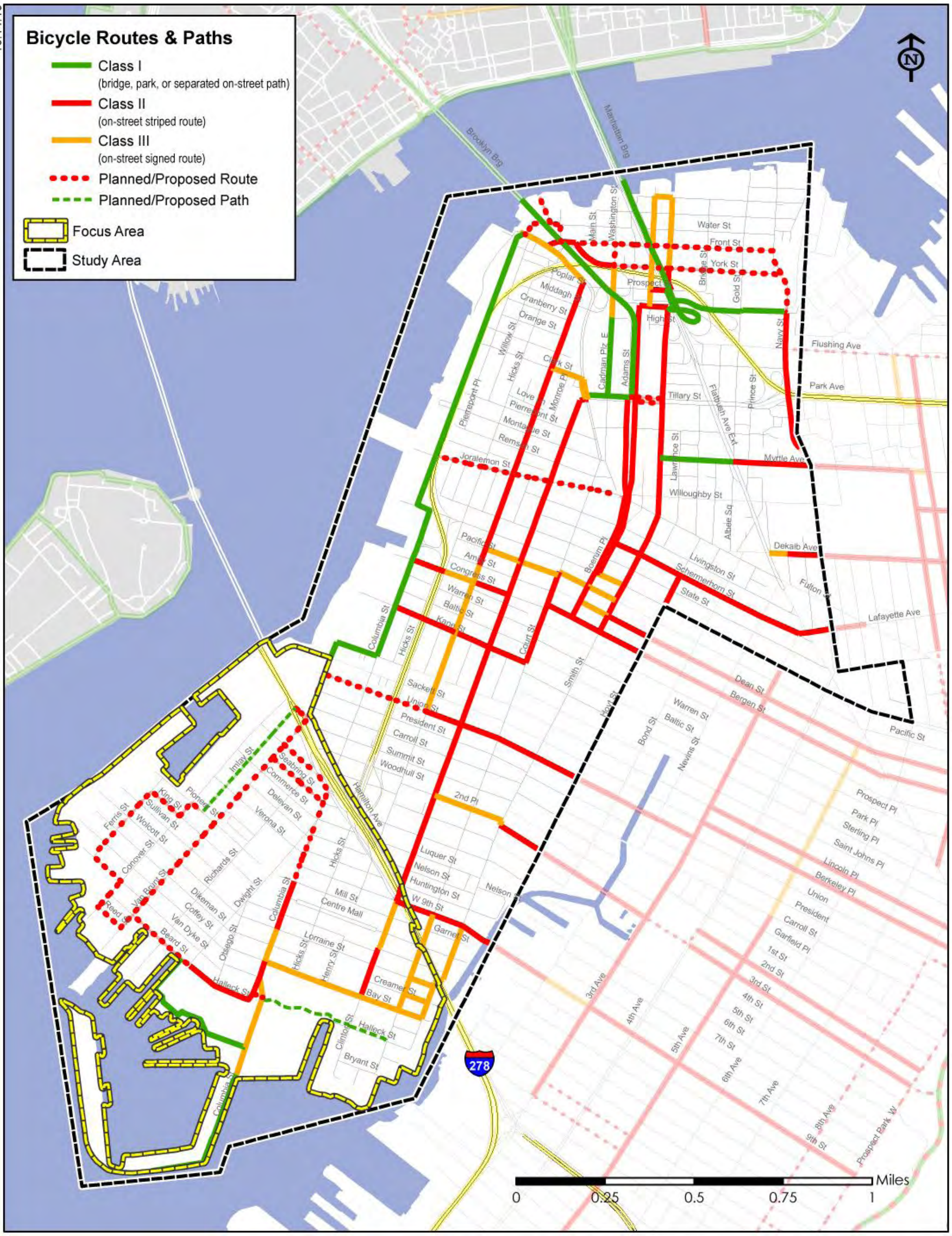


FIGURE 4-3:
ON-STREET PARKING REGULATIONS

The “No Parking / No Standing” category encompasses several different regulations that restrict on-street parking. Some examples are: Commercial loading/unloading only; No parking 7 AM-7 PM Monday through Friday; and No parking 8 AM-6 PM Monday through Friday. No parking except authorized vehicles is proved at locations in Downtown Brooklyn. Other typical areas where parking is restricted are fire zones and school zones.

Atlantic Avenue and Downtown Brooklyn contain nearly all metered spaces. Atlantic Avenue’s “No Parking / No Standing” regulation is primarily for commercial loading and unloading. In the Focus Area, most streets are alternate side parking blocks. Industrial areas typically have prohibited parking except for commercial vehicles. Beard Street along the front of IKEA is a no standing zone.

4.2 TRAVEL CHARACTERISTICS

This section describes the travel characteristics of residents and employees of the Focus Area and Study Area based on the 2000 Census Transportation Planning Package, which is the most recent information available at the block group level.

RESIDENTS (JOURNEY-TO-WORK)

According to the 2000 Census, 2,349 of the Focus Area’s residents are employed. Most of these residents work within New York City with many in the surrounding neighborhood and Downtown Brooklyn (see Figure 4-4). Approximately 15 percent of residents work in the Focus Area, and another 11 percent commute to Downtown Brooklyn. About 13 percent commute to Lower Manhattan and 14 percent travel to Midtown Manhattan. Other areas with a notable concentration of workers from the Focus Area include the Greenpoint and Bushwick neighborhoods in Brooklyn, Long Island City, and the area near John F. Kennedy Airport.

As shown in Figure 4-5, the majority (58 percent) of Focus Area residents commute to work by public transportation (subway or bus). About 14 percent of the residents drive alone to work; five percent carpool; and 18 percent of the residents walk to work.

There are a lower percentage of commuters by public transit in the Focus Area than in the Study Area. Whereas 58 percent of Focus Area residents use public transit to commute, 65 percent of Study Area residents commute by public transit (see Figure 4-6). There is a corresponding difference in automobile commutes between the Focus Area and the Study Area. In the Focus Area, 18 percent commute by auto (drove alone or carpool) as compared to 13 percent for the Study Area.

In the Focus Area, commuters using public transit decreased by approximately one percent between 1990 and 2000 (59 percent in 1990 compared to 58 percent in 2000). Walk only commuters increased during this period, from 13 percent to 18 percent. There was a four percent reduction in the percentage of automobile commutes. Between 1990 and 2000, the percentage of drive alone commuters decreased by approximately one percent and the percentage of carpool commuters decreased by nearly five percent. In the overall Study Area, commuters using public transit increased by one percent, from 65 percent to 66 percent. At the same time, the percentage of drive alone commuters decreased by approximately two percent, and the percentage of carpool commuters decreased by approximately two percent.

FIGURE 4-4:
PLACE OF WORK FOR FOCUS AREA RESIDENTS

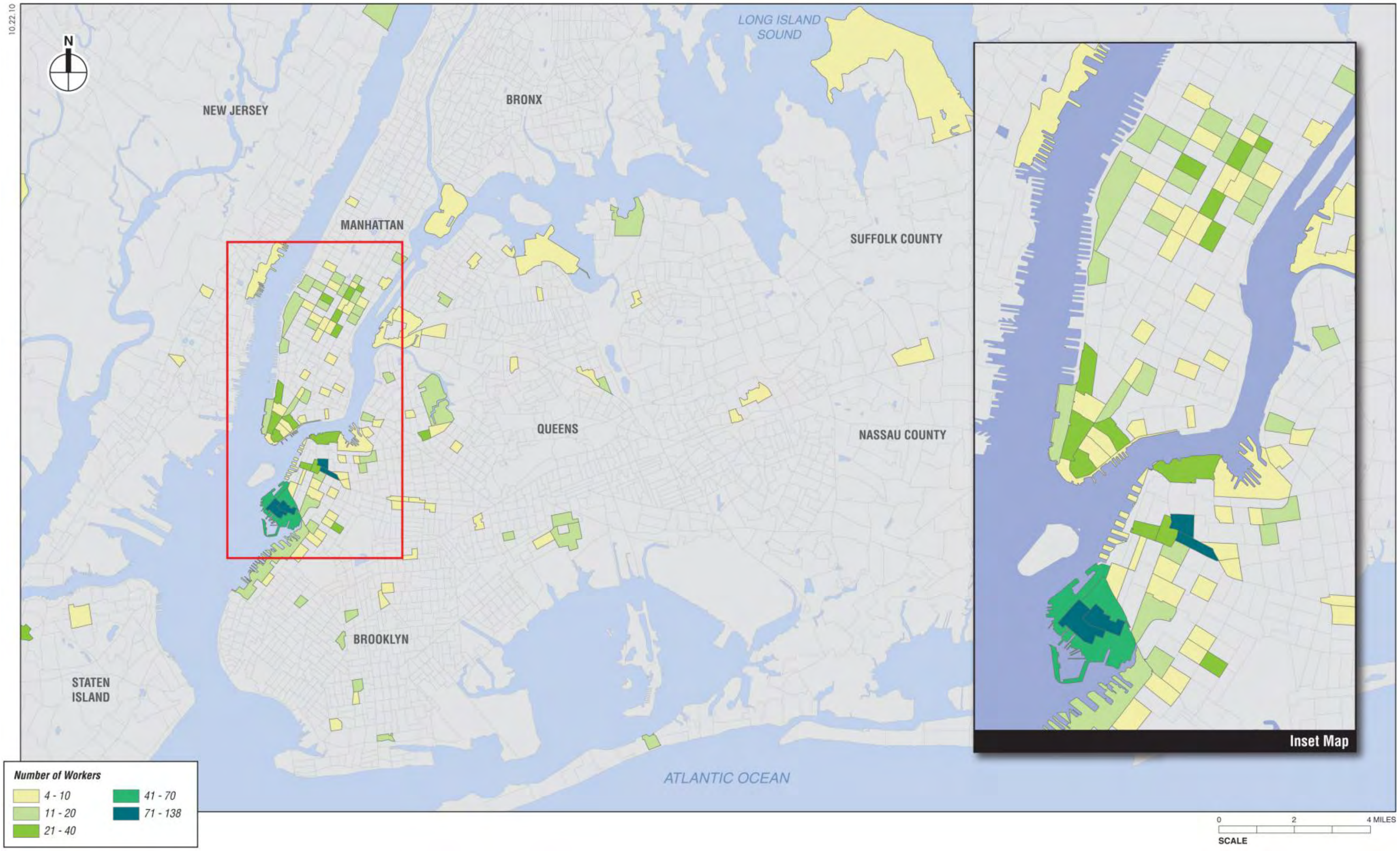


FIGURE 4-5:
MEANS OF TRANSPORTATION TO WORK FOR FOCUS AREA RESIDENTS

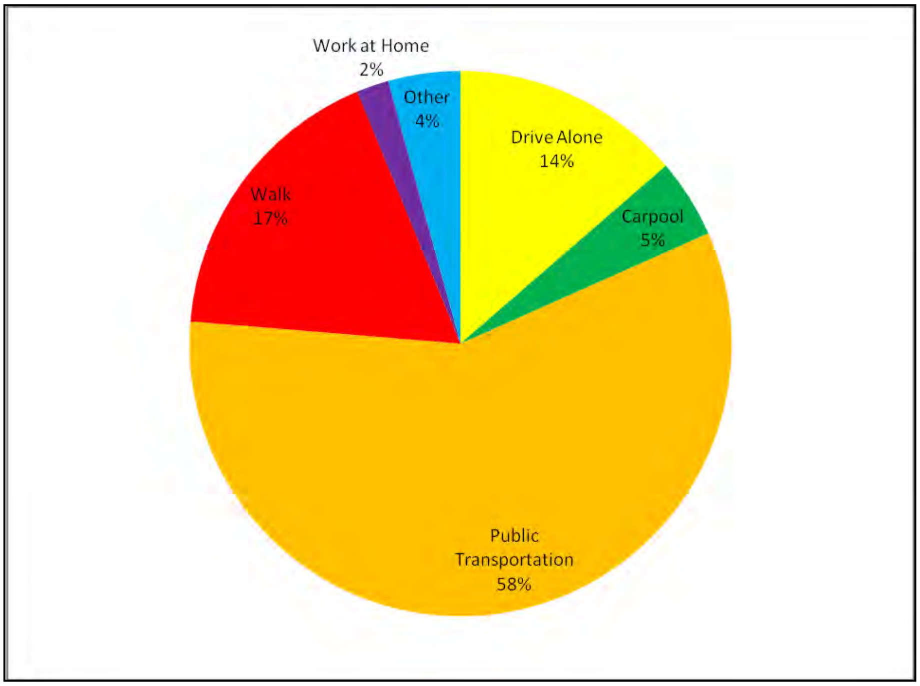
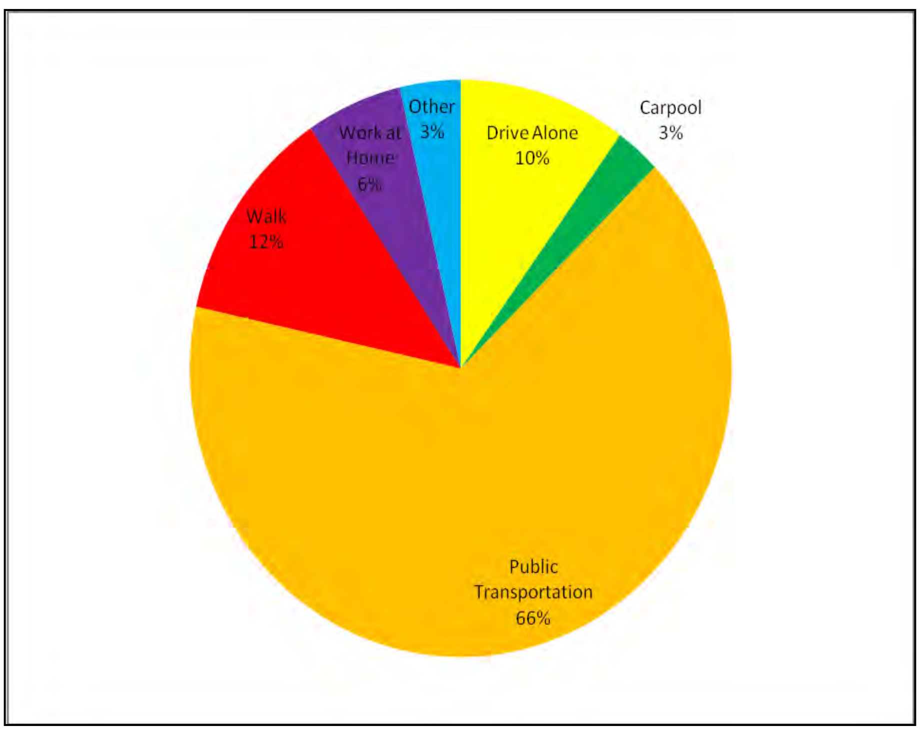


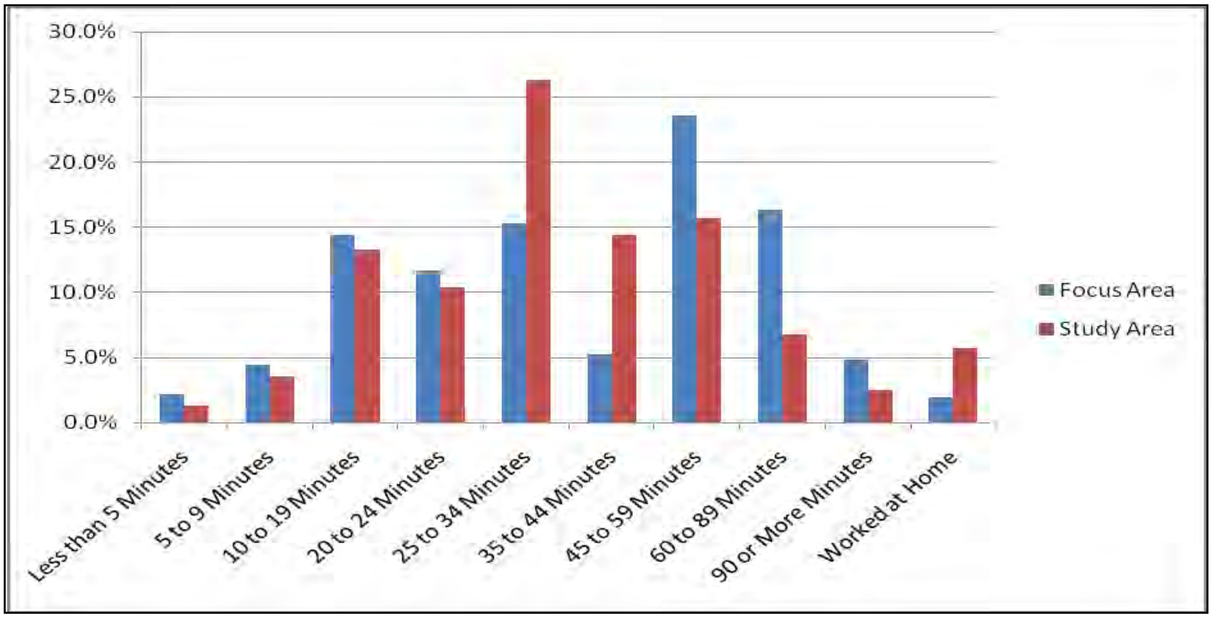
FIGURE 4-6:
MEANS OF TRANSPORTATION TO WORK FOR STUDY AREA RESIDENTS



A relatively low percentage of households own automobiles in the Focus Area. About 83 percent of households do not own a vehicle, 14 percent own one vehicle, and less than three percent own more than one vehicle. In the Study Area, 65 percent of households do not own a vehicle, 31 percent own one vehicle, and 4 percent own more than one vehicle.

Figure 4-7 shows the distribution of travel time to work for the Focus Area and Study Area populations, based on 2000 Census data. Generally, Focus Area residents have a longer commute than Study Area residents. In the Focus Area, 48 percent of the population reaches work in less than 34 minutes, but 21 percent travels more than an hour to work. In the Study Area, approximately 55 percent of the population reaches work in less than 34 minutes, and nine percent travel more than an hour to work.

FIGURE 4-7:
TRAVEL TIME TO WORK FOR FOCUS AREA AND STUDY AREA RESIDENTS



EMPLOYEES (REVERSE JOURNEY-TO-WORK)

According to U.S. Census, there are 5,445 people who work in the Focus Area and 143,854 who work in the Study Area. Figure 4-8 shows the place of residence for Focus Area workers. Most people who work in Red Hook live within New York City, with many coming from the surrounding neighborhood and from Brooklyn in general. Other areas with a high concentration of residents who work in the Focus Area include Woodside, Jamaica, Howard Beach, and Lindenwood in Queens and Union City in New Jersey. There are 345 (6.34 percent) people who work in Red Hook and also live in Red Hook.

As shown in Figure 4-9, the predominant mode of travel to work for individuals who work in the Focus Area is by automobile (59 percent), and only eight percent of workers commute on foot. This indicates that a large percentage of the workers of the Focus Area do not live in the Focus Area. Twenty-nine (29) percent of workers commute to the Focus Area by public transit. In the Study Area, the largest portion of workers (49 percent) commutes by public transit. About 36 percent arrive by vehicular modes, and six percent commute by foot (see Figure 4-10).

FIGURE 4-8:
PLACE OF RESIDENCE FOR FOCUS AREA WORKERS

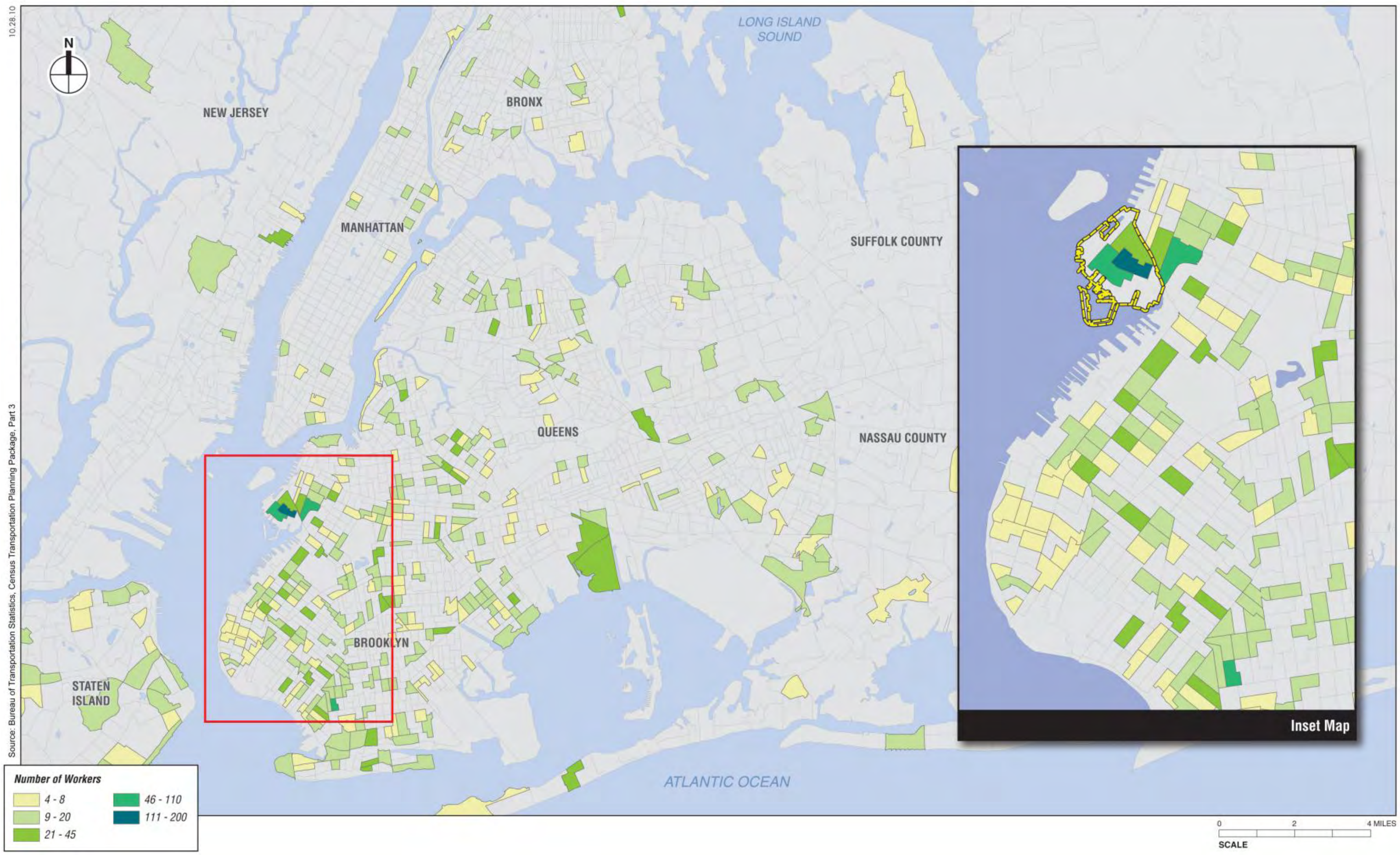


FIGURE 4-9:
MODE OF TRAVEL TO WORK FOR FOCUS AREA WORKERS

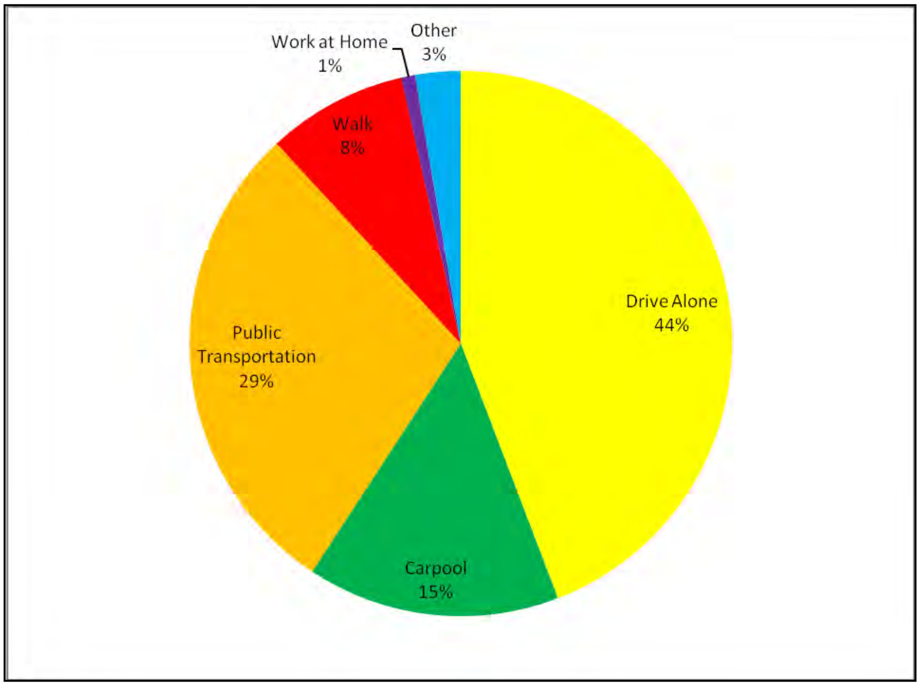


FIGURE 4-10:
MODE OF TRAVEL TO WORK FOR STUDY AREA WORKERS

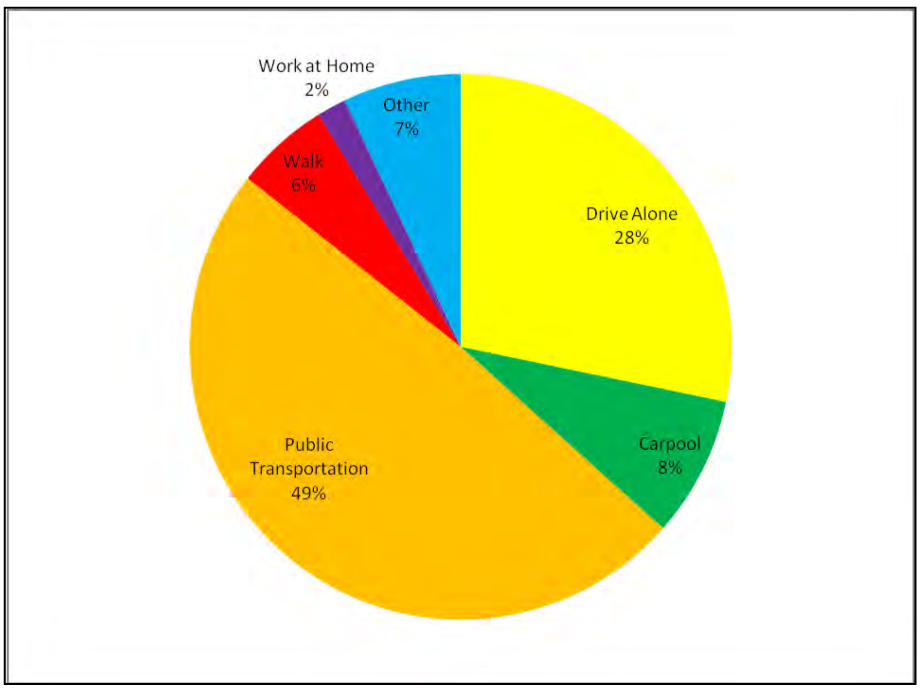
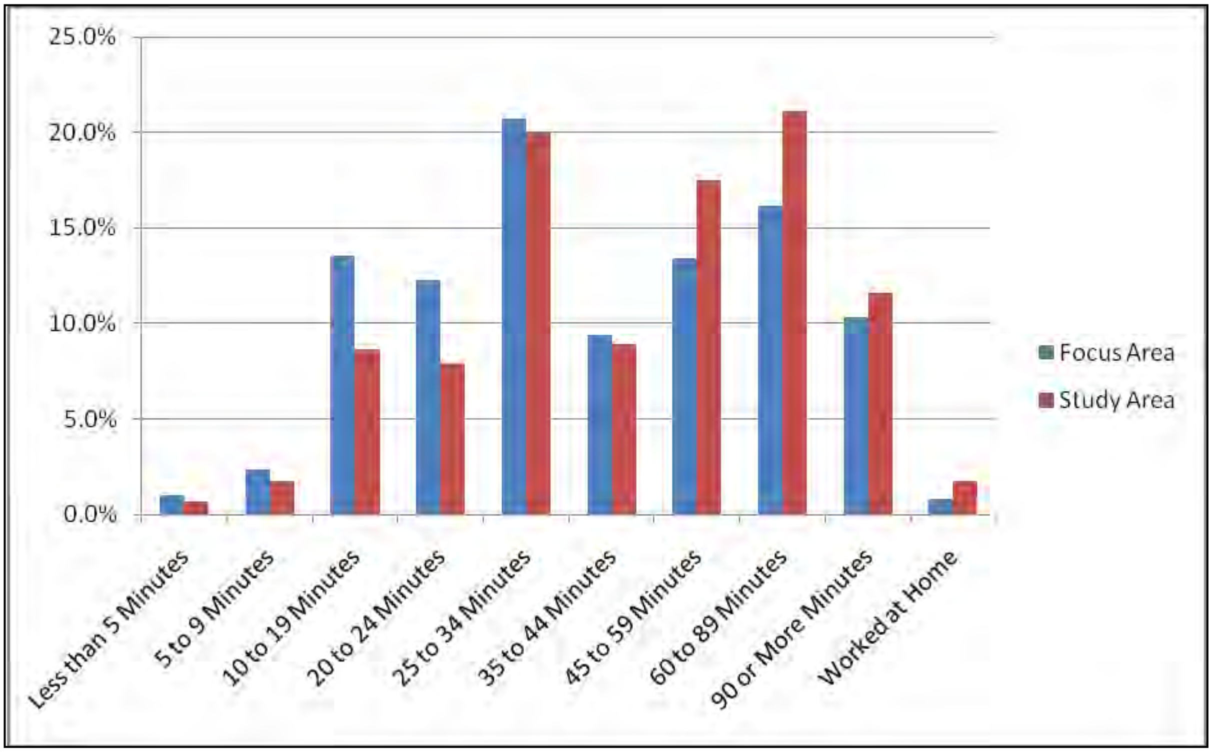


Figure 4-11 shows the distribution of travel time to work for employees of the Focus Area and Study Area, based on 2000 census data. Generally, Study Area workers have a longer commute than Focus Area workers. In the Study Area, 39 percent of the population reaches work in less than 34 minutes, but 33 percent travels more than an hour to work. Approximately 50 percent of Focus Area workers reach work in less than 34 minutes, while 26 percent travel more than an hour to work.

FIGURE 4-11:
TRAVEL TIME TO WORK FOR FOCUS AREA AND STUDY AREA WORKERS



4.3 CONCLUSION

Interstate 278 and the Brooklyn-Battery Tunnel are prominent transportation facilities in the Focus Area and physically isolate it from surrounding areas of Brooklyn. As such, there is limited north-south and east-west access to and from Red Hook.

The Focus Area has no direct subway service and is served by only one bus route—the B61. Although the B61 offers good coverage in Red Hook and operates every eight to nine minutes during peak periods, many residents decry its lack of reliability, which may be related to the length of the route and congestion encountered outside the Focus Area. The nearest subway station is Smith-9th Street (FG). Access to the subway is by a lengthy walk or a transfer from the B61.

Despite limited transit service, the largest share of Focus Area residents relies on the bus and subway to commute. On the other hand, those who work in the Focus Area rely much more heavily on their automobiles than on transit or other modes. In both cases, the poor access to Red Hook contributes to long commutes for its residents and employees. Nearly 50 percent of residents commute more than 45 minutes to work. More than 50 percent of its employees also commute more than 45 minutes to work.

Area residents and workers rely on transit for access to and from Red Hook. With limited options and poor connections, however, they endure long commutes. Even for the many that commute relatively short distances to places like Downtown Brooklyn, Lower Manhattan, and Midtown Manhattan, the commute is long. Improved transit services should focus on reducing travel times, improving connections to existing subway services, and serving common destinations.

5.0 PRINCIPAL CONCLUSIONS

The Brooklyn highway network physically isolates the Focus Area from adjoining areas and there is limited transit service. Although the area experienced a rapid economic decline from 1950 to 1990, over the past twenty years and especially in the last decade, a focus on reinvestment has spurred both large- and small-scale commercial, industrial, and residential development. The Focus Area's residential and worker populations have grown in recent years, but the area remains poorly served by transit. Currently, there is one bus route that serves the Focus Area even though many of its residents rely on public transportation.

The Study Area, for the most part, is well served by public transportation. However, there has been rapid redevelopment along its waterfront with new recreational, residential, and commercial uses. Like the Focus Area, these waterfront sites, particularly those south of Atlantic Avenue, are not well served by public transportation, but many of their occupants also rely on transit service for their daily needs.

3.0 CASE STUDY REPORT

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FIGURES

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APPENDIX A

1.0 INTRODUCTION

The following Case Study Report was prepared to illustrate relevant streetcar components and experiences that are applicable to the Brooklyn Streetcar Feasibility Study. This report is intended to serve as a reference document to inform the study process, and to develop and evaluate streetcar system components. The information in this Case Study Report will be used as a reference for the subsequent tasks in the study.

As a starting point, ten streetcar systems that are in operation, or beyond the planning phase, were considered as potential case studies for this Case Study Report. These include:

- Portland Streetcar;
- Charlotte Streetcar;
- Seattle South Lake Union Streetcar;
- San Francisco Historic Streetcar;
- Tacoma Link Rail (Streetcar);
- Tampa Ybor City Historic Streetcar;
- Tucson Starter Streetcar;
- Kenosha Streetcar;
- Philadelphia Trolley; and
- Toronto Streetcar.

To assist DOT in the selection of three streetcar systems for the Case Study Report, summaries of these ten streetcar systems were provided by the Study Team. This document is included as Appendix A. While this Case Study Report focuses specifically on three systems, there may be times during the overall Brooklyn Streetcar Feasibility Study when lessons learned from other systems, beyond the original three selected, could be applicable. Whenever possible, the URS Team will incorporate the most relevant examples.

DOT chose the following three streetcar systems to be further studied for their applicability to a Brooklyn Streetcar:

Portland Streetcar

The Portland Streetcar demonstrates the use of modern streetcar technology in mixed street-running operation along urban streets. In addition, the Portland Streetcar offers multiple examples of utility impact mitigation techniques and well-documented economic development impacts. Other relevant lessons for Brooklyn include system expansion process, use of non-Federal funding, use of one-way pairs for operations, and strategies to deal with the integration with bike lanes and pedestrian pathways.

Seattle South Lake Union Streetcar

The South Lake Union Streetcar is a new modern streetcar system in full revenue service, similar to Portland, in a larger urban setting. The process to develop this system provides relevant information and lessons learned for Brooklyn.

Philadelphia Girard Avenue/Route 15 Trolley

Philadelphia's Route 15 trolley demonstrates the re-use of PCC heritage streetcar vehicles and existing infrastructure. In addition, the Route 15 Trolley is located in a northern climate, similar to Brooklyn, and in relatively close proximity to New York allowing study site visits. While this system is not the only example of PCC cars in operation today, it does demonstrate the lessons learned, both positive and negative, of returning a former streetcar line into regular revenue service using heritage streetcar equipment.

In coordination with DOT, the URS Team selected the most relevant system components to be investigated for the above three streetcar systems. These include:

- Planning Process Overview – Design Criteria, Alignment Decision Process, and Principal Challenges;
- System Operations – Operating Entity, Service Plan, Ridership, Bus Network, and Bicycle Integration;
- Financial Characteristics – Capital Costs, Operation and Maintenance Costs, Funding Strategies, and Economic Development; and
- Vehicle – Type, Storage and Maintenance Facilities, and Traction Power.

2.0 PORTLAND

The Portland Streetcar is an approximately eight-mile continuous loop (four miles in each direction) streetcar line serving Downtown Portland and the surrounding areas. The system demonstrates the use of modern streetcar technology in mixed street-running operation along urban streets, accommodating existing curbside parking and loading. The Portland Streetcar also offers multiple examples of utility impact mitigation techniques and well-documented economic development impacts. Other relevant lessons for Brooklyn include system expansion process, use of non-Federal funding, use of one-way pairs for operations, and strategies to deal with the integration with bike lanes and pedestrian pathways.

As shown in Figure 2-1, the Portland Streetcar travels from Legacy Good Samaritan Hospital on NW 23rd Avenue, NW Lovejoy and Northrup Streets, through the Pearl District, 10th and 11th Avenues, SW Mill and SW Market Streets, Portland State University Urban Center, SW Harrison Street, RiversPlace, Oregon Health and Science University, the Aerial Team, and to a terminus on SW Lowell Street and Bond Avenue in the South Waterfront District. Service opened in July 2001, with extensions commencing service in March 2005, October 2006, August 2007, and a fourth extension (adding another 6.6. track miles) planned to open in 2012, as shown in Figure 2-2.

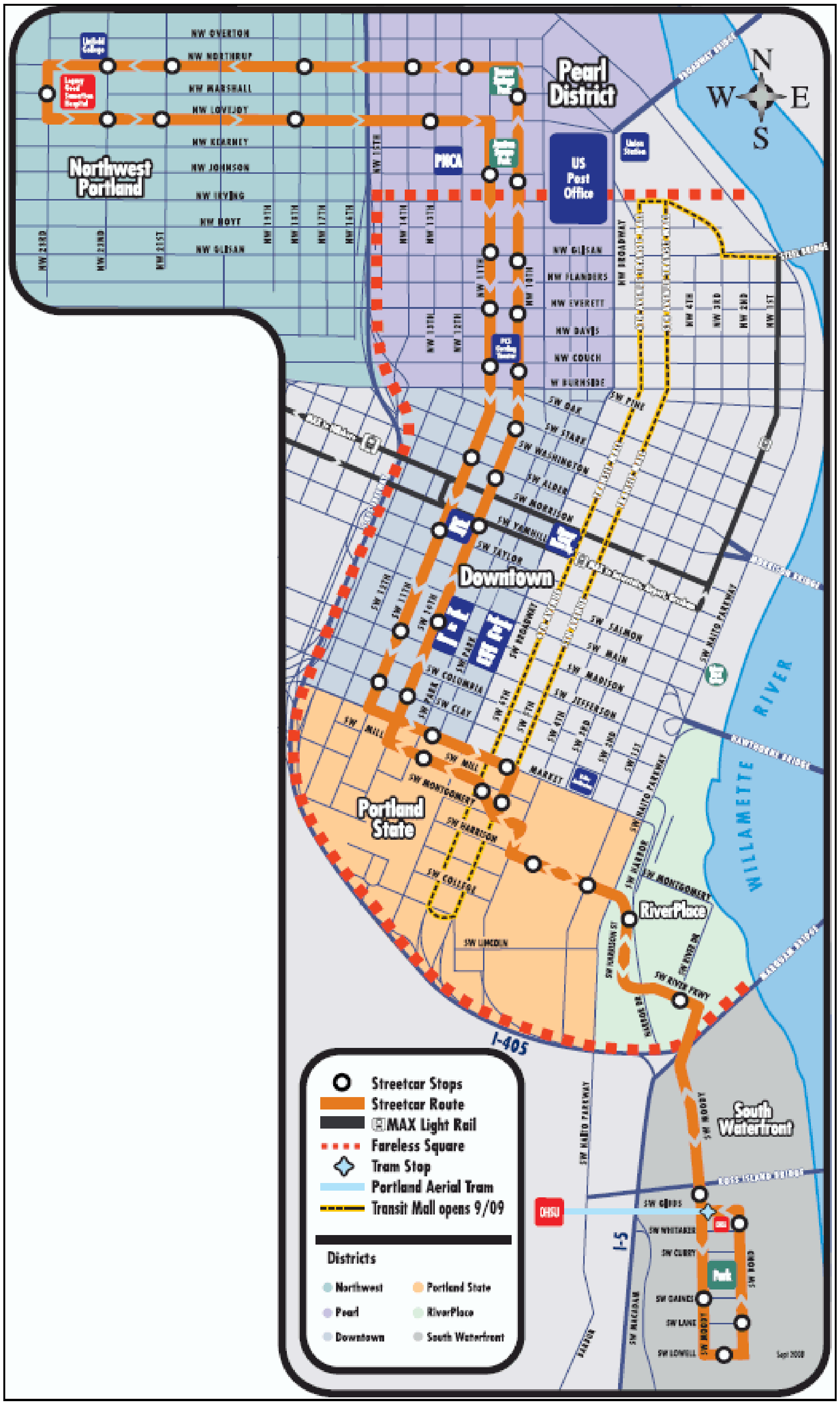
2.1 Planning Process Overview

In 1990, the City of Portland initiated a feasibility study for the Portland Streetcar to connect two major redevelopment areas – 70 acres of abandoned rail yards and contaminated brownfield sites just north of Downtown (the River District) and 128 acres of largely underused or vacant industrial land requiring environmental remediation at the opposite end of Downtown (the South Waterfront).[1] By May 1999 construction of the project began, and passenger service was first made available in July 2001 with a fleet of five modern vehicles with street-level boarding. The original route, which opened in 2001, was a 2.4-mile double track loop, connecting Portland State University and the Legacy Good Samaritan Hospital. This first segment served an already rich transit zone that offered free bus service ('Fareless Square')[2] through downtown Portland.

In March 2005, service was extended 0.6 miles of double track to RiverPlace, and in October 2006, an additional 0.6 miles of single track was extended to SW Moody and Gibbs to serve the South Waterfront. In August 2007, service began on 0.4 miles of double track extending to Lowell & Bond in the South Waterfront District. A fourth extension, the Portland Streetcar Loop Project, is planned for 2012 and will extend tracks from the Pearl District, across the Broadway Bridge, connecting via NE Weidler Street to Lloyd Center at NE 7th Avenue, south on NE MLK Boulevard to Oregon Museum of Science and Industry, and return north on NE Grand Avenue to NE Broadway and the Pearl District. The Loop Project will introduce 28 new streetcar stops.

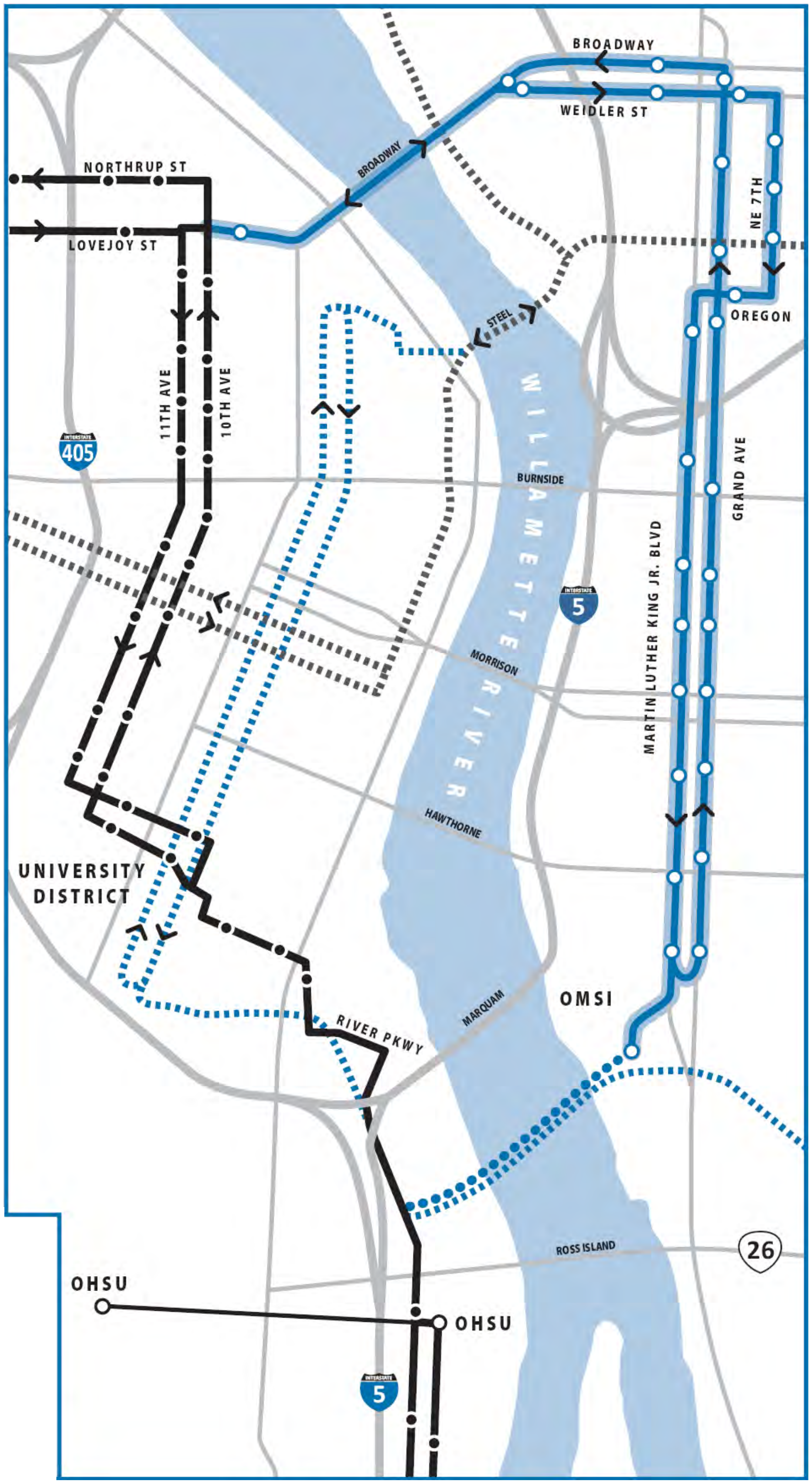
1 The Office of Transportation and Portland Streetcar, Inc., Portland Streetcar Development Oriented Transit, 2008.
2 Fareless Square was initiated 34 years ago to help address air quality issues, reduce car trips downtown, and increase transit usage. Originally, the transit system consisted of only buses, but has since expanded to four MAX lines and the Portland Streetcar. On January 3, 2010, TriMet's board of directors voted to change Fareless Square to rail-only. As a result, bus service is no longer free in downtown Portland and the Lloyd District.

Figure 2-1: Portland Streetcar Service



http://www.portlandstreetcar.org

Figure 2-2: Portland Streetcar Loop Project



URS Corporation

The Portland Streetcar was designed to fit the scale and traffic patterns of the neighborhoods through which it travels.[3] Throughout the evolution of streetcar planning in Portland, the goals have remained consistent:[4]

- Use a commitment to high quality transit service as an incentive for high density mixed-use development;
- Link neighborhoods with a convenient and attractive transportation alternative and attract new transit ridership;
- Connect major attractions in the Central City with high quality transit;
- Build and operate in mixed traffic and on existing right-of-way (ROW) at lower costs than other fixed rail options;
- Fit the scale and traffic patterns of existing neighborhoods; and
- Reduce short inner-city auto trips, parking demand, traffic congestion, and air pollution.

DESIGN CRITERIA

Streetcar design criteria include alignment geometry, speed, roadway cross section, lane selection, traffic signalization, and streetcar stops. General guidelines for these criteria are described below.

Alignment Geometry

General geometric values to illustrate typical streetcar limitations include the following:

Horizontal Curves

- Minimum horizontal radius is 82 feet (a smaller horizontal radius may be achievable depending upon vehicle capabilities); and
- Minimum curve radius is 600 feet +/- (with spirals) to achieve 25 miles per hour (mph).

Vertical curves (@ 25 mph design speed K value (K=L/A))

- Minimum vertical curve for crest K = 25 +/-; and
- Minimum vertical curve for sags K = 15 +/-.

Grades

The absolute maximum grade is vehicle dependent (typically seven to nine percent); however, the desirable maximum grade for streetcar vehicles is five percent. Even if the vehicle can achieve a certain grade, in most cases it is not desirable to exceed five percent. Almost all modern streetcar vehicles can climb a five percent grade with no issues. However, some vehicles may be limited in their capabilities at greater than five percent grades.

Portland has grades near nine percent for small (less than 200 feet) segments of the existing alignment. In these circumstances, the system was designed with grades up to nine percent, which is the maximum grade Portland's vehicle is capable of climbing while in revenue service. As a result, any future vehicles procured by Portland must be able to climb a nine percent grade to operate on these small segments. Portland has not experienced any performance issues, related to braking, on

3 Portland Streetcar, "Streetcar History", accessed November 1, 2010, http://www.portlandstreetcar.org/node/33.
4 The Office of Transportation and Portland Streetcar, Inc., Portland Streetcar Development Oriented Transit, 2008.

these small segments, even with inclement weather. However, during the fall season, when there are a lot of wet leaves on the tracks, streetcars can slip while accelerating up these higher grades. Moreover, since Portland does not receive the snow and ice that can be seen in the Northeast, Toronto is perhaps a better comparison to Brooklyn. In Toronto, grades exceeding five percent are avoided, as anything five percent or over can be a problem during snow removal.

Speed

Generally, the streetcar schematic alignment is developed to operate within 10 mph of automobile speeds. If the automobile speed for a road is 30 mph, the streetcar is designed to operate at a minimum of 20 mph. Speeds are interrupted by stops and traffic signals. Therefore, the average speed of most streetcar lines is less than 15 mph. Some areas where slower speeds are expected are listed below.

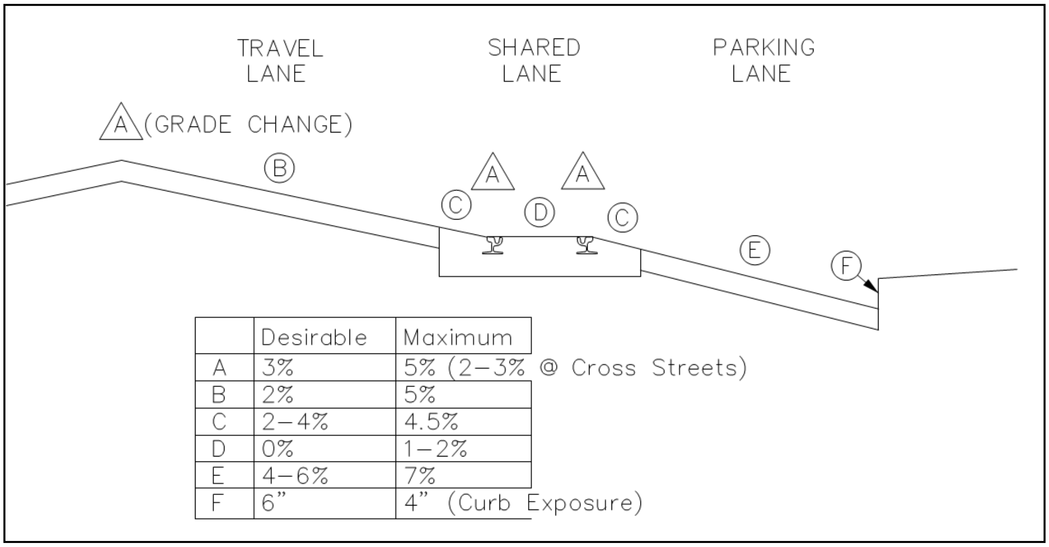
- 90 Degree turn - when the streetcar turns from one street to another, the speeds are limited to approximately five mph.
- Lane changes - when the streetcar shifts from one lane to another at an intersection where it is performing a transit-only maneuver, slower speeds (approximately 15 mph) are expected.
- Urban stops - the alignment at streetcar stops may have to shift slightly closer to the curb to interface with the platform and accommodate American with Disability Act (ADA) boarding requirements. In addition, the vehicle will stop and briefly dwell for approximately twenty seconds (potentially in mixed traffic).
- Turnouts - most turnouts (switches) for a streetcar system in a downtown environment are 25 meter (82 feet) European designs to minimize impacts to adjacent parking and sidewalks, and are limited to five to ten mph.

Roadway Cross Section

Track slabs are designed to provide a flat (zero percent) slope between the rails. Any slope greater than zero percent, or reverse super-elevation in curved sections, is undesirable and can result in uneven rail and wheel wear. A level streetcar track slab is used for all tangent track except in highly restrictive grading situations where some cross slope may be required to accommodate existing roadway cross slopes. A slight cross slope can be introduced to reduce pavement reconstruction or drainage impacts, but the best solution is to provide a zero percent cross slope between rails with flexible 1.5-feet ‘wings’ on the outer portions of the track slab guideway that vary in slope (zero to five percent) to accommodate for the overall cross slope of the existing roadway.

Generally, detailed grading is not accomplished until final design. However, the track design attempts to limit roadway reconstruction to only the track slab and installation of relocated utilities. The approach is further outlined in Figure 2-3. Figure 2-3 illustrates the general cross slope grading of the streetcar track. Typically the track is at least five feet from the curb, which puts the rail approximately 2.5 feet from the face of the curb. The area between the rail and the face of the curb is sloped similar to a gutter to carry the water to the nearest inlet. Portland uses this design methodology; and therefore, there have been no real issues with drainage in Portland, despite the city’s significant amount of rain and a zero percent cross slope between the rails.

Figure 2-3: Roadway Cross Section



	Desirable	Maximum
A	3%	5% (2–3% @ Cross Streets)
B	2%	5%
C	2–4%	4.5%
D	0%	1–2%
E	4–6%	7%
F	6”	4” (Curb Exposure)

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Lane Selection

When selecting the lane to place a streetcar trackway, several factors affect the decision- making process. Existing and future traffic volumes, presence of existing utilities, presence of bicycle lanes and on-street parking, and desired station configuration all influence the lane selection of streetcar tracks on a multi-lane street. For early alignment evaluation purposes, or determining alignment options in a corridor, the pros and cons of left lane versus right lane running options are considered based on the type of street on which the streetcar will operate. For example, a wide ROW two-way street with large existing medians or continuous left turn lanes operates better with a left lane running alignment and shared median stops, which also minimizes conflicts with bike lanes and impacts to parking. Side running alignments and side stops are common to one-way couplets and narrow two-way streets, which do not have a median or left turn pockets. A detailed evaluation of the best operation is accomplished and refined once a desired alignment is selected.

The alignment of the first phase of the Portland Streetcar was primarily located in the right traffic lane, due to the lack of conflicts and because the streetcar was operating primarily on one-way streets. However, during the design of the 2005, 2007, and future 2012 extensions, the location of existing public utilities led to alternative alignments.

Traffic Signalization

Traffic signals along the streetcar route generally provide two-phase operations. Protected left-turn phases are limited to intersections with higher turn volumes. Where the streetcar operates in mixed flow in the existing traffic lane, streetcar movements are controlled by normal traffic signal operations. At locations where sight distance is limited or the streetcar must make a left-turn movement, transition into or out of special lanes, or transition into semi- exclusive operations, special transit-only signals are provided. These transit signals are physically separated from the traffic signals and will use transit-only display indications. In addition, the use of Part Time Warning Signs (PTWs), which flash “train” or a train symbol add an additional factor of safety to indicate to the automobile users that the streetcar is entering the intersection through a transit only phase, as shown in Figure 2-4.

Figure 2-4: Part Time Warning Signs

URS Corporation

Streetcar Stops

The type of stops considered can have a dramatic effect on the cost and urban design elements of the rail system. Stops can make architectural statements with unique canopies and artwork, or simply provide a boarding area and small shelter. The Portland Streetcar utilizes a simplistic approach by providing a streetcar specific shelter (similar to a standard bus shelter), while avoiding canopies and other costly features. These stops, as shown in Figure 2-5, generally cost between $60,000 and $100,000 each, and can accommodate one streetcar vehicle.

Figure 2-5: Portland Streetcar Stop

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The design of streetcar stops is specific to each location, as stops are designed to integrate with the existing ROW. For example, much of the Portland alignment is adjacent to parking. Therefore, bulbouts are relatively common. Bulbouts extend the corner sidewalk to the edge of the streetcar travel lane in these locations where parking is immediately bordering the streetcar. Similarly, many of the streets in Red Hook are lined with parking. Although these bulbouts are a pedestrian-friendly amenity, shortening pedestrian crosswalks, their down side is the added construction costs and the removal of parking. In addition, bulbouts can be challenging to maintain during snow removal. In areas with no parking, the streetcar runs curb tight and the stop is integrated into the sidewalk. In these cases, no bulb out from the sidewalk to meet the track is necessary.

ALIGNMENT DECISION PROCESS

As reported in the *Transportation Cooperative Research Program (TCRP): Synthesis 86: Relationships between Streetcars and the Built Environment*, it is difficult to generalize the planning and goals of streetcar systems, as each has a unique history. To obtain first-hand knowledge of the current state of the practice, a detailed survey instrument was prepared by the Transportation Research Board Synthesis Panel. This survey was administered as telephone interviews with two subjects in each of the communities studied. The two subjects were identified as a transit agency expert with institutional knowledge, economic development expert, or land use planner who managed the related land use and economic development process associated with the streetcar system.[5]

Table 2-1 includes the survey tabulation results for the Portland Streetcar. As shown in Table 2-1, streetcar route planning was focused on land use, future development, intermodal connections, and service to cultural/educational activities.

Table 2-1:
Rating of Importance of Route Selection/Planning for Operations

PORTLAND STREETCAR	RATING
Serving commuters to daily job locations	1
Serving tourists and visitors	1
Serving students	4
Connecting cultural, entertainment, or civic destinations	5
Connecting with other modes of transit (light rail, commuter rail, bus)	4
Stimulating revitalization	5
Generating affordable or workforce housing	4
Organizing new neighborhoods around transit	5
Compatibility with comprehensive/general plans	5
Notes: 1 = NOT important in route planning, 5: VERY important in route planning	

TCRP: Synthesis 86: Relationships between Streetcars and the Built Environment (based on input from the Portland Development Corporation and the Executive Director of Portland Streetcar, Inc.)

Future Planning

In addition to the existing streetcar system and the Streetcar Loop Project, currently under construction, Portland has initiated the Portland Streetcar System Concept Plan (SSCP). The SSCP is a strategy for an enhanced streetcar network that is a part of a broader vision by the City of Portland to sustainably accommodate future population growth in a manner that will effectively manage the consumption of limited natural resources and reduce greenhouse gas emissions. The SSCP builds upon the success of the existing streetcar system to expand service to best serve Portland's neighborhoods and business districts.

Specifically, the 2009 *Portland Street System Concept Plan: A Framework for Future Corridor Planning and Alternative Analysis* identified and selected corridors for future Alternatives Analysis and planning studies as funding becomes available. Transit corridors citywide were assessed to determine their potential for future streetcar investment. Detailed corridor by corridor analysis, study, and discussions with corridor neighborhoods are necessary to determine if a streetcar investment is warranted. No individual corridor can move forward without a detailed analysis and planning study to address the purpose and need of a streetcar project and to comprehensively evaluate project impacts. In the fall of 2007, the SSCP Project Team developed the following mission statement and project goals:[6]

5 Golem, R. and J. Smith-Heimer, TCRP Synthesis 86: Relationships between Streetcars and the Built Environment, Transportation Research Board, National Research Council, Washington, D.C., 2010.
6 The Office of Transportation and Portland Streetcar, Inc., Portland Streetcar Development Oriented Transit, 2008.

The Portland SSCP can play a key role in shaping the City by:
- Reinforcing walkable and economically diverse neighborhoods and vibrant main streets;
- Encouraging sustainable and equitable development and infrastructure;
- Supporting reduction of vehicle trips; and
- Supporting greater accessibility, housing options, employment, and economic development.

A successful streetcar system will:
- Help Portland achieve its peak oil and sustainability strategies;
- Provide an organizing structure and catalyst for Portland's future growth along streetcar corridors; and
- Integrate streetcar corridors into Portland's existing neighborhoods.

Successful streetcar corridors need to:
- Be a viable transit option with adequate ridership;
- Have (re)development potential; and
- Demonstrate community support to make the changes necessary for a successful streetcar corridor.

Portland city planners defined a potential urban design concept for future growth and health of neighborhoods and communities, known as the "20-minute neighborhood." This concept promotes an environment where one can walk, bike, or take transit to essential amenities and services in 20 minutes. Streetcars can support and enhance this environment by connecting 20-minute neighborhoods to each other and to the regional transit network.

PRINCIPAL CHALLENGES

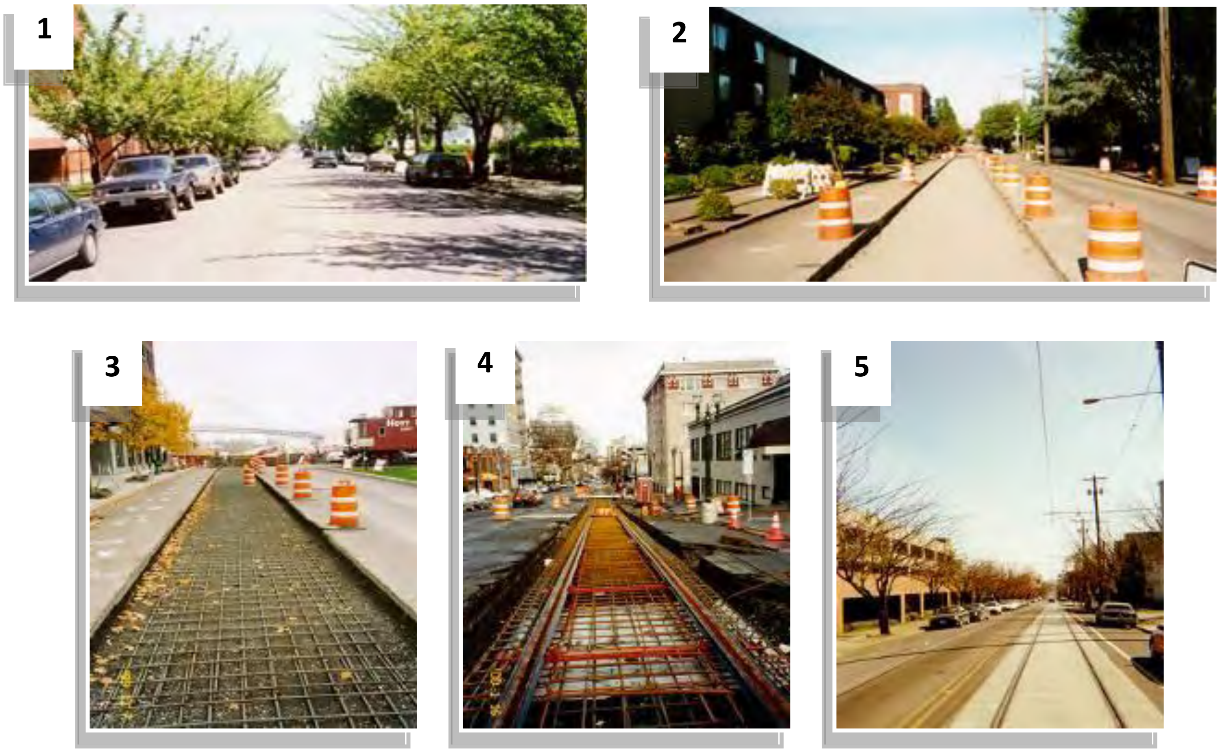
Constructability

Portland used the following construction sequence to minimize construction time and costs. These steps are visually shown in Figure 2-6.

- Sawcut and Excavate Trackway Trench (inset 2): The streetcar tracks were embedded in a concrete slab that was roughly eight feet wide and one foot deep. Sawcut lines were made in existing streets and the roadway was removed to a depth of approximately one foot. In some cases the existing road bases were adequate to support the concrete track slab, but in other areas an additional six-inch depth of excavation was required to install an aggregate base layer to support the track slab.

- Install Reinforcing Steel and Rails (inset 3 and 4): After the trackway trench was completed, track slab reinforcing steel was placed and rails were positioned to their proper alignment and profile. The rails were aligned by the use of gage ties spaced approximately every 10 feet. The gage ties held the rail in position during the subsequent concrete pour.

Figure 2-6: Portland Streetcar Construction



- Pour Concrete Track Slab: After a final check to ensure the proper rail alignment, the concrete track slab was poured. In most cases this concrete pour was done in a single lift and was either hand finished or with a slip-form paving machine that straddled the tracks.

- Final Paving and Striping (inset 5): Once the track slab concrete was sufficiently cured, the adjacent asphalt pavement was ground to allow a minimum asphalt overlay of two inches next to the tracks. The overlay was then compacted; the roadway was re-striped; and the section of roadway was reopened to vehicular traffic.

Utilities

Portland did not create a formal procedure regarding utilities, as relocations varied by utility. The Portland Streetcar engineering team identified utilities in direct conflict with the track slab. These utilities were relocated. Similarly, the public utilities had the opportunity to define conflicts. Maintenance was Portland's main concern in determining utility work.

Perpendicular utilities, or "crossings", remained in place, and were not relocated. Depending on the pipe material and utility owner's desire, perpendicular crossings were sometimes sleeved for stray current protection. Future crossings are either trenched or jacked under the track slab.

Approximately 90 to 95 percent of the utilities parallel and beneath the track slab were relocated. Very few parallel utilities remained in place. These utilities were not relocated either because there was no other option or because of sufficient depth. Deep utilities were not relocated if they were determined to have a long service life. Vehicle loads are not a significant factor in utilities, as streetcar vehicle axle weight is significantly less than typical truck loading used in design (HS-20).

Generally, the streetcar project pays for any public utility relocations (water, sewer, lighting, and signals). However, the City of Portland has used a method called "pipe life credits" to determine what portion of the relocation is paid for by the project and by the utility department. Portland assumed a sewer main life to be 75 years and a water main life to be 100 years. If a water line is 40 years old, the streetcar project paid for 60 percent of the relocation (as 40 years is 40 percent of its 100 year life span) and the utility department paid for the remaining 40 percent of the relocation.

In some segments, sewer relocations were limited to direct conflicts with the track slab and sewer mains or manholes. A condition assessment was performed on the existing line to determine if it was left in place, repaired in place, or relocated. In general, few sewer relocations were performed. For sanitary sewer condition assessments, Portland made a large amount of in-situ pipe lining repairs.

Sewer laterals were installed as needed during construction. However, no future laterals were installed as Portland assumed these would be bored and trenched beneath the track slab at a later date, which Portland successfully accomplished using the following process:

- Bore half way under the track slab;
- Install the sewer pipe;
- Fill the trench with low strength flowable fill;
- Excavate the remaining distance under the track slab;
- Install the remainder of the pipe; and
- Fill with low strength flowable fill.

In terms of sewer access, offset manholes were utilized. Manholes were only located within the first ten inches on either side of the track slab. These manholes were replaced with larger diameter manholes to adjust the ring and cover to be as far away from the slab as possible. Portland also used "Beaver Slide" manholes, with sloping access lids to allow for easier accessibility.

When working with the City of Portland water department, the streetcar project incurred unexpected costs associated with the cost of engineering and administering the relocations. As such, Portland now has an intergovernmental agreement between the streetcar project and the water department to minimize these costs. The water department initially defined a direct conflict to be a line less than three feet away from the track slab. However, as Portland's streetcar was extended, this distance has increased to ten feet. Despite this guideline, there is a 48 inch water line less than ten feet away from the track slab that runs parallel for a portion of the alignment. If the water department ever needs to access this line and disturb the track slab, the streetcar project will pay to make any repairs needed to the track slab.

In terms of access to utilities while the streetcar is in operation, for the most part this is not an issue as parallel utilities were cleared from beneath the track slab prior to installing the track. Therefore, there is adequate access to maintain and/or replace any of the utilities. In the instances where the track was constructed over a parallel utility, an agreement between the city and utility owner was developed to establish guidelines to for utility access. Agreements were established to identify the organization (utility or streetcar entity) responsible for removing and reconstructing the track slab or, in some cases, abandoning the utility and relocating it (since that costs less than rebuilding the track).

2.2 System Operations

OPERATING ENTITY

The Portland Streetcar is managed by the Portland Office of Transportation, under the direction of the Commissioner-in-charge of Transportation. The City of Portland contracts with Portland Streetcar, Inc. (PSI) to construct and operate the streetcar system. PSI is overseen by a board of directors that includes business and residential representatives, the Mayor of Portland, and the general manager of the Tri-County Metropolitan Transportation District of Oregon (TriMet). TriMet is the public transit agency that provides public transportation for much of the three counties in the Portland area: Multnomah, Washington, and Clackamas.

The initial segment of the Portland Streetcar system was planned by the city to support and complement planned redevelopment in a former rail yard, an area that came to be known as the "Pearl District". During the planning phase the city briefed key governmental partners such as TriMet. However, the initial concept was solely the product of the city's initiative.

The city and PSI considered various methods of operating the streetcar line (using city employees, private contractors, TriMet staff, etc.). They determined that contracting with TriMet to operate the vehicles made the most economic and political sense. TriMet provided a deep well of experienced drivers trained in operating similar vehicles (light rail). Neither city employees nor a private contractor provides the same depth of resources or the level of flexibility as TriMet.

Today, Portland Streetcar is jointly owned and operated by the City of Portland and TriMet. These entities work hand and hand, as TriMet realizes the streetcar is a very beneficial asset to the transit system. In fact, TriMet was the grantee for the Streetcar Loop Project, which is currently under construction as a Federal Transit Authority (FTA) Small Starts Project.

SERVICE PLAN

The current system has a total of 46 stops, located approximately every three to four blocks. Streetcars run from 5:30 AM to 11:30 PM on weekdays (except for Friday, when service is extended to 11:45 PM), 7:15 AM to 11:45 PM on Saturdays, and 7:15 AM to 10:30 PM on Sundays. Streetcar stops are scheduled approximately every 12 minutes during most of the day Monday through Saturday, and less frequently (14 to 20 minutes) in early mornings, evenings, and on Sundays.

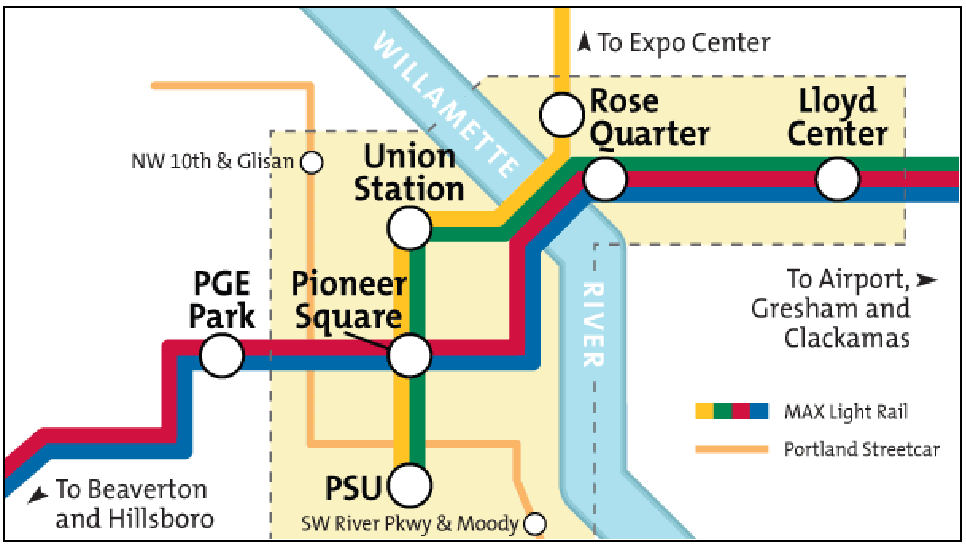
Stops on the Portland Streetcar are not made automatically. Passengers must signal a stop by pushing a level or button on a door, and the reader board inside the streetcar will read 'Stop'. Otherwise, stops are made only if new passengers are waiting at designated stop platforms.

Fares

Portland Streetcar accepts all TriMet passes and transfers, allowing free transfers between streetcar and TriMet bus and MAX (light rail) routes. The majority of the current streetcar route is within the Free Rail Zone. Outside of the Free Rail Zone, as shown in Figure 2-7, fares are as follows:

- Adult 18-64: $2.05 - valid all day on Streetcar
- Adult 65+: $1.00 - Valid all day on Streetcar
- Youth (7-17): $1.50 - Valid all day on Streetcar
- Streetcar-Only Annual Pass $100.00

Figure 2-7: TriMet Free Rail Zone



http://trimet.org/fares/freerailzone.htm

RIDERSHIP

Portland Streetcar ridership has grown steadily since opening in 2001.[7] Figure 2-8 shows a quarterly breakdown of daily ridership calculated from the opening of the system in July 2001 to the winter of 2009/2010.

Weekday ridership increased from 4,982 in summer 2001 to 11,914 in winter 2009/2010, an increase of 139 percent. In 2001, when the project first opened, original targeted ridership was 3,500 weekday rides.[8] Ridership immediately exceeded this target, and by spring 2005, with the RiverPlace extension, ridership was more than double the original goal with 7,837 rides each weekday. Saturday daily ridership has increased from 5,239 rides in summer 2001 to 7,735 in winter 2009/2010, an increase of 48 percent. Sunday ridership, while remaining lower than weekday or Saturday ridership, has increased from 3,177 average Sunday rides in summer 2001 to 5,892 rides in winter 2009/2010, an 85 percent increase.

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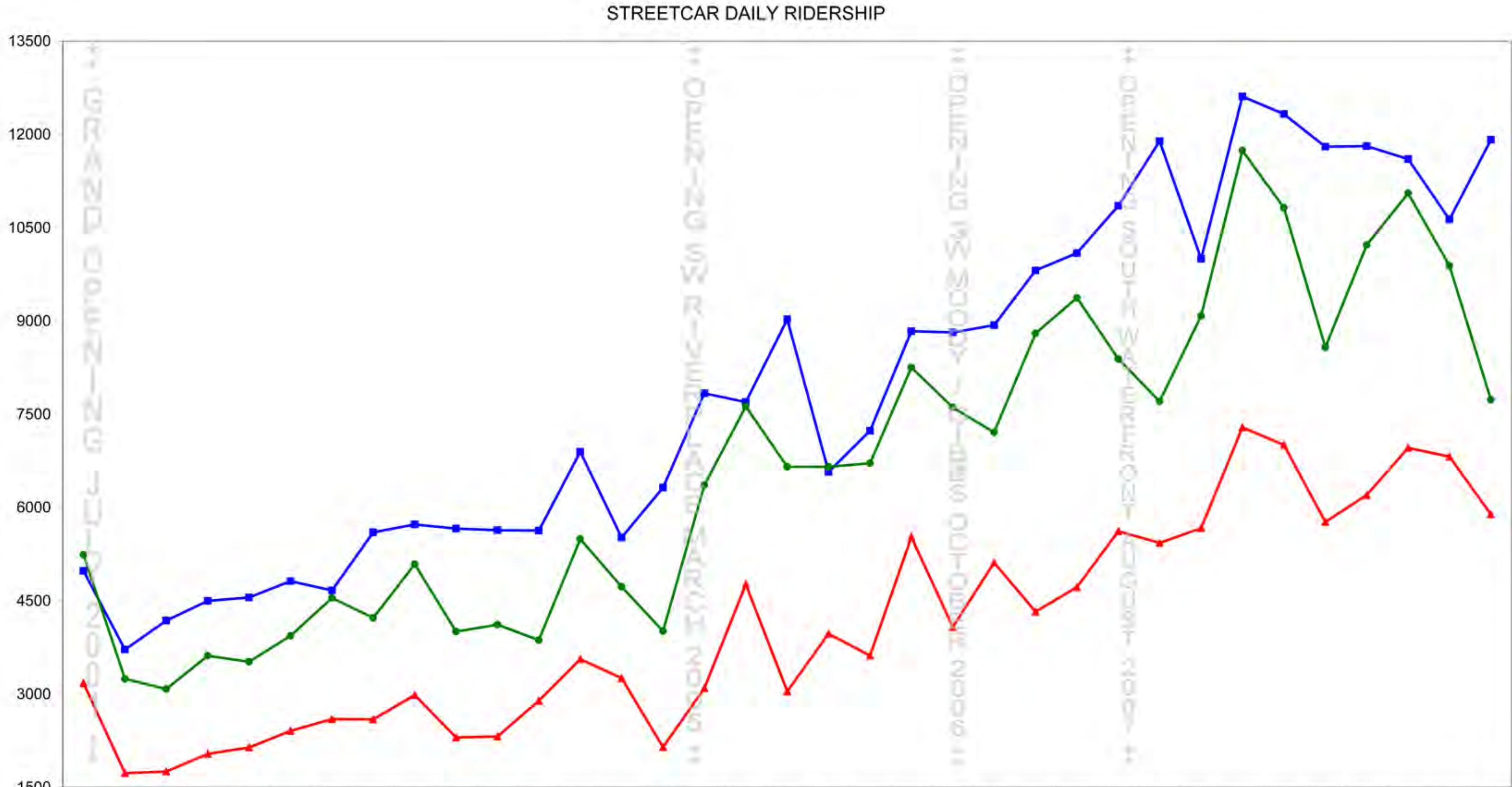
7 Burgress, E and Ashley Road, Reinventing Transit: American Communities Finding Smarter, Cleaner, Faster Transportation Solutions, Environmental Defense Fund, 2009.
8 The Office of Transportation and Portland Streetcar, Inc., Portland Streetcar Development Oriented Transit, 2008.

Figure 2-8: Portland Streetcar Daily Ridership



	Sum 2001	Fall 2001	Win 1/02	Spr 2002	Sum 2002	Fall 2002	Win 02/03	Spr 2003	Sum 2003	Fall 2003	Win 03/04	Spr 2004	Sum 2004	Fall 2004	Win 04/05 <VT>	Spr 2005	Sum 2005
Mon - Fri	4982	3715	4183	4500	4554	4817	4668	5602	5729	5662	5636	5629	6899	5518	6320	7837	7697
Saturday	5239	3244	3082	3617	3521	3937	4545	4227	5089	4006	4116	3866	5492	4727	4012	6359	7627
Sunday	3177	1729	1756	2037	2143	2407	2597	2592	2984	2302	2318	2894	3561	3258	2148	3094	4764

	Fall 2005	Win 05/06	Spr 2006	Sum 2006	Fall 2006	Win 06/07	Spr 2007	Sum 2007	Fall 2007	Win 07/08	Spr 2008	Sum 2008	Fall 2008	Win 08/09	Spr 2009	Sum 2009	Fall 2009	Win 09/10
Mon - Fri	9027	6572	7235	8836	8817	8933	9813	10092	10853	11891	10001	12611	12328	11802	11812	11605	10633	11914
Saturday	6656	6654	6712	8253	7610	7210	8800	9374	8389	7708	9083	11741	10820	8579	10221	11054	9890	7735
Sunday	3043	3971	3618	5524	4079	5113	4326	4720	5620	5430	5668	7290	7007	5767	6201	6959	6819	5892

http://www.portlandstreetcar.org/pdf/

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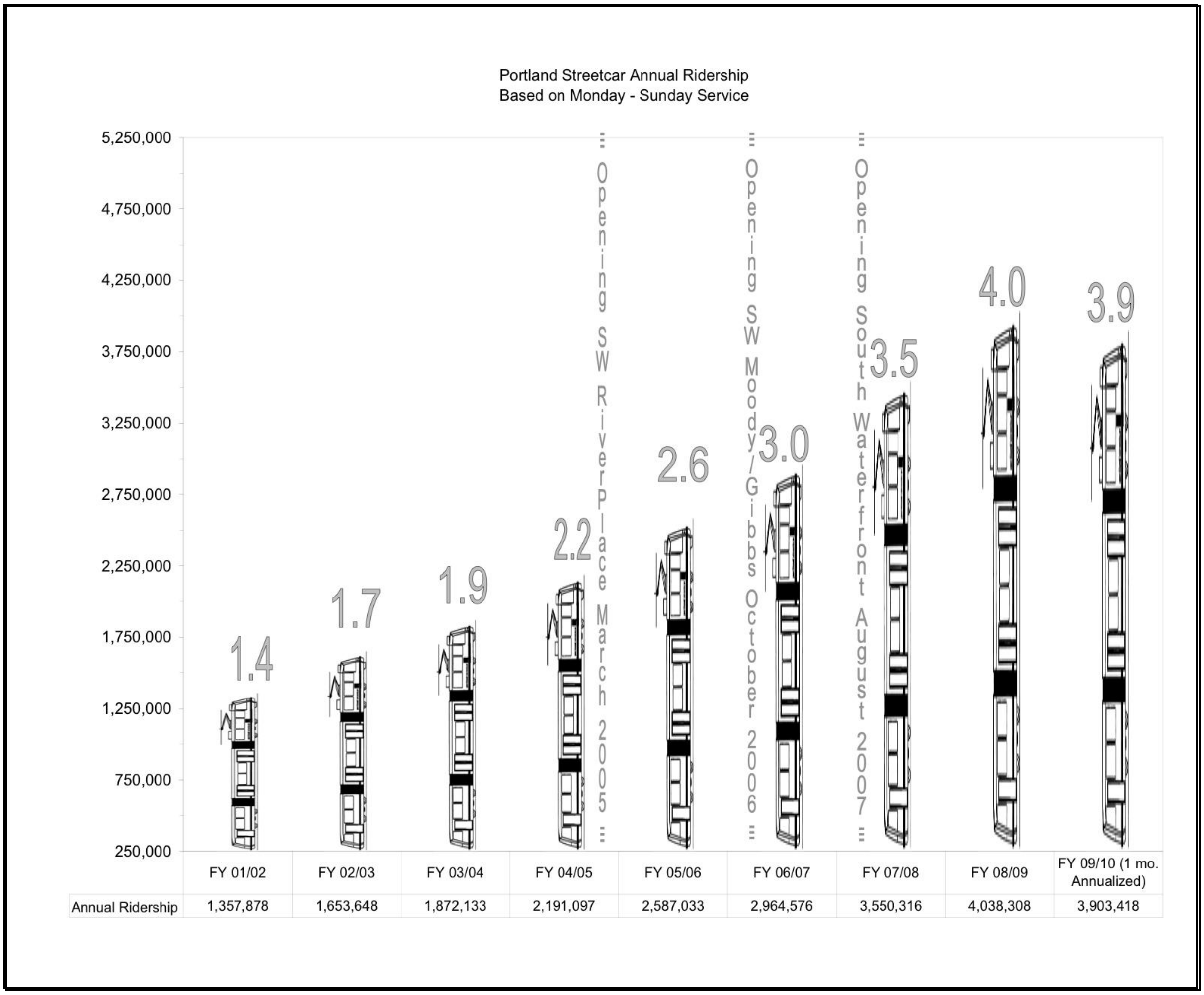
Annual ridership is shown in Figure 2-9. Annual ridership has increased from 1.4 million in FY01/02 to 3.9 million in FY09/10. Each consecutive year has seen an increase, with the exception of FY08/09 to FY09/10. During this time annual ridership decreased from 4.0 million to 3.9 million.

Figure 2-9: Portland Streetcar Annual Ridership



http://www.portlandstreetcar.org/pdf/

The Portland Streetcar reached its highest-ever spring ridership in 2010, while total streetcar ridership in the first half of the year is up by 11 percent over the same period in 2008. This increase occurred despite declining gas prices and a flagging economy that has had a negative impact on transit passenger counts elsewhere.[9]

Although growth prior to 2008 can be attributed to the expansion of the system, transportation professionals and TriMet cannot identify a direct contributor to the recent increased ridership.

9 Williams-Derry, Clark. "Portland Streetcar Defies Gravity', Sightline Daily, Northwest News that Matters, September 14, 2010.

Nothing significant has changed in or near the streetcar route (between 2008 and 2010) that explains the increase. The areas serviced by the streetcar were fully developed by 2008, no new major employers have located on the route, service has not increased, and nearby transit has basically remained the same.[10]

BUS NETWORK

TriMet operates a fleet of 651 buses on a network of eighty bus routes, as shown in Figure 2-10. Thirteen of these routes are designated "Frequent Service" bus routes, running every 15 minutes or better during the weekday morning and afternoon rush hour. TriMet's bus routes also include express buses from downtown Portland to South Beaverton, Sherwood and Oregon City, and from Marquam Hill to Beaverton, Tigard, Southwest Portland, and Milwaukie, as well as several "cross-town" routes that do not serve downtown Portland.

The Portland Streetcar provides a north-south transit alignment through the western edge of downtown Portland, serving the Pearl District redevelopment area and traveling west to the relatively dense, older neighborhoods adjacent to NW 21st and NW 23rd Avenues. No bus routes previously (or currently) provide a similar north-south connection through the west edge of downtown into northwest Portland. As shown in Figure 2-10, two bus routes connect from central downtown to NW 21st and NW 23rd Avenues (lines 17 and 15, respectively), but they travel along W Burnside Street and do not serve the west edge or the Pearl District.

Lines 17 and 15 do serve many similar destinations in northwest Portland including Legacy Good Samaritan Hospital. Depending on where they access the system, some riders do have a choice between one of the bus routes or the streetcar. Most riders will choose the route that provides the best travel time and the most convenient access and egress. However, surveys have shown that streetcar riders differ quite a bit from bus riders. For example 70 percent of streetcar riders are considered "choice" riders, while only 51 percent of bus riders are choice riders.[11] Fewer than 12 percent of weekday streetcar trips transfer to or from a TriMet bus or light rail line.

BICYCLE INTEGRATION

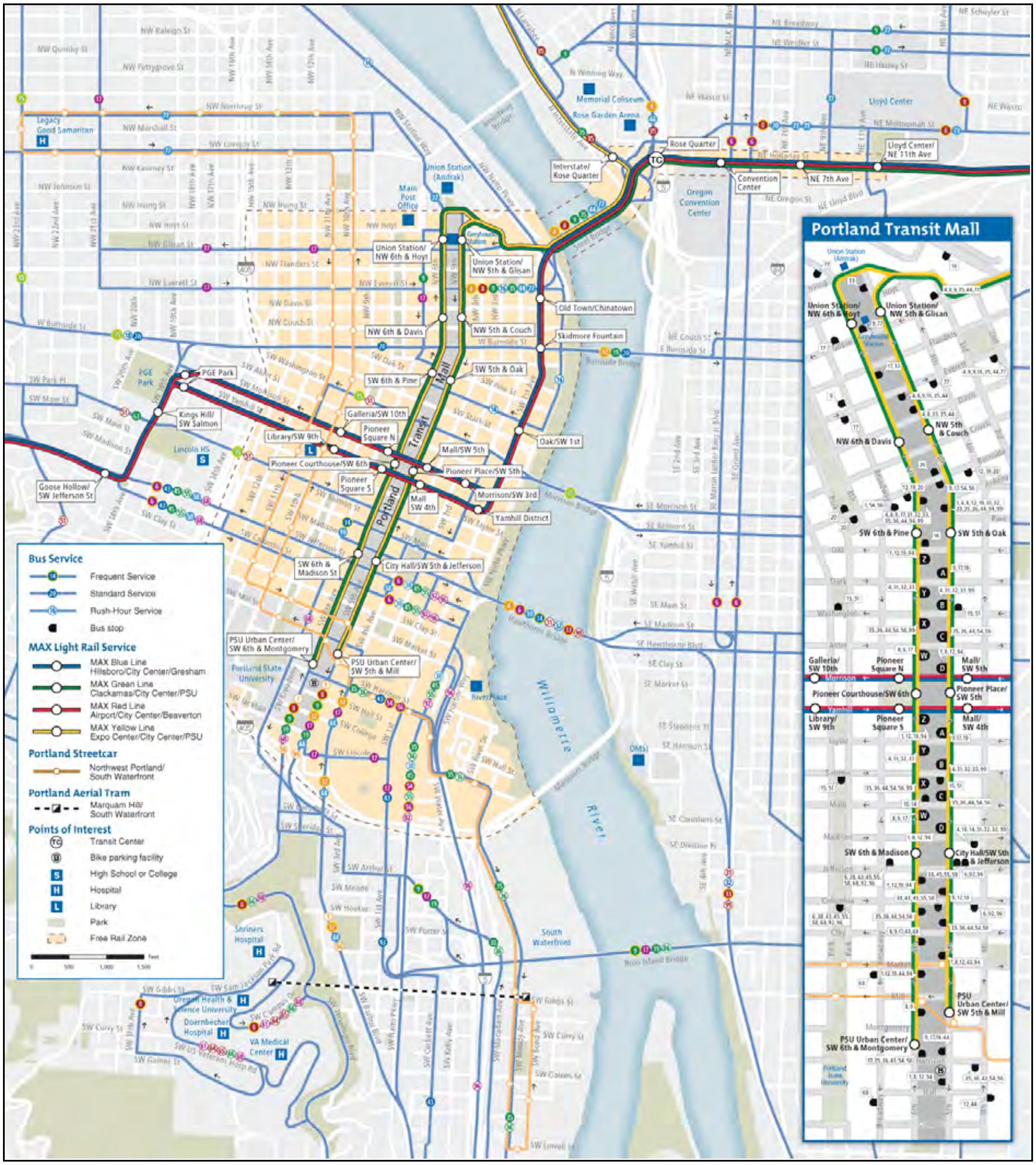
In addition to the development and popularity of the Portland Streetcar, cycling use has also increased. In theory, bicycles and streetcars are complementary modes. However, in practice, many cyclists feel the Portland Streetcar has deteriorated cycling conditions, creating new hazards.[12] To examine the interaction of these two modes, the Lloyd District Transportation Management Association (LDTMA), whose mission is to support and promote the economic vitality and livability of the Lloyd District through cooperative, business-supported programs promoting efficient, balanced transportation systems, and land use patterns, engaged in a bicycle and streetcar interaction study in 2008.

10 Williams-Derry, Clark. "Portland Streetcar Defies Gravity', Sightline Daily, Northwest News that Matters, September 14, 2010.

11 Draft Portland Streetcar Trips, 2004 Origin/Destination Data, TriMet Marketing Information Department, 2005.

12 Atla Planning + Design, "Bicycle Interactions and Streetcars: Lessons Learned and Recommendations", Lloyd District Transportation Management Association, October 17, 2008.

Figure 2-10: TriMet City Center Map



http://trimet.org/maps/citycenter.htm

Based on the 2008 study, *Bicycle Interactions and Streetcar Lessons Learned and Recommendations*, streetcar tracks pose a safety issue for bicyclists, and better integration of bicycle facility designs into streetcar planning is essential. Initial Portland Streetcar planning lacked the design guidelines and clear policy guidance needed to integrate streetcar and bicycles.[13] The primary issues for bicyclist-streetcar interaction are further discussed below.

Flange Gap and Angle of Crossing - Bicycle wheels and tires are very susceptible to getting caught within the gap of the streetcar track flange, as shown in Figure 2-11.

Figure 2-11: Flange Gap

http://www.altaplanning.com/App_Content/files/pres_stud_docs/Bicycle_Streetcar_Memo.pdf

Specifically, this situation occurs when a bicyclist is required to cross the tracks at less than a 60 degree angle. When a track “catches” a wheel, a bicyclist may be thrown from their bicycle and possibly suffer a severe, traumatic injury. To decrease the number of crashes caused by bicycle interaction with streetcar facilities, streetcar infrastructure is designed to minimize the number of situations a bicyclist must cross tracks at an unsafe shallow angle, or at a minimum, is designed with as close to 90 degree crossing as possible.

Right-running Tracks - Right-side running tracks and streetcar track curves, as shown in Figure 2-12, may create an instance where a bicyclist riding in the right lane chooses to cross the tracks at an angle less than 60 degrees. This is not desired and can lead to accidents. Center-running and left-running tracks are typically safer scenarios for bicyclists, as they avoid many of the conflicts between side running streetcars and parallel bike tracks.

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13 Atla Planning + Design, “Bicycle Interactions and Streetcars: Lessons Learned and Recommendations”, Lloyd District Transportation Management Association (LDTMA), October 17, 2008.

Figure 2-12: Streetcar Track Curves

http://www.altaplanning.com/App_Content/files/pres_stud_docs/Bicycle_Streetcar_Memo.pdf

In response to cyclist concerns, where possible, Portland has separated bicycle travel from streetcar tracks, as shown in Figure 2-13. Such bikeway facilities mark cycle tracks or bicycle lanes adjacent to streetcar tracks, with platforms designed to allow bicyclists to bypass pedestrian zones without encountering waiting pedestrians. In addition, signs (as shown in Figure 2-14) and pavement markings can be used to assist cyclists in maneuvering around track curves at safe angles. Portland continues to work with the bicycle community to develop solutions to create a safe environment for both transit and bicycle users.

2.3 Financial Characteristics

CAPITAL COSTS

The total capital cost of constructing the initial Portland Streetcar was approximately $103.2 million, or $12.9 million per track mile. This amount includes less than $25 million per alignment mile and the purchase of seven vehicles for Phase 1, $16 million ($13 million per track mile) for the 0.6 mile extension to RiverPlace and a new roadway for retained structures to provide access to properties along the riverfront (in preparation for an extension to South Waterfront), $15.8 million for the Gibbs Extension ($13 million per track mile) and the purchase of three vehicles, and $14.5 million for the 0.4 mile Lowell Extension ($12 million per track mile).[14]

14 Office of Transportation and Portland Streetcar, Inc., “Portland Streetcar Development Oriented Transit”, April 2008.

Figure 2-13: Bicycle Path along Portland Streetcar

Figure 2-14: Bicycle / Streetcar Signage

URS Corporation

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The latest streetcar extension, the Portland Streetcar Loop Project, has a higher cost due to the increase in vehicle and construction costs. This 3.3 mile extension has a total capital budget of $147 million, or $44.5 million per route mile, including vehicles, engineering, administration, and construction.

OPERATION AND MAINTENANCE COSTS

The 2010 Fiscal Year Portland Streetcar operations budget for the four-mile alignment is $5.5 million.[15] Sources for this operating budget include TriMet ($3.2 million), the City of Portland Office of Transportation ($1.8 million), and fares, sponsorship, and promotions ($0.5 million).

Prior to the opening of streetcar service in 2001, the City of Portland and TriMet reached an agreement on responsibility for operating costs. TriMet estimated an approximate cost of $1.6 million per year to operate bus service to the newly developing Pearl District. (However, this estimated bus service was not identical, and was a slightly shorter route compared to the streetcar.) This amount covered two-thirds of the annual streetcar system operating cost of $2.4 million. The City of Portland and fare revenues covered the remaining one-third. At the same time TriMet and the City of Portland signed an Intergovernmental Agreement (IGA) that committed TriMet to provide two-thirds of the funding for the ongoing streetcar operations.

Subsequent to the 2001 agreement, TriMet agreed to provide an additional $400,000 per year for each of the three extensions. In addition, TriMet agreed to increase their annual contribution based on the Consumer Price Index (CPI). In 2009, due to TriMet's financial problems, a revised IGA was signed allowing TriMet to reduce their contribution to streetcar operations by eight percent. By Fiscal Year 2010, the TriMet contribution had decreased to approximately 58 percent of the total Portland Streetcar system operating costs.

The initial proportion of operating cost assigned to TriMet was based on an estimate of bus service savings and the subsequent agreement to contribute $400,000 to operate each extension was also based on a general sense of the potential bus service savings. However, TriMet Board actions recognize streetcar service is an important element of the regional transit system, and is appropriately supported through TriMet general funds regardless of a direct relationship to savings in bus operations.

The City of Portland, fare revenues, and limited private sources (i.e. streetcar stop sponsorship) account for the remaining operating funding (non-TriMet) for the Portland Streetcar. The City funding primarily comes from parking meter revenues and parking fine revenues from geographic areas that are served by the streetcar service.

FUNDING STRATEGIES

Financing of the Portland Streetcar has followed a different path and used a different mixture of funding sources for each segment constructed. The 2.4 mile first phase cost a total of $56.9 million, which was locally funded, making Portland's Streetcar a unique transportation project. The most substantial share of capital costs was financed by a municipal parking revenue bond supported by

15 http://www.portlandstreetcar.org/pdf/capital_and_operations_detail_20100908.pdf

parking fees in the area of the streetcar. Additional local mechanisms relied on value capture, including a Local Improvement District (LID) and a Tax Increment Finance (TIF) District. Major tax-exempt property owners, including Portland State University, pay the LID fee because of the benefits they receive from streetcar service.

The city and the region decided not to seek federal funding for the initial project in part due to other regional priority light rail projects (i.e. Westside MAX) that were seeking New Starts funding during that time period. The region also recognized the complexity involved with attempting to be the first streetcar project funded using the New Starts program.

Funding sources varied as each of the three subsequent, shorter segments were constructed. To date, Portland's Streetcar has been financed by approximately 79 percent local funds, including 19 percent contributed by LID funds, and 21 percent by TIF funds. Funding sources for the current system, including the three extensions, are shown in Table 2-2.

Table 2-2:
Capital Funding Sources

SOURCE OF FUNDS	AMOUNT
Bonds revenues from a parking rate increase in City-owned parking garages	$28.6 million
Tax Increment Funds	$21.5 million
Local Improvement Districts	$19.4 million
Regional Transportation Funds	$10.0 million
City funds	$8.75 million
Connect Oregon	$2.1 million
Reallocated transit funds from TriMet	$5.0 million
Transportation land sale	$3.1 million
Other sources	$4.7 million
Total	$103.2 million

Source: Office of Transportation and Portland Streetcar, Inc.

Funding sources for the fourth stage of streetcar system expansion, which will add 3.3 miles of double-tracked lines and connect the Pearl District in northwest Portland with areas across the Willamette River east of the downtown core, are shown in Table 2-3. This extension will rely more extensively on federal Small Starts funds, with $75 million, or just over 51 percent of the project, federally funded. This was the first streetcar project funded through Small Starts, which required completing an Environmental Assessment and extensive work on ridership forecasting. Local funding from a LID and the Portland Development Commission will contribute 10 percent and 19 percent, respectively.

Table 2-3:
Sources of Funds for Planned Streetcar Expansion

SOURCE OF FUNDS	AMOUNT	PERCENT
Local Improvement District	$15,000,000	10.3%
Portland Development Commission	$27,000,000	18.5%
System Development Charge	$6,000,000	4.1%
Regional Funds	$3,000,000	2.1%
Vehicles from State	$20,000,000	13.7%
Federal Transit Administration	$75,000,000	51.4%
Total Project	$146,000,000	100.0%

Source: Portland Streetcar Loop Fact Sheet, City of Portland & TriMet, September 2007

ECONOMIC DEVELOPMENT

The Portland Streetcar has been analyzed extensively, primarily in terms of the amount, density, and timing of development it has stimulated.

Existing Development

The initial stage of the Portland Streetcar is credited with stimulating accelerated development of condominiums and specialty retail in the Pearl District, an urban revitalization area. This area garnered substantial press in the late 1990s when a major developer promoting the streetcar concept agreed to build higher densities when streetcar funding was finalized.[16] According to surveys performed for the *TCRP Synthesis 86: Relationships between Streetcars and the Built Environment*, the streetcar was one of many components of a longstanding and ongoing program to revitalize downtown Portland and reshape the city as transit- oriented.

The TCRP surveys also indicated there is no single key factor for streetcar success. Rather, a host of urban amenities have supported the streetcar and contributed to its success in Portland. These amenities include an extensive light rail system, the Fareless Square (free transit service in the downtown[17]), extensive streetscape improvements, substantial allowable density, fine-tuned parking regulations, strong design guidelines and review process, and financial incentives offered by the Portland Development Commission.
There are four distinct areas that have been the focus of streetcar-related development; Pearl District, South Waterfront, Lloyd District, and Central Eastside.

The existing zoning in all four areas is a flexible mixed use zone that allows commercial, employment, and residential uses. In the case of the Pearl District and South Waterfront, these

16 Golem, R. and J. Smith-Heimer, TCRP Synthesis 86: Relationships between Streetcars and the Built Environment, Transportation Research Board, National Research Council, Washington, D.C., 2010.

17 Fareless Square was initiated 34 years ago to help address air quality issues, reduce car trips downtown, and increase transit usage. Originally, the transit system consisted of only buses, but has since expanded to light rail and the Portland Streetcar. On January 3, 2010, TriMet's board of directors voted to change Fareless Square to rail and streetcar only. Bus service is no longer free in downtown Portland and the Lloyd District.

zones were implemented as part of master planning efforts. While in the Lloyd District and Central Eastside, this zoning has been in place since the Central City Plan of 1988.

The Pearl District is served by the original streetcar alignment. Much of the area was a former rail yard and redevelopment was planned through a master planning effort that included applying an EX (Central Employment) zoning to the area. This is a mixed use zone that encourages employment but also allows residential. This zone was applied in this area through a public master planning process, which included the streetcar, parks, and other elements. The Portland Development Commission (PDC), the city's redevelopment agency also negotiated developer agreements whereby developers agreed to develop at higher densities after the city provided key infrastructure, such as the streetcar and parks.

The South Waterfront area is served by the south extensions of the streetcar. This is a former riverfront industrial area that was also planned through a master planning effort, including an evolution from industrial to mixed use, a new street grid system, and the streetcar extension. This area currently has predominantly a CX (Central Commercial) zone, which is a mixed use zone that allows for residential development with an emphasis on commercial. This zone allows for some of the highest densities outside of downtown Portland. The PDC also negotiated developer agreements with developers in this area.

The Lloyd District/Central Eastside area will be served by the Eastside Loop Streetcar scheduled to open in 2012. Unlike the Pearl District and South Waterfront, these areas are largely developed. The Lloyd District has the same CX zoning as South Waterfront and the Central Eastside along the future streetcar alignment, generally has the same EX zoning as the Pearl District. All of this zoning was in place prior to the decision to extend the streetcar to these areas. The PDC is working to support streetcar supportive infill development in these areas.

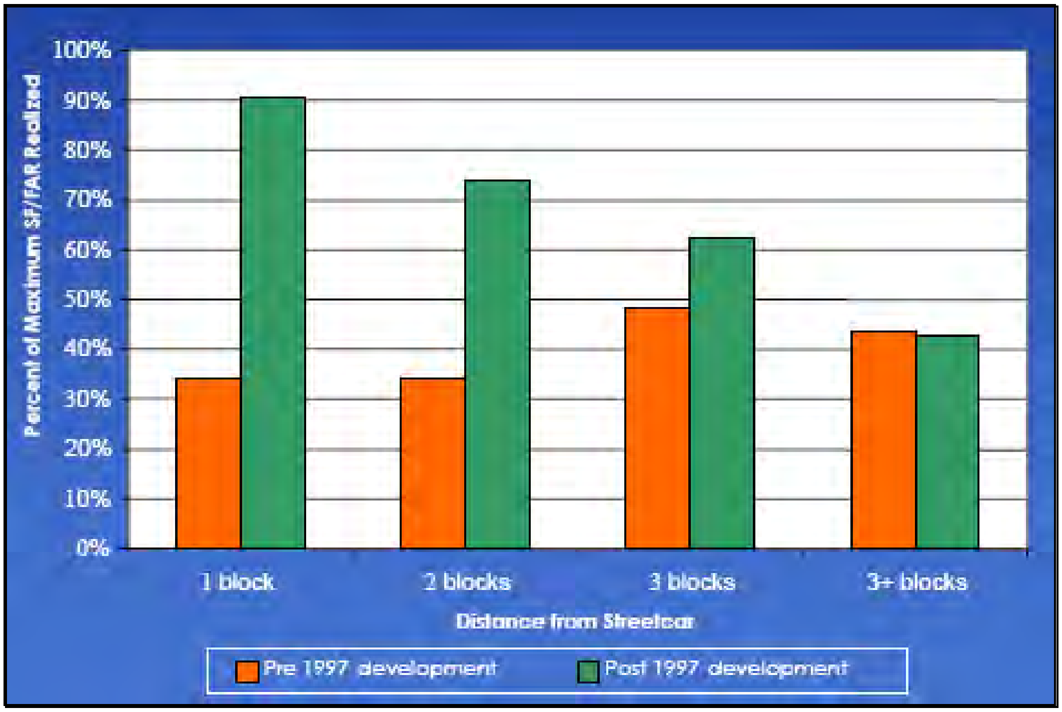
New Development

A 2005 report prepared by E. D. Hovee & Company for Portland Streetcar, Inc. analyzed the development patterns experienced after the streetcar system was announced for downtown Portland. The study looked at new development quantities before and after 1997, based on the number of blocks from the streetcar route, with the one block distance representing three blocks in width, as a result of the double streetcar tracks built with a block in between as well as another block on either side of the track.

Hovee's analysis found that between 1997 and 2004, the blocks adjacent to the streetcar attracted more and denser development. As shown in Figure 2-15, for the blocks adjacent (within one block) to the streetcar tracks, new development averaged 90 percent of allowable Floor Area Ratio (FAR) post-1997, compared to 34 percent before the streetcar. Similarly, for parcels within two blocks of the streetcar tracks, development increased from 34 percent pre-1997 to 74 percent post-1997. The streetcar shifted the attractiveness of sites adjacent or near to its tracks from moderate to high.[18]

18 Golem, R. and J. Smith-Heimer, TCRP Synthesis 86: Relationships between Streetcars and the Built Environment, Transportation Research Board, National Research Council, Washington, D.C., 2010

Figure 2-15: Portland Streetcar Development



www.piketransit.com/downloads/Portland-Streetcar-2-03202006.pdf

Based on a 2006 Portland Office of Transportation study *Portland Streetcar Development Oriented Transit, which* reported 7,248 housing units had been constructed along Portland's streetcar line by the end of 2005, the VMT savings of locating these households within a mixed use, transit-rich environment as opposed to an 'average' suburban environment was calculated. Using the estimated vehicle miles per capita decrease for residents living in mixed use, transit-rich neighborhoods of 9.8 miles, which is 26 percent lower than transit-rich but non mixed use neighborhoods and 122 percent lower than the regional average, the neighborhood around Portland's Streetcar experiences a vehicle mile savings of 60 million.[19]

However, as previously mentioned, other factors contributed to the growth in new development, including local land use policies, the construction of a light rail system, urban renewal, and the ability to use TIF funds to subsidize infrastructure and development projects. Moreover, other development trends were present in Portland at that time, such as increased developer demand for more densely developable sites, the real estate boom for condominiums offering urban lifestyles with high amenities in downtown Portland, and rising land costs.

19 E.D. Hovee & Company, LLC, Economic and Development, Streetcar-Development Linage: The Portland Streetcar Loop, February 2008.

2.4 Vehicle

TYPE

The Portland Streetcar operates the modern Škoda -Inekon streetcar, as shown in Figure 2-16. The streetcars are a Czech design built in the Czech Republic and shipped to the United States upon completion. They have a low-floor center section between the trucks, one door on each side, and are equipped with an ADA bridge plate that extends from the vehicle doorway to allow wheelchair access, as shown in Figure 2-17. Couplers on the streetcars are hidden behind bumper skirts and are only used to move disabled units back to the yard. This safety feature protects motorists who may collide with the end of a streetcar.

Figure 2-16: Portland Streetcar at the Portland State University Stop

http://en.wikipedia.org/wiki/File:PortlandStreetcar5.jpg

The current fleet includes ten streetcars, supplied between 2001 and 2009, which were built by two different manufacturers. However, they are nearly identical in design. The streetcars have the capacity to carry up to thirty seated and 127 total passengers. Cars 001 through 005 have been in operation since 2001, while cars 006 and 007 were added in 2003. These seven were built by a now-defunct joint venture between Škoda and Inekon.

Figure 2-17: ADA Bridge Plate

URS Corporation

Due to the fact that Portland's fleet of imported streetcars have been reliable and easy to maintain, United Streetcar partnered with Skoda, and in 2006 obtained an exclusive license to manufacture Skoda-designed modern streetcars in the United States.[20] After receiving a $4 million contract to produce the nation's first domestically-manufactured modern streetcar,[21] Oregon Iron Works Inc. unveiled its first streetcar in July 2009.[22] This US-made streetcar will be used as Portland continues with its Streetcar Loop Project and adds additional vehicles to the system. The prototype vehicle, delivered in July 2009, is still in development and not currently in operation.

20 Merry Mackinnon, "Streetcars soon to be made in Oregon," Portland Tribune, May 14, 2009, accessed November 1, 2010, http://www.portlandtribune.com/news/story.php?story_id=124225153770065200.

21 "Oregon Iron Works gets contract for streetcar," Portland Business Journal, January 26, 2007, accessed November 1, 2010, http://www.bizjournals.com/portland/stories/2007/01/22/daily45.html.

22 Joe Brugger, "Transportation secretary watches as 'Made in the USA' streetcar makes debut," The Oregonian, July 1, 2009, accessed November 2, 2010, http://www.oregonlive.com/business/index.ssf/2009/07/transportation_secretary_watch.html.

STORAGE AND MAINTENANCE FACILITIES

The Portland Streetcar has a total of 10 Skoda Streetcars housed at the maintenance facility, which is located at 1516 NW Northrup (under Interstate 405) and also houses the staff of Portland Streetcar. Staff includes 24 Operators, three Superintendents, and five Maintenance Technicians from TriMet, as well as a Manager, Assistant Manager of Maintenance, Manager of Operations and Safety, Assistant Manager of Operations, and two stop and car cleaners from the City of Portland.

TRACTION POWER

A streetcar systems power supply is how electricity from the local electric utility's voltage distribution network is transferred to the streetcar vehicles. This power supply includes the traction electrification system (TES) and overhead-contact stems (OCS) for power distribution. The utility distributes power as alternating current (AC), while the power to the vehicle is direct current (DC). Therefore, the TES substation must contain transformers to convert the power to a usable voltage.

Streetcar vehicles draw power from the OCS by either a trolley pole (a spring-loaded pole with a grooved 'shoe' that straddles the wire and slides along its axis) or pantograph (a `hinged frame or tube with a wide contact surface that slides along the wire and can move laterally). Two configurations are also common for the overhead wires. A simple trolley wire is a single wire hung from pole to pole that conducts current and provides a contact surface for the trolley pole or pantograph. A catenary is a combination of wires, including an upper 'messenger' wire and a suspended contact wire. The simple trolley wire creates less of a visual disturbance. However, the advantage of a catenary system include greater overhead current distribution, greater spacing between support structures, and higher speeds.

When transferring power from the wire to the streetcar vehicles, because it is DC, the electricity must be grounded. Typically this is done by directing the current through the vehicle's steel axles and wheels. An insulation material is then used to ground any return current, avoiding any deterioration to nearby conductors.[23]

The Portland Streetcar TES and OCS power supply system includes a simple trolley wire and pantograph, as shown in Figure 2-18. Substations are spaced closely together at approximate half mile intervals. These substations are approximately 10 feet by 18 feet, small enough to be placed in unobtrusive locations. For example, one substation is situated in a city parking garage, another in an alley near the streetcar route, and several are placed in vaults under the sidewalk. As a result, no costly and disruptive excavation was necessary for underground conduit.

Instead of connecting to a medium- or high- voltage distribution line, which can be costly, the substations tap into the 480-kilowatt commercial power supplied to adjacent buildings. The steel rail, which is embedded in a concrete track slab in the street, is encased in a rubber boot. Due to the close spacing of the substations, parallel buried feeder or return cables are not necessary, and the

23 The America Public Transportation Association and the Community Streetcar Coalition, "Street Smart, Streetcars and Cities in the Twenty-First Century", Gloria Ohland and Shelley Poticha (Oakland, CA) 2009.

single contact wire is sufficient to maintain line voltages within specified limits. This spacing also reduces the possibility of return voltage traveling to nearby underground pipes and structures.[24]

Figure 2-18: Portland Streetcar Overhead Contact System

http://sustainstl.org/is-a-sustainable-st-louis-solution-found-in-its-past/

24 The America Public Transportation Association and the Community Streetcar Coalition, "Street Smart, Streetcars and Cities in the Twenty-First Century", Gloria Ohland and Shelley Poticha (Oakland, CA) 2009.

3.0 SEATTLE

The Seattle Streetcar is a 1.3-mile streetcar line of single- and double-track segments serving the South Lake Union neighborhood of Seattle. This system is a new modern streetcar system in full revenue service, in a larger urban setting. The planning process to develop this system provides relevant information and lessons learned for Brooklyn. First, the South Lake Union service was developed in response to a need to provide transit service to a localized area considered to have little or no existing bus or transit service. While Red Hook has an existing bus service, it is perceived by residents to be unreliable and infrequent. In addition, there is no fixed-guideway or subway service. Second, in addition to improving transit service, there was a great interest in promoting economic development in the South Lake Union neighborhood. Similarly, there are opportunities for development in Red Hook. Local investment initiated and continues to heavily fund the South Lake Union streetcar. This was possible due to the size and simplicity of the system. Third, Seattle's streetcar serves a waterfront area similar to Red Hook's waterfront area.

As shown in Figure 3-1, the South Lake Union Line travels from the Westlake hub to the Fred Hutchinson Cancer Research Center in South Lake Union, with stops every three blocks or up to one-quarter of a mile apart. Transfers can be made at Westlake to many bus routes on the surface streets and to some bus routes and Light Rail service in the Downtown Seattle Transit Tunnel's Westlake Station. Service opened in December 2007.

3.1 Planning Process Overview

In February of 2004, the Seattle Department of Transportation began a study in response to the City Council's request for information to "support decision-making about a proposed new route in South Lake Union, and about proposed extensions of the Waterfront Streetcar." The *Seattle Streetcar Network and Feasibility Analysis* provided information about the South Lake Union route and potential Waterfront Streetcar extensions, taking a preliminary look at what a future streetcar network looks like.

There was little to no bus service within this neighborhood prior to the Southlake Union Streetcar. This was primarily due to lack of ridership potential as there was little residential development in the neighborhood. Development of the streetcar was timed with the beginning of a large redevelopment phase of the neighborhood.

As reported in the *Seattle Streetcar Network and Feasibility Analysis*, based on comparing streetcars to other modes and on researching streetcar systems in other cities in North America, the following conditions were identified as contributing to successful operations:

Demand for relatively short trips where speed is not a critical factor. Streetcars are a good application for point-to-point trips in a dense, mixed-use environment. These trips do not necessarily need to be fast because the distances are not great and there may be no time advantage to using a faster mode.

Figure 3-1: South Lake Union Streetcar Service

http://www.seattlestreetcar.org/

Demand for high capacity network connections and neighborhood circulation. Streetcars have a role as neighborhood circulators working in concert with regional transit. Many cities with streetcars report that passengers ride streetcars after transferring from regional routes, despite previously being reluctant to transfer to buses for their distribution trip.

Lack of extreme street congestion and limited competition with high capacity services. Where streetcars operate in mixed traffic, reliability is vastly improved if there is less congestion on the street and limited opportunities for traffic to impede the movement of the streetcar. In addition, streetcar operations are separated from other higher capacity or high frequency routes operating on the same street to minimize space competition.

Demand for high frequency service, but without light rail capacity demands. Streetcars are generally not connected into multi-car trains and therefore do not offer high capacity. Streetcar systems typically run no less frequently than every 15 minutes and are designed to operate reliably. Adding frequency, rather than increasing vehicle size, increases demand.

Mixed uses or a variety of markets. Streetcars are good at serving multiple user markets on a single line, rather than being focused on a single market. Short workday trips are served along with trips for recreation, errands, and tourist activities.

Presence of tourists and occasional users. Streetcars encourage visitors and other occasional users to take transit, especially if the streetcar connects local and regional destinations.

Desire to accelerate planned development. Streetcars alone are not necessarily development catalysts. However, in areas that are likely to develop, a streetcar can help accelerate and organize development, encouraging transit-oriented development.

Property owners willing to contribute to the success of the streetcar. Streetcars benefit when property owners are willing to participate in aspects of the system, including financing and development orientation.

DESIGN CRITERIA

Streetcar design criteria includes: alignment geometry, speeds, roadway cross section, lane selection, traffic signals, and streetcar stops. General guidelines for these criteria are described above for the Portland Streetcar.

ALIGNMENT DECISION PROCESS

The *Seattle Streetcar Network and Feasibility Analysis* began with routes identified by the City Council then broadened to look at additional routes. A more detailed analysis was conducted to provide information to support decision-making about the South Lake Union route or potential extensions of the Waterfront Streetcar.[25]

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25 Seattle's Waterfront Streetcar was in operation at the time of the Seattle Street Car Network and Feasibility Analysis; however, service ended abruptly and controversially in 2005 when the land housing its streetcar maintenance facility was taken over by the Seattle Art Museum for a new sculpture garden.

Based on the design criteria explained above, the *Seattle Streetcar Network Feasibility Study* evaluated the following potential streetcar routes:

- South Lake Union from Westlake to Yale
- South Lake Union from Yale to University of Washington
- Chinatown/International District/S. Jackson Street Corridor
- Waterfront North to Interbay
- Waterfront to SoDo and/or T-46

For each of these routes, the following attributes were considered:

- Possible termini
- Demand/market
- Land uses
- Connections to other modes
- Financing potential
- Traffic conflicts
- Dependencies
- Known issues/advantages
- Potential implementation order

South Lake Union. This corridor connects the developing South Lake Union and Denny Triangle neighborhoods with the retail core and major transportation node at Westlake Center. South Lake Union is a former light industrial area that was planned and rezoned for redevelopment to accommodate new office, research, and residential uses. It was designated in 2004 as one of the city's six urban centers where the city seeks to direct most of its residential and employment growth. Historically, the area lacked transit. Thus, the streetcar supported the development of jobs and housing in the area and became an implementing action for the urban center.

This line meets the design criteria and could be built without being dependent on, or inte rrupted by, any of the major construction projects anticipated in the Center City area. This corridor could be extended to serve the Eastlake neighborhood and destinations in the University district, including the University of Washington medical campus, and/or connecting to the regional transit system at NE 45th Street and Brooklyn Avenue NE.

In preparation for the feasibility of future extensions to the South Lake Union line, the city prepared the *Streetcar Network Development Report*. The previous report included connections to the former Waterfront streetcar that no longer exists. In addition, there are topographical conditions that create grade challenges in connecting the South Lake Union and Downtown Seattle areas to the waterfront via streetcar. Several corridors were identified.

The Central Streetcar Line. This corridor would connect the South Lake Union Line to downtown Seattle, the International/Chinatown District, and Seattle Center (including the Space Needle). This potential line would serve community and tourist events at Seattle Center, the high density residential area of Belltown, downtown Seattle, and the multimodal regional transportation hub served by Link Light Rail, Sounder Commuter Rail, and Amtrak rail.

The First Hill-Capitol Hill Line. This corridor would connect the Capitol Hill and First Hill high density neighborhoods, two colleges, several hospitals, and medical centers to the International District/Chinatown District and the multimodal regional transportation hub described above. This line is currently under design.

The Fremont-Ballard Line. This corridor would extend the South Lake Union Line to the north/northwest, crossing the ship canal into the Fremont and Ballard neighborhoods. These neighborhoods have a mixture of residential, commercial, office, and light industrial uses and continue to increase in density/intensity as redevelopment occurs.

The U-Line. This corridor would extend the South Lake Union Line to the north/northeast, crossing the "Montlake Cut" or ship canal, through the Eastlake neighborhood to the University District and University of Washington. The corridor is currently well served by bus service, and the University will soon be connected by Link light rail. If redundant bus service is removed from Eastlake upon opening of the Link extension, the demand for local service may increase. In addition, the corridor has a major shuttle van connecting the University of Washington Medical Center, Seattle Children's Hospital, and the various cancer research and clinics on Eastlake such as the Fred Hutchinson Cancer Center.

In addition to the *Seattle Streetcar Network and Feasibility Analysis*, the *TCRP: Synthesis 86: Relationships between Streetcars and the Built Environment* performed a survey to obtain first-hand knowledge of the current state of the practice. Table 3-1 includes the survey tabulation for Seattle's South Lake Union Streetcar. As the table shows, streetcar route planning was focused on many factors, with only 'Generating affordable or workforce housing' ranking low.

Table 3-1:
Rating of Importance of Route Selection/Planning for Operations

SOUTH LAKE STREETCAR	RATING
Serving commuters to daily job locations	5
Serving tourists and visitors	4
Serving students	3
Connection cultural, entertainment, or civic destinations	5
Connecting with other modes of transit (light rail, commuter rail, bus)	5
Stimulating revitalization	5
Generating affordable or workforce housing	2
Organizing new neighborhoods around transit	5
Compatibility with comprehensive/general plans	5
Notes: 1= NOT important in route planning, 5: VERY important in route planning	

TCRP: Synthesis 86: Relationships between Streetcars and the Built Environment (based on input from the Director of the Department of Planning and Development, City of Seattle and the Streetcar Project Manager, Department of Transportation, City of Seattle)

Future Planning

The next stop for the Seattle Streetcar is the First Hill Streetcar Line. In November 2008, voters in the Puget Sound area approved "ST2", the mass transit expansion plan for the region. This measure builds on the Sound Move plan approved in 1996 to expand light rail, commuter rail, and express bus service. The ST2 Plan includes funding for the First Hill Streetcar connector project, which links First Hill employment centers to the light rail system via connections on Capitol Hill and in the International District. Through an interlocal agreement, the City of Seattle will build this new streetcar line with funding provided through the mass transit expansion measure. The First Hill Streetcar will connect diverse and vibrant neighborhoods on Capitol Hill, First Hill, and in the Chinatown/International District, while serving medical centers.

PRINCIPAL CHALLENGES

Constructability

As previously mentioned, in terms of constructability the South Lake Union corridor had the advantage of being constructed without being dependent on any of the major construction projects anticipated in the Center City area.

Figure 3-2: South Lake Union Streetcar Construction

As reported in the *Seattle Streetcar Network Feasibility Study*, constructing a streetcar network in Seattle was expected to be similar to the construction of peer city streetcar lines, particularly Portland. In the typical construction method for the streetcar track system, the top 12 to 18 inches of pavement is removed and replaced with rail-embedded reinforced concrete slabs within a trench approximately eight feet wide. Using low-cost methods, similar to Portland, construction began, as shown in Figure 3-2, on July 7, 2006 and was completed the following year.[26]

Construction of the South Lake Union Streetcar also involved the installation of traction power substations, relocation of utilities, and upgrading the stormwater detention system.

Utilities

The *Seattle Streetcar Network Feasibility Study* identified potential utility impacts and made the following recommendations.

- Relocate a 12-inch water main adjacent to the northbound track along Westlake Avenue from Olive Street to Denny Way.
- Explore options to minimize impacts of a 20-inch, high-pressure gas main adjacent to the southbound track along Westlake Avenue from 6th Avenue to West Thomas Street.
- Identify possible alignment conflict with overhead power lines along the north side of Fairview Avenue N.
- Identify possible need for reconfiguration to avoid conflicts with the track slabs on Westlake and several electrical vault accesses located between Stewart Street and 8th Avenue.

Following local, state, and federal regulations, potential environmental impacts to the existing combined stormwater system and drainage in the project area arising from the construction and operation of the proposed Seattle Streetcar project were evaluated.

Specifically, a stormwater pollution prevention plan (SWPPP) was prepared consistent with the Seattle Municipal Code 22.800 and the City of Seattle Standard Plans and Specifications for Municipal Construction. The SWPPP was required as a part of the NPDES Baseline General Permit and incorporated Temporary Erosion and Sediment Control (TESC) measures required to minimize sediment runoff during construction. The TESC measures help to avoid or minimize the occurrence of excavated soils and construction materials being deposited on streets or in conveyance piping, and help prevent turbid water from entering Lake Union. The SWPPP also describes the temporary Best Management Plans (BMPs) selected for water quality treatment during project construction.

Similar to Portland, Seattle did not create formal guidelines with respect to utilities. Generally, utilities running parallel to the streetcar and located within five feet of the track slab were relocated. In determining utility relocation, corrosion was Seattle's number one concern, with maintenance access second. To determine the condition of perpendicular crossings, Seattle excavated test holes (or test pits) to verify the size and location of underground utilities. If the existing utility was in poor condition, a casing was installed. Offset manholes were not used.

Laterals were installed as needed during construction, but not for future users. Since construction of the South Lake Union Streetcar, one water lateral has been installed beneath the track slab. Construction was coordinated through the City of Seattle's street maintenance department and progressed smoothly.

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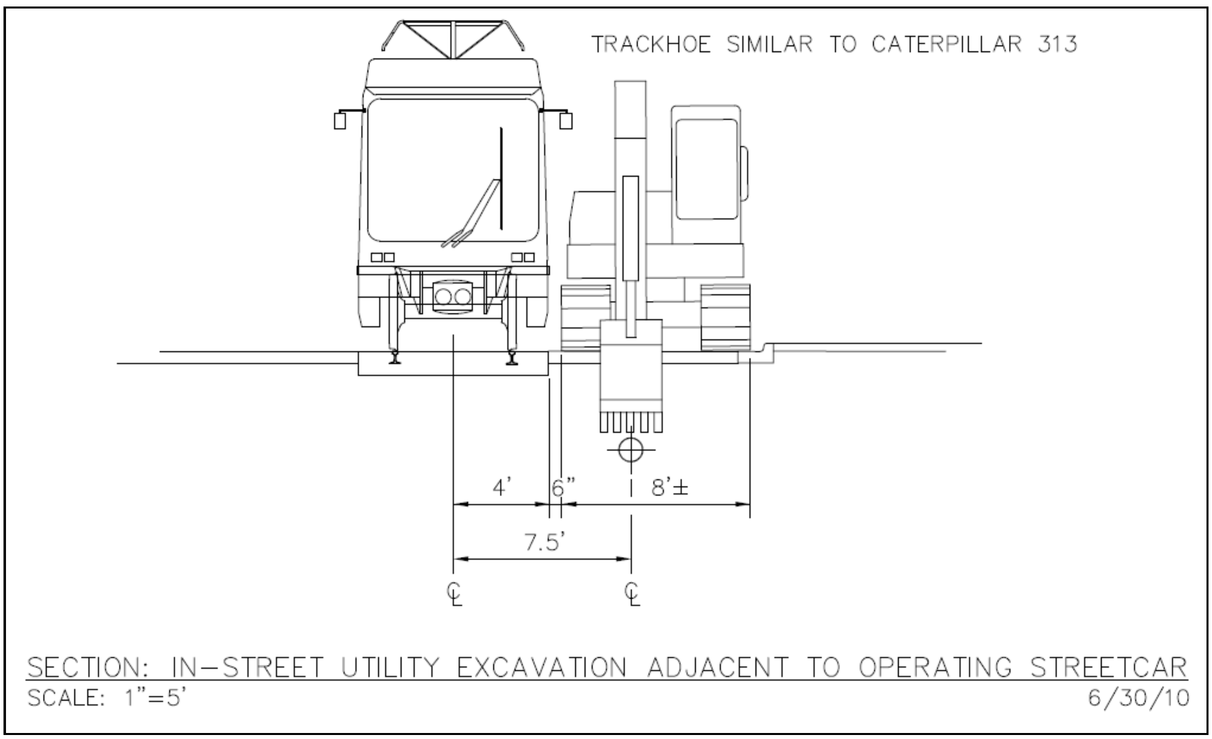
26 Peter Ehrlich, "South Lake Union Trolley/Seattle Streetcar", accessed October 18, 2010, http://world.nycsubway.org/us/seattle/southlake.html

During construction of the streetcar, Seattle Stormwater Department replaced multiple catch basins that were in poor condition. As a result, the Streetcar project exceeded its construction budget for incidental costs (traffic control, pavement patching, etc.). In the future, Seattle will ensure that the costs borne by the utility include incidentals.

In addition, for future streetcar extensions, Seattle plans to reduce relocations by allowing the track to be removed and replaced in sections to accommodate maintenance and repairs to existing infrastructure. The City will perform a "risk analysis" to determine the chance of a utility becoming damaged. In some cases, it might be easier to fix the utility in place in the future rather than relocating it to accommodate the streetcar.

In terms of access to utilities, Figure 3-3 is a graphic URS prepared for Seattle to illustrate to a utility owner the required clearances necessary between the track and the utility pipe in order to maintain access.

Figure 3-3: Utility Clearance



URS Corporation

3.2 System Operations

OPERATING ENTITY

Seattle Department of Transportation (SDOT) owns the South Lake Union Streetcar. However, SDOT does no operate any transit, and at the time did not want to get into the business. Therefore, the streetcar is operated by King County Metro, the public transit authority of King County, Washington, a division of the King County Department of Transportation. King County Metro also operates Seattle's buses, while Sound Transit contracts with King County Metro to operate some of its services. King County Metro staffs the South Lake Union Streetcar operations, and SDOT manages the facilities and other owner responsibilities.

SERVICE PLAN

The South Lake Union Streetcar runs seven days a week at approximately 15-minute intervals during the following hours:

- Monday through Thursday: 6:00 AM to 9:00 PM
- Friday and Saturday: 6:00 AM to 11:00 PM
- Sunday: 10:00 AM to 7:00 PM

These hours of operation are coordinated with other modes of transportation, such as Metro and Sound Transit buses, as well as local and regional events.

Fares

During its inaugural period, December 12 to December 31, 2007, the South Lake Union streetcar was free to ride. The fare was then increased to $1.50, followed by an increase to $1.75, and a final increase to $2.25 per trip as of March 2010. The fare of $2.25 applies to adults, with reduced fares of $0.50 for seniors, youth, and disabled riders. Children under five years of age ride free. Other transit agency passes, such as PugetPass and Metro, are accepted, along with Metro transfers. Fare box revenues cover approximately 20 percent of operating costs.

The South Lake Union Streetcar accepts Metro passes and all Metro transfers. However, Sound Transit and Community Transit transfers are not accepted. In addition, although the streetcar began with its own fare system, the South Lake Union Streetcar is currently being integrated into the regional fare card system called "Orca" (one regional card for all). Orca can be used on Sound Transit "Sounder" regional commuter rail, "Link" light rail or "Express" bus service; WSDOT ferries; KC Metro transit, Pierce Transit; Community Transit; Kitsap Transit; Everett Transit; and now SDOT streetcar. The card may be "filled" with money and used as a debit card, paying for each ride, or as a monthly/annual pass with unlimited rides within a service area.

RIDERSHIP

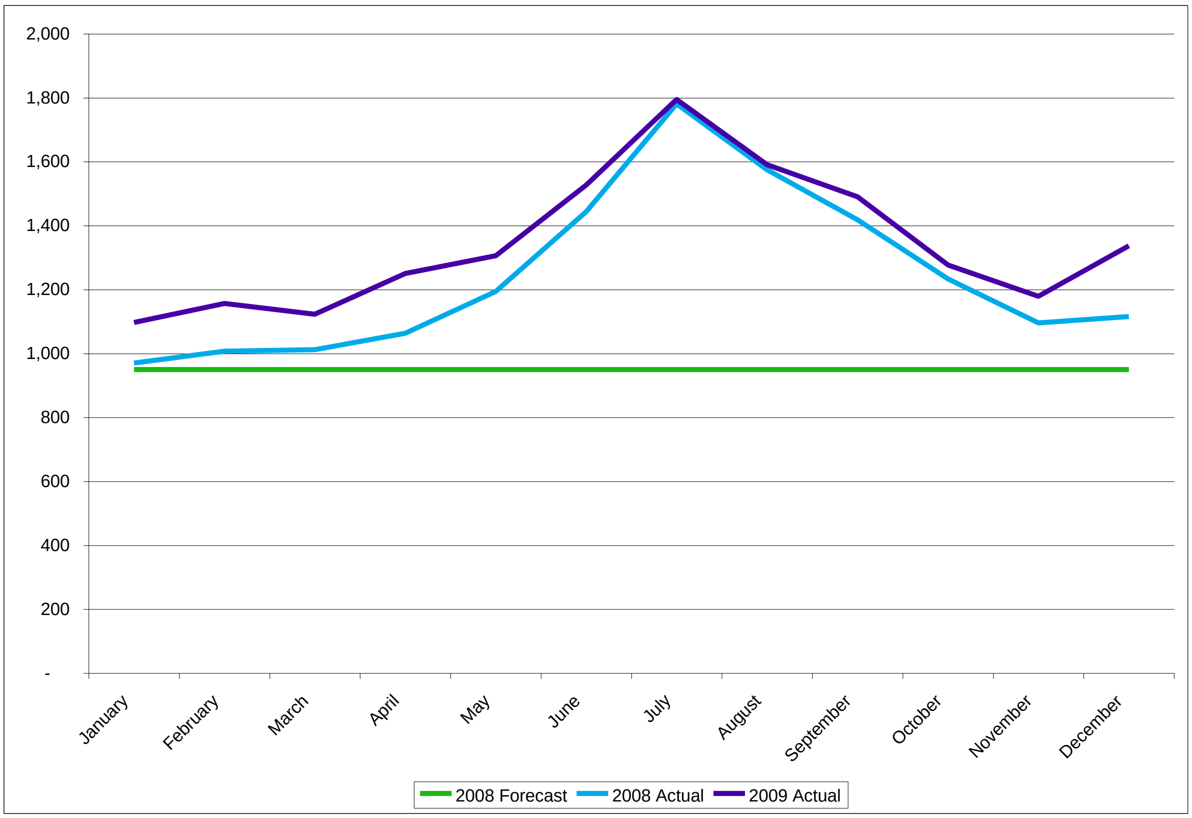
Following the initial free ride period in December 2007, the City predicted 950 daily riders throughout 2008 (7.5 percent of the system's capacity).[27] The 2008 forecast was not adjusted for monthly ridership fluctuations. In planning the South Lake Union Streetcar, the headways were determined by the number of vehicles, not the number of riders. Thus, the streetcar was projected with lower ridership percentages. Just like roads, transit systems are not designed to be at capacity on opening day.

27 Aimee Curl, "Won't You Ride the S.L.U.T?," Seattle Weekly News, January 23, 2008, accessed October 19, 2010, http://www.seattleweekly.com/2008-01-23/news/won-t-you-ride-the-s-l-u-t.php/.

On its one year anniversary, the City announced that 507,000 people had ridden the streetcar, which represents an average of 1,283 riders per day (10.2 percent capacity).[28] Average annual ridership has been approximately 450,000, and trends for 2010 suggest ridership will reach or exceed 500,000 riders for the full year.[29] During the first year of operation, peak ridership occurred during the weekends. However, by the second year of operation, weekday ridership exceeded weekend boardings. As shown in Figure 3-4, average daily ridership in 2008 greatly exceeded forecast ridership. Similarly, 2009 ridership surpassed 2008 actual ridership.

Also shown in Figure 3-4, ridership is highest during the summer months, particularly July. The South Lake Union Streetcar had record ridership in July 2010 with weekday and weekend/holiday average ridership accounting for 2,193 and 1,459 boardings, respectively.[30]

Figure 3-4: South Lake Union Streetcar Forecast and Average Daily Ridership



http://seattletransitblog.com/

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28 Office of the Mayor, "Seattle Streetcar: Half million riders and counting, Mayor Nickels announces free rides for holiday season," Press Release, December 10, 2008, accessed October 19, 2010, http://www.seattle.gov/mayor/newsdetail.asp?ID=9117&dept=40.
29 Golem, R. and J. Smith-Heimer, TCRP Synthesis 86: Relationships between Streetcars and the Built Environment, Transportation Research Board, National Research Council, Washington, D.C., 2010.
30 Sherwin Lee, August 4, 2010 (7:02 a.m.), "SLU Ridership Reaches a Record in July," Seattle Transit Blog, http://seattletransitblog.com/2010/08/04/slu-ridership-reaches-a-record-in-july/

Based on fare checks, approximately 80 percent of riders have a transit pass, which suggests riders are regular local users of multiple transit modes. Tourist traffic is also significant, as the streetcar itself is an attraction. Additionally, weekend ridership is increasing as riders use the streetcar to get to recreational opportunities.[31] In the future, if ridership outgrows the existing system capacity, headways will have to be more frequent with additional vehicles servicing the streetcar line.

BUS NETWORK

The South Lake Union streetcar connects to Metro bus service, as shown in Figure 3-5. Metro routes 3, 4, 5, 8, 17, 23, 25, 26, 28, 30, 39, 42, 66, 70, 71, 72, 73, 98, and 358 serve the South Lake Union area. Of these, Routes 8, 17, 23, 28, 39, 42, 71, 72, and 73 also serve a South Transit light rail stop. Route 8 (Seattle Center, Capitol Hill, Central District) and Route 25 (Montlake, University District, Laurelhurst) make convenient, useful connections at selected streetcar stops.

The streetcar also connects to SoundTransit's Central Link Light Rail, running between downtown Seattle and the Seattle-Tacoma International Airport. Service operates seven days a week, from 5:00 AM to 1:00 AM Monday through Saturday and from 6:00 AM to midnight on Sundays. Central Link passengers can transfer to the South Lake Union Streetcar at the Westlake stop.

Additionally, the South Lake Union Streetcar connects to the Seattle Center Monorail, providing service between downtown Seattle and the Seattle Center. The Monorail departs every ten minutes (every five minutes or less during special events) from the station at Seattle Center (across from the Space Needle) and from Westlake Center Mall (at Fifth and Pine Street). Each trip takes two minutes to cover the one-mile route. Each train can carry up to 200 passengers per trip. At Westlake Center, as shown in Figure 3-6, passengers can transfer to the South Lake Union Streetcar.

31 Golem, R. and J. Smith-Heimer, TCRP Synthesis 86: Relationships between Streetcars and the Built Environment, Transportation Research Board, National Research Council, Washington, D.C., 2010.

Figure 3-5: Metro Transit Downtown Seattle

http://metro.kingcounty.gov/tops/bus/area_images/CBDSeattleMap_1010.pdf

Figure 3-6: Westlake Hub on the opening of the Streetcar

http://sdotblog.seattle.gov/2009/08/12/making-connections/

In addition to integration with the Seattle bus network, each of the eleven streetcar stops are conveniently located a short walk from other transportation hubs. The Westlake Center is a transportation hub that serves as the terminus for the streetcar and Seattle Center Monorail terminus with stops for Metro buses and Sound Transit's Link Light Rail. The last streetcar stop on Westlake is approximately 1.5 blocks north of the Westlake Link light rail tunnel station. Streetcar-bus connections are within one to two blocks.

BICYCLE INTEGRATION

Seattle's streetcar system integrates with bicycle planning by allowing bicycles in the center section of streetcar vehicles. However, as previously described for the Portland Streetcar, bicycle and streetcar interaction can create safety issues. The safety of Seattle's Lake Union Streetcar tracks in relation to bicyclists has been receiving negative attention.[32] Bicycle tires can become caught in the track flange that holds the streetcar wheel within the train. As reported by the Seattle Times and local television stations, several bicyclists suffering crashes due to the tracks recently filed a lawsuit. For future lines, the City is leaning towards a median running streetcar to avoid conflict with bike lanes adjacent to the curb.

32 Millie Magner, "Bicycling and the South Lake Union Streetcar," Examiner, June 5, 2010, accessed October 26, 2010, http://www.examiner.com/bicycle-transportation-in-seattle/bicycling-and-the-south-lake-union-streetcar.

3.3 Financial Characteristics

CAPITAL COSTS

The total capital cost of constructing the South Lake Union streetcar line was approximately $50.5 million. This amount included $25 million from a Local Improvement District (LID) and $25.5 million provided by various local, state, and federal sources.

OPERATION AND MAINTENANCE COSTS

Similar to the share of capital costs, the City of Seattle planned to leverage local support for the operation and maintenance of the streetcar system. The two phase Operations and Maintenance Financing Plan involved a partnership between the City of Seattle, King County Metro, and the private sector. Although the streetcar would be operated by King County Metro, operating costs would be covered through investment from the city and other agencies or organizations.

As reported in the 2005 *South Lake Union Streetcar Capital Financing and Operating and Maintenance Plan*, Table 3-2 summarizes planned revenue sources for Phase One of the South Lake Union Streetcar Operations and Maintenance Financing Plan, which began with the initial streetcar service and extended through mid-2009.

Table 3-2:
South Lake Union Phase One Projected Operation and Maintenance Expenses and Sources

	2007	2008	2009 (JAN – JUN)	TOTAL
O&M Expense	814,176	1,592,649	777,118	3,183,943
Revenue Sources				
Farebox Recovery	123,750	286,318	163,053	573,120
FTA 5307/5309	63,000	131,040	68,141	262,181
Operations Fund[1]	627,426	1,175,292	545,924	2,348,641
1. Operations Fund sources include the sale of sponsorships and the bulk purchase of streetcar passes.				

2005 South Lake Union Streetcar Capital Financing and Operating and Maintenance Plan

As shown in Figure 3-2, a large percentage of operation and maintenance expenses would be funded by private contributions through the Operation Fund. The Operations Fund includes revenues from a sponsorship program (including the sponsorship of vehicles and stations), participation in a Streetcar Amenities Guide, and bulk ticket pre-sales. Bulk tickets sales are not included in the farebox recovery, which is defined as revenues the streetcar accumulates in farebox and fare revenue from trips made using the Orca card through the Regional Fare Collection Agreement with local transit agencies such as Metro and Sound Transit. One example of bulk sales is through employers in the South Lake Union area as the streetcar can assist in meeting Commute Trip Reduction goals, a Washington State regulation.

Table 3-3 summarizes planned revenue sources for Phase Two of the South Lake Union Streetcar Operations and Maintenance Financing Plan, which began in the summer of 2009.

Table 3-3:
South Lake Union Phase Two Projected Operation and Maintenance Expenses and Sources

	2009 (JUL – DEC)	2010	2011	2012	2013	2014	2015	2016
O&M Expense	777,118	1,592,158	1,631,007	1,670,804	1,711,571	1,753,334	1,796,115	1,839,940
Revenue Sources								
Farebox Recovery	163,053	366.888	408,691	451,538	495,457	540,473	586,615	633,910
FTA 5307/5309	68,141	141,733	147,402	153,298	159,430	165,807	172,440	179,337
Operations Fund[1]	85,375	164,585	158,177	151,518	144,598	137,408	129,935	122,170
King County Metro	460,549	918,952	916,737	914,449	912,086	909,645	907,125	904,522

1. Operations Fund sources include the sale of sponsorships and the bulk purchase of streetcar passes.

2005 South Lake Union Streetcar Capital Financing and Operating and Maintenance Plan

During Phase Two, three important transportation projects were scheduled to occur: Sound Transit's LINK Light Rail service, the Seattle Monorail Project's Green Line, and the Alaskan Way Viaduct and seawall project. These transportation projects will have a substantial impact on transit delivery in Seattle, and the South Lake Union streetcar will provide an important feeder service to both systems at the Westlake multi-modal hub. As a result, King County Metro will pay 75 percent of the operations of the streetcar after farebox recovery, and city of Seattle will pay the remaining 25 percent through the Operations fund and the Federal Transit Administration funds.

As referenced in the King County Metro Transit, *2007 Annual Management Report*, public transportation fund revenues included $678,478 in South Lake Union Streetcar non-operations fund revenues. Of the $678,478 in non-operation fund revenues, $110,220 was used for transit operations and $568,258 was used for capital expenses. In 2007, operating expenditures for the South Lake Union Streetcar totaled $148,167. Operations included providing design, facility, and vehicle maintenance support, as well as staff training and customer information for start up of the South Lake Union Streetcar.

As reported in King County Metro Transit, *2008 Annual Management Report*, 2008 the South Lake Union Streetcar contributed $2,382,572 in non-operation fund revenues to King County's public transportation fund. Of this amount, $2,194,965 was allocated for transit operations and $187,607 was allocated for capital expenses. In 2008, operating expenditures for the South Lake Union Streetcar totaled $1,915,893, which is slightly higher than the original projections.

FUNDING STRATEGIES

In 1981, waterfront businesses formed the LID to contribute $1.1 million to the construction of the waterfront streetcar. The LID was advantageous because the South Lake Union area has several major property owners participating with the City of Seattle on revitalization.

To estimate the value of a LID, an assessment for each parcel must be agreed upon. This assessment is based on 1) the special benefits the parcel receives as a result of the improvement relative to the total special benefits accrued to the LID; and 2) the amount of the project the LID will pay for. In Seattle, the special benefits were determined through an appraisal process called a "Special Benefits Study," which measures the special benefits, or the increase in value, experienced by parcels as a result of a public improvement project. Instead of utilizing a strict engineering-style approach to allocate assessments to properties on square footage of land, distance from station, lineal foot, or some other physical relationship, the City of Seattle valued the before and after values of each property within the LID. The difference constitutes the special benefits.

The Final Special Benefits Study found that in the aggregate, the before value of all properties in the LID zone totaled $5.385 billion, and the after aggregate value was $5.454 billion. This represents a "special benefit" value of $69 million. Because the City of Seattle was seeking to assess a total of $25.7 million through the LID assessment process, it captured 38 percent of the "special benefits" value indicated.[33]

The adoption of the LID worked well because the South Lake Union area has several major property owners participating with the city of Seattle on revitalization, including Vulcan Properties (a private development company) and the University of Washington. The University, as a tax-exempt entity, still pays the LID fee because of the benefits it receives from the streetcar line. In addition, the proposal to develop a streetcar in South Lake Union attracted the support of property owners. Adjacent property owners formed a group called "Build the Streetcar" to advocate for and support the LID.

ECONOMIC DEVELOPMENT

The South Lake Union has become an attractive new area for development in Seattle. As reported in the *Transportation Cooperative Research Program (TCRP): Synthesis 86: Relationships between Streetcars and the Built Environment*, without the streetcar (or improved bus service), it would have been much harder to attract firms. The area has attracted company headquarters, including Amazon.com, Group Health Coop, and PATH. Part of the attraction for these companies is the campus feel of the area and the convenient connection to the Central Business District. The streetcar, as part of a broader strategy, is credited with giving the South Lake Union area an advantage over other areas of the city.

In terms of marketing, the streetcar has had an impact on the development market, with projects being sold and promoted as being on the line or within one block of the line. Vulcan, as the major land owner in the area, has been careful to bring the types of retail it considers most compatible, avoiding an emphasis on national retailers. City staff sees the success of the area as a combination of the urban center zoning, Vulcan's actions, and the development of the streetcar.[34]

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33 Golem, R. and J. Smith-Heimer, TCRP Synthesis 86: Relationships between Streetcars and the Built Environment, Transportation Research Board, National Research Council, Washington, D.C., 2010.
34 Golem, R. and J. Smith-Heimer, TCRP Synthesis 86: Relationships between Streetcars and the Built Environment, Transportation Research Board, National Research Council, Washington, D.C., 2010.

New Development

Washington State does not allow tax increment financing and is limited in terms of the types of financial incentives it can offer developers or businesses. As such, zoning is the primary controlling incentive used for municipal planning. Most new development in the area is being built to the maximum zoning allowances.

As one of six urban centers, the City increased height limits to 90 feet to allow denser development in South Lake Union. Previously, height limits were specifically increased to accommodate biotech and allow an 85-foot, five-story building. In addition, all parking requirements were eliminated, allowing the market to determine the necessary parking. Public parking garages are not available in the area, and the nearest garage is at the Seattle Center.

Changes in Future Land Use Plans and Regulations

The City of Seattle is now working on site-level zoning regulations for its comprehensive plan and is looking to increase height limits to allow high-rise buildings and density. The streetcar is viewed as supporting greater height and density.

In addition, following Vulcan's lead in obtaining LEED building certification from the U.S. Green Building Council, much of the development along the line is seeking LEED certification. Future zoning changes allowing greater downtown heights and densities may lead to a future City requirement for projects to obtain LEED Certification to be eligible for density bonuses.

The City has adopted a concept for streetcar expansion to continue the line north across Lake Union toward the University of Washington, as well as to other established urban neighborhoods. Other lines would run through the downtown area to various destinations and down through to West Seattle.

3.4 Vehicle

TYPE

The South Lake Union streetcar uses the Inekon TRIO 12 vehicle, as shown in Figure 3-7, a double-ended, three-section articulated electric streetcar with a low floor center section.[35] The Inekon TRIO 12 streetcars have the capacity to carry up to 140 passengers (27 seated) and feature regenerative braking, on-board passenger information system with audible announcements and digital displays, and a Global Positioning System (GPS) system for real-time arrival information at stations and on the internet. The streetcar stations feature raised platforms for easy boarding and digital displays of real-time arrival information.

35 This is the same vehicle as used in the Portland system, but with modifications.

Figure 3-7: South Lake Union Streetcar on Test Ride

http://www.inekon-trams.com/seattle_streetcar.html

Each streetcar features three sets of doors on each side: one-panel at each end next to the cab and double two-panel sets in the lower passenger area. Under one of the two-panel door sets on each side of the streetcar, there is a retractable bridgeplate that allows disabled passengers to board the vehicle. The system is controlled by the operator with passenger request controlled by interior/exterior push-buttons that feature stripe switches and Intercom system. Passenger counting is accomplished by the INIT passenger counter with sensors mounted above each door set.

STORAGE AND MAINTENANCE FACILITIES

As reported in the 2005 *South Lake Union Streetcar Capital Financing and Operating and Maintenance Plan*, a maintenance facility at the southwest corner of Fairview Avenue N and Valley Street was built as part of the South Lake Union Streetcar for daily vehicle maintenance and inspections and minor repairs. This maintenance facility building is approximately 112 feet by 55 feet, eight inches. Two additional yard storage tracks were also built.

TRACTION POWER

Seattle used a similar traction power system as the Portland Streetcar. For stray current, one of the interesting things Seattle did was to use a different concrete mix with resistivity for the track slab, in addition to rubber boots.

Specifically, for the future First Hill Streetcar, the streetcar will be powered with a traction power system featuring traction power substations (TPSS) and an overhead contact system. Up to four TPSS may be required. The City and King County Metro are analyzing the potential for some of the substations to be joint use of existing Metro trolley bus substations. The City also has reserved space for a TPSS within the City-owned King Street Station. Sound Transit has designed the Capitol Hill

Station of the University Link Light Rail project to provide space for a future streetcar TPSS. If joint use of the Metro TPSS is not pursued, TPSS are commonly located in existing parking garages or parking lots close to a streetcar alignment, through agreements with the facility owners.

4.0 PHILADELPHIA

Route 15 (Girard Avenue Trolley) is an approximately eight-mile heritage streetcar line along Girard Avenue and Richmond Street through North and West Philadelphia. This system was selected for review as a case study because it demonstrates the re-use of PCC heritage streetcar vehicles and existing infrastructure. The borough of Brooklyn, including the Red Hook neighborhood also had a historical streetcar system, which used PCC cars. In addition, the Route 15 Trolley is located in a northern climate, similar to Brooklyn, and in relatively close proximity to New York allowing study site visits. Some of the operating conditions experienced by SEPTA would be similar in Red Hook, as both areas have similar street widths (narrow) and on-street parking. While this system is not the only example of PCC cars in operation today, it does demonstrate the lessons learned, both positive and negative, of returning a former streetcar line into regular revenue service using heritage streetcar equipment.

The line began operation in 1895 between Richmond and Norris and 54th and Girard. In 1902, the route was extended to 63rd and Girard, and in 1903, service was further extended to Richmond and Allegheny. In 1956, trolley service continued turning at the Richmond Loop at Westmoreland Street.[36] Service was suspended and replaced with buses in 1992, due to escalating streetcar maintenance costs associated with the aging fleet of streetcar vehicles. Trolley service was restored in September 2005, when SEPTA was awarded federal funding to restore PCC cars and rehabilitate the existing streetcar track and infrastructure.

As shown in Figure 4-1, the western terminus is at the intersection of Girard Avenue and 63rd Street. Traveling east Girard Avenue and Route 15 briefly overlap, along with the Route 10 trolley. After crossing over the Paoli/Thorndale Line at the intersection with Belmont Avenue, the line passes by the Philadelphia Zoo, loops partially around the south side of Girard College, rejoins Girard Avenue, and passes St. Joseph's Hospital. Further east, Route 15 crosses the Broad Street Line's Girard Station and the Route 23 bus line. Girard Avenue ends at Exit 23 on Interstate 95, where it connects to the Route 60 bus, another former trolley line.

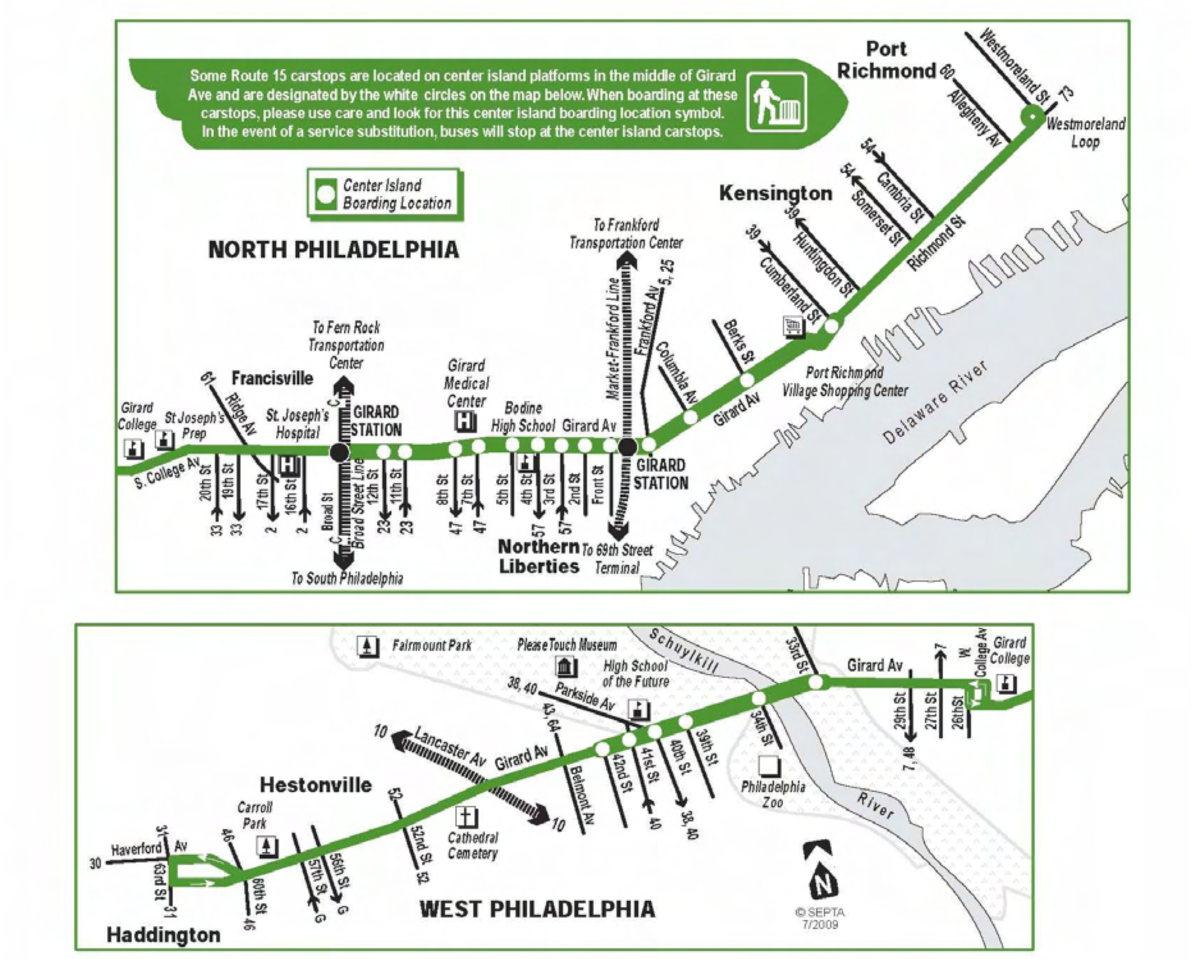
4.1 Planning Process Overview

The Route 15 began service as one of the city's bustling electric rail lines. Philadelphia neighborhoods were built along the various trolley lines, which were first operated by independent companies and later combined into the Southeastern Pennsylvania Transportation Authority (SEPTA). The operation of Philadelphia's trolley lines was challenging, because although SEPTA operated the trolley service, they did not own or operate Philadelphia's city streets. However, SEPTA was responsible to maintain the portion of the city street between the rails.

In 1992, the last of the three trolley lines – Route 56, Route 23 (the longest line in the World), and Route 15 were eliminated. The decision to temporarily suspend streetcar service was a result of the aging infrastructure and equipment, and the realized cost savings of replacing the lines with bus service.

36 Philadelphia Trolley Tracks, "1974 Brochure: The History of Trolley Cars and Routes in Philadelphia", accessed November 2, 2010, http://www.phillytrolley.org/1974history/8-9.html.

Figure 4-1: Route 15 Trolley Line Map



http://www.septa.org/maps/trolley/pdf/015.pdf

Route 15 was replaced with diesel bus service in 1992 with a promise that trolley service would be reinstated in 1997. During a September 1997 City Council hearing, SEPTA General Manager Jack Leary announced SEPTA's plan to restore trolley service as an upgraded light rail, with articulated light rail vehicles, which can operate on both subway and street surfaces.[37] However, due to lack of funding, SEPTA was forced to pull back on this commitment.

The return of trolley service to Girard Avenue was then initiated by a local string of communities, with strong political support, who argued trolley service triggers economic development. The group of active and vocal citizens, known as the Trolley Jollies, was intent on seeing streetcar service returned.[38] Route 15 returned to trolley service in September 2005.

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37 Philadelphia Trolley Tracks, "Route 15 / Girard Avenue Trolley", accessed December 13, 2010, http://www.phillytrolley.org/route15.girardavenue.html
38 Samuel Scheib, "Through the Looking Glass", *Trip Planner Magazine*, Fall 2009.

DESIGN CRITERIA

Streetcar design criteria includes: alignment geometry, speeds, roadway cross section, lane selection, traffic signals, and streetcar stops. General guidelines for these criteria are described above for the Portland Streetcar. However, because Route 15 was a previous trolley line, an existing streetcar track was in place. Some track reconstruction work and traffic signalization was necessary, as described later in the Constructability section.

ALIGNMENT DECISION PROCESS

Route 15 used the original Girard Avenue alignment, which had been replaced by diesel buses from 1992 through 2005. Although the decision to replace the line was trigged by anticipation for economic growth along the corridor, the process lacked the master planning approach, as presented with both Portland and Seattle. The alignment decision process for Route 15 was focused on restoring the existing service (as promised), rather than considering investment opportunities for a 21st Century Philadelphia. Variants to the original Girard Avenue alignment were not considered.

A majority of the Route 15 alignment has a median ROW, with both near- side and far-side stops. This ROW is legally restricted to trolleys and left-turning vehicles at certain intersections, but it is not physically protected. As a result, the ROW is widely used for left turns and through traffic. In addition to generating delays through queue volumes, these illegal traffic flows increase the chance of accidents or disruptions, degrading the trolley rider's experience and weakening the potential for economic development benefits.[39]

PRINCIPAL CHALLENGES

Service Reliability

Since the Route 15 trolley line was reinstated in 2005, SEPTA has experienced reliability issues. Most of the line runs within mixed traffic, along narrow streets, as shown in Figure 4-2. In years past, Girard Avenue's roadway cross sections were of sufficient width to allow simultaneous operation of both streetcar vehicles and automobiles. However, as the prevalence of larger vehicles such as sport utility vehicles (SUVs) has grown, the corridor's narrow streets are no longer as accommodating. Operating space is further compromised during the winter months when there is snowfall. Along Route 15's narrow streets (which are similar to Red Hook's narrow streets, as shown in Figure 4-3) it is not uncommon for a trolley to be blocked by a double parked vehicle, as streetcars can only travel along the provided tracks. Frequently, streetcar operators must stop the streetcar and exit the vehicle to move an adjacent vehicle mirror that is blocking the streetcar ROW. In addition, SEPTA's has used vehicles equipped with bumpers designed to move double-parked vehicles out of the way.

39 Delaware Valley Regional Planning Commission, "Speeding up SEPTA, Finding Ways to Move Passengers Faster, 2008.

Figure 4-2: Route 15 Narrow Streets

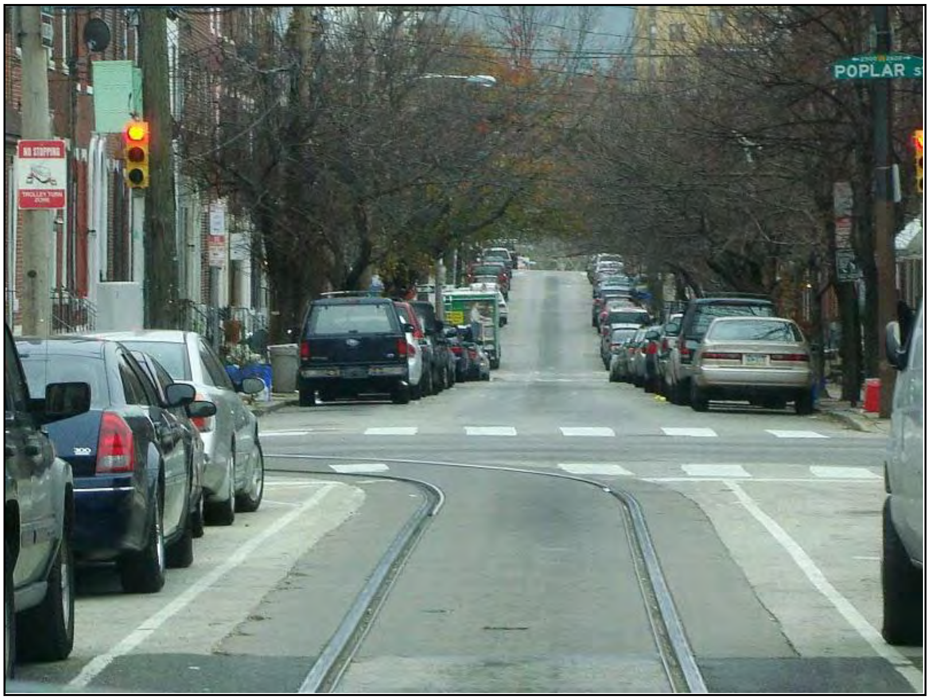

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Figure 4-3: Red Hook Narrow Streets

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Moreover, there are numerous segments where the trolley right of way is intended to be exclusive, but is unprotected aside from fairly unobtrusive overhead signage. This leads to a circumstance where no segment is exclusive in reality.[40] As a result, delays occur on a daily basis, due to various reasons (i.e. traffic incidents, emergency situations, and weather conditions). A majority of these delays last 15 to 20 minutes; however, some delays, for example those attributed to major traffic accidents can last much longer.

The Delaware Valley Regional Planning Commission 2008 Report, *Speeding up SEPTA, Finding Ways to Move Passengers Faster*, reported Route 15 incident delays from May 2007 through July 2007. Based on this data, incidents of many types occur throughout the Route 15 alignment, and in aggregate, generate more than one full day of delay. The chief delay generator during this period was emergency personnel activity, followed by vehicles parked too close to the rail.

Service can also be interrupted due to the low clearances along some portions of the corridor, clearances, as shown in Figure 4-4. Despite warning signage, overhead contact system wires are regularly torn down at locations where there are low clearances. Additionally, the establishment of center island platforms resulted in unexpected accidents by motorists. These accidents further exacerbate delays.

Figure 4-4: Route 15 Overhead Contact Wire Clearances

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During heavy delays, or when the system requires maintenance and is shut down, substitute bus service is instituted. Buses are selectively pulled from various lines to provide substitute service. To

40 Delaware Valley Regional Planning Commission, "Speeding up SEPTA, Finding Ways to Move Passengers Faster, 2008.

minimize impact, track work is typically planned during the summer months, when transit demand is lower.

Constructability

The restoration of Route 15 incorporated actuation of traffic signals and traffic signage and replaced traffic signal controllers at 36 intersections along Girard Avenue. The new controllers are interconnected with fiber optic cable to allow progression to the City of Philadelphia's signal network. This allows interactive communications and programming from the City's central control facility to correct signal malfunctions, implement progression schemes, and diagnose on-street operational problems as they occur. As reported by SEPTA, this communication network is used regularly. When an incident occurs, a message is sent to the control center, and the significance, associated delay, and mitigation measures are determined. Also reported by SEPTA, the Route 15 trolley runs without traffic signal preemption.

Associated intersection hardware, such as traffic signal heads, poles, conduit, cable, junction boxes, and regulatory signs, were replaced as needed. Construction also included the rehabilitation and/or construction of new substations, feeders, cables, overhead, and track. Approximately 25 percent of the track was replaced. Construction began in January 2002,[41] and progressed at a rate of approximately one block every two weeks.

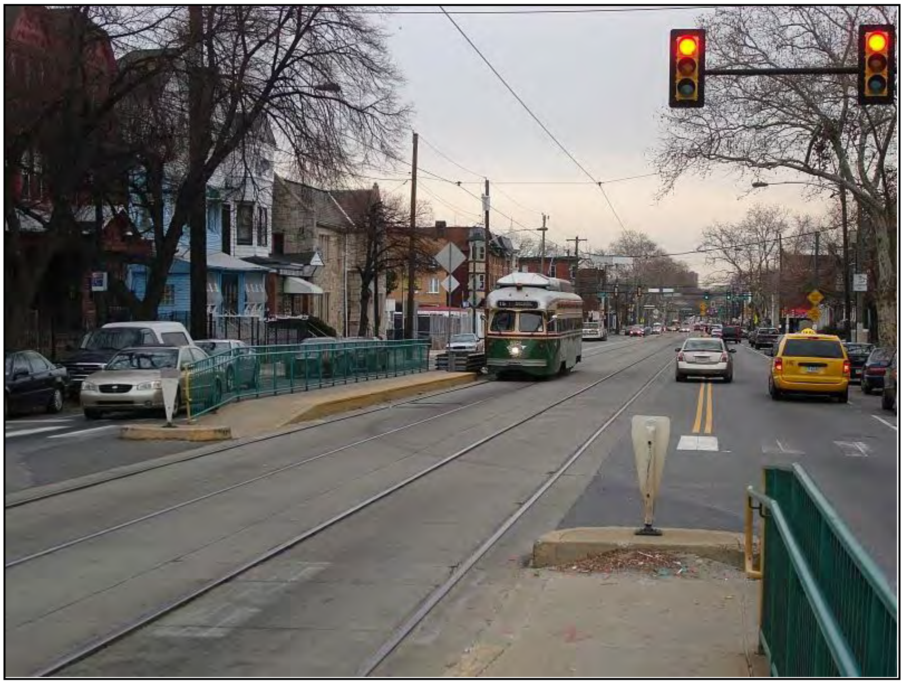
As part of the track work, pedestrian islands, as shown in Figure 4-5, were added to accommodate wheelchair loading and unloading. The pedestrian islands from the previous trolley service were very narrow and did not meet ADA regulations. Even with the new ADA-compliant pedestrian islands, about one third of the Route 15 bus stops were discontinued because there is no safe place for wheelchair loading and unloading.[42]

Utilities

During construction, locating the underground utilities became a major issue along segments of the alignment, and at least one incidence of breaking an existing water main occurred, according to SEPTA officials involved in the track reconstruction. There were also numerous times when work affected unexpected utility connections to adjacent homes. Much of this was due to a lack of accurate as-built drawings reflecting the location of utilities. SEPTA officials indicated that the initial estimates to "rehabilitate" the system proved to be less than what was actually required, and the allotted budget for the entire project turned out to be insufficient given the conditions encountered during construction.

41 SEPTA Capital Projects Update, Flexible Funded Projects, January 2008, accessed November 2, 2010, http://www.septa.org/reports/pdf/flexprojects08.pdf.
42 Samuel Scheib, "Through the Looking Glass", Trip Planner Magazine, Fall 2009.

Figure 4-5: Route 15 Pedestrian Islands



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Post construction, SEPTA coordinates with the city utility departments when access or repair is necessary. For example, if the water department has a problem and needs to dig into the track to access a water pipe, they contact SEPTA. During utility work, SEPTA replaces the trolley service with buses.

4.2 System Operations

OPERATING ENTITY

Route 15 is operated by SEPTA, a regional municipal authority serving 3.8 million people in and around Philadelphia. SEPTA also operates other forms of public transit, including bus, subway, subway-surface trolley lines, elevated rail, commuter rail, and light rail.

SERVICE PLAN

Route 15 operates 24 hours a day, at approximate 15 minute headways. During weekday peak hours, Route 15 operates at ten minute increments, and less frequently during weekends and off peak hours.

Fares

The base fare for trolley service is $2.00, which is the same as SEPTA's bus and subway service. Cash is accepted; however, the exact fare must be used. Customers purchasing various ticket packages receive discounted fares. Similarly, tokens, which can be used for bus, subway, or trolley service, can be purchased at the discounted rate of $1.55 each. Discounted fares may be purchased at stations, from over 400 retail sales locations, and online at www.shop.SEPTA.org.

If a trip requires more than one transit mode in the same direction of travel, a transfer may be purchased for an additional $1.00. A re-transfer may also be purchased for an additional $1.00. The purchase of a transfer must occur when a customer boards the first service used, and a re-transfer must be purchased on the second service.

RIDERSHIP

SEPTA's Annual Service Plan for Fiscal Year includes an Annual Route Performance Review for each route. For Route 15, ridership forecasts for 2011 are 10,992 weekday passengers (number of total boardings, i.e. unlinked passengers) and 3,297,600 annual passengers. Compared to FY 2010 forecasts, this is an increase of 2.3 and 2.8 percent from 10,742 weekday and 3,206487 annual passengers, respectively.

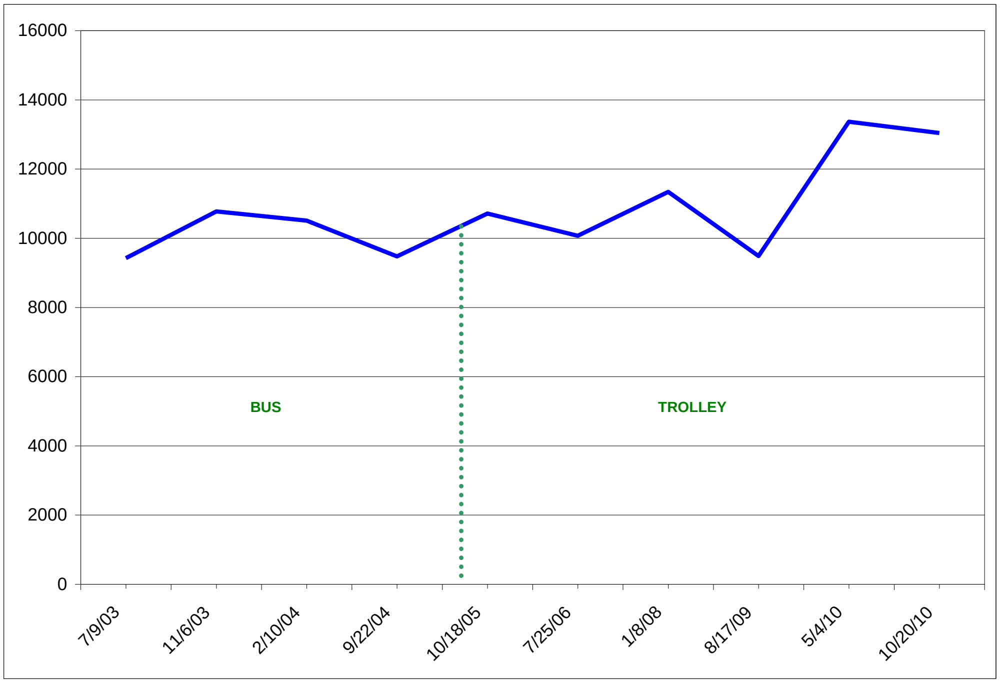
To record actual ridership, SEPTA performs ride checks, as shown in Figure 4-6. Based on the ride checks taken from July 2003 through October 2010, ridership along the Girard Avenue trolley has increased. Ridership also fluctuates based on the time of year, lower during summer months, compared to fall or winter months.

Average daily ridership along Route 15 from 1990 through 2009 is shown in Figure 4-7. As previously mentioned, Route 15 was operated by a trolley until 1992, when the line was replaced by diesel bus service. Trolley service was then reinstated in 2005. During both transitions (trolley to bus and bus to trolley), ridership initially decreased. This was likely a result of passengers adjusting to the new service. Particularly when trolley service resumed in 2005, SEPTA experienced an operating learning curve. With reduced reliability, potential passengers used other service within the vicinity.

As reported by SEPTA's Manager of City Service Planning, Steve D'Antonio, ridership in a transit city like Philadelphia can be misleading. Service along Girard Avenue never went away, only the mode changed.[43] Route 15 (whether trolley or bus) operates between an elevated rail and subway line, through transit dependent neighborhoods, and is five blocks from Temple University. High ridership is inevitable with such demand, no matter the mode. Passengers are more concerned with on-time performance.

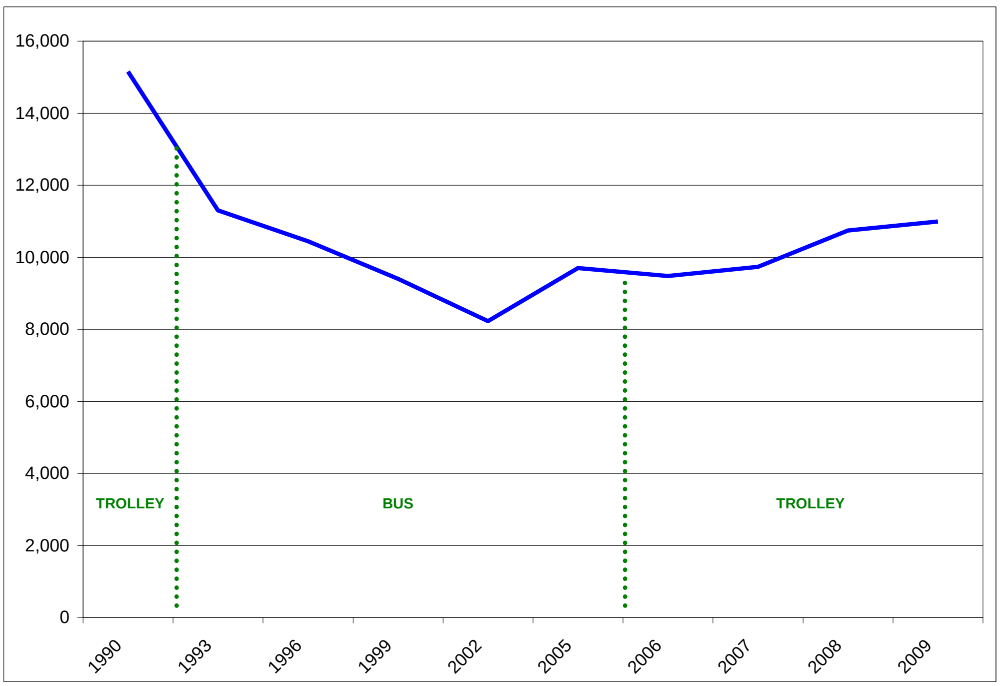
43 Samuel Scheib, "Through the Looking Glass", Trip Planner Magazine, Fall 2009.

Figure 4-6: Route 15 Weekday Ride checks (Bus/Trolley)



SEPTA

Figure 4-7: Route 15 Average Weekday Ridership (Trolley/Bus/Trolley)



SEPTA

BUS NETWORK

Route 15 connects to various SEPTA bus routes. Traveling from east to west, passengers may connect to the following bus routes: Routes 33, 2, 23, 47, 57, 5, 25, 39, 54, 60, and 73. Route 15 also serves as a feeder service to the Market-Frankford and Broad Street subway lines.

In addition to Route 15, SEPTA operates seven other trolley lines, as shown in Figure 4-8 and Figure 4-9. Routes 10, 11, 13, 34, and 36 (Figure 4-8) serve West Philadelphia as streetcars (in mixed traffic) and operate in an exclusive underground tunnel serving Center City Philadelphia. Routes 101 and 102 (Figure 4-9) operate in an exclusive ROW serving the Philadelphia suburbs of Drexel Hill, Springfield, and Clifton Heights. Route 15 is distinctive, because it is the only trolley line that does not operate on an exclusive ROW.

BICYCLE INTEGRATION

SEPTA encourages bicyclists to use transit service to complete journeys to work or personal trips. Most vehicles can accommodate two-wheeled, manually powered or electrically assisted bicycles, and folding bicycles are permitted on all vehicles at all times. In addition, many SEPTA facilities have bicycle racks. Since the tracks have been there for more than a hundred years, there was no learning curve for cyclists negotiating streets with streetcar tracks, as with new systems in other cities.

4.3 Financial Characteristics

CAPITAL COSTS

In 2000, SEPTA was able to secure the necessary capital funding to begin the restoration of Route 15. Restoration work included renewing the existing track, overhead wires, and substations. In lieu of purchasing new vehicles, in 2002 a contract was awarded to Brookville Equipment Corporation for the refurbishment of 18 vehicles. Concurrently, several capital improvements were initiated to prepare for the restoration of streetcar service.

Approximately 25 percent of the track was replaced, pedestrian islands were added, and signal priority (extending cycles and preemption) was provided. (As reported by SEPTA, Route 15 signal priority is no longer in use.) Total capital costs include the following:[44]

- Infrastructure (rehabilitation/construction of new substations, feeders, cables, overhead, and track) - $48 million
- Signals (improved trolley stops and preferential traffic signals and installation of 36 intersections along Girard Avenue) - $5 million
- Streetscapes - $0.5 million

Vehicles (rehabilitation of 18 1947 PCC streetcars) - $30 million

44 American Public Transportation Association, "APTA Streetcar and Heritage Trolley Site", accessed November 2, 2010, http://www.heritagetrolley.com/planPhiladelphia4.htm.

Figure 4-8: SEPTA Routes 10, 11, 13, 15, 34, and 36 Trolley Line Map

http://www.septa.org/maps/trolley/city.html

Figure 4-9: SEPTA Routes 101 and 102 Trolley Line Map

OPERATION AND MAINTENANCE COSTS

Route 15 operating costs, which are approximately $10 million, include both variable expenses and fixed costs. FY 2010 variable expenses are based on actual Route 15 Vehicle Hours and Vehicle Miles (FY 2009) and Cost-per-Mile figures (FY 2010) derived from the entire SEPTA City trolley system. Variable expense (vehicle operations and maintenance) include the following:

- Operations Labor – $3.4 million
- Propulsion Power – $387,000
- Maintenance Parts – $457,000
- Maintenance Labor – $591,000 (Route 15's per-vehicle-mile maintenance costs are $4.88 (which compares to $3.01 for buses.[45])
- Claims Paid – $1.3 million

Fixed Costs are based on total Peak Vehicle requirements (FY 2009) and cost-per-peak-vehicle figures (FY 2009) derived from the entire SEPTA City system. FY 2009 fully allocated expenses (ROW and facilities maintenance, overhead and administration) amount to $3.8 million.

These costs are shared by SEPTA and the City of Philadelphia. SEPTA uses a formula based on the vehicle miles traveled, peak ratios and number of vehicles to determine the City split.

FUNDING STRATEGIES

SEPTA received Federal Flexible Funding for infrastructure work along Route 15. Flexible Funding was initiated through the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) legislation to provide opportunities to state and local governments allowing the option of using some Federal Highway Administration (FHWA) funds for transit projects and vice versa. SEPTA received $4.8 million in Flexible Funding, which was used for the rehabilitation / construction of new substations, feeders, cables, and track.

ECONOMIC DEVELOPMENT

Route 15 was justified for economic redevelopment reasons. However, since service returned in 2005, little development has occurred. Local businesses along the Girard Avenue corridor have indicated the new trolley line did not bring in a new crowd of tourists.[46]

This lack of development can be attributed partly to the economic recession that began in 2008/9. However, limited planning was also a large determinant. Despite hopes for economic growth along the corridor playing heavily into the decision to replace the line, the process lacked a master planning approach, as shown with other streetcar systems throughout the United States.

Recent development, related to the Pennsylvania Department of Transportation's reconstruction of the Interstate I-95 Girard Avenue interchange provides the possibility for future development. During the Pennsylvania Department of Transportation's reconstruction of Interstate I-95 when the

45 Samuel Scheib, "Through the Looking Glass", *Trip Planner Magazine*, Fall 2009.
46 Brian Rademaekers, "Historic trolley off track", October 13, 2010, accessed December 17, 2010, http://www.philly.com/community/Historic_trolley_off_track.html?viewAll=y

Girard Avenue Bridge will be closed, Route 15 will be rerouted to allow eastbound trolley service to continue through to the Market-Frankford Subway Elevated Line. The Route 15 Turnback Loop project, which is currently under construction, as shown in Figure 4-10, includes construction of a trolley turnback along Route 15 at Frankford Avenue. This turnback, being constructed along Frankford Avenue from Girard Avenue to Delaware Avenue, will become a permanent feature of the trolley line, providing new track and overhead wire and traffic signal improvements at Girard and Delaware Avenues. The Route 15 Loop will carry passengers to and from the SugarHouse Casino, as shown in Figure 4-11.

Figure 4-10: Route 15 Loop Construction along Frankford Avenue

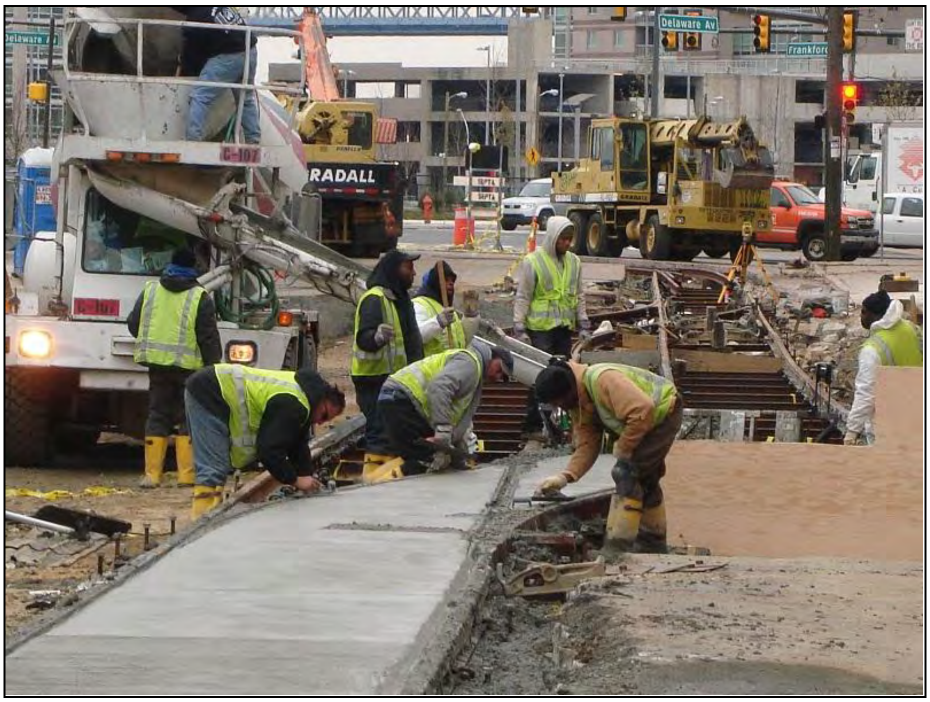


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Figure 4-11: SugarHouse Casino

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4.4 Vehicle

TYPE

Route 15 uses PCC II cars, as shown in Figure 4-12, which are 1947 Presidential Conference Committee (PCC) streetcars that were completely rebuilt at a cost of $1.3 million per vehicle. Eighteen vintage trolley cars were disassembled down to bare metal and rebuilt to create a unique vehicle that blends the historical appearance with modern passenger amenities. The cars were rebuilt by Brookville Equipment Company, located in Brookville, Pennsylvania.

The PCC II cars are 46 feet, 6 inches long, 8 feet, 5 inches wide, and 11 feet, 9 inches high. Seating capacity is 46 passengers without wheelchairs) or 40 passengers with two wheelchairs. With the addition of standing passengers, total capacity reaches 113 passengers. Passenger amenities include:

- Automatic heating and air conditioning;
- Wheelchair accessibility at the center door and additional interior features designed in collaboration with the disability community;
- Newly designed interior (stainless steel seating with cloth-upholstered inserts);
- Passenger Stop Request and PA system; and
- Original style “Art Deco” lighting.

Figure 4-12: SEPTA PCC Trolley Vehicle

http://www.trolleyville.com/tv/times/oct2003/oct03.htm

The PCC cars, which were painted in their original green and cream, rather than SEPTA's white with red and blue stripes, were chosen largely due to their cost savings, as well as their historic aesthetic. SEPTA also considered the Kawasaki light rail vehicles (LRV), which are used on the other Philadelphia trolley lines. However, LRVs cost $3.2 to $3.5 million per car, which is more than double the cost of refurbishing a PCC car.

Despite the lower cost and romantic appeal, PCC cars do have some disadvantages. PCC cars have a lower capacity when compared to modern streetcar vehicles. Although the rehabilitation included ADA compliance, the wheelchair lifts can be a time consuming process, due to the numerous flaps (required to accommodate the existing infrastructure), as shown in Figure 4-13. PCC cars also have less flexibility than LRVs. While LRVs can operate on all of SEPTAs trolley lines, the PCC cars can only operate on surface tracks, and not through the various trolley tunnels.

Figure 4-13: PCC Wheelchair Lift

URS Corporation

In addition, SEPTA's PCC cars were refurbished to have a useful life of 15 years, as opposed to the LRV lifespan of 30 plus years. As the current fleet has been in operation for over five years, SEPTA will need to replace the Route 15 fleet in less than ten years. Moreover, SEPTA uses 16 vehicles of the 18-car fleet to operate Route 15. This results in a tight spare ratio in the case of breakdowns or incidents. SEPTA reports PCC car breakdowns are few; however incidents related to weather, traffic accidents, or emergencies occur more often.

STORAGE AND MAINTENANCE FACILITIES

The refurbished PCC II Route 15 Trolley vehicles are stored at Callowhill Depot. Callowhill Depot is located in the heart of West Philadelphia, on the southwest corner of the 5900 block of Callowhill Street. The bus and trolley bays are across the street. The depot is surrounded by 59th, Vine, 58th, and Callowhill Streets. SEPTA's Callowhill Depot also serves the Route 10 Trolley and bus Routes 21, 30, 31, 38, 40, 42, 43, 44, 46, 52, 65, 121, 400, 401, 403, 404, 406, 407, 408, 409, 410, and the Market-Frankford OWL.

Light repair work occurs at the Callowhill Depot; however, vehicles are sent to SEPTA's Elmwood facility for major repairs. The Elmwood Carhouse (or Elmwood Loop), located at 73rd Street and Elmwood Avenue in the Elmwood Park section of West Philadelphia, is a storage facility and alternate terminus for the SEPTA Route 36 trolley. The facility also stores and maintains cars from Routes 11, 13, and 34.

Future Improvements

As reported in SEPTA's Fiscal Year 2010 Capital Budget and Fiscal Years 2010-2021 Capital Program, SEPTA has allocated $115,600,000 the replacement of the 96-year old Callowhill Garage. The Callowhill Garage, which was originally constructed as a trolley carbarn, is ill equipped to support the needs of a modern bus fleet. A myriad of deficiencies and limitations currently exist at this garage, such as the poor condition of the roof and underground drains; obsolete equipment; and narrow bus storage bays, which limit vehicle maneuverability. The new facility will also include a new trolley shop and storage yard. The trolley shop will be used to perform running repairs for SEPTA's trolleys operating on the Route 10 and Route 15 Trolley Lines.

TRACTION POWER

The Route 15 Trolley used the previous traction power system, but included renewed overhead wires. SEPTA's Route 15 Trolley has a total of three substations used to service the entire 8.5 mile long line. SEPTA used these existing substations, because there was no space or land available for new substations. Working with the aging infrastructure resulted in some poor conditions. Specifically, the underground cables for the return wire were encased in 90-year old octagonal terracotta sleeves. When the old cables were pulled to make room for new ones, the sleeves moved, making it very difficult to install new cables, and at times requiring additional digging.

5.0 SUMMARY OF LESSONS LEARNED

The following matrix summarizes the relevant service components of the Portland Streetcar, Seattle's South Lake Union Streetcar, and Philadelphia Route 15 Trolley and a brief summary of lessons learned and relevant reference to the Brooklyn Streetcar Feasibility Study.

Table 5-1: Case Study Summary and Relevent Reference to BSFS

Streetcar Service Components	Portland Streetcar	South Lake Union Streetcar	SEPTA Route 15	Relevant Reference to the BSFS
Design Criteria	General guidelines only: Alignment geometry, speed, roadway cross section, lane selection, traffic signalization, and streetcar stops	General Guidelines Only: Alignment geometry, speed, roadway cross section, lane selection, traffic signalization, and streetcar stops	Existing streetcar track, which required some rehabilitation and traffic signalization	Design criteria should take into consideration both criteria developed for other streetcars as well as existing MTA and other NYC standards
Alignment Decision Process	Most important factors: land use, future development, intermodal connections, and service to cultural/educational activities	Most important factors: serving commuters and tourists, intermodal connections to cultural activities, future development, and land use	N/A (Route 15 was an existing trolley/bus line)	Goals should consider land use, intermodal connections, and future development
Principle Challenges	Unexpected costs associated with the cost of engineering and administering utility relocations	Exceeded construction budget for incidental costs (traffic control, pavement patching, etc.), due to utility repairs	N/A (Route 15 was an existing trolley/bus line)	Early utility coordination with both public/private entities is a key factor in establishing guidelines for mitigating utility impacts, and can influence alignment selection A contingency budget itemized by potential risks: unexpected utility relocations, traffic control modifications, etc. should be considered; and a risk assessment should be performed early on
Operating Entity	TriMet	King County Metro	SEPTA	TBD

Table 5-1: Case Study Summary and Relevent Reference to BSFS

Streetcar Service Components	Portland Streetcar	South Lake Union Streetcar	SEPTA Route 15	Relevant Reference to the BSFS
Service Plan	Weekdays - 5:30 AM to 11:30 PM, 12 minute intervals	Weekdays – 6:00 AM to 9:00 PM, 15-minute intervals	Weekdays - 24 hours, 10 minutes during peak and less during off peak	Philadelphia offers an example of 24-hour service
Ridership	09/10 Quarter average weekday ridership - 11,914	Record July 2010 ridership - 2,193 weekday boardings	FY 2010 average daily ridership - 9,575	Portland and Seattle demonstrate that streetcar ridership builds from first year of operation
Bus Network	Connections to bus routes: 35, 36, 43, 54, 56, and 77	Metro routes 3, 4, 5, 8, 17, 23, 25, 26, 28, 30, 39, 42, 66, 70, 71, 72, 73, 98, and 358 serve the South Lake Union area	Connections to bus routes: 2, 5, 23, 25, 33, 39, 47, 54, 57, 60 and 73	Connections to existing bus and subway should be an integral part of system planning
Bicycle Integration	Flange gap and crossing angles, interface at stops etc. need to be evaluated.	Flange gap and crossing angles, interface at stops etc. need to be evaluated.	No issues reported; however existing flange gap is wider and could create safety concerns	Bike advocacy groups should be involved early in the planning process; and design elements should be developed to minimize impacts and employ techniques from Portland and Seattle
Capital Costs	$103.2 million (not including the Streetcar Loop Project currently under construction)	$50.5 million	$83.5 million	Capital costs could be reduced by employing Portland's low-cost approach to stations; however, Philadelphia's labor and utility costs more likely reflect Brooklyn costs
Operation and Maintenance Costs	$5.5 million	$2.0 million	$6.2 million	Generally O&M costs for streetcars run 30 percent higher than bus

Table 5-1: Case Study Summary and Relevent Reference to BSFS

Streetcar Service Components	Portland Streetcar	South Lake Union Streetcar	SEPTA Route 15	Relevant Reference to the BSFS
Funding Strategies	Municipal parking revenue bond, Local Improvement District, and Tax Increment Finance District.	Local Improvement District	Federal Flexible Funding	Portland and Seattle demonstrate increased development within two to three blocks of the route; the value of development could be captured as a means of helping pay for system
Economic Development	Shifted the attractiveness of sites adjacent or near to the streetcar tracks from moderate to high	Credited with giving the South Lake Union area an advantage over other areas of the city	Little to no economic development impact	See above funding strategy
Vehicle Type	Modern Škoda - Inekon and Inekon TRIO 12 Approximate acquisition cost ($3.5 to 4.5 million)	Modern Inekon TRIO 12 Approximate acquisition cost ($3.5 to 4.5 million)	Refurbished 1947 Presidential Conference Committee (PCC) Approximate acquisition cost ($1.5 million)	Portland and Seattle's modern vehicles provide have more amenities, larger capacities, and provide easier ADA compliance; however Philadelphia's refurbished cars have lower acquisition and capital costs
Storage and Maintenance Facilities	1516 NW Northrup – located just outside of the central business district under a freeway Ramp 90 feet x 88 feet, 8 inches	Fairview Avenue N and Valley Street 112 feet x 55 feet, 8 inches	Callowhill Depot 490 x 440 feet (also serves other SEPTA vehicles)	Facility location influences alignment process Although there is flexibility in size and shape of facility, the MTA practice is for enclosed vehicle storage facility, which would require larger footprint

Table 5-1: Case Study Summary and Relevent Reference to BSFS

Streetcar Service Components	Portland Streetcar	South Lake Union Streetcar	SEPTA Route 15	Relevant Reference to the BSFS
Traction Power	Traction electrification system (TES) or overhead-contact system (OCS), small substations spaced closely together at approximate half mile intervals, and a simple trolley wire overhead contact system	Similar to Portland	Used the previous traction power system, but included renewed overhead wires and the reconstruction of substations	Visual impacts of the OCS should be mitigated very early in the planning process; the case studies demonstrate under-ground location of substations is viable; substation size can be flexible

In addition to the summary provided in Table 5-1, the case studies of the Portland Streetcar, South Lake Union Streetcar, and SEPTA's Route 15 Trolley provide several lessons learned.

DESIGN CRITERIA

Portland and Seattle utilized a combination of Light Rail Criteria, TCRP reports, other codes, and lessons learned from European tram operators to develop project specific guidelines. However, no formal design criteria were developed for either streetcar system. The engineers and city took a "best practices" approach and worked together to clearly identify the minimum requirements of each project. Due to the close coordination between the city and engineers, this did not result in any major issues. In fact, it encouraged an open dialog between the owner and engineer to establish project specific minimum guidelines that focused on the goals and objectives of each individual project.

SEPTA experiences several issues related to design criteria. The design of the trolley system called for center island station platforms. However, Philadelphia motorists were not used to the location of the new platforms and a number of accidents occurred as cars ran into the center islands. Similarly, the majority of the Route 15 alignment has a median ROW, with both near- side and far-side stops. This ROW is legally restricted to trolleys and left-turning vehicles at certain intersections, but because it is physically protected, it is widely used not for left turns and through traffic. Moreover, there are numerous segments where the trolley right of way is intended to be exclusive, but is unprotected aside from fairly unobtrusive overhead signage. In addition, there are very tight clearances at several under-grade bridges on the Route 15 line. Despite warning lights and restrictions, the overhead trolley wire is frequently torn down.

A future Red Hook streetcar should take into consideration the criteria developed for other streetcars, the lessons learned in Philadelphia, as well as existing MTA and other NYC standards. In terms of a potential alignment in Red Hook, land use, intermodal connections, and future development should be considered. As shown in Philadelphia, a streetcar system that lacks a master planning approach results in service reliability concerns, and does not gain from economic growth as shown in both Portland and Seattle.

CONSTRUCTABILITY

Portland instituted a shallow track, single pour system that minimized excavation and expedited construction. Once the utilities are out of the way, the track and all civil components (roadway and sidewalk reconstruction) were accomplished at a pace of approximately three blocks in three weeks (one block is approximately 200 feet). Following the track and civil construction, the overhead cable system, lighting, and traffic signals were installed. This process, as shown in Figure 5-1, which was developed to minimize the impacts to adjacent businesses and has worked fairly well. As such, the process was also instituted in Seattle.

Figure 5-1: Portland Streetcar Construction

http://www.walkerevanseffect.com/blog/the-columbus-streetcar-construction-impact-memo/

For SEPTA's Route 15, in some areas the original track was in good condition and did not need to be replaced. However, a block by block inspection of the system was required to determine the work necessary to rebuild and restore service. This contributed to additional cost and construction time. In some areas, no girder or flanges were left and the asphalt was holding the track together.

UTILITIES

Portland did not create a formal procedure regarding utilities, as relocations varied by utility. The Portland Streetcar engineering team worked with each private utility to identify conflicts evaluating utilities on a "case by case" basis. Similar to Portland, Seattle did not create formal guidelines with respect to utilities. Generally, utilities running parallel to the streetcar and located within five feet of the track slab were relocated. However, both Portland and Seattle had to establish general guidelines as part of each project to use as a baseline for identifying potential impacts. The DOT should coordinate with both public/private entities early on to establish guidelines for mitigating utility impacts. Similarly, the identification of potential utility locations can influence alignment selection.

During construction of Philadelphia's Route 15 Trolley, as-built drawings were not available for the locations where the existing track had to be replaced or repairs to underground cables had to be made. In one instance, available drawings indicated the water main was at a certain depth. However, during construction, the contractor hit a shallow force main on Girard Avenue under the viaduct leading to Market Street East Station, causing significant flooding. In other areas, the plumbing and underground cable to residential homes was affected, as a result of the unavailability of as-built drawings to confirm utility locations. Early, open, and clear communication between utility companies will avoid similar issues in Brooklyn.

Early coordination will also reduce the potential for unexpected costs, as experienced in both Portland and Seattle. Specifically, the Portland Streetcar project incurred unexpected costs associated with the cost of engineering and administering the water utility relocations. As such, Portland now has an intergovernmental agreement between the streetcar project and the water department. Similarly, during construction of the South Lake Union streetcar, the Seattle Stormwater Department replaced multiple catch basins that were in poor condition. As a result, the Streetcar project exceeded its construction budget for incidental costs (i.e. traffic control, pavement patching). A contingency budget itemized by potential risks (unexpected utility relocations, traffic control modifications, etc) should be considered for a Brooklyn streetcar.

For future streetcar extensions, Seattle plans to reduce relocations by allowing the track to be removed and replaced in sections to allow for maintenance and repairs to existing infrastructure. Similarly, a "risk analysis" should be performed in Red Hook to determine the chance of a utility becoming damaged. In some cases, it might be easier to fix the utility in place in the future rather than relocate it to accommodate the streetcar.

BICYCLE INTEGRATION

Both the Portland Streetcar and the South Lake Union Streetcar experience safety issues with bicycle integration. Bicycle wheels and tires are very susceptible to getting caught within the gap of the streetcar track flange. Specifically, this situation occurs when a bicyclist is required to cross the tracks at less than a 60 degree angle. When a track "catches" a wheel, a bicyclist may be thrown from their bicycle. To decrease the number of accidents, streetcar infrastructure should be designed to eliminate crossings with less than 60 degree crossing angles and be designed with as close to 90 degree crossing as possible.

In addition, right-side running tracks and streetcar track curves may create an instance where a bicyclist riding in the right lane chooses to cross the tracks at an angle less than 60 degree. This is not desired and can lead to accidents. Center-running and left-running tracks are typically safer scenarios for bicyclists, as they avoid many of the conflicts between side running streetcars and parallel bike tracks. Signs and pavement markings can be used to assist cyclists in maneuvering around track curves at safe angles.

In planning a streetcar in Brooklyn, bike advocacy groups should be involved early in the planning process. Design elements should be developed to minimize impacts and employ techniques from Portland and Seattle. Both cities continue to work with the bicycle community to develop solutions to create a safe environment for both transit and bicycle users. For example, Seattle is considering a median running streetcar to avoid conflict with bike lanes adjacent to the curb.

FUNDING STRATEGIES

Both Portland and Seattle exemplify that the value of development can be captured as a means of helping to finance a system. Financing of the Portland Streetcar has used a different mixture of funding sources for each segment constructed. However, the 2.4 mile first phase is particularly unique as the total cost of $56.9 million was completely locally funded. The most substantial share of capital costs was financed by a municipal parking revenue bond supported by parking fees in the area of the streetcar. Additional local mechanisms relied on value capture, including a Local Improvement District and a Tax Increment Finance District. Because Portland did not use Federal funding on the first phase, they were not required to adhere to the *Buy America Act* for the purchase of streetcar vehicles.

Similarly, to fund the South Lake Union Streetcar, waterfront businesses formed a Local Improvement District to contribute $1.1 million to the construction of the waterfront streetcar. The adoption of the LID worked well because the South Lake Union area has several major property owners participating with the city of Seattle on revitalization, including private developers and the University of Washington.

Contrastingly, although the return of the Route 15 trolley was initiated through local community and political support, SEPTA's Route 15 Trolley experienced funding shortfalls. Unlike Portland and Seattle, Philadelphia did not have local financial investment. Due to this lack of funds, only the portions of Route 15's existing infrastructure in the worst condition were replaced Also, Instead of streetcars traversing the wide portion of Girard Avenue in a reserved ROW, they were designed to run on the existing alignment, sharing the center lanes with left-turning automobiles. SEPTA received $48 million in Federal funding, which was used for these infrastructure costs.

ECONOMIC DEVELOPMENT

In terms of economic development, both Portland and Seattle demonstrate increased development as a result of a streetcar system. Portland's streetcar shifted the attractiveness of sites adjacent or near its tracks from moderate to high. However, other factors likely contributed to the growth in new development, including local land use policies, the construction of a light rail system, urban renewal, and the ability to use TIF funds to subsidize infrastructure and development projects.

Similarly, Seattle's South Lake Union neighborhood has experienced growth since the development of a streetcar system. Like Portland, economic development was triggered by a multitude of factors, such as the urban center zoning, major developers, and the development being sold and promoted as being on the streetcar line or within one block of the streetcar.

The Girard Avenue corridor has not experienced this type of growth. Although the return of the Route 15 trolley was justified for economic redevelopment reasons, the planning process lacked a master planning approach, as shown with other streetcar systems throughout the United States. The DOT should adhere to this lesson learned, and use a more holistic approach when planning and designing a streetcar system for Brooklyn.

CONCLUSION

The case studies presented in this report demonstrate the multitude of planning components that comprise a streetcar system. These factors collectively determine the future success or demise of a streetcar operation. As the BSFS continues along with the future planning and design of a Red Hook streetcar, the examples provided in this Case Study Report should be considered. Streetcars provide a historic, romantic appeal and have transformed blighted districts into vibrant areas. However, in these success stories contributing factors were implemented in a master planning approach. As such, it is critical that a holistic approach be applied to the planning and design of a Red Hook streetcar.

6.0 APPENDIX A: POTENTIAL STREETCAR CASE STUDY SYSTEMS

URS

PROJECT NOTES

Client:	**DOT**
Project Name:	**Brooklyn Streetcar Feasibility Study**
Location:	**Brooklyn, NY**
Project Number:	**10312392**
Issue Date:	**20 SEPT 2010**

TO: **Chris Hrones, DOT**

FROM: **Stephen Gazillo, URS**

SUBJECT: **Brooklyn Streetcar Feasibility Study: Summary of Potential Streetcar Case Study Systems**
DOT – ESA: Transportation Planning, Transportation Engineering, Urban Design and Related Services, Citywide. PIN: 84107MBTR187

To assist DOT in the selection of three streetcar systems for the Task 2.1 Case Study Report, we have put together notes/brief summaries of the 10 streetcar systems listed in the Brooklyn Streetcar Feasibility Study task order scope. While the case studies will focus specifically on three systems, there may be times during the study when lessons learned from other systems, beyond the original three selected, could be applicable. Whenever possible, the URS Team will incorporate the most relevant examples into this study.

CASE STUDY SYSTEMS

Portland, OR Streetcar

System Summary: First modern streetcar system in the U.S, began as 2.4 mile loop, expanding now to a nearly 8 mile system with 11 cars now operating (first U.S. built modern streetcars now in manufacturing). System most often cited for positive economic development, cost-effectiveness, strong ridership and innovative financing. Significant data on Portland available, as history of operations dates back to 2001.

Applicability to Brooklyn: This system demonstrates use of modern streetcar technology in mixed street-running operation along urban streets; multiple examples of utility impact mitigation techniques; well-documented economic development impacts, system expansion process, funding, use of one-way pairs for operations, integration with bike lanes and pedestrian pathways.

One Penn Plaza, Suite 610 • New York, NY 10119-0698 • (212) 736-4444 • Fax (212) 629-4249

Charlotte, NC Streetcar

System Summary: This is a ten-mile planned system that will connect various downtown Charlotte neighborhoods and the to the new LYNX LRT system. Portions of starter system infrastructure built; received Urban Circulator grant funds.
Applicability to Brooklyn: Older infrastructure in east coast downtown area; development of rules of practice for utility impact mitigation; innovative shallow depth track slab design used.

Seattle, WA Seattle South Lake Union Streetcar

System Summary: South Lake Union system is a 2.6 mile 11-stop loop system. Seattle streetcar network now in development as a result of initial success of South Lake.
Applicability to Brooklyn: new modern streetcar system in full revenue service, similar to Portland in larger urban setting.

San Francisco, CA Historic Streetcar

System Summary: San Francisco Muni operates 17 historic PCC streetcars painted in schemes of other city's old streetcars on the F Market and Fisherman's Wharf routes. First opened in 1995, extension to the Wharf in 2001. Operates in regular revenue service by Muni, in-street running, tourist attraction.
Applicability to Brooklyn: Similar to the historic trolley proposed by Brooklyn Historic Railway Association (BHRA).

One Penn Plaza, Suite 610 • New York, NY 10119-0698 • (212) 736-4444 • Fax (212) 629-4249

Tacoma, WA Tacoma Link Rail (Streetcar)

System Summary: Modern streetcar, 1.6 mile starter primarily single-track system; initiated August 2003. System is street running but mostly in exclusive right-of-way.
Applicability to Brooklyn: Example of modern streetcar connecting to a multi-modal facility.

Tampa, FL Ybor City Historic Streetcar

System Summary: Replica streetcar system (9 Birney cars) operates in exclusive lane over 2.4 miles system, 15-minute headways in peak with section operating in contra-flow lane.

Applicability to Brooklyn: Use of Special Assessment Tax districts, naming rights and advertising for funding; contra-flow operation in sections; example of tourist impacts and economic development impacts.

Tucson, AR Starter Streetcar

System Summary: Proposed double track along most of the alignment; approximately 4.4 mile system operating primarily on two-way streets in mixed traffic with left turn lanes.
Applicability to Brooklyn: Currently in design; have some clearance issues; new system is extension of older historic trolley line segment. Simulation and visualization use.

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Kenosha Streetcar, Kenosha, WI

System Summary: this is a 2.1 mile streetcar system begun in 2001 and operating in a loop with 17 stops. System operates on grassy median for approximately half the route. Five donated Toronto PCC cars were refurbished.
Applicability to Brooklyn: Example of use of refurbished PCC cars and city operated system. Very low budget start-up ($5 million for entire system).

Philadelphia Trolley, Philadelphia, PA

System Summary: Rt. 15 Girard Avenue line has operated in street running by SEPTA on an 8.5 mile route. Use of older heritage PCC refurbished equipment, one of few U.S. cities with continuous streetcar operation.
Applicability to Brooklyn: example of older east coast system using heritage PCC streetcar vehicles.

Toronto Streetcar, Toronto, ON

System Summary: Largest operating streetcar system in North America in street running mixed-traffic. This has been a 47-mile, 11 routes in system. Some upgrades to exclusive lanes.
Applicability to Brooklyn: Example of complete streetcar system. Upgrades in process. Potentially valuable for lessons learned.

4.0 TRANSIT DEMAND ANALYSIS TECHNICAL MEMORANDUM

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1.0 TRANSIT DEMAND

1.1 Executive Summary

Future demand for higher capacity transit service in Red Hook was projected based on current transit service using a multi-step methodology. Existing met and unmet demands (existing transit riders and those not currently riding, respectively) were first determined using available information and travel patterns in peer New York City neighborhoods. Future demand was based on the calculated existing demands, current transit level of service, and proposed increase in transit level of service. The projection also considers any future additional demands generated by planned developments within Red Hook and the areas directly between Red Hook and Downtown Brooklyn. Table 1-1 presents the number of new riders attributable to streetcar by applying the difference between the two neighborhood types to current transit boardings. The table also presents the number of boardings generated by new developments within the Focus Area and Study Area. In total, these factors combine for a total projected number of boardings of 5,521 from the Focus Area and 12,544 from the Study Area.

**Table 1-1:
Projected Transit Boardings**

	TOTAL CURRENT TRANSIT BOARDINGS	NEW RIDERS	BOARDINGS FROM PLANNED DEVELOPMENTS WITH STREETCAR	TOTAL BOARDINGS WITH PLANNED DEVELOPMENTS AND STREETCAR
Focus Area	3,852	474	1,195	5,521
Study Area	9,902	1,218	1,424	12,544

1.2 Project and Analysis Objectives

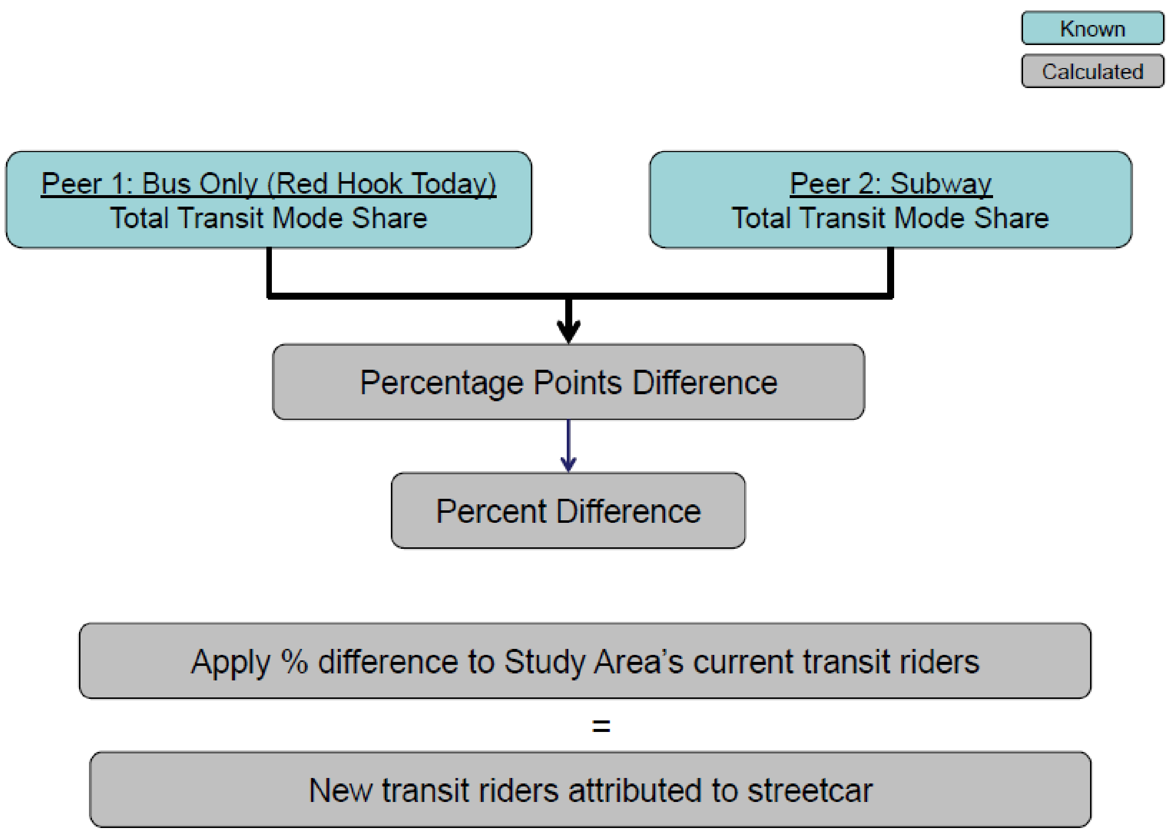
One component of determining the feasibility of a potential streetcar servicing Red Hook is to project the number of anticipated riders. This demand will help set the context for the initiative, providing one factor of "benefit" to compare against "cost." Existing met and unmet demands (existing transit riders and those not currently riding, respectively) were first determined using available information and travel patterns in peer New York City neighborhoods. Future demand was based on the calculated existing demands, current transit level of service, and proposed increase in transit level of service. The projection also considers any future additional demands generated by planned developments within Red Hook and the areas directly between Red Hook and Downtown Brooklyn.

1.3 Methodology

Existing unmet transit demand estimates were generated through a multi-step process. To begin, the Focus Area was compared to similar New York City neighborhoods. These neighborhoods fell into two categories: (1) ones that, like Red Hook, have bus transit only; and (2) ones with rail transit comparable to the level of connecting service that would be provided by a streetcar in Red Hook (for example, neighborhoods served only by the crosstown G subway line). Since New York City currently is not served by streetcar, Peer 2 neighborhoods were chosen based upon the next most comparable service. A list of nine potential neighborhoods was evaluated with DOT and narrowed down to a final list of five places most similar to Red Hook in terms of demographics, travel patterns, land use, and proximity to one of New York City's three main Central Business Districts (Midtown Manhattan, Lower Manhattan, and Downtown Brooklyn).

To better understand current transit use in each neighborhood and to define comparable conditions, transit Journey To Work mode share[1] was calculated per neighborhood. Peer 1 neighborhoods were compared to Red Hook to gain a sense of where Red Hook ranks within the "bus only" neighborhood boardings and percentage of residents commuting to work by each mode ("work mode shares"). Transit boardings and mode shares for Peer 2 neighborhoods indicate the potential transit demand streetcar service in Red Hook would generate. The difference in boardings and mode shares between Peer 1 neighborhoods (including Red Hook) and Peer 2 neighborhoods is indicative of the unmet demand that results from not having rail connections within a New York City neighborhood. A graphic showing the steps underpinning this analysis is shown in Figure 1-1.

Figure 1-1: Streetcar Demand Methodology

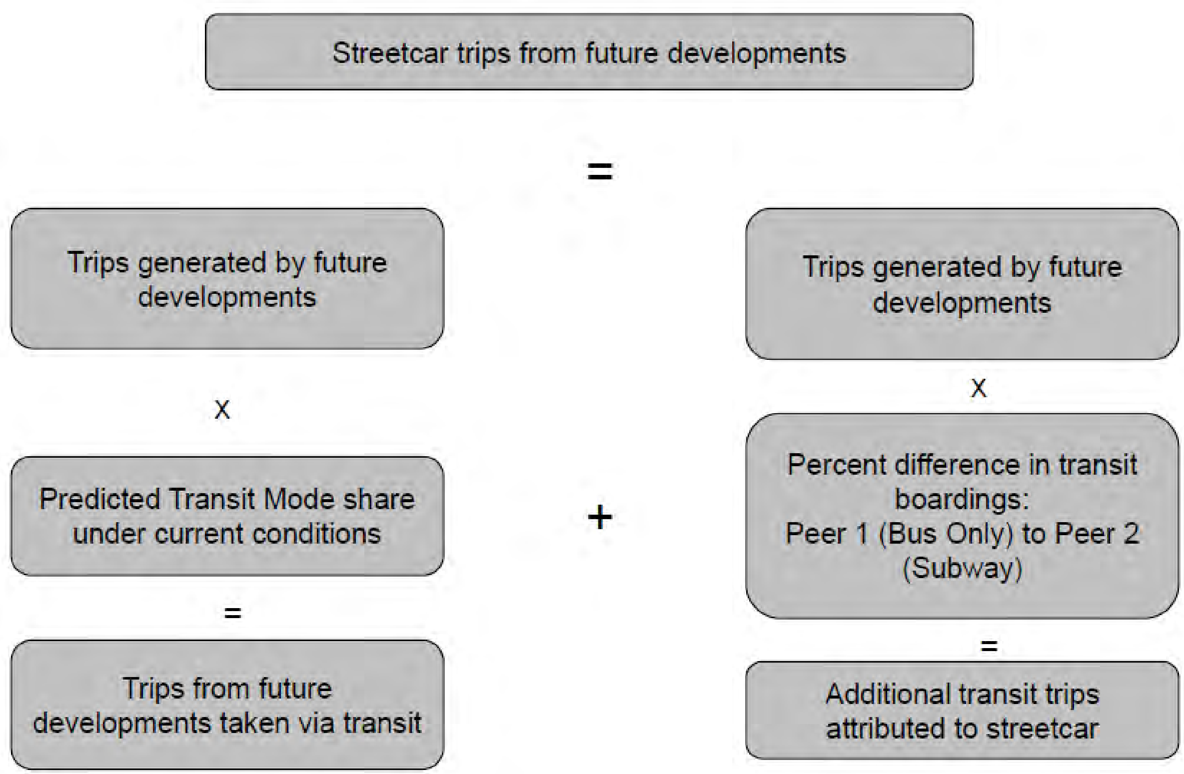


[1] The percentage of people who reported that they rode transit to work, as documented in the 2000 US Census.

Future transit demand also takes into account potential new riders residing within developments anticipated to open within the next five years. Demand for these riders is calculated based on the trip generation characteristics of anticipated commercial and residential developments within the Focus Area and Study Area, based on input from the Department of City Planning (DCP).

A streetcar in Red Hook would also be used by residents and employees of the larger Study Area. The Study Area was identified after initial streetcar alignments that could connect Red Hook to Downtown Brooklyn along Columbia Street and Atlantic Avenue were identified. Similar to the process undertaken to compute transit demand in the Focus Area, projections for the Study Area calculated current transit boardings and applied to it the percent difference from Peer 1 to Peer 2. Although the Study Area is served by multiple bus and subway routes, a new streetcar service is not expected to cause riders to shift from an existing quick and direct transit route. Instead, only boardings on the B61 were included, as they represent future streetcar riders traveling between Red Hook and Downtown Brooklyn with faster or more direct options. Future Study Area developments and transit trip generation were also computed. A flow chart showing how the analysis of future developments was undertaken is presented in Figure 1-2.

Figure 1-2: Streetcar Ridership from Future Developments



1.4 Peer Neighborhoods

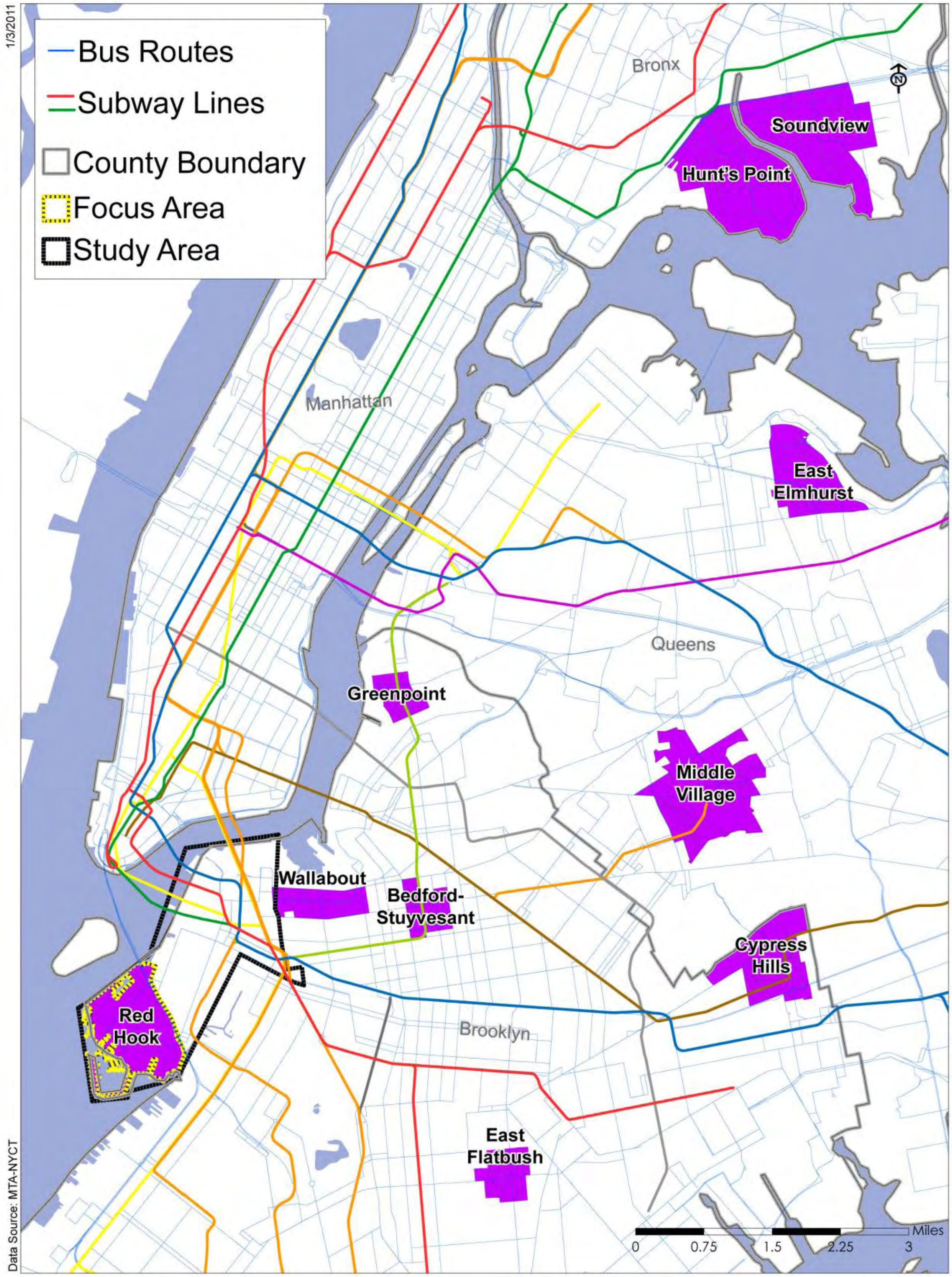
PEER NEIGHBORHOODS – INITIAL LIST

Peer neighborhoods with a) bus service only; and b) one indirect subway line were chosen for initial analysis. Neighborhoods in New York City can be quite large. Therefore, each peer neighborhood was narrowed and defined at the block group level to provide a finer grain of detail for analysis. Given the density of transit in Manhattan, there are no neighborhoods of comparable demographics and levels of service there for this analysis. Conversely, the low density of Staten Island excluded it from comparison to Red Hook. Focusing on the boroughs of Brooklyn, Queens, and the Bronx, the team utilized maps of bus and subway service plus demographic information to create an i nitial list of nine potential peers.

Table 1-2 to Table 1-11 present the transportation and socioeconomic data for Red Hook and the nine evaluated neighborhoods.

Figure 1-3 presents Red Hook and the nine evaluated peer neighborhoods.

Figure 1-3: Red Hook and Nine Evaluated Peer Neighborhoods



Peer 1 – Bus Only

These peers represent neighborhoods with no subway service:

- Wallabout, Brooklyn – Bound by the East River to the north, Myrtle Avenue to the south, Ashland Place to the west, and Kent Avenue/Taffe Place to the east, this neighborhood is just northeast of Downtown Brooklyn. The area surrounds the Navy Yard and has an industrial context that is similar to Red Hook.
- East Flatbush, Brooklyn – Located between the 3/4 and 2/5 subway lines, this neighborhood has high bus use and a population size that is similar to Red Hook.
- East Elmhurst, Queens – Located north of the 7 train, north of the Grand Central Parkway, this neighborhood has a racial makeup that is similar to Red Hook.
- Hunt's Point, Bronx – This peninsula east of Bruckner Boulevard and south of Soundview is industrial in nature, but with a growing residential population.
- Soundview, Bronx – This neighborhood surrounding Soundview Park is similar in size to Red Hook, and a comparable percent of its residents take the bus to work.

Peer 2 – One Subway Line

These peers include neighborhoods that are served by just one subway line that provides limited service compared to most of the City's subway system. A half-mile (10-minute walking distance) was identified around each subway station to define each neighborhood as being within walking distance of the subway. While many New York City districts are served with one subway line, care was taken to choose neighborhoods comparable to Red Hook. For example, Bay Ridge in south Brooklyn has the R line, but it is not demographically similar to Red Hook.

- Bedford-Stuyvesant, Brooklyn – This neighborhood is close to Downtown Brooklyn and has a high rate of households without a vehicle. The portion of Bedford-Stuyvesant under study is within a half-mile radius around the Myrtle Avenue G station.
- Greenpoint, Brooklyn – This neighborhood is most comparable to Red Hook. Greenpoint, like Red Hook, is a peninsula that feels cut off from the surrounding neighborhood, retains an industrial waterfront, but also has a growing population attracted to the area's lower rents. The portion of Greenpoint under study is within a half-mile radius around the Greenpoint Avenue G station.
- Cypress Hills, Queens – The J/Z lines, before the 2010 service changes, were considered routes with a lower level of service than the rest of the system because there were not as many transfer opportunities and there was no direct route to Midtown. Cypress Hills along the J/Z line includes the Cypress Hills, Crescent Street, and Norwood Avenue stations.
- Middle Village, Queens – This area surrounds the Metropolitan Avenue M station.

Peer Neighborhood Analysis

Travel patterns and population characteristics were analyzed in order to narrow down the list of peer neighborhoods to those most comparable to Red Hook. Transit propensity indicators[2] were identified from the 2000 Census (the most recent year that this information is available at the block group level), including population size, race, vehicle availability, and mode share. To project these

[2] Transit propensity indicators are measures of the relative demand for transit.

numbers to a more recent date, borough-wide growth rates from the 2006-2008 American Community Survey were applied to the 2000 block group data.

Travel times and distances to each of the city's three main Central Business District (CBDs) were calculated from a central address in each area. Google Transit mapped the transit travel time to each of the CBD centers:

- Downtown Brooklyn: 201 Joralemon Street
- Lower Manhattan: 11 Wall Street
- Midtown Manhattan: 620 8th Avenue

FINAL PEER NEIGHBORHOODS FOR ANALYSIS

The final five neighborhoods chosen as peers include:

- Peer 1 – Bus Only
  - Wallabout
  - East Flatbush
  - Hunt's Point
- Peer 2 – Subway (with station)
  - Bedford-Stuyvesant (Myrtle Avenue G station)
  - Greenpoint (Greenpoint Avenue G station)

Peer 1 neighborhoods were chosen because they had similar commute modal shares (auto and/or) transit), travel time to a CBD, and vehicles with no households[3]. Peer 2 neighborhoods were chosen because they are served by the G train, which is the most comparable service to a streetcar currently found in New York City. A typical subway provides a high level of service – it has its own right-of-way with stations that are underground and weather-protected – whereas bus has a lower level of service. A streetcar falls somewhere in between the two. It has better stations and amenities than a bus, but it typically operates in mixed traffic, making it slower than a subway. The G train is perceived as a less direct subway route because it does not travel to the Lower Manhattan or Midtown Manhattan CBD's; it also has less off-peak service than most other New York City subway lines (though more than streetcar service may provide).

[3] Data points that are similar to Red Hook are highlighted in yellow in Tables 1-1 to 1-10.

Table 1-2: Red Hook Profile

Focus Area and Study Area		
Population	Focus Area	Study Area
Total Population	9,916	80,297
Mode Share[4]	Focus Area	Study Area
Transit	61%	72.5%
Bus	18.1%	4.7%
Streetcar	0%	0.4%
Subway	42%	96.7%
Railroad	0.9%	1.5%
Ferry	0%	0%
Car	15.4%	10.8%
Walk	17.3%	12.2%
Bike	7.2%	1.9%
Other	3.5%	8%
Focus Area		
Distance From:	Miles	Minutes (Transit)
Downtown Brooklyn	2	20
Lower Manhattan	4.5	35
Midtown Manhattan	7	55
Race		
White	24.9%	
Black	44.9%	
American Indian	1.5%	
Asian	0.3%	
Hawaiian/Pacific Islander	0%	
Other	22.9%	
Two or more races	1.9%	
Vehicles Availability		
Households with no vehicle	81.5%	

Data Source: US Census 2000, American Community Survey 2006-2008

Figure 1-4: Red Hook Transit – Focus Area

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[4] Totals may not equal 100% due to rounding.

PEER 1: BUS ONLY

Table 1-3: Wallabout Profile (Final Peer Neighborhood for Analysis #1)

Population		
Total Population	16,332	
Mode Share		
Transit	52.6%	
Bus	19.2%	
Streetcar	0%	
Subway	33.7%	
Railroad	0.2%	
Ferry	0%	
Car	19%	
Walk	24.3%	
Bike	2.6%	
Other	2.5%	
Distance From:	Miles	Minutes (Transit)
Downtown Brooklyn	1.5	25
Lower Manhattan	3.3	35
Midtown Manhattan	5.3	40
Race		
White	19.6%	
Black	55.4%	
American Indian	0.3%	
Asian	1.1%	
Hawaiian/Pacific Islander	0%	
Other	18.1%	
Two or more races	1.8%	
Vehicles Availability		
Households with no vehicle	79%	

Data Source: US Census 2000, American Community Survey 2006-2008

Figure 1-5: Wallabout Transit

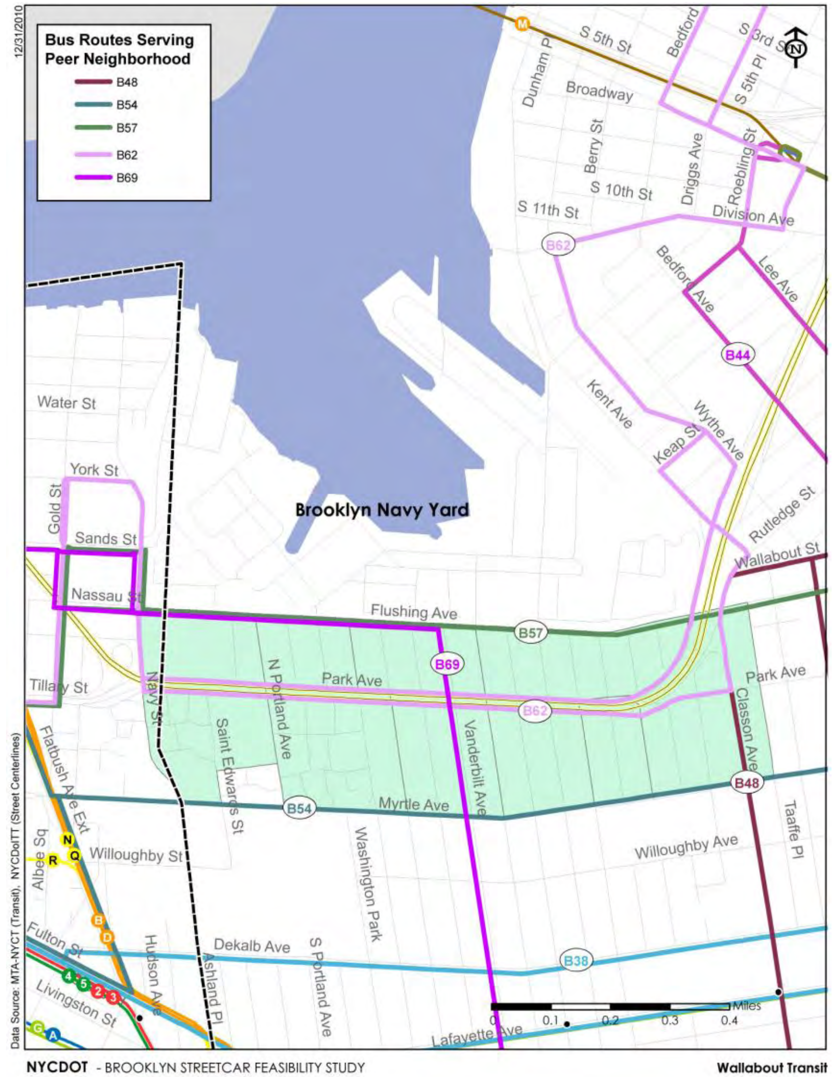


Table 1-4: East Flatbush Profile (Final Peer Neighborhood for Analysis #2)

Population		
Total Population	11,921	
Mode Share		
Transit	66.9%	
Bus	20.8%	
Streetcar	0.9%	
Subway	42.5%	
Railroad	3%	
Ferry	0%	
Car	23.9%	
Walk	5.1%	
Bike	0.6%	
Other	4.1%	
Distance From:	Miles	Minutes (Transit)
Downtown Brooklyn	5	40
Lower Manhattan	7.3	45
Midtown Manhattan	9.5	65
Race		
White	1.8%	
Black	88.9%	
American Indian	0.6%	
Asian	0.7%	
Hawaiian/Pacific Islander	0%	
Other	1.2%	
Two or more races	1.1%	
Vehicles Availability		
Households with no vehicle	57.1%	

Data Source: US Census 2000, American Community Survey 2006-2008

Figure 1-6: East Flatbush Transit

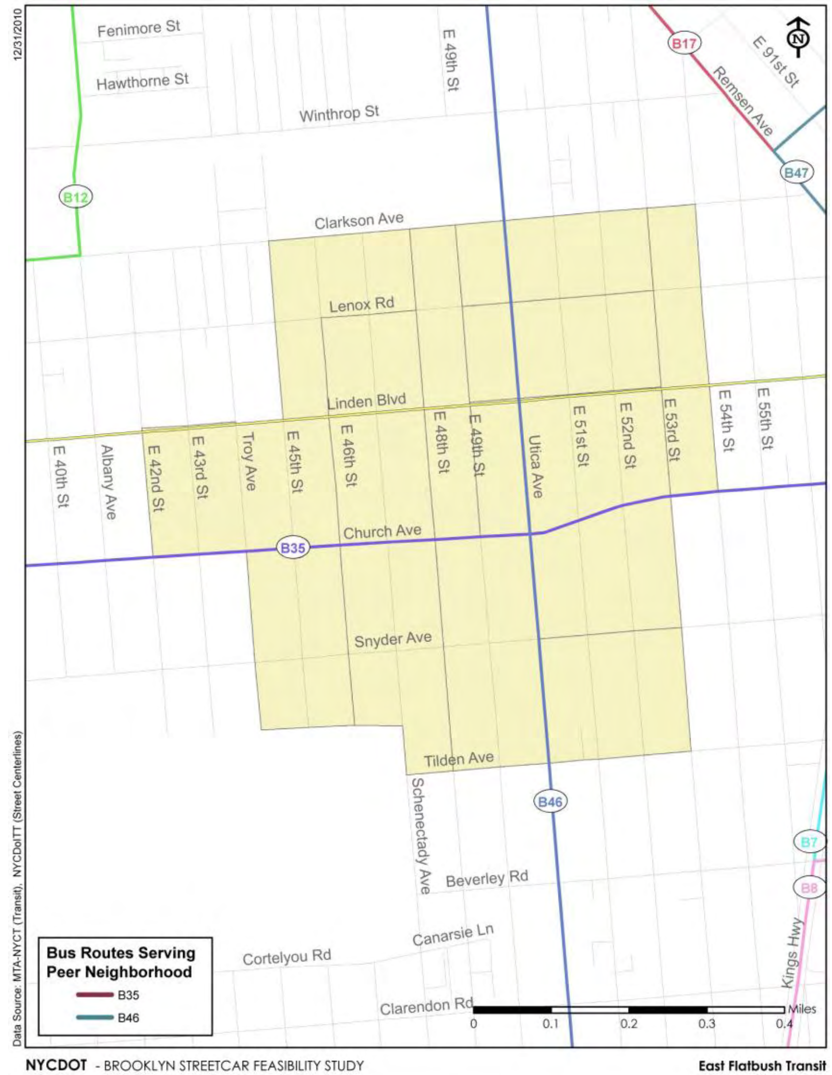


Table 1-5: Hunt's Point Profile (Final Peer Neighborhood for Analysis #3)		
Population		
Total Population	11,794	
Mode Share		
Transit	53.8%	
Bus	13%	
Streetcar	0%	
Subway	37.2%	
Railroad	3.2%	
Ferry	0%	
Car	34.9%	
Walk	14.9%	
Bike	0%	
Other	4.6%	
Distance From:	Miles	Minutes (Transit)
Downtown Brooklyn	12	65
Lower Manhattan	11.5	62
Midtown Manhattan	8.4	58
Race		
White	27.9%	
Black	33%	
American Indian	0.1%	
Asian	0.9%	
Hawaiian/Pacific Islander	0%	
Other	52.1%	
Two or more races	2.4%	
Vehicles Availability		
Households with no vehicle	72.6%	

Data Source: US Census 2000, American Community Survey 2006-2008

Figure 1-7: Hunt's Point Transit

PEER 2: ONE SUBWAY LINE

Table 1-6: Bedford-Stuyvesant Profile (Final Peer Neighborhood for Analysis #4)

Population		
Total Population	14,481	
Mode Share		
Transit	68.4%	
Bus	20.2%	
Streetcar	0%	
Subway	47%	
Railroad	1.2%	
Ferry	0%	
Car	20.8%	
Walk	5.6%	
Bike	2.3%	
Other	5.1%	
Distance From:	Miles	Minutes (Transit)
Downtown Brooklyn	2.5	20
Lower Manhattan	4.5	30
Midtown Manhattan	6	35
Race		
White	11.1%	
Black	61.9%	
American Indian	0.3%	
Asian	0.2%	
Hawaiian/Pacific Islander	0%	
Other	20.6%	
Two or more races	1.6%	
Vehicles Availability		
Households with no vehicle	75.3%	

Data Source: US Census 2000, American Community Survey 2006-2008

Figure 1-8: Bedford-Stuyvesant Transit

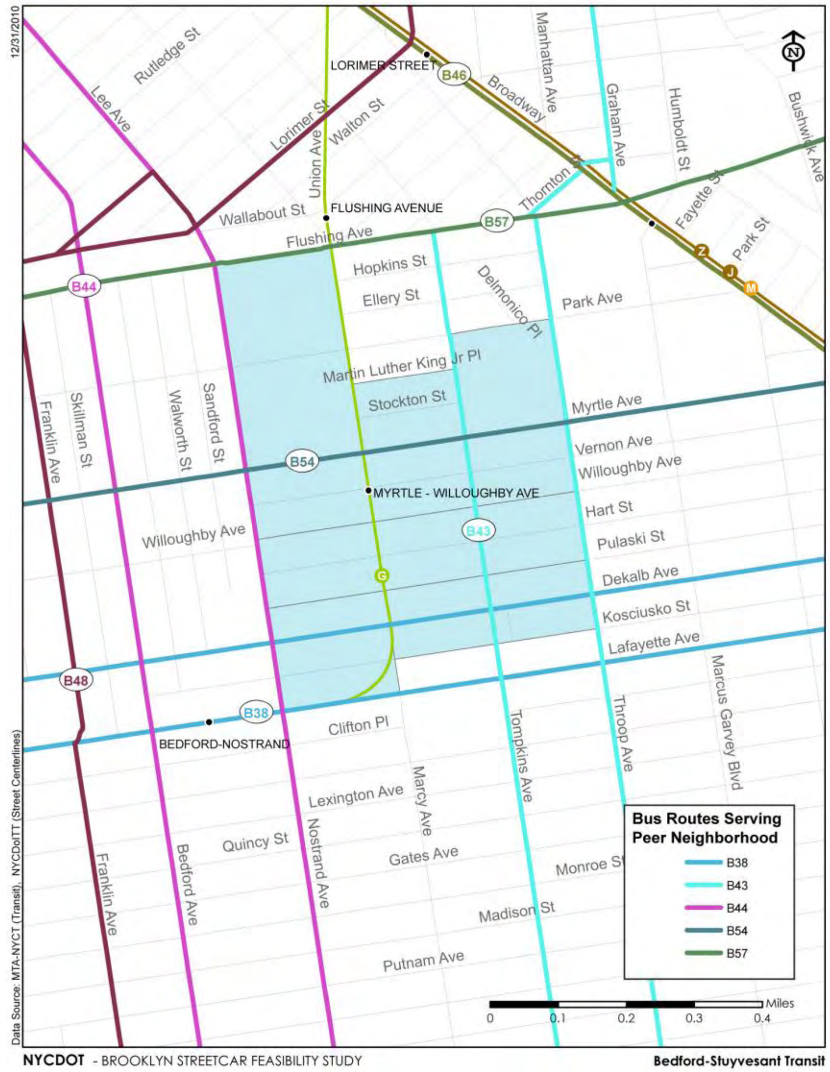
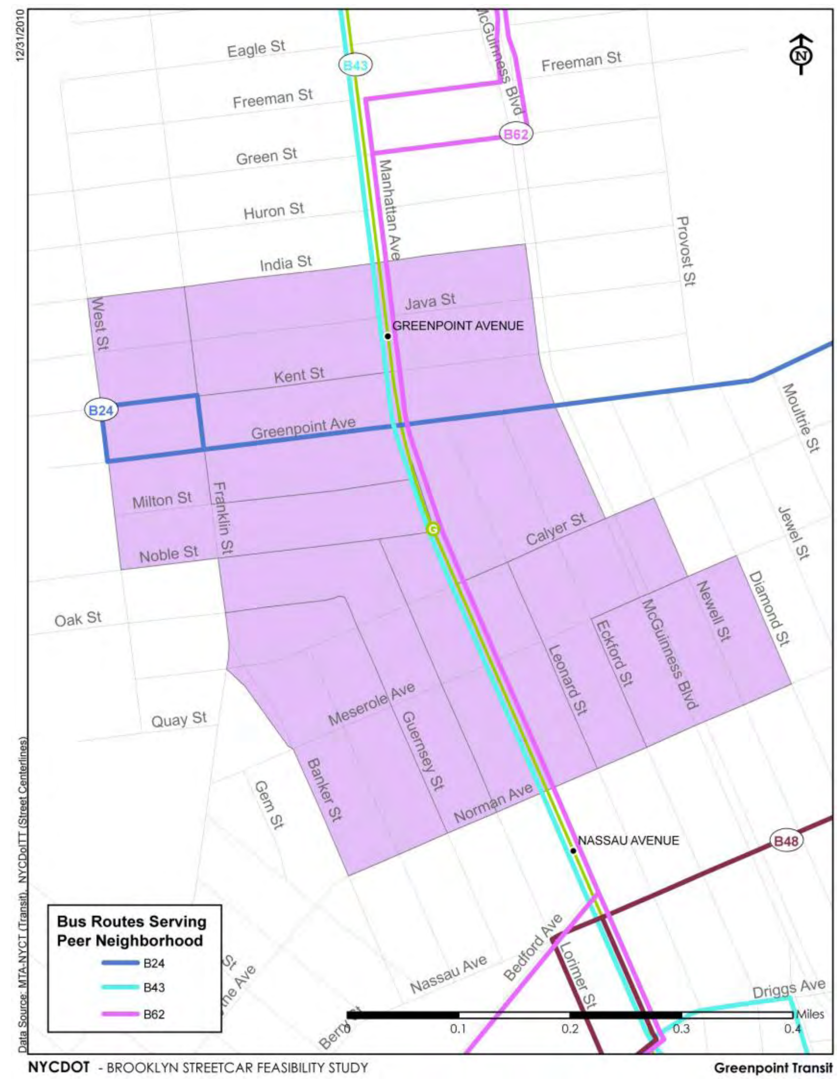


Table 1-7: Greenpoint Profile (Final Peer Neighborhood for Analysis #5)

Population		
Total Population	10,492	
Mode Share		
Transit	65%	
Bus	6.1%	
Streetcar	0%	
Subway	57%	
Railroad	0.5%	
Ferry	0%	
Car	18.5%	
Walk	12.7%	
Bike	2.7%	
Other	3.2%	
Distance From:	Miles	Minutes (Transit)
Downtown Brooklyn	4.5	30
Lower Manhattan	5	35
Midtown Manhattan	5.3	25
Race		
White	88.4%	
Black	1.6%	
American Indian	0%	
Asian	6%	
Hawaiian/Pacific Islander	0%	
Other	7.2%	
Two or more races	1.1%	
Vehicles Availability		
Households with no vehicle	62.5%	

Data Source: US Census 2000, American Community Survey 2006-2008

Figure 1-9: Greenpoint Transit



PEER NEIGHBORHOODS NOT CHOSEN FOR FURTHER ANALYSIS

Table 1-8: East Elmhurst Profile

Population		
Total Population	18,961	
Mode Share		
Transit	48.4%	
Bus	16.6%	
Streetcar	0%	
Subway	29.5%	
Railroad	2.2%	
Ferry	0%	
Car	38.8%	
Walk	7.8%	
Bike	1.4%	
Other	3.9%	
Distance From:	Miles	Minutes (Transit)
Downtown Brooklyn	9.6	75
Lower Manhattan	10.5	70
Midtown Manhattan	7.6	55
Race		
White	19%	
Black	53%	
American Indian	0.3%	
Asian	2.7%	
Hawaiian/Pacific Islander	0%	
Other	20.1%	
Two or more races	1.5%	
Vehicles Availability		
Households with no vehicle	76.3%	

Data Source: US Census 2000, American Community Survey 2006-2008

Figure 1-10: East Elmhurst Transit

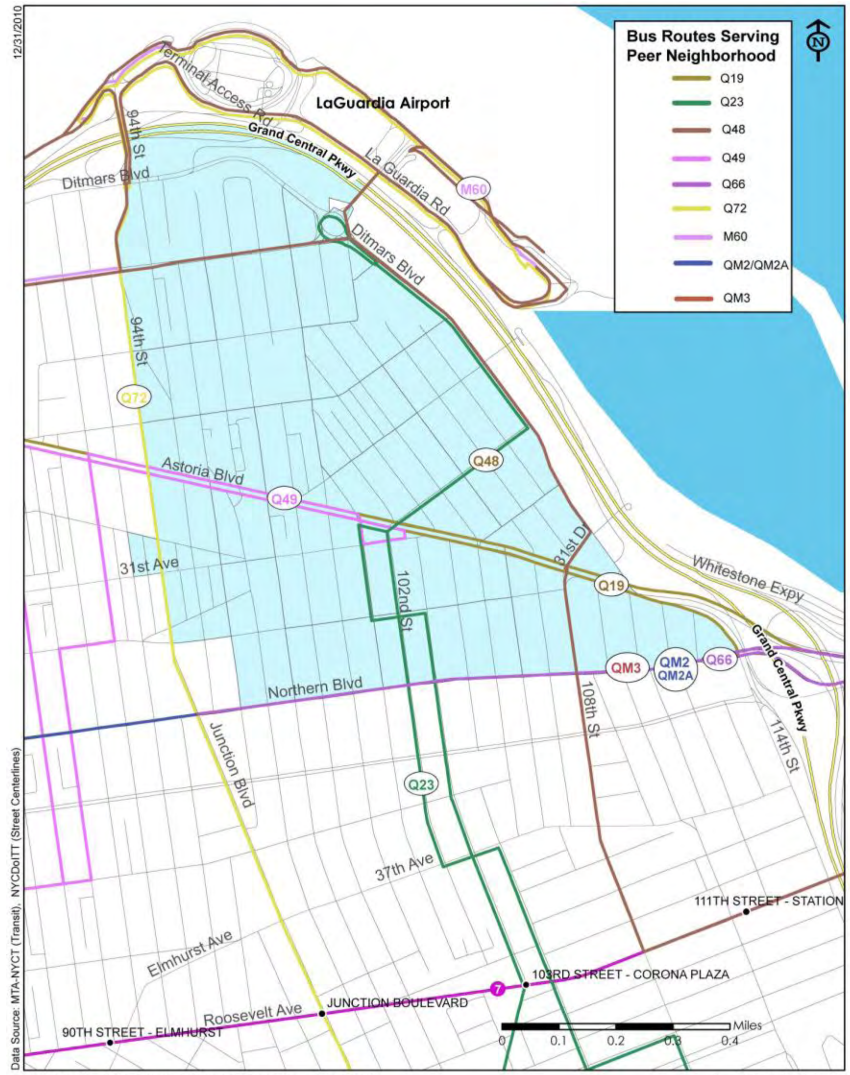


Table 1-9: Soundview Profile

Population		
Total Population	10,871	
Mode Share		
Transit	53.6%	
Bus	20.3%	
Streetcar	0.6%	
Subway	32.3%	
Railroad	0.6%	
Ferry	0%	
Car	36.7%	
Walk	4.7%	
Bike	0.1%	
Other	2.8%	
Distance From:	**Miles**	**Minutes (Transit)**
Downtown Brooklyn	13.6	70
Lower Manhattan	12.8	65
Midtown Manhattan	9.7	60
Race		
White	15.7%	
Black	47.3%	
American Indian	0.2%	
Asian	0.4%	
Hawaiian/Pacific Islander	0.3%	
Other	32.9%	
Two or more races	2.7%	
Vehicles Availability		
Households with no vehicle	57.2%	

Data Source: US Census 2000, American Community Survey 2006-2008

Figure 1-11: Soundview Transit

Table 1-10: Cyprus Hills Profile

Population		
Total Population	12,685	
Mode Share		
Transit	62.6%	
Bus	9.5%	
Streetcar	0.8%	
Subway	50.8%	
Railroad	0.8%	
Ferry	0.1%	
Car	26.2%	
Walk	6.9%	
Bike	0%	
Other	3.8%	
Distance From:	**Miles**	**Minutes (Transit)**
Downtown Brooklyn	6.6	40
Lower Manhattan	8.5	45
Midtown Manhattan	10	55
Race		
White	22.9%	
Black	16.4%	
American Indian	0.6%	
Asian	9.8%	
Hawaiian/Pacific Islander	0%	
Other	44.3%	
Two or more races	3.4%	
Vehicles Availability		
Households with no vehicle	52.6%	

Data Source: US Census 2000, American Community Survey 2006-2008

Figure 1-12: Cypress Hill Transit

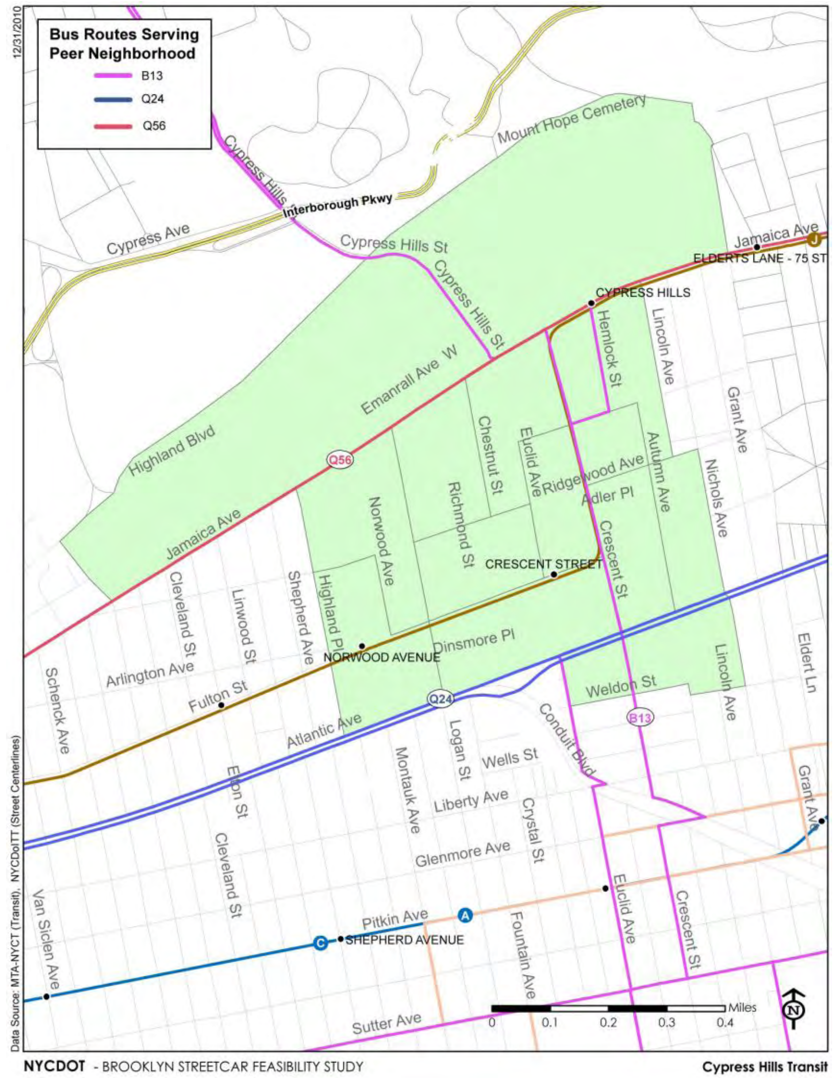
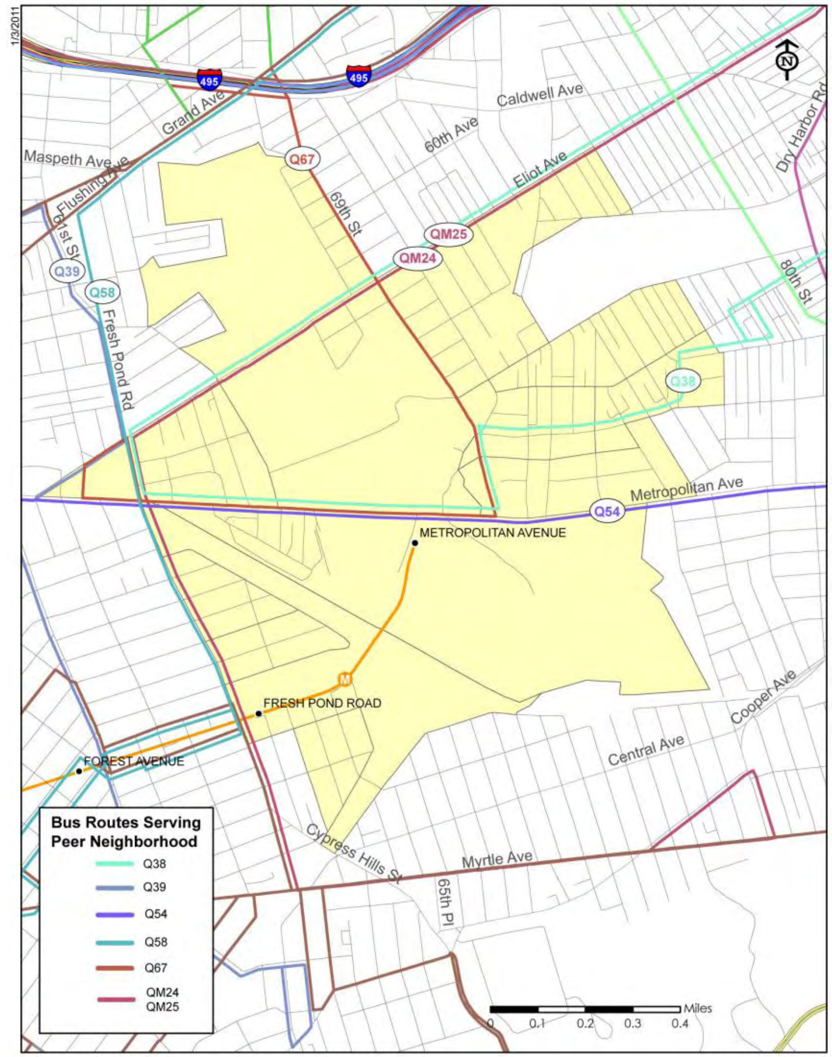


Table 1-11: Middle Village Profile		
Population		
Total Population	17,154	
Mode Share		
Transit	44.6%	
Bus	15.1%	
Streetcar	0.2%	
Subway	28.5%	
Railroad	0.6%	
Ferry	0%	
Car	46.9%	
Walk	4.4%	
Bike	0.6%	
Other	2%	
Distance From:	Miles	Minutes (Transit)
Downtown Brooklyn	6.5	60
Lower Manhattan	7.7	55
Midtown Manhattan	7.8	60
Race		
White	92.4%	
Black	.35%	
American Indian	0.1%	
Asian	3.1%	
Hawaiian/Pacific Islander	0.1%	
Other	3.75%	
Two or more races	0.7%	
Vehicles Availability		
Households with no vehicle	26.6%	

Data Source: US Census 2000, American Community Survey 2006-2008

Figure 1-13: Middle Village Transit



NYCDOT - BROOKLYN STREETCAR FEASIBILITY STUDY Middle Village Transit

MODE SHARES AND RIDERSHIP

Journey to Work commute mode share[5] for each neighborhood was used to provide a complete picture of transit usage in each neighborhood (see Table 1-12).

Table 1-12:
Transit Demand Factors

PEER NEIGHBORHOOD	POPULATION	TOTAL LABOR FORCE	LABOR FORCE TRANSIT SHARE
PEER 1 NEIGHBORHOODS			
Wallabout	16,332	4,049	52.9%
East Flatbush	11,921	6,370	63.3%
Hunt's Point	11,794	2,477	50.2%
Peer Total	**40,047**	**12,896**	**57.5%**
PEER 2 NEIGHBORHOODS			
Bedford-Stuyvesant	14,481	3,570	67.2%
Greenpoint	10,492	5,946	63.1%
Peer Total	**24,973**	**9,516**	**64.6%**
RED HOOK			
	10,346	2,416	60.1%

Data Source: US Census 2000, American Community Survey 2006-2008

Peer 1/Peer 2 Mode Shares

The mode shares between Peer 1 and Peer 2 neighborhoods reflect a range of projected ridership for a new streetcar. Streetcars attract riders who currently drive, take the subway, or take the bus. Investment in a streetcar also demonstrates an agency's commitment to transit, which in turn helps to increase overall transit use. The total transit use in Peer 1 neighborhoods is 57.5 percent and in Peer 2, 64.6 percent.

Ridership Projections

Table 1-13 presents the projected ridership based on the difference in total transit mode share between the Peer 1 and Peer 2 neighborhoods. The difference in Peer 1 and Peer 2 total transit mode share is 7.1 percentage points (64.6-57.5); this represents a 12.3 percentage difference between the Peer 1 and Peer 2 neighborhoods (7.1/57.5).

[5] Percentage of commuters who reported they travel to work by each mode as documented in the 2000 US Census.

Table 1-13:
Peer Mode Shares

PEER NEIGHBORHOODS	TOTAL TRANSIT TRIPS %
Peer 1	57.5%
Peer 2	64.6%
Percentage Points Difference	7.1
Percent Difference	12.3%
RED HOOK	**TOTAL TRANSIT TRIPS %**
Existing	60.1%
Projected Future Transit Share	67.5%

Data Source: US Census 2000, American Community Survey 2006-2008

1.5 Transit Demand Projections

The Peer Neighborhood analysis from the previous section illustrates how transit ridership could be expected to change in the Focus and Study Areas. The 12.3 percent difference will next be applied to the existing Focus Area and Study Area transit boardings and future developments.

RED HOOK TRANSIT RIDERSHIP

Bus and subway boardings, in combination with Census data, were utilized to understand current travel patterns and obtain a baseline number for transit boardings in the Focus Area and Study Area.

Bus Ridership – Focus Area

Focus Area bus boardings on the B61 and the former B77 were computed. The B77 was included as the B61 data was collected after service restructuring of that route in January 2010 but before the B61 began incorporating the old B77 route in June 2010. Thus the B61 data did not include stops on Lorraine Street, Court Street, or Otsego Street.

Bus Ridership – Study Area

After initial streetcar alignments that could connect Red Hook to Downtown Brooklyn along Columbia Street and Atlantic Avenue were identified, it was possible to determine which sections of the larger Study Area could experience increased transit demand attributable to a new streetcar. Although the Study Area is served by multiple bus and subway routes, a new streetcar service is not expected to cause riders to shift from an existing quick and direct transit route. Instead, only boardings on the B61 were included, as they represent future streetcar riders traveling between Red Hook and Downtown Brooklyn with faster or more direct options. B61 boardings for the entire Study Area were calculated up to the point where the bus turns off Atlantic Avenue onto Smith Street, as that area is within a very short walking distance of Borough Hall, the major employment area of Downtown Brooklyn. Anyone living north of Atlantic Avenue is an assumed walk trip. Typically those living within a 10-minute walk distance of a major destination will choose to walk. However, while several B61 stops along Atlantic Avenue are within a 10-minute walk of Borough Hall, boardings on the B61 demonstrate that the public perceives this walk distance as much farther than 10 minutes, likely due to the long blocks along Atlantic Avenue. A total of 1,295 boardings, or 23.7 percent of all

B61 boardings, occurred along Atlantic Avenue. These boardings were included as they are potential streetcar riders. Although one of the preliminary alignment alternatives (Atlantic Avenue east of Boerum Place) would replicate current B63 bus service rather than B61 service along Atlantic Avenue, demand from existing B63 riders was not estimated, as counting both B61 and B63 riders would not accurately inform streetcar demand, which would draw from one but not both bus ridership bases, depending upon which alignment is chosen. At this stage, a Downtown Brooklyn (B61) alignment was chosen for transit demand analysis purposes. If the Atlantic Avenue alignment (B63) is instead advanced, the analysis should be updated utilizing the methodology employed here.

A summary table of bus boardings is shown in Table 1-14.

Table 1-14:
Red Hook Bus Boardings

BUS ROUTE	DESCRIPTION	DAILY BUS BOARDINGS
Red Hook Focus Area		2,738
B61	Red Hook-Downtown Brooklyn	1,816
B77	Park Slope-Red Hook (discontinued June 2010)	922
Study Area		4,564
B61	Red Hook- Downtown Brooklyn	3,142
B77	Park Slope-Red Hook (discontinued June 2010)	922

Data Source: MTA-NYCT

Subway Boardings – Focus Area

The Focus Area does not include a subway station; however, many residents are within walking distance of the Smith and 9th Street F and G station just east of the Focus Area boundary. In order to avoid double counting bus riders who transferred to the subway, bus transfers (582) were subtracted from Smith & 9th Street average daily boardings (4,579). Thus a total of 3,997 non-transferring riders board daily at this subway station.

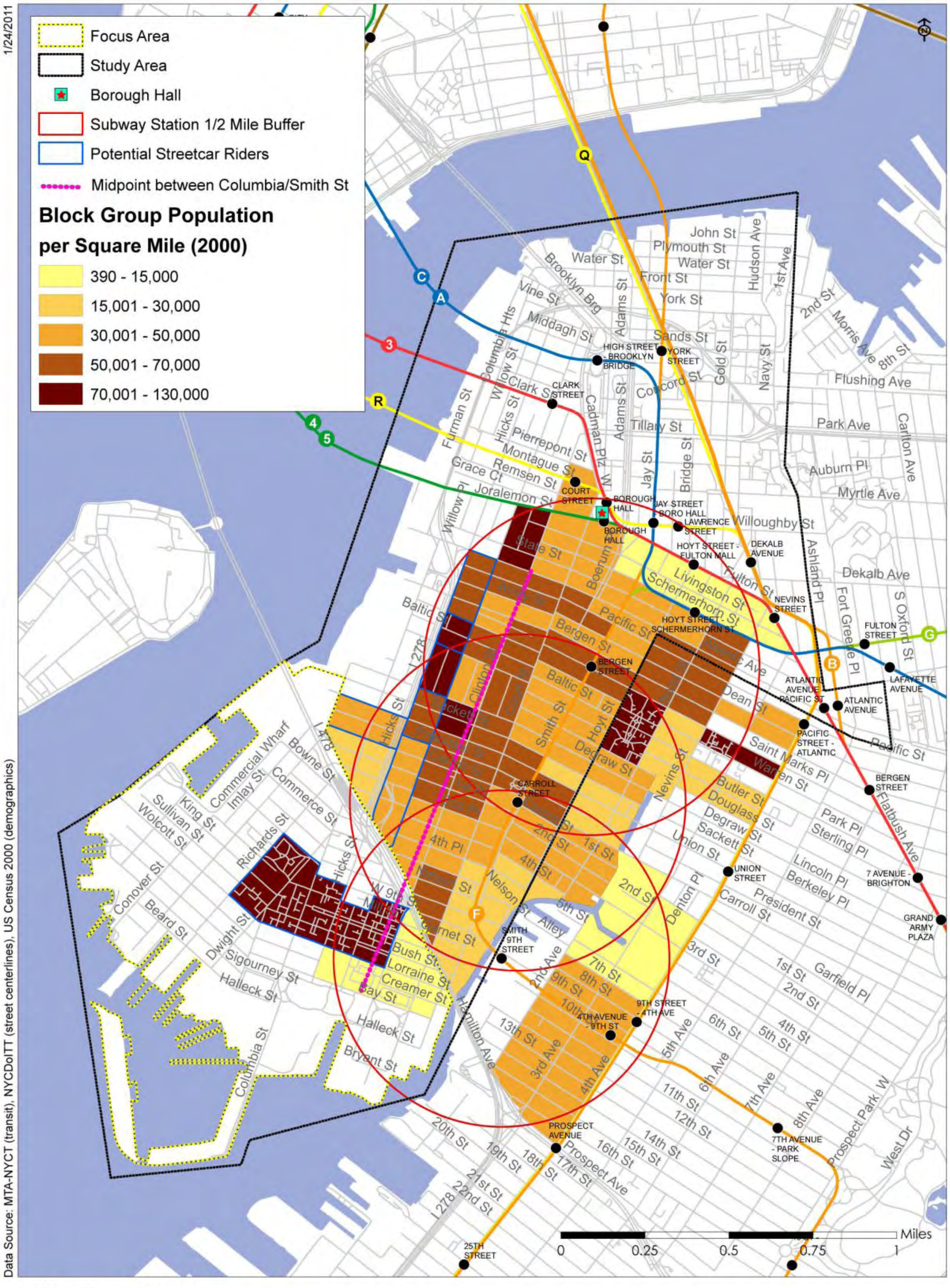
The catchment area of the Smith and 9th Street station includes neighborhoods beyond the Focus Area. To calculate the number of the total Smith and 9th Street station riders who live in the Focus Area, Census block group population numbers were calculated for the half-mile buffer surrounding the subway station. A total of 17,796 people live in that buffer area. The block groups that are both within the half-mile subway buffer as well as within the Focus Area boundary contain 4,959 residents, or 27.9 percent of the total. By applying that same percentage of Smith and 9th Street station daily riders, an estimated total of 1,114 people using the station are assumed to originate from the Focus Area.

Subway Boardings – Study Area

The Study Area contains numerous subway stations; however, only three are relevant to the understanding of a potential future streetcar. Those three stations are Smith and 9th Street, Bergen Street, and Carroll Street, along the F-G lines. Any stations north of Bergen Street are too close to Downtown Brooklyn to attract streetcar ridership to Downtown Brooklyn. In total, 23,937 riders board the three subway stations daily (this is net of bus transfers at Smith and 9th Street station; no transfers were recorded at Carroll Street or Bergen Street stations). The residential population within a half-mile buffer of the three stations totals 59,223. As shown in Figure 1-14, there is considerable overlap between the subway buffers and the study area; however, it cannot be assumed that residents living along the F-G line within the Study Area will be future streetcar riders as there is no time incentive to switch. Similarly, as described above in the Study Area bus boardings section, anyone living north of Atlantic Avenue is likely walking to Downtown Brooklyn today and is not anticipated to switch modes.

Only residents of those block groups west of approximately Clinton Street (halfway between most of the F/G subway line at Smith Street and Columbia Street) and south of Atlantic Avenue were counted as subway riders coming from the Study Area and are considered potential streetcar riders. A total of 13,220 people are residents of this area, representing 22.3 percent of total boardings. Thus 5,338 riders who board the subway are attributed to this area.

Figure 1-14: Study Area Subway Buffers by Block Group



Projected Transit Ridership

Table 1-15 presents the number of new riders attributable to streetcar by applying the 12.3 percent difference between Peer 1 and Peer 2 neighborhoods to current transit boardings. Based on this methodology, a streetcar in the Study Area would serve a demand of 1,218 new riders.

Table 1-15:
Projected Transit Boardings

	BUS BOARDINGS	SUBWAY BOARDINGS	TOTAL CURRENT TRANSIT BOARDINGS	% INCREASE DUE TO STREETCAR	NEW RIDERS	TOTAL TRANSIT WITH STREETCAR
Focus Area	2,738	1,114	3,852	12.3%	474	4,326
Study Area	4,564	5,338	9,902		1,218	11,120

Data Source: MTA-NYCT (current transit ridership)

FUTURE DEVELOPMENTS

Several developments are currently approved or going through approval processes in Red Hook. This demand is not attributable to a future streetcar, as these developments are already in the approval process. The new Red Hook residents and employees associated with these new developments will be potential streetcar customers, and thus their demand is included in the demand projection. A list of developments was collected with input from DCP. A variety of resources were used to compute trip generation from these developments.[6] Trip generation rates vary by land use and take into account both work and non-work trips.

New developments are assumed to exhibit the same modal splits as current uses. Thus the transit mode share for Peer 1 neighborhoods with only bus service (57.5 percent) has been applied to the total number of trips generated by each development. This number represents the number of people who would take transit should options remain the same as they are today. Similar to the previous analysis of Study Area subway riders who might be potential streetcar riders, only Study Area developments west of the Clinton Street area representing the midpoint between Columbia Street and the F/G service corridor were included. As this area today has no subway service, it falls within the Peer 1: Bus Only category, thus the 57.5 percent transit mode share is applicable. Once the transit mode share under current conditions was calculated, a second factor was applied – the 12.3 percent transit increase that a streetcar would bring about.

Focus Area Developments

In the Focus Area, six parcels are under development. The largest development, at 160 Imlay Street, includes 153 residential units. An additional 13 units are planned for other sites. Additionally, 15,000 square feet of office space and 5,000 square feet of community facilities are planned within the Focus Area. Developments included in demand projections are expected to be completed within a five-year period (by 2015).

[6] Sources include: CEQR Technical Manual, Atlantic Yards Arena and Redevelopment Projec8t FEIS (2006), The Jamaica Plan FEIS (2007), Downtown Brooklyn Development FEIS (2004), Brooklyn Bridge Park FEIS (2005).

In total, developments in the Focus Area are projected to generate 1,850 daily trips. Trip generation rates include both work and non-work trips; thus, there is no need to interpolate from commute trips to total trips. The rates used here are 8.075 trips per dwelling unit, 18 trips per 1,000 gross square feet of commercial space, and 48 trips per 1,000 gross square feet of community facilities. Table 1-16 calculates total typical daily trips generated by each development, the number of transit trips, and trips induced because of streetcar.

Table 1-16:
Development Trip Generation – Focus Area

ADDRESS	DESCRIPTION	DAILY TRIP RATE	TOTAL TRIPS	TRANSIT (57.5%)	STREETCAR INCREASE (12.3%)	TOTAL TRANSIT
160 Imlay St	153 residential units	8.075 per unit	1,235	710	87	797
164 Beard St	4 residential units	8.075 per unit	32	19	2	21
440 Van Brunt St	1 residential unit, 9,000 sf office	8.075 per unit 18 per 1,000 sf	170	98	12	110
216 Conover St	6,000 sf office	18 per 1,000 sf	108	62	8	70
141 Dwight St	5,000 sf community facilities	48 per 1,000 sf	240	138	17	155
96 Lorraine St	8 residential units	8.075 per unit	65	37	5	42
TOTAL			1,850	1,064	131	1,195

Data Source: DCP (development data)

Study Area Developments

An additional five developments are slated within the Study Area west of Clinton Street. People in those developments are anticipated to be streetcar riders. These developments include 44 new residential units (Table 1-17).

Table 1-17:
Development Trip Generation – Study Area

ADDRESS	DESCRIPTION	DAILY TRIP RATE	TOTAL TRIPS	TRANSIT (57.5%)	STREETCAR BOOST (12.3%)	TOTAL TRANSIT
Study Area						
245 Hamilton Ave	20 residential units	8.075 per unit	162	93	11	105
671 Henry St	5 residential units	8.075 per unit	40	23	3	26
151 Carroll St	8 residential units	8.075 per unit	65	37	5	42
56 Strong Pl	3 residential units	8.075 per unit	24	14	2	15
25-33 Carroll St	8 residential units	8.075 per unit	65	37	5	42
Plus Focus Area						
160 Imlay St	153 residential units	8.075 per unit	1,235	710	87	797
164 Beard St	4 residential units	8.075 per unit	32	18	2	21
440 Van Brunt St	1 residential unit, 9,000 sf office	8.075 per unit 18 per 1,000 sf	170	98	12	110
216 Conover St	6,000 sf office	18 per 1,000 sf	108	62	8	70
141 Dwight St	5,000 sf community facilities	48 per 1,000 sf	240	138	17	155
96 Lorraine St	8 residential units	8.075 per unit	65	37	5	42
TOTAL			2,206	1,268	156	1,424

Data Source: DCP (development data)

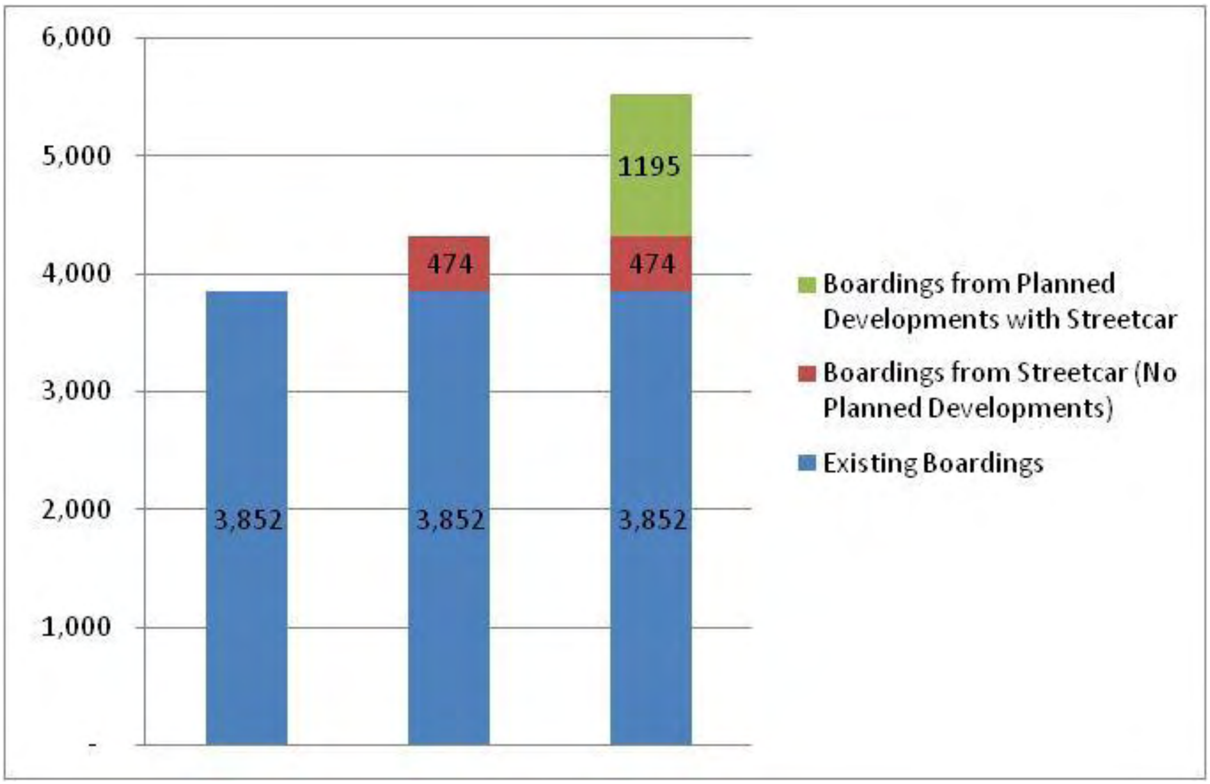
1.6 Summary of Demand

Based upon the peer neighborhood analysis, transit mode change in the Study Area and Focus Area, and new developments, the following ranges of streetcar demand are projected.

FOCUS AREA

Figure 1-15 displays how transit ridership will increase in the Focus Area due to streetcar alone, as well as with future developments.

Figure 1-15: Focus Area Projections

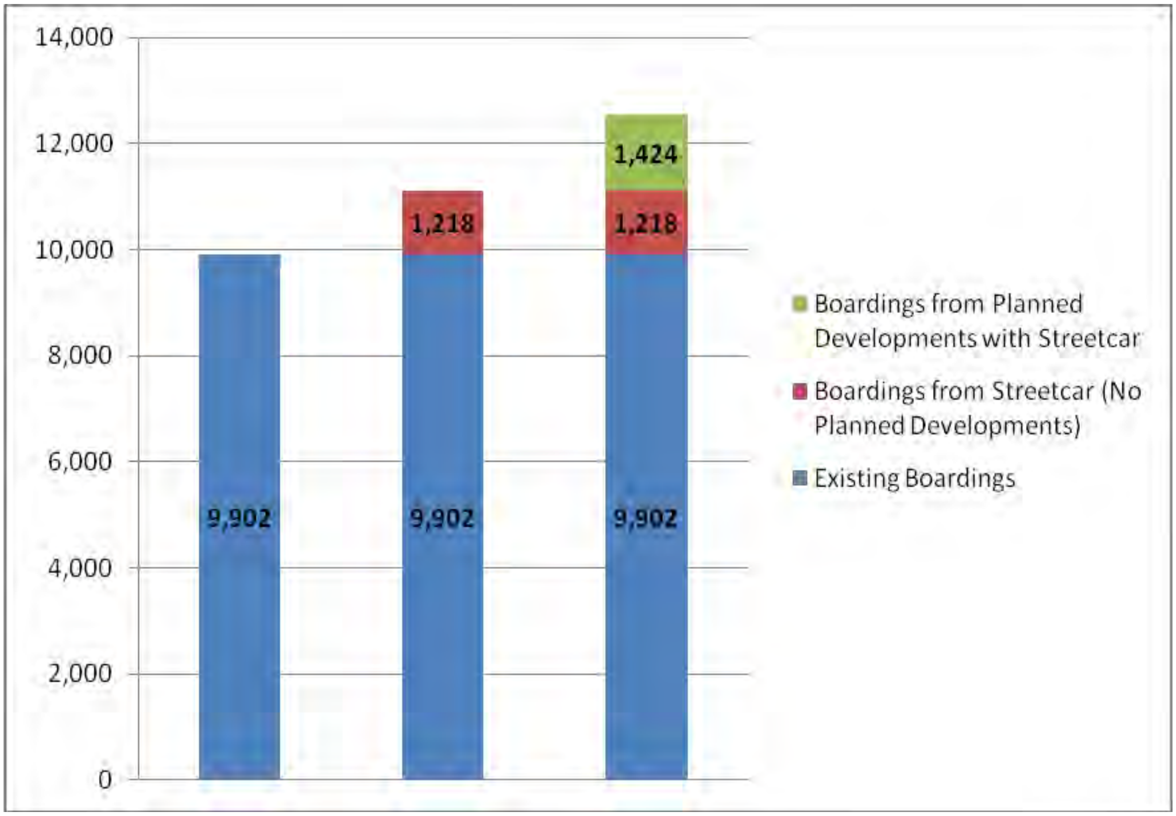


Data Source: MTA-NYCT (existing boardings)

STUDY AREA

Figure 1-16 displays how transit ridership will increase in the Study Area due to streetcar alone, as well as with future developments.

Figure 1-16: Study Area Projections



Data Source: MTA-NYCT (existing boardings)

1.7 Additional Factors for Consideration

Ridership demand reflects the various forms a streetcar can take, as well as surrounding factors that can encourage transit use. These well-known factors include:

1. Intensity of land use (within walking distance) - including both residential and employment density
2. Mix of land use - residential, employment, retail, and recreational
3. Travel time (speed of service)
4. Frequency of service
5. Fares
6. Connectivity to a broader network
7. Legibility and information
8. Comfort

Each of these factors and how they are influenced by streetcar development are summarized in Table 1-18. While there is no direct mathematical relationship between these individual factors and ridership, they have collectively proven to be key factors in attracting ridership to all types of transit. Specifically, cities that have implemented an integrated land use and transportation planning process with streetcar service and the elements listed in Table 1-18 have recorded ridership increases of 12-20%. Toronto's streetcar ridership was 15% higher than a previously operated bus route. Seattle's ridership increased by 19% between its first and second years of operation when coupled with development of a mixed use, walkable neighborhood for the street car to serve (see Peer Review report for complete details of peer system ridership).

**Table 1-18:
Comparison of Streetcar Factors**

FACTOR	HOW IT INFLUENCES RIDERSHIP	SOURCES
Intensity of Land Use	Density is the most direct influence on transit ridership – the greater the intensity of land use, the greater the ridership.	Boris S. Pushkarev and Jeffrey M. Zupan (1977), *Public Transportation and Land Use Policy*, Indiana University Press (Bloomington). Robert Cervero, et al (2004), *Transit-Oriented Development in the United States: Experience, Challenges, and Prospects*, TCRP Report 102, Transit Cooperative Research Program, Transportation Research Board
Mix of land uses	Different land uses have different demand patterns. Mixing land uses ensures steady ridership through the day, rather than directional peaking.	Marya Morris (1996), *Creating Transit-Supportive Land-Use Regulations*, Planning Advisory Service Report No. 468, American Planning Association
Travel Time	Riders are attracted to transit services that more closely match auto travel times.	Phil Goodwin (1992), "Review of New Demand Elasticities With Special Reference to Short and Long Run Effects of Price Changes," *Journal of Transport Economics*, Vol. 26, No. 2, May 1992. John F. Kain and Zvi Liu (1999), "Secrets of Success," *Transportation Research A*, Vol. 33, No. 7/8, Sept./Nov. 1999
Frequency and Span of Service	Frequent services reduce wait times and allow riders to make trips without planning. Services with a longer service span are attractive to more types of trips. Longer evening service ensures riders who work late or attend events in the evening will be able to get home.	TRL (2004), *The Demand for Public Transit: A Practical Guide*, Transportation Research Laboratory, Report TRL 593

**Table 1-18:
Comparison of Streetcar Factors**

FACTOR	HOW IT INFLUENCES RIDERSHIP	SOURCES
Fares	High fares discourage ridership. Lower fares encourage ridership.	Todd Litman (2004), "Transit Price Elasticities and Cross-Elasticities," *Journal of Public Transportation*, Vol. 7, No. 2
Connectivity to a Broader Network	Connecting to regional services provides greatly enhanced mobility and enhances the productivity of the overall system.	TRL (2004), *The Demand for Public Transit: A Practical Guide*, Transportation Research Laboratory, Report TRL 593
Legibility and Information	The easier it is to understand a transit system, the more occasional riders will use it. Real time information has been proven to increase ridership by as much as 5%.	Robert G. Stanley and Robert Hyman (2005), *Evaluation Of Recent Ridership Increases*, TCRP Research Results Digest 69, Transportation Research Board
Comfort	Roomier seats, ample room for standees, and a less "rocky ride" contribute to rider comfort and to patronage.	TRL (2004), *The Demand for Public Transit: A Practical Guide*, Transportation Research Laboratory, Report TRL 593

5.0 OPERATIONS PLANNING TECHNICAL MEMORANDUM

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1.0 INTRODUCTION

Evaluating the feasibility of a future streetcar system for Red Hook, Brooklyn and the surrounding neighborhoods involves a multi-step process. One key step in this process is the development of a preliminary operations plan. This technical memorandum presents the operating plan for a future Brooklyn streetcar, outlining the key variables that typically affect streetcar service. Development of these operating parameters will be used to guide several components of the Brooklyn Streetcar Feasibility Study, including the potential vehicle labor requirements and energy costs, preliminary operating and vehicle costs, and an estimate of overall capital costs. The variables that could affect future streetcar operations in Red Hook and comprise the operations plan are listed below and described in greater detail in the next section.

Service Operations

In determining the hours of operation and frequency of a future Brooklyn streetcar system, consideration should be given to the existing Red Hook transit service, consistency with the Metropolitan Transportation Authority New York City Transit (MTA NYCT) services, and future transit needs. Incorporating these elements into the planning of a future Brooklyn streetcar will allow the streetcar system to seamlessly connect with other transit services (subway, bus, and commuter rail).

Vehicle Characteristics

A general assumption is that a future Brooklyn streetcar system would operate at speeds similar to the existing MTA NYCT bus service in the Study Area. Streetcar vehicles have faster acceleration rates than buses, and based on other streetcar systems in the United States, boarding times are generally faster due to low-floor operations and all-door boarding capabilities. However, it is assumed a future Brooklyn streetcar would operate in mixed traffic (non-exclusive lanes), which could restrict travel speeds to those generally experienced by buses.

The number of vehicles required for a streetcar system is driven by the frequency of service and spare vehicle requirements. Streetcar vehicle layover requirements are typically similar to those required for bus service, which is 15 to 20 percent of the total travel time.

Maintenance Requirements

Streetcar systems require a storage and maintenance facility, or ‘car barns’ for servicing and storing the vehicle fleet, administering system operations, and supporting employees. As such, the servicing and storage of the streetcar fleet should be considered as an integral part of streetcar operations. The storage and maintenance facility should be located within close proximity to the streetcar route and outfitted to maintain the streetcar fleet, both now and in the future.

2.0 STREETCAR OPERATIONS PLANNING

2.1 Service Operations

OPERATING ENTITY

Details on operating entity alternatives will be further developed in the Feasibility Report.

OPERATING HOURS

In terms of operating hours, the MTA NYCT currently provides 24-hour transit service to and within Red Hook. This service span should be maintained under any future transit service for Red Hook. In order to accomplish this, two potential alternatives have been developed for weekday service. Alternative 1 is 24-hour streetcar service and Alternative 2 is 6 AM to midnight streetcar service and midnight to 6 AM bus service. The late night bus service could potentially be an extension of an existing route.

Alternative 1 has the advantage of being less confusing for passengers and would provide consistent service throughout the day. However, operating costs would be higher and 24-hour service would limit streetcar track maintenance or utility access. The late night bus service in Alternative 2 would provide an allocated period for vehicle and track maintenance, as well as maintenance by others in the corridor, such as utilities.

SERVICE FREQUENCY

Preliminary headways (defined as the frequency of service or time between vehicles arriving at a stop) have been developed based on the existing headways on the MTA NYCT's B61 bus route. Frequency of service is a key determinant in establishing vehicle requirements for the streetcar system. Proposed streetcar headways are presented in Table 2-1.

Table 2-1:
Proposed Streetcar Headways (minutes)

	AM PEAK (6 AM – 9 AM)	MID-DAY (9 AM – 4 PM)	PM PEAK (4 PM – 7 PM)	EVENING (7 PM – MIDNIGHT)	LATE NIGHT* (MIDNIGHT – 6 AM)
Weekdays	8	12	8	10	40
Saturdays	15	15	15	15	40
Sundays	20	20	15	15	40
*Could potentially be operated as a bus.					

The headways shown in Table 2-1 are similar to the existing B61 headways. The increased demand for transit, as a result of implementing a streetcar system, is assumed to be absorbed by the increased capacity of the streetcar. Actual headways will be adjusted as transit demand changes, similar to the current policy of the MTA NYCT.

SYSTEM INTEGRATION

Intermodal connections and complete integration with the MTA NYCT existing transit network is essential to the success of a future Brooklyn streetcar. The southern terminal of the streetcar would be the Smith-9th Street Station, which is served by the F-G subway routes. Two alternative northern terminals also connect to existing rail services: Borough Hall, which is served by the 2, 3, 4, 5, A, C, F, N, and R subway routes, and Atlantic Terminal, which is served by the 2, 3, 4, 5, B, D, N, Q, and R subway routes as well as the Long Island Rail Road (LIRR) commuter rail. Additional connections should be established to the Study Area and Focus Area's bus network, including the B63, the B65 along Atlantic Avenue, and the B61, which would potentially undergo significant restructuring. Potential transfer points identified along the various options of the potential alignment are shown in Figure 2-1.

The fare collection method would be determined by the operating entity. However, for consistency of service and operations, the streetcar system should accept the current fare payment methods used by the MTA NYCT, and the fare collection system should be completely integrated with the MTA NYCT.

Fare collection systems on streetcars generally operate without the use of turnstiles, and fare payment is typically on-board vehicles. On-board fare collection has resulted in improved travel times, as it helps reduce dwell times (the time it takes passengers to board) at each stop.

Off-board collection is another option, as used for the MTA NYCT's Select Bus Service (SBS) along Fordham Road-Pelham Parkway and First/Second Avenue. Before boarding the bus, riders pay their fares on the sidewalk at a SBS station stop using their MetroCard or coin machines. When the bus arrives, riders can enter or exit through any of the three doors, holding on to their receipt as proof of payment. This off-board fare collection method has resulted in faster and more reliable service.

2.2 Vehicle Characteristics

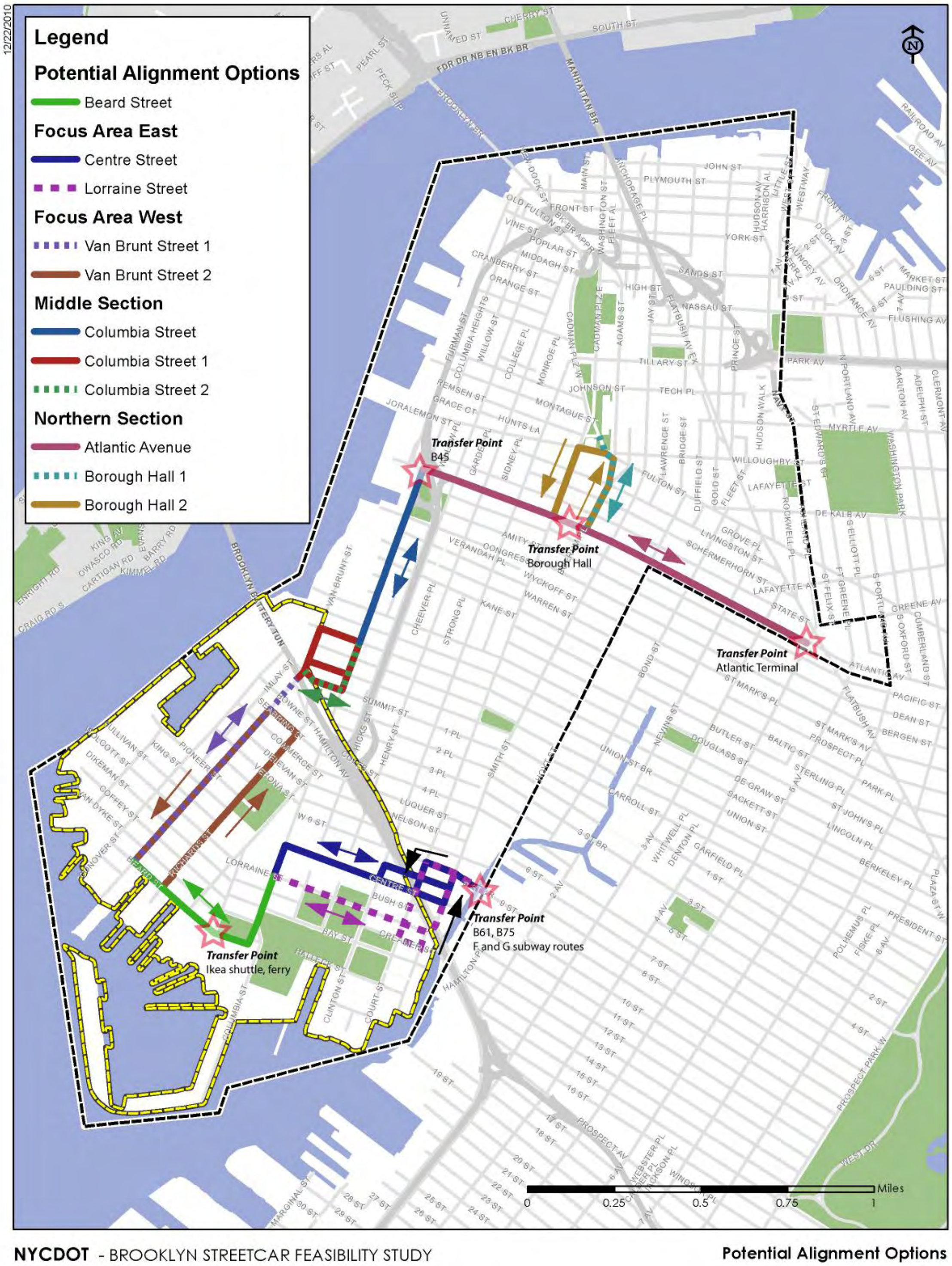
AVERAGE SPEED

A general assumption is that a future Brooklyn streetcar system would operate at speeds similar to the existing MTA NYCT bus service in the Study Area. As such, the scheduled time of the existing B61 from Red Hook to Downtown Brooklyn and the distance between these two locations were used to calculate the average speed of the B61, as shown in Table 2-2.

Table 2-2: B61 Average Speed

SCHEDULED TIME FROM RED HOOK TO DOWNTOWN BROOKLYN	DISTANCE FROM RED HOOK TO DOWNTOWN BROOKLYN	AVERAGE SPEED
15 minutes	2 miles	8 mph

Figure 2-1: Potential Alignment Options and Transfer Points



The average speed of 8 miles per hour (mph) is a conservative estimate, assuming a future Brooklyn streetcar would operate in mixed traffic. Without an exclusive streetcar right-of-way, the travel speed of a streetcar system could be similar to the existing bus service. However, streetcar vehicles have faster acceleration rates than buses, and based on other streetcar systems in the United States, boarding times are generally faster due to low-floor operations and all-door boarding capabilities.

LAYOVER REQUIREMENTS

In general, streetcar systems in the United States have used 15 to 20 percent of the total travel time as recovery time and layover time.

NUMBER OF VEHICLES

Assumptions for streetcar vehicle requirements are listed in Table 2-3. These estimates were calculated using low and high speed estimates from the Case Study Report and the longest and shortest streetcar route based on the potential alignment options. Using these options produces a range of conservative and aggressive estimates.

Table 2-3: Vehicle Requirements Range

	MEAN SPEED (MPH)	ROUND TRIP DISTANCE (MILES)	REVENUE SERVICE TIME (MIN.)	LAYOVER TIME (MIN.)	TOTAL TRAVEL TIME (MIN.)	PEAK HEADWAY (MIN.)	PEAK VEHICLE REQ.	SPARE	TOTAL FLEET
High speed / shorter route	10.5	7.4	42	6	48	8	6	2	8
High speed / longer route	10.5	8.4	48	7	55	8	7	2	9
Low speed / shorter route	7.0	7.4	63	10	73	8	9	2	11
Low speed / longer route	7.0	8.4	72	11	83	8	10	2	12

Minutes are rounded to the nearest whole minute

Transit fleets generally have a spare ratio of at least 20 percent of the peak vehicle requirement in order to maintain service during vehicle maintenance. In the case of smaller fleets, such as Seattle's South Lake Union streetcar fleet and a potential Red Hook streetcar fleet, a minimum of at least two vehicles is suggested. Based on these assumptions, between eight and 12 vehicles would be required to run a future streetcar system along the proposed alignment options.

2.3 Maintenance Requirements

Streetcar systems require a storage and maintenance facility, or 'car barns' for servicing and storing the vehicle fleet, administering the system operations, and supporting employees. The car barn typically accommodates vehicle storage, cleaning, and maintenance, equipment maintenance, materials storage, operations management and supervision, dispatching, emergency-response communications equipment and supplies, secure parking for nonrevenue vehicles, and employee locker rooms. In addition, due to streetcar systems' historic appeal, maintenance activities may be of interest to the general public. Maintenance shops can be sectioned off with glass to provide a controlled environment for active display of the work activity.

Although these are separate functional areas, for economy of space, the facilities can be constructed as separate portions of a single structure. Moreover, additional space should ideally be provided to allow for system expansion. However, land can be in short supply, particularly in urban areas. Similarly, financial constraints can restrict initial facility size.

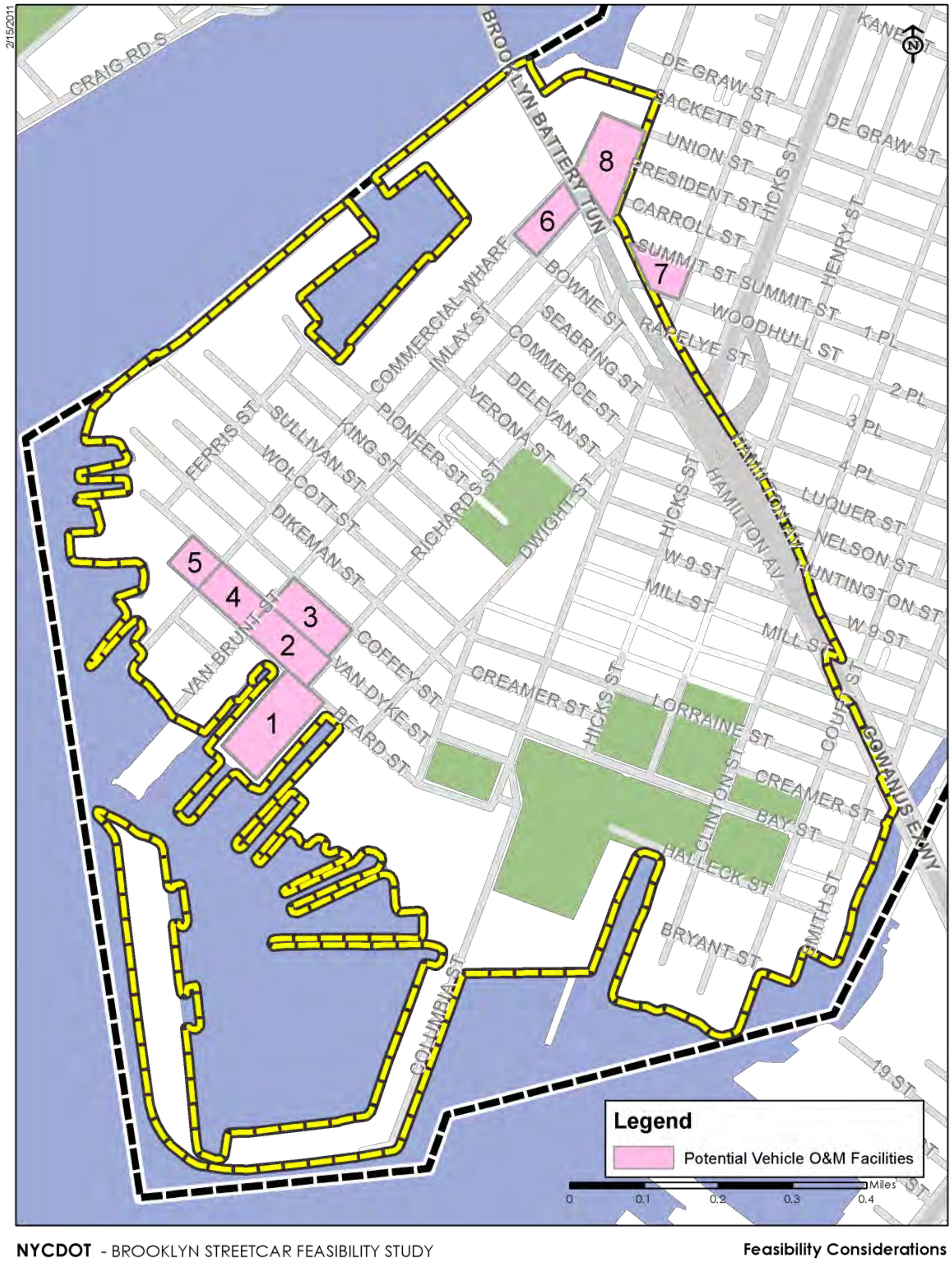
The storage and maintenance facility should be located within close proximity to the streetcar route and outfitted to maintain the streetcar fleet, both now and in the future. The facility should be sized for a minimal, but adequate, maintenance regimen and consist of equipment that is typically required for continuous routine maintenance. For example, removing or replacing motors, removing wheels for re-truing offsite, performing routine repairs, and cleaning and washing streetcar vehicles.

Based on standard transportation planning of similar transit modes in the New York City metropolitan area,[1] the footprint for the entire facility is typically 150 feet wide by 150 feet long, and includes six tracks that can accommodate a minimum of two cars each, to provide space for the total number of vehicles, as indicated in Table 2-3. One track should have a dual structured pit for maintenance repairs to be performed underneath the chassis. This dual structured pit should include a gauge pit, roughly four feet wide between the rails and an open pit, at least twelve feet wide with the streetcar vehicle supported on posts. In addition, the pit track should be long enough to provide walkways for employees to access the pit from both ends with two cars in place. The adjacent tracks could be utilized for internal repairs, cleaning, and washing the cars, as well as covered storage. These five tracks should be at a distance of 25-feet between track centers, providing adequate room for safety and car cleaning activity, and an additional storage or run-through track. Embedded tracks approaching the barn entrance should provide a location for truck deliveries.

For the proper layout of a storage and maintenance facility, the site should be between 1 and 2 acres. Based on this standard, as well as initial field visits, existing land use, zoning requirements, and proximity to the potential alignments, several initial sites have been identified as potentially satisfying these criteria. These sites are identified in Figure 2-2. According to MapPLUTO and the New York City Department of City Planning (DCP), existing MTA NYCT bus depots are zoned manufacturing (between M1-1 and M2-5). The sites identified in Figure 2-2 are either fully or partially zoned as manufacturing and are vacant or underutilized. Additional analysis, involving the New York City Economic Development Corporation (NYCEDC), DCP, and DOT would be needed for the final selection of a streetcar storage and maintenance facility.

[1] Hudson Bergen Light Rail

Figure 2-2: Potential Vehicle Operation and Maintenance Facilities



3.0 CONCLUSION AND NEXT STEPS

This technical memorandum presents the operating parameters appropriate for a future Brooklyn streetcar if determined to be feasible, outlining the key variables that typically affect streetcar service. A summary of the assumptions of these variables is as follows:

Service Operations

- Operating entity: alternatives to be presented in the Feasibility Report
- Operations hours: Alternative 1 – 24-hour streetcar service; or Alternative 2 – 6 AM to midnight streetcar service and midnight to 6 AM bus service
- Service frequency: 8 to 40 minute headways, depending on time of day
- System integration: integration with the MTA NYCT existing transit system, including fare collection and intermodal transfer points

Vehicle Characteristics

- Average speed: 8 miles per hour
- Layover requirements: 15 to 20 percent of trip time
- Number of vehicles: 8 to 12 based on speed, headways, alignment length, layovers, and spare requirements

Maintenance Requirements

- 150 feet x 150 feet facility with six tracks
- 1 to 2 acre site
- Zoned manufacturing

The key variables of service operations, vehicle characteristics, and maintenance requirements for a future Brooklyn streetcar system comprise the operations plan, as outlined in this technical memorandum. Development of these operating parameters will be used to guide several components of the Brooklyn Streetcar Feasibility Study, including the potential vehicle labor requirements and energy costs, preliminary operating and vehicle costs, and an estimate of overall capital costs.

6.0 ALIGNMENT EVALUATION METHODOLOGY AND FEASIBILITY CONSIDERATIONS TECHNICAL MEMORANDUM

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1.0 INTRODUCTION

This Technical Memorandum outlines the Brooklyn Streetcar Feasibility Study's alignment evaluation methodology. It also presents key technical considerations that will help determine the feasibility of each alignment option to be evaluated as the study moves forward. Goals and objectives were developed at the earliest stage of the study to help guide alignment selection. These are also presented in this document. A number of potential alignments were identified and through the initial evaluation process these were refined and reduced to one potential alignment with various options.

A more detailed evaluation of these options employs a rating scale that considers the degree to which each alignment option satisfies the study's defined goals and objectives. The results of this ranking will be included in the forthcoming Feasibility Report.

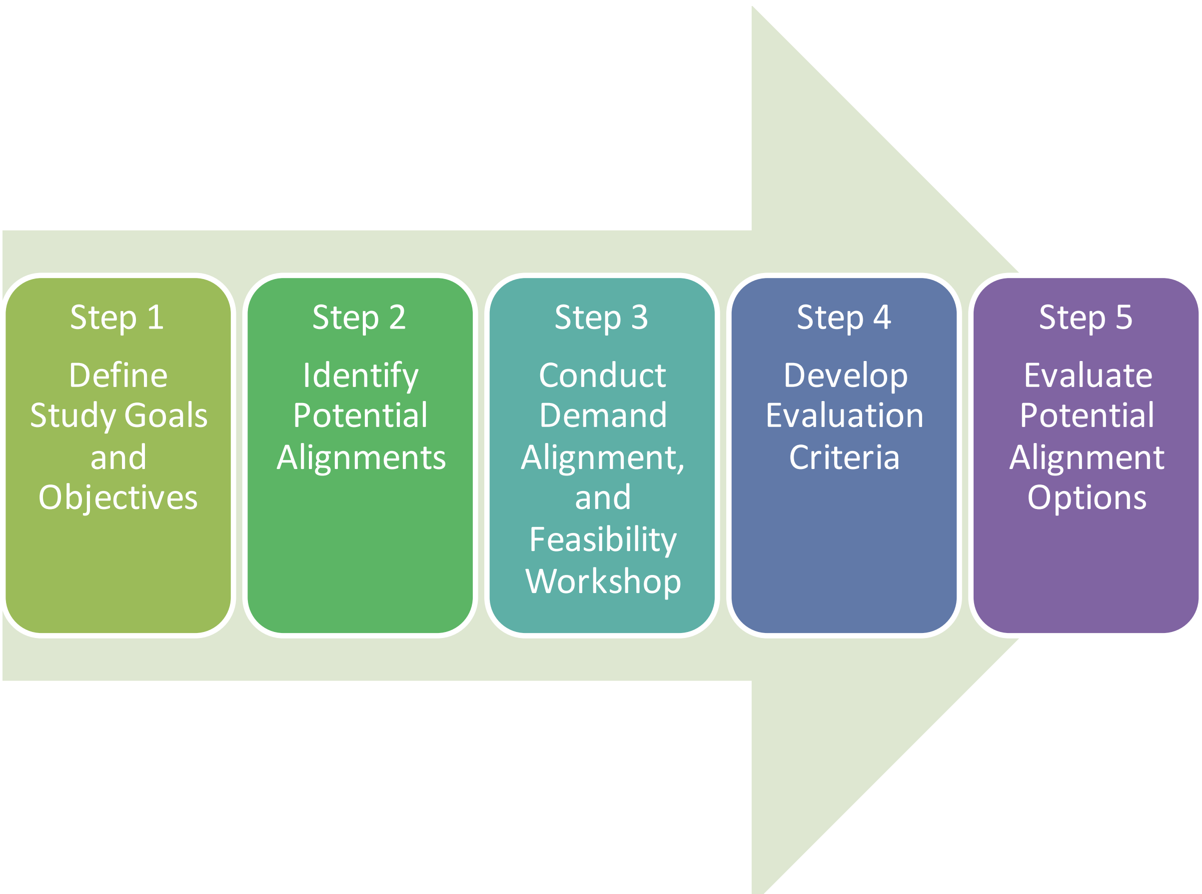
In addition to establishing how the alignment options will be evaluated, this memo presents a number of technical considerations that could affect how viable each option is. Specific areas of concern were identified using the following feasibility considerations:

- Horizontal alignment and curvature
- Grades
- Station platforms
- Vertical clearance
- Roadway cross slopes
- Right-of-way
- Structural operations
- Traffic operation / signals
- Bicycle integration
- Utilities
- Track structure / pavement reconstruction

2.0 ALIGNMENT SELECTION AND EVALUATION METHODOLOGY

This section of the Alignment Evaluation Methodology and Feasibility Considerations Memorandum outlines the process used for selecting and evaluating potential alignments for a streetcar system in Brooklyn. This process includes defining the study's goals and objectives, identifying potential streetcar alignments, developing evaluation criteria, and evaluating and ranking various alignment options. This multi-step process is graphically shown in Figure 2-1, and described in further detail below and throughout this section.

Figure 2-1: Alignment Selection and Evaluation Process



In Step 1, study goals and objectives were discussed and developed during the initial study meetings. In Step 2, alignments were identified based on a number of factors, including land uses that generate significant person trips, employment densities that concentrate these trip generating uses, existing transit that allows for citywide access, and input from the Community Advisory Committee.

In Step 3, additional streetcar alignments were identified and reviewed during a Demand, Alignment, and Feasibility Workshop attended by DOT and members of the consultant team. Based on the input received at this workshop and considering planning factors such as existing land use, employment density, existing transit, and the roadway network, the alignments were refined to include one potential alignment with various alternative options. This potential alignment with options was presented at the second Community Advisory Committee (CAC) meeting on December 13, 2010 for validation and additional input.

Using the goals and objectives defined in Step 1, evaluation criteria were developed in Step 4 to assess how well the alignment options address the defined goals and objectives. Step 5 considers the degree to which each alignment option satisfies the defined goals and objectives using a rating scale for the developed evaluation criteria. The rating scale will be used to identify high performing to low-performing options. Each alignment option will be assigned a point value based on where it falls in the spectrum (high to low), and the points for all of the evaluation criteria will be summed to come up with a final point total for each alignment option. The alignment options will then be ranked to determine the alignment that best meets the defined goals and objectives.

2.1 Brooklyn Streetcar Goals and Objectives

Goals and objectives for the Brooklyn Streetcar Feasibility Study were developed at the earliest meetings and further refined as the study progressed. Factors that informed this process include the existing conditions in the Focus and Study Areas, the examples provided in the Case Study Report (Portland, Seattle, and Philadelphia), and input from the CAC. These Brooklyn Streetcar goals and objectives are shown in Table 2-1.

Table 2-1:
Brooklyn Streetcar Goals and Objectives

GOAL	OBJECTIVE
Improve transportation mobility	✓ Transit accessibility ✓ Travel time ✓ Intermodal connectivity ✓ Enhance pedestrian movements ✓ Accommodate bikeways
Provide economic opportunity and investment and enhance the community character	✓ Serves existing and planned development ✓ Serves developable and re-developable land ✓ Neighborhood resident sentiments ✓ Local business community sentiments
Maintain traffic and delivery access	✓ Maintain delivery access to local businesses ✓ Maintain access to Red Hook's arterial roadways and Brooklyn highways

Table 2-1:
Brooklyn Streetcar Goals and Objectives

GOAL	OBJECTIVE
Minimize adverse impacts on the built and natural environment	✓ Minimize adverse impacts on historical resources ✓ Minimize property acquisition ✓ Minimize construction impacts ✓ Minimize impacts to natural features/resources and coastal waters ✓ Minimize traffic impacts ✓ Minimize noise and vibration impacts
Minimize streetcar capital and operating costs and impacts	✓ Implement within a reasonable construction timeframe ✓ Implement within a reasonable construction cost ✓ Avoid conflicts with existing and proposed infrastructure during construction and operation ✓ Avoid or minimize utility relocation

2.2 Selection of Potential Streetcar Alignments

The key factors that guided the identification of potential streetcar alignments included land uses that generate significant person trips, employment densities that concentrate these trip generating uses, existing transit, and input from the stakeholders and agencies through the CAC. Each of these are described below in greater detail.

LAND USE

The primary reason for considering land use when identifying alignments is the potential each land use has for generating ridership for a new streetcar system. This relationship also works in reverse: the specific transportation mode, such as the streetcar, can impact the development and growth of specific land uses, such as residential and commercial uses. This is particularly evident when transit supportive zoning and land use policies are in place. As shown in Figure 2-2 and reported in the Existing Conditions Report, the Focus Area is defined primarily by industrial and manufacturing uses along the waterfront. This type of land use is typically not a strong generator of ridership for streetcar systems, as these uses tend to have low population and employment densities. The City of New York's policy is to reinforce its industrial and manufacturing zoning along the Red Hook waterfront area, particularly as this type of land use is considered to be increasingly scarce throughout the five boroughs.

The interior of the Focus Area is mostly residential, including the Red Hook Houses, the Focus Area's largest residential land use. The primary commercial corridor runs along Van Brunt Street and along the southern waterfront area where major new retailers IKEA and Fairway have recently opened. It is expected that a future streetcar alignment would improve mobility to and within Red Hook and could be advantageous to the Focus Area's primary commercial and residential corridors. These areas offer the greatest potential for a future streetcar system, based on the experience of other cities, as demonstrated in the Case Study Report.

EMPLOYMENT DENSITY

Figure 2-3 shows the geographic distribution of residential population and employment densities within the Focus Area and the Study Area, based on data from the U.S. Census Bureau (2000), which was the most recent data available. Residents are more closely concentrated on interior blocks with fewer people living along the waterfront. However, recently-completed development and proposed developments in DUMBO, Vinegar Hill, and the Columbia Street Waterfront are anticipated to increase the population density of those waterfront neighborhoods.

Also based on 2000 Census data, the Focus Area is approximately 0.87 square miles with an employment density of approximately 6,274 employees per square mile. The overall Study Area is approximately 2.93 square miles and is significantly denser in employment. The Study Area had approximately 49,072 employees per square mile.

As shown in Figure 2-3, Downtown Brooklyn has a concentrated employment density. This was an important factor when considering future streetcar alignments. Assuming potential streetcar riders would use the streetcar as a travel mode to and from work, the streetcar alignment should connect to Downtown Brooklyn to service the employment center.

EXISTING TRANSIT

Figure 2-4 shows the subway and bus routes that traverse the Focus Area and Study Area. Transit coverage in the Study Area varies greatly from north to south. North of Atlantic Avenue, several bus and subway routes converge, forming a transit hub at Borough Hall. To the south, fewer buses and only two subway lines serve the area, with no subway service within the Focus Area.

As reported in the Existing Conditions Report, the Study Area (outside the Focus Area) is generally well served by public transportation. Eleven subway routes cross into Brooklyn from Manhattan between Jay Street and Joralemon Streets in Downtown Brooklyn, and the G train crosses Downtown Brooklyn on its route connecting to Queens. Most of these subway routes continue easterly or southeasterly from Downtown Brooklyn and exit the Study Area. However, the F and G trains continue southward to serve Cobble Hill and Carroll Gardens.

The F and G subway station at Smith-9th Street is the closest stop to the Focus Area, but accessing the Smith-9th Street Station from Red Hook requires a bus ride or a lengthy and circuitous walk. In addition to subway service, there is one bus route that traverses the Focus Area. The B61 serves Red Hook along Columbia and Van Brunt Streets. The Focus Area is generally poorly served by transit, even though many of its residents rely on public transportation. Recent growth in residenti al and worker populations has increased the need for transit accessibility.

Figure 2-2: Land Use

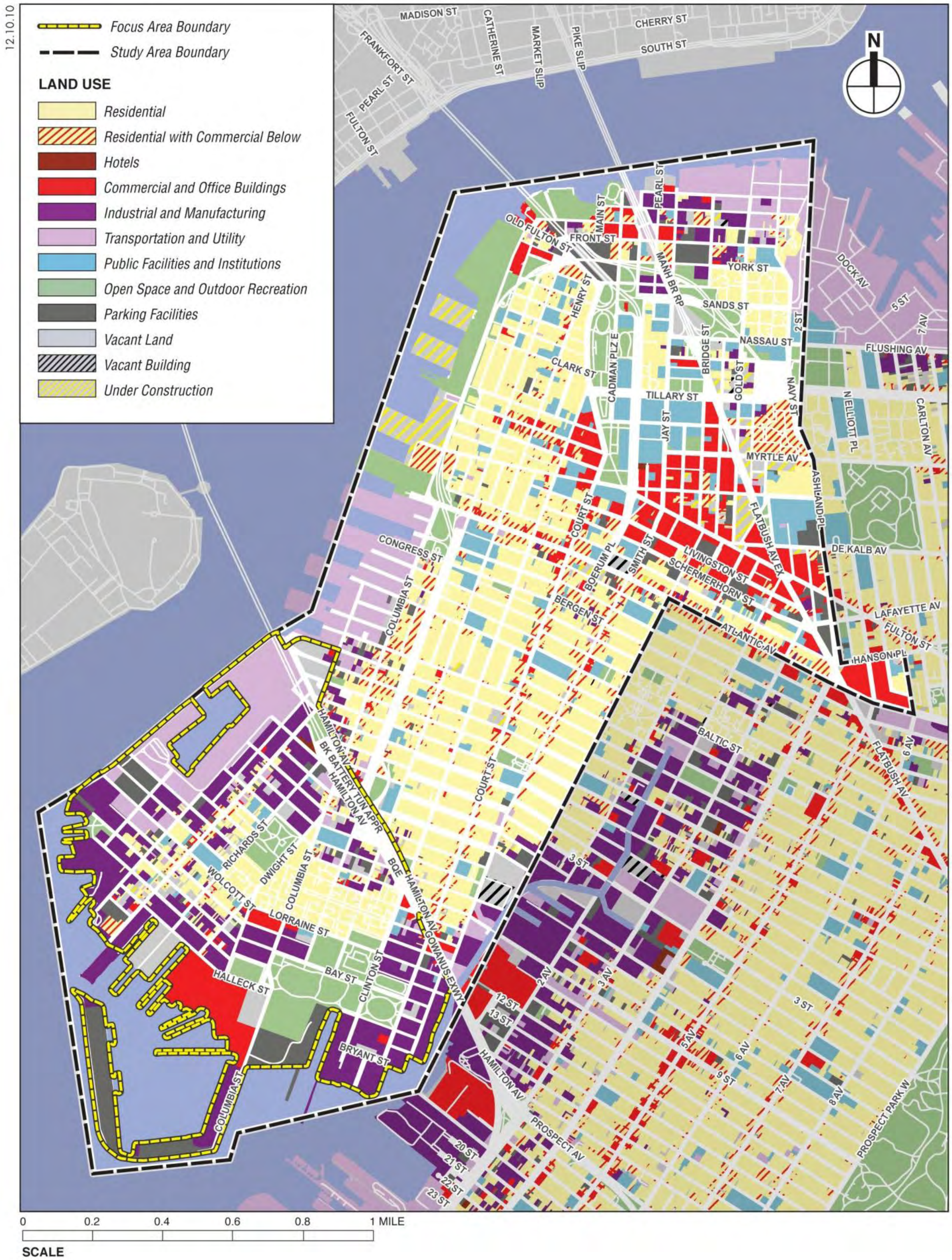
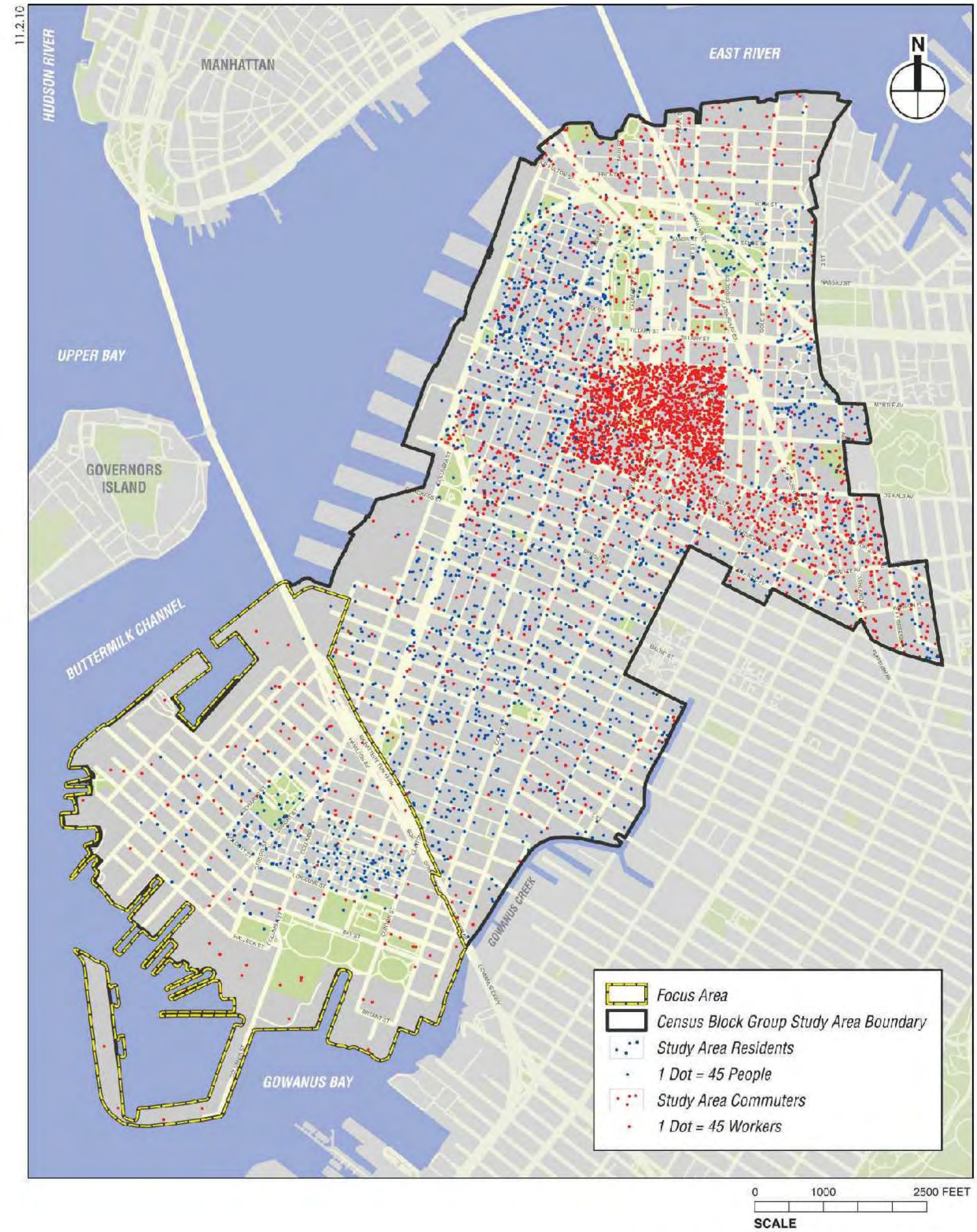
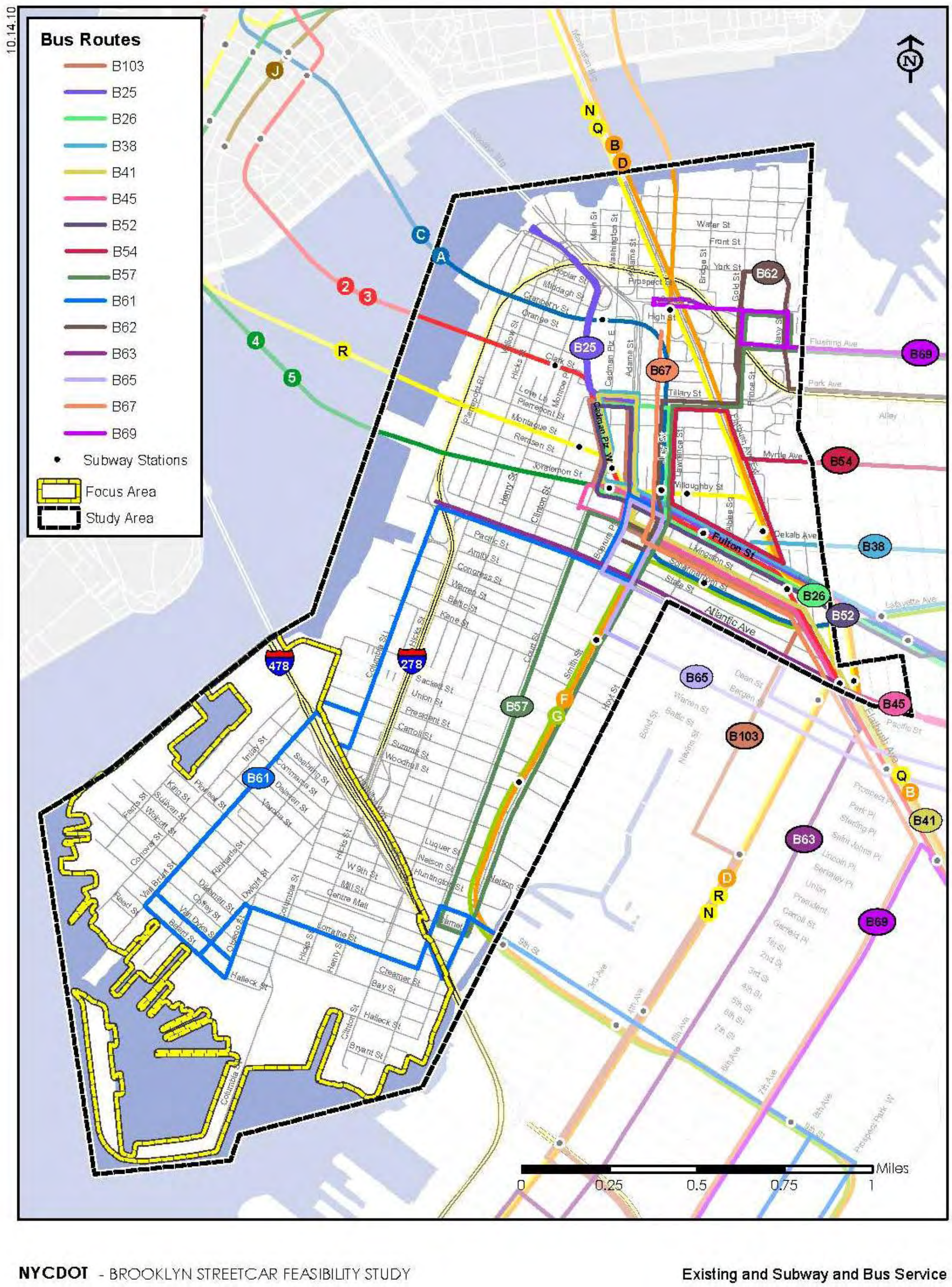


Figure 2-3: Population and Employment Density



Population and Employment Density

Figure 2-4: Existing Transit



URS

COMMUNITY ADVISORY COMMITTEE

DOT invited representatives from various public agencies and non-profit interest groups to form a CAC to support the Brooklyn Streetcar Feasibility Study. The CAC first met on October 18, 2010.

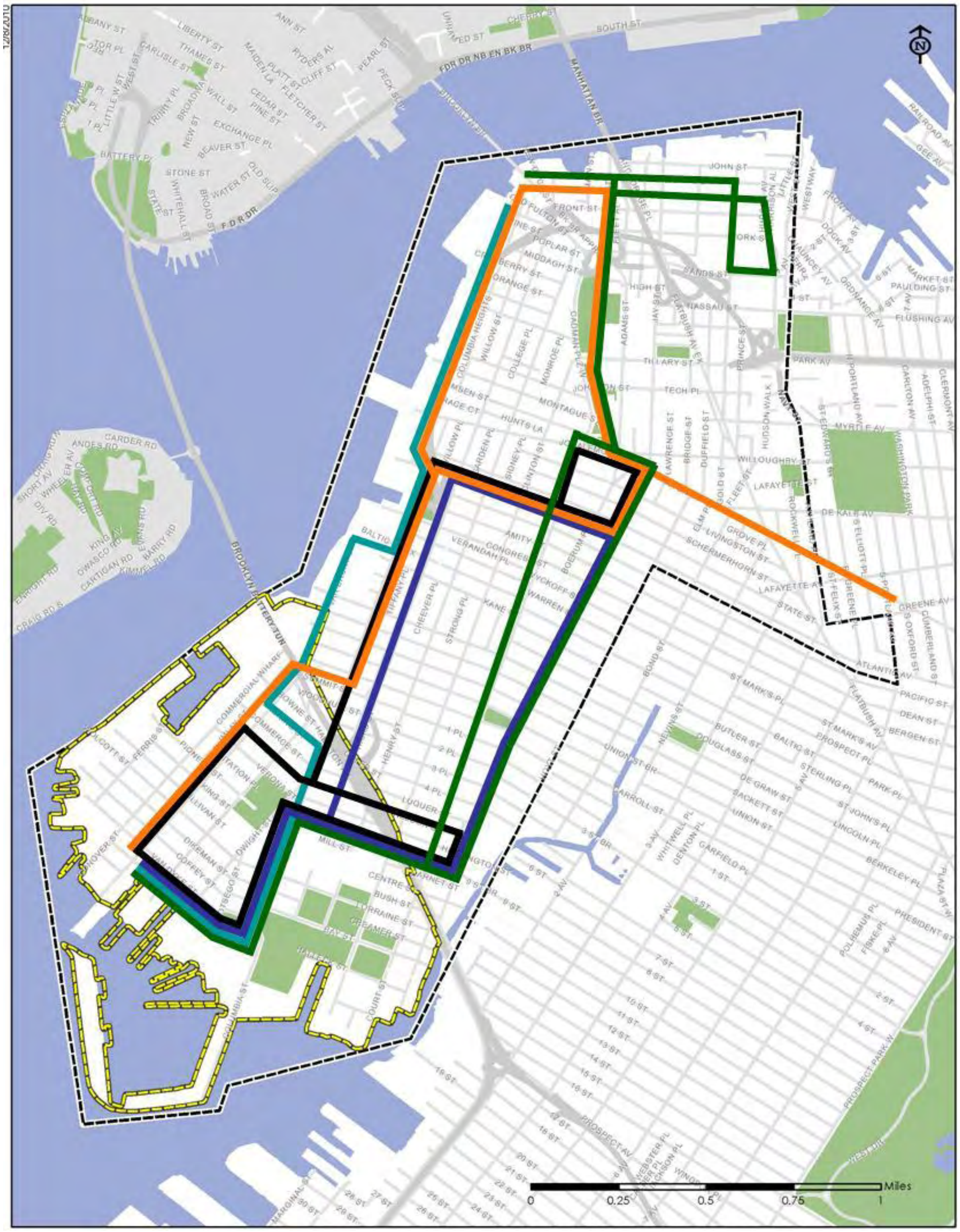
Following the initial CAC meeting, the CAC members were invited to participate in identifying potential streetcar alignments using an online mapping tool. Figure 2-5 presents the results of the online mapping tool. All alignments utilized either Columbia Street or Van Brunt Street within the Focus Area to connect Beard Street with the Study Area. From there the suggested alignments, utilized either the Columbia Street corridor or the Smith Street / Court Street corridor to travel north towards downtown Brooklyn. In downtown, most alignments terminate at one of three terminal points Borough Hall, Brooklyn Bridge Park, or DUMBO.

One CAC member asked if the abandoned rail tunnel under Atlantic Avenue or the route over the Brooklyn-Queens Expressway were considered. The study team considered this alignment; however, both of these routes would require a significantly higher capital investment and are not consistent with desired streetcar characteristics (pedestrian friendly, street-level service). Another attendee asked if the number of employees at the Red Hook Marine Terminal was considered and whether travel between various terminal sites were factored into the ridership estimate. DOT indicated all Red Hook employee trips were considered, and the potential alignment is an attempt to capture both port and commercial areas.

HISTORICAL ROUTES

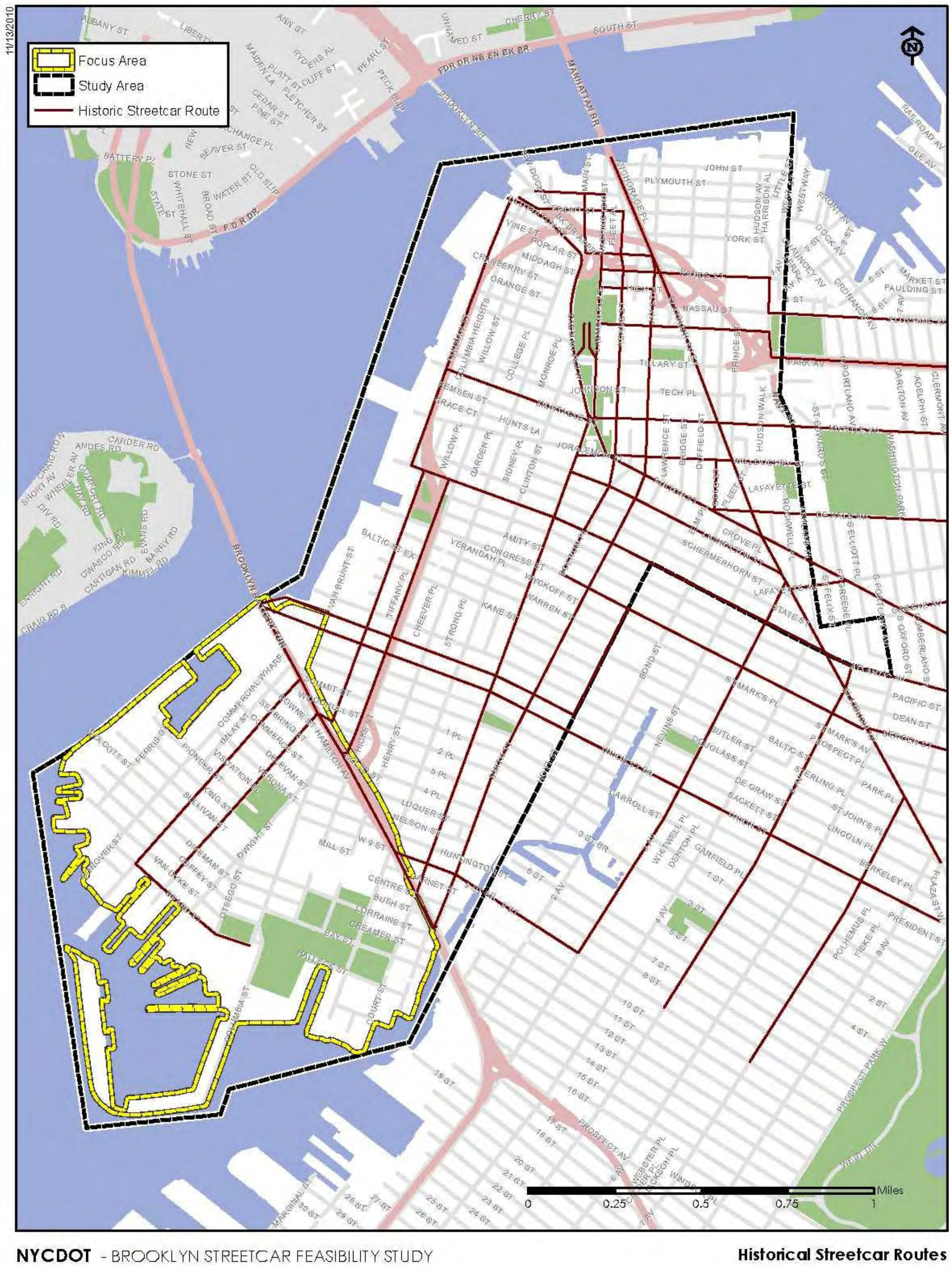
The study team also looked at historic streetcar routes in Brooklyn. This was informative from the standpoint of showing the breadth of streetcar operations that once extended throughout Brooklyn. Several streetcar lines ran through Red Hook from 1893 through 1949, when Brooklyn's streetcar lines were converted to bus routes, with the Borough's last streetcar ceasing operation in 1956. These routes are shown in Figure 2-6. The Furman Street, Erie Basin, and Crosstown Lines ran along Columbia Street, and the Hamilton Avenue Line ran between Red Hook and Bay Ridge. Although these streetcar lines at one time successfully provided transit service in Brooklyn, land uses and other conditions have significantly changed since these historic routes were in service. Therefore, these lines did not influence the alignment selection process.

Figure 2-5: Community Advisory Committee Alignments



- Van Brunt and Columbia Streets
- Van Brunt, Columbia, and Fulton Streets
- Hicks and Smith Streets
- Court and Smith Streets

Figure 2-6: Historical Streetcar Routes



2.3 Demand, Alignment, and Feasibility Workshop

A Demand, Alignment, and Feasibility Workshop was held on November 15, 2010 to discuss the potential streetcar alignments that were initially identified based on land use, population and employment density, existing transit, and input from the CAC. The workshop included representatives from DOT and the consultant team. Based on the workshop discussions, the list of potential alignments was narrowed to one primary alignment with a number of options that will be further evaluated as the study progressed. Alignments that were removed from current consideration, and the reason they were removed are listed in Table 2-2.

Table 2-2:
Alignments Removed from Consideration

ALIGNMENT	SOURCE	REASON REMOVED
Court Street or Smith Street, from Focus Area to Atlantic Avenue	CAC	Proximity to the F and G subway lines
Clinton Street or Henry Street, from Focus Area to Atlantic Avenue	DOT / Consultant Team	Exclusively residential land uses Limited right-of-way
Hicks Street, from Focus Area to Atlantic Avenue	CAC	Major infrastructure obstacles (Proximity to Interstate 278), Exclusively residential land uses
Furman Street, from Atlantic Avenue to DUMBO (along Brooklyn Bridge Park)	CAC	No connection to transit hub
Carroll Street and Summit Street, 1st Place from Van Brunt Street to Smith Street	DOT / Consultant Team	No connection to transit hub

Specifically, the following factors were discussed:

Land Use

The focus of the Brooklyn Streetcar Feasibility Study is to study the feasibility of a streetcar in Red Hook and to provide service for Red Hook residents and visitors. Therefore, any alignment that would not serve the interior residential land uses within the Focus Area was eliminated. As previously mentioned, the Red Hook Houses is the largest residential land use in the Focus Area. As such, a future streetcar should provide service to this land use.

Similarly, Red Hook's primary commercial corridor running along Van Brunt Street and the southern waterfront area (along Columbia Street) where major new retailers have recently opened offer strong potential for a future streetcar system. The alignments along Clinton Street and Henry Street were eliminated, as they do not have the commercial-advantage as does Van Brunt Street and Columbia Street.

Employment Density

Downtown Brooklyn is New York City's third largest central business district (CBD) after Midtown and Downtown Manhattan. Downtown Brooklyn serves as a government center, with city, state, and Federal institutions. As reported in the Existing Conditions Report, approximately 11 percent of Focus Area residents commute to Downtown Brooklyn. Another 15 percent of residents work in the Focus Area. Therefore, a future streetcar service providing better connectivity within the Focus Area, as well as to Downtown Brooklyn has the potential to serve up to 26 percent of the Focus Area. To serve this employment market, connection to Downtown Brooklyn will be included as an option.

Existing Transit

The F and G subway station at Smith-9th Street is the closest stop to the Focus Area, but accessing the Smith-9th Street Station from Red Hook requires a bus ride or a lengthy and circuitous walk. The addition of a streetcar line would improve transit accessibility for the Focus Area. In addition, connection to the Atlantic Avenue Station with the B, Q, 2, 3, 4, and 5 subway lines, the Pacific Street Station with the D, M, N, and R subway lines, and the Jay Street-Borough Hall Station with the A, C, and F subway lines would improve overall transit access and circulation. As such, connection to all three of these subway stops will be included as an option, as an alignment that provides intermodal connections would further enhance the effectiveness of transit service in the area. For this reason the alignments along Furman Street and Carroll Street were eliminated, as these alignments would not provide a connection to a major transit hub. These alignments, however, could be part of future extensions to the initial streetcar system.

Existing transit service was also considered in order to meet the needs of underserved areas and avoid redundancy with existing fixed-guideway rail service (subway). The Focus Area is poorly served by transit, even though many of its residents rely on public transportation. A future streetcar system would help improve mobility to and within Red Hook. Similarly, Smith and Court Street are served by existing subway service, and the alignments along these corridors would provide redundant service. In an effort to provide better transit accessibility throughout Red Hook and meet the needs of underserved areas, the alignments along Court and Smith Streets were eliminated for this feasibility study.

Roadway Network

Interstate 278 (I-278), a major east-west highway that runs from New Jersey to the Bronx via Staten Island, Brooklyn, and Queens runs along Red Hook's eastern and northern edges within the Focus Area. From the Verrazano Narrows Bridge, I-278 constitutes the Gowanus Expressway, a single-level six-lane freeway, widening to eight lanes before the Brooklyn Battery Tunnel, which runs under the East River and connects Brooklyn and Manhattan. Entrances to the Brooklyn Battery Tunnel are situated at Red Hook's northern edge.

As reported in the Existing Conditions Report, these transportation facilities established *de-facto* neighborhood borders for Red Hook by cutting it off physically and socially from adjacent neighborhoods. In terms of planning for a future streetcar line, the location of both I-278 and the Brooklyn Battery Tunnel are important in terms of the constructability of a streetcar line crossing these facilities. Specifically, the Hicks Street alignment was eliminated due to its proximity to I-278. Similarly, based on preliminary investigation, Columbia Street would provide the most feasible option for crossing I-278.

POTENTIAL STREETCAR ALIGNMENT FOCUS AREA OPTIONS

As a result of the Demand, Alignment, and Feasibility Workshop, one potential alignment was identified with a number of options, as shown in Figure 2-7. In the future, with more data and more detailed site investigations, as well as further public input, additional alignments could also be considered if the study continues into a Federal Transit Administration (FTA) Alternatives Analysis (pending the outcome of this feasibility study).

As shown in Figure 2-7, the potential streetcar alignment travels along Beard Street in the southern most segment of the alignment. For the Focus Area East, the potential alignment has two options: traveling in both directions on either Centre Street or Lorraine Street. For the Focus Area West, the alignment also has two options: traveling in both directions on Van Brunt Street or traveling northbound on Richards Street and southbound on Van Brunt Street. For the Middle Section of the potential alignment, three options are available connecting Van Brunt Street to Columbia Street, and for the Northern Section, the potential alignment either travels further east and terminates on Atlantic Avenue, or terminates at Borough Hall with a dead end or loop track.

These alignment options parallel the ideas presented by the CAC. The alignment options serve the commercial corridors of Beard Street and Van Brunt Street similar to the suggested alignments shown in Figure 2-5. In addition, the alignment options connect the Focus Area to downtown Brooklyn and existing transit services at Borough Hall or Atlantic Terminal.

2.4 Evaluation Criteria

Evaluation criteria were developed to help assess how well each alignment option meets the study's Goals and Objectives, shown in Table 2-1. While these measures are generally qualitative, they allow for a comparison of the order of magnitude benefits and detriments of each alignment option. This method also provides a means to compare options to each other to identify the best solution. Table 2-3 includes the streetcar goals and objectives and the corresponding evaluation criteria for the forthcoming evaluation of the streetcar alignment options.

Each alignment option will be assessed based on the goals and objectives identified in Table 2-2 using the evaluation criteria identified in Table 2-3. This evaluation will consider the degree each alignment option satisfies the goals and objectives based on the respective evaluation criteria. To do this, a rating scale, ranging from high performing to low-performing scores, is used. This rating scale is shown below. Point values are assigned for the respective ratings of each performance measure identified in Table 2-3. Below is the point system that is designated for the respective performance measures.

High performing	●	◕	◑	◔	○	*Low performing*
	20	*15*	*10*	*5*	*0*	

The points for all the performance measures are added to come up with a final point total for each alignment option. The alignment options are then ranked to determine the alignment(s) that best meet(s) the defined goals and objectives.

Figure 2-7: Potential Alignment Options

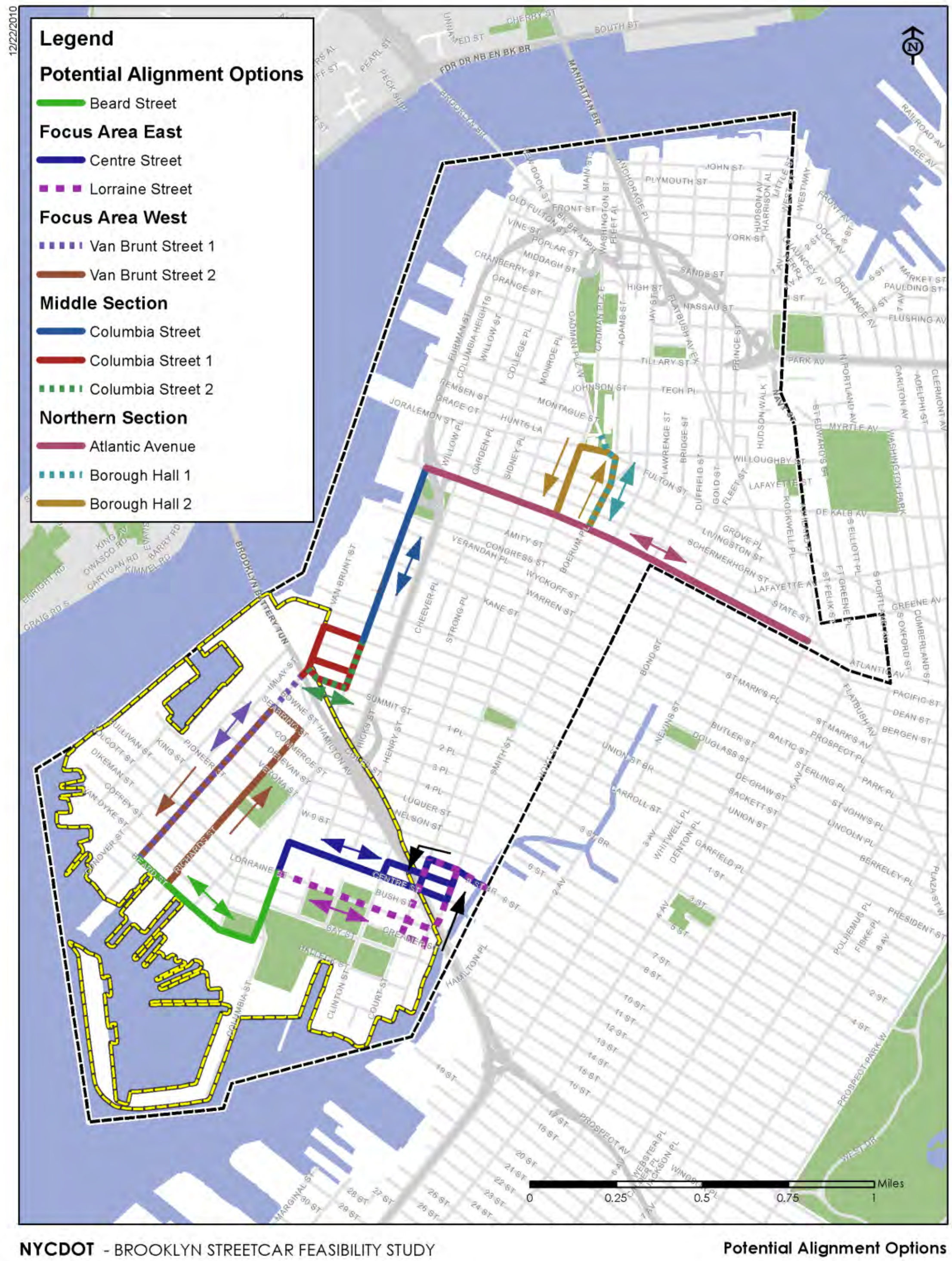


Table 2-3:
Brooklyn Streetcar Evaluation Criteria

GOAL/OBJECTIVE	EVALUATION CRITERIA
IMPROVE TRANSPORTATION MOBILITY	
Transit accessibility	– Population within 1/3–mile of streetcar stops – Employment within 1/3–mile of streetcar stops – Activity centers within 1/3-mile of streetcar stops
Travel time	– Trip time savings to and from various trip-generators, compared to existing bus service
Intermodal connectivity	– Provides bus connections – Provides subway connections
Enhance pedestrian movements	– Minimizes interference with pedestrian movements – Improve pedestrian space
Accommodate bikeways	– Minimizes interference with existing/planned bikeways – Minimizes impacts to bicyclist safety – Minimizes conflicts with proposed Greenway alignments
PROVIDE ECONOMIC OPPORTUNITY AND INVESTMENT AND ENHANCE THE COMMUNITY CHARACTER	
Serves proposed/projected development	– Estimated population within 1/3–mile of streetcar stops – Estimated employment within 1/3–mile of streetcar stops – Proposed activity centers within 1/3-mile of streetcar stops – Minimizes vehicle restrictions to access Red Hook's arterial roadways and Brooklyn highways – Minimizes changes to parking supply – Minimizes changes to delivery access

Table 2-3:
Brooklyn Streetcar Evaluation Criteria

GOAL/OBJECTIVE	EVALUATION CRITERIA
Serves developable and re-developable land	– Access to proposed streetcar stops
Neighborhood resident sentiments	– Amount of streetcar support/opposition
Local business community sentiments	– Amount of streetcar support/opposition
MAINTAIN TRAFFIC AND DELIVERY ACCESS	
Maintain curb access	– Change in curb access (linear feet)
Maintain access to Red Hook's arterial roadways and Brooklyn highways	– Minimizes vehicle restrictions to access Red Hook's arterial roadways and Brooklyn highways – Maintain truck access to local and through truck routes
MINIMIZE ADVERSE IMPACTS ON THE BUILT AND NATURAL ENVIRONMENT	
Minimize adverse impacts on historical resources	– Minimizes visual impacts to historic resources – Minimizes historic property acquisition
Minimize property acquisition	– Minimizes property acquisition
Minimize construction impacts	– Shorter construction duration
Minimize impacts to natural features/resources and coastal waters	– Minimizes interference with parkland or coastal waters
Minimize traffic impacts	– Minimizes negative impact on traffic flow
MINIMIZE STREETCAR CAPITAL AND OPERATING COSTS AND IMPACT	
Implement within a reasonable construction timeframe	– Shorter construction duration
Implement within a reasonable construction cost	– Lower construction cost

**Table 2-3:
Brooklyn Streetcar Evaluation Criteria**

GOAL/OBJECTIVE	EVALUATION CRITERIA
Avoid conflicts with existing and proposed infrastructure during construction and operation	– MINIMIZES INFRASTRUCTURE CONFLICTS
Avoid or minimize utility relocation	– MINIMIZES UTILITY CONFLICTS – MAINTAIN ACCESS TO UTILITIES

3.0 FEASIBILITY CONSIDERATIONS

This section describes general streetcar feasibility considerations typical of a streetcar operating in an urban environment, which will be considered for the proposed Brooklyn Streetcar. These general considerations include the geometric constraints, or physical conditions necessary to provide reasonable operations (i.e. width, height, slope, grade, weight, and existing utilities). These general considerations were derived from the Case Study Report as well as research into systems from Charlotte, North Carolina; Philadelphia, Pennsylvania; Portland, Oregon; and Seattle, Washington.

In addition to a discussion of general feasibility considerations, this section describes the applicability to streetcar feasibility within the Study Area. This approach identifies specific areas of concern in the Study Area and provides an assessment of the potential future streetcar alignment options. Additional analyses to examine these feasibility considerations will be conducted as part of the Brooklyn Streetcar Feasibility Study, and will be reported in the Brooklyn Streetcar Feasibility Study – Feasibility Report.

Specifically, this section will describe the following feasibility considerations:

- Horizontal alignment and curvature
- Grades
- Station platforms
- Vertical clearance
- Roadway cross slopes
- Right-of-way
- Structural operations
- Traffic operation / signals
- Bicycle integration
- Utilities
- Track structure / pavement reconstruction

3.1 Horizontal Alignment and Curvature

Horizontal alignment for a streetcar is primarily concerned with the horizontal clearances to the right and left of the vehicle. Unlike a rubber-tired vehicle, streetcars cannot shift their position laterally within the street. Moreover, since streetcars operate in the same travel lanes as other vehicles, consideration must be given to the available clearances for parked cars and vehicles in adjacent lanes (both in the same direction and on-coming). Adequate clearance must be provided for the horizontal envelope of the streetcars themselves, and this becomes particularly critical at curves.

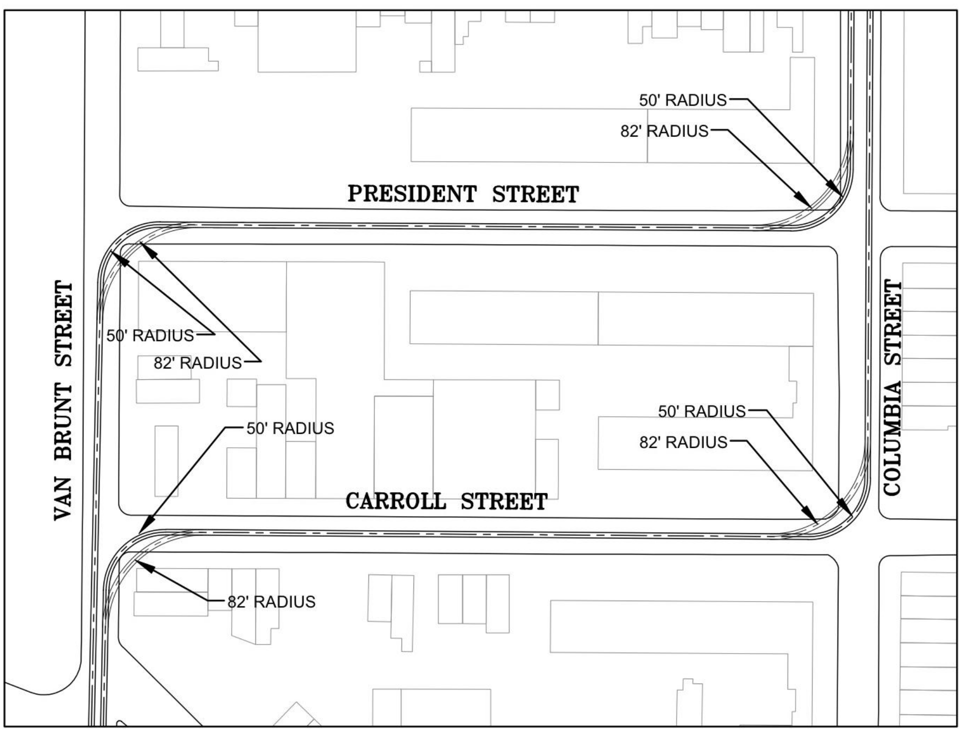
A typical streetcar width is nine feet, and the minimum lateral clearance for a streetcar running adjacent to a parking lane includes an eight foot wide parking lane and a total of 15 feet from the curb line to the center of the track. In locations where there is a likelihood of winter snow conditions, a wider parking lane (11 feet) is desired to account for snow piling conditions. Generally, 12 feet (center-to-center) spacing is recommended for adjacent tracks, although some vehicle types require less clearance. The design of the lane widths to accommodate both street traffic and streetcars is discussed in a later section of this technical memorandum.

Horizontal curvature for streetcar operations is primarily a function of the type of vehicle utilized on the system. The industry standard[1] for the minimum desired horizontal radius for streetcar tracks is 82 feet. However, depending on the vehicle type being utilized, the radius can be reduced to as little as 50 feet to accommodate specific field conditions. Heritage vehicle types are able to negotiate tighter turning radii than those of the modern streetcar vehicles. Specifically, Philadelphia's Route 15 Trolley is in operation with radii as low as 50 feet.

In addition, horizontal curvature is related to the required speeds. At the low operating speeds typically found in mixed traffic service, the radius of the curve is a function of the ability of the vehicle's truck to pivot without encountering physical obstruction in the drive mechanism or car body. On tangent sections (straight track), a curve radius of 600 feet is required to achieve operation speeds of 25 miles per hour.

Based on preliminary investigation in the Study Area, the minimum desired horizontal radius of 82 feet would be difficult to achieve in many locations, as the track would infringe on existing sidewalks, as shown in Figure 3-1 or buildings, as shown in Figure 3-2. For these locations, a turning radius of 50 feet or 60 feet may be necessary, also shown in Figures 3-1 and 3-2.

Figure 3-1: Horizontal Curvature (82 feet versus 50 feet)



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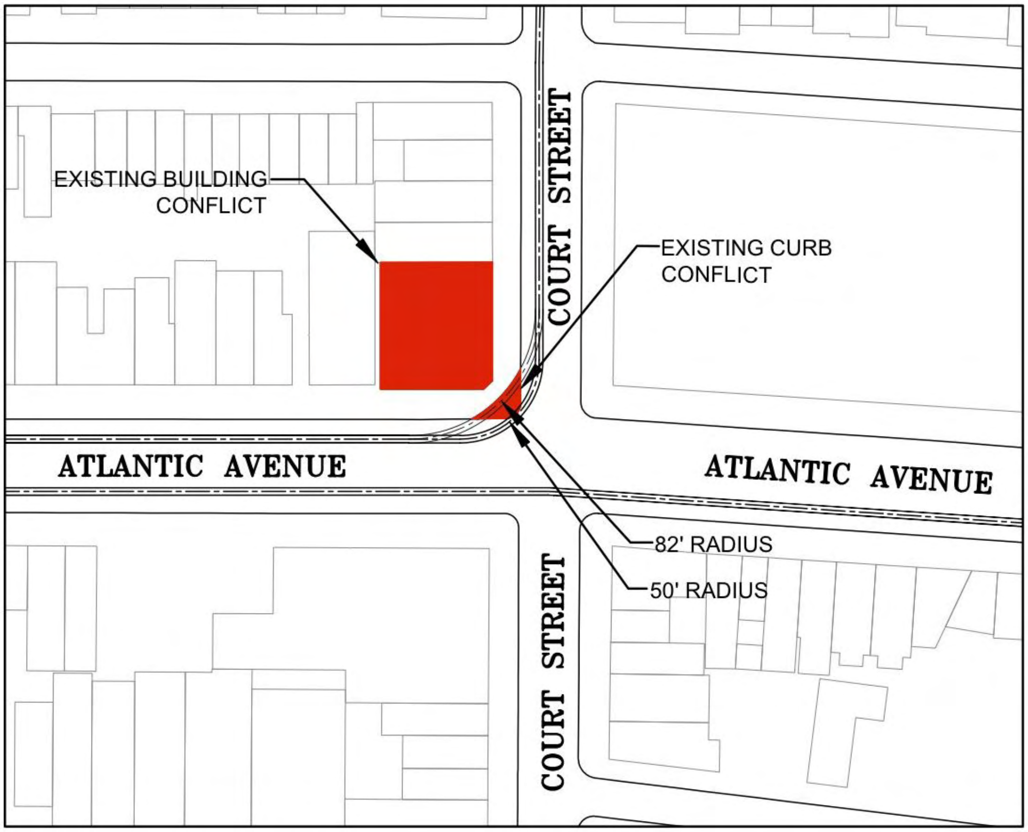
[1] TCRP Report 57 – Track Design Handbook for Light Rail Transit

Figure 3-2: Curb and Potential Building Conflict at Atlantic Avenue and Court Street



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Specifically, the following locations have been identified as needing radii smaller than 82 feet:

- Atlantic Avenue at Court Street – Curb and Potential Building Conflict (Northeast Corner)
- Atlantic Avenue at Columbia Street – Curb and Potential Abutment Conflict (Southwest Corner)
- Columbia Street at President Street – Curb Conflict (Northeast Corner)
- Columbia Street at Carroll Street – Curb Conflict (Northeast Corner)
- President Street at Van Brunt Street – Curb Conflict and Potential Building Conflict (Southwest Corner)
- Carroll Street at Van Brunt Street – Curb Conflict and Potential Building Conflict (Southwest Corner)
- Van Brunt Street at Beard Street – Curb Conflict and Potential Building Conflict (Northeast Corner)
- Beard Street at Otsego Street – Curb Conflict and Potential Building Conflict (Northeast Corner)
- Clinton Street at Mill Street – Curb Conflict and Potential Building Conflict (Southwest Corner)
- Mill Street and West 9th Street at Gowanus Expressway – Conflict with Existing Viaduct Columns

- Court Street at West 9th Street – Curb Conflict (Northeast Corner)
- Garnet Street at Smith Street – Curb Conflict and Potential Building Conflict (Southwest Corner)

At many of the intersections listed above, comprehensive intersection reconstruction could be required to allow for the required streetcar turning radii. Moreover, in some cases reconfiguration of access to a building could be required. For example, there are several options for the potential alignment to travel between Columbia Street and Van Brunt Street (including Sackett Street, Union Street, and Summit Street), as previously shown in Figure 2-7 (page 2-17). Any of these options would require difficult turns due to the narrowness of the streets and the small existing corner radii. In order to make this turn, one or two corner on-street parking spaces would have to be removed. Similarly, the turns to and from Lorraine Street (if this alignment option is selected) would require on-street parking to be removed in order to make the turns feasible.

3.2 Grades

Although the absolute maximum allowable grade is vehicle dependent, and can range as high as nine percent, the desirable maximum grade for streetcar vehicles is five percent. During the fall (with wet leaves) and winter (with snow and ice) grades exceeding five percent can cause severe upgrade slippage, and are therefore generally avoided.

Elevation data obtained from the Department of Information Technology and Telecommunication (DoITT) was used to perform a basic analysis of the slope along the potential alignment options. The highest grades were calculated along Atlantic Avenue between Columbia Street and Henry Street. In these areas the grade is approximately four percent. Therefore, based on this preliminary analysis, there are no grade issues identified. Figure 3-3 shows the general elevation within the Study Area.

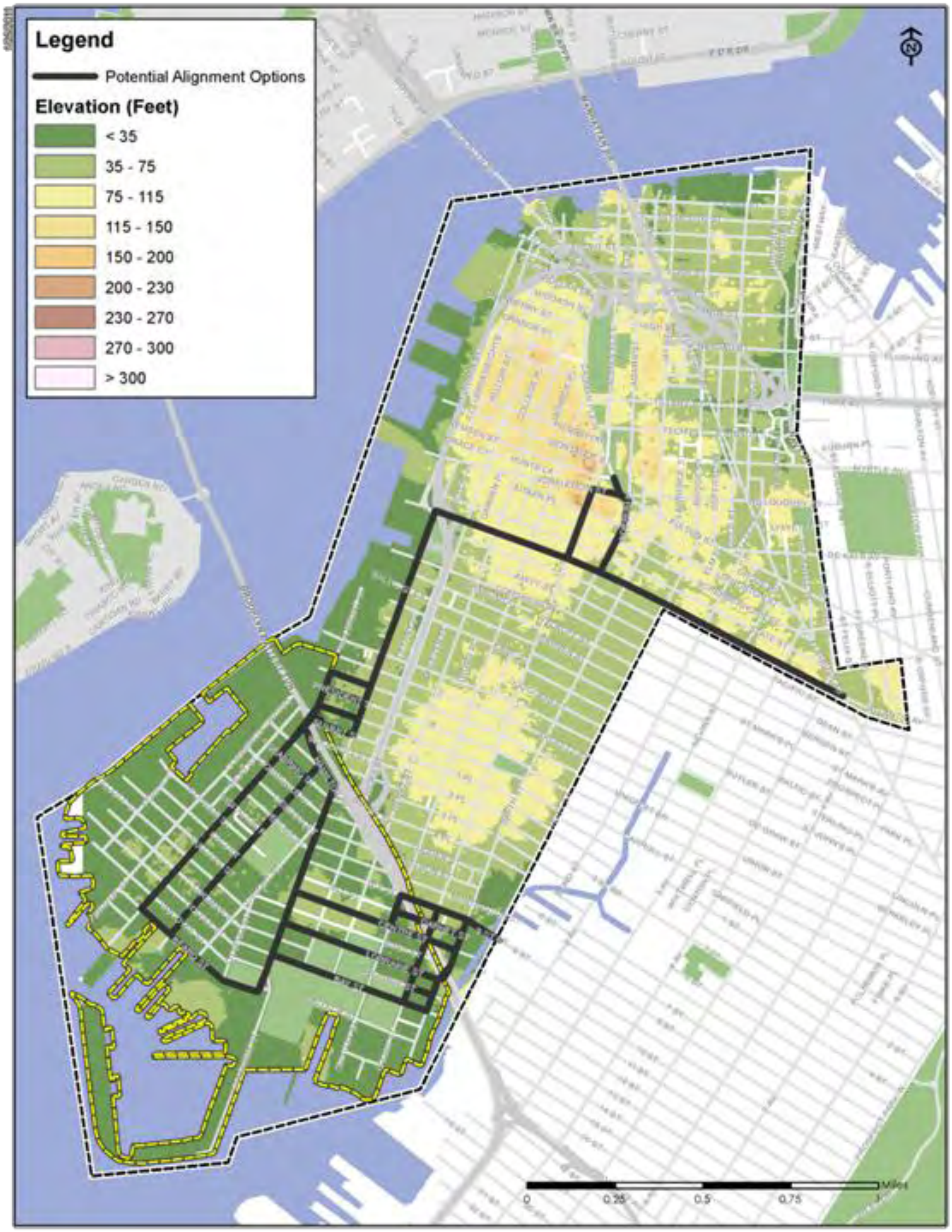
3.3 Station Platforms

The track alignment at the platform should be tangent with less than a two percent grade. Assuming a typical modern streetcar vehicle, the length of the platform should be between forty and sixty feet in order to provide platform access to all vehicle doors. In addition, the platform is treated as an extension of the curb and sidewalk at intersections with stops. At a minimum, the width of the platform should be ten to 12 feet to allow for good pedestrian circulation.

The typical curb height at stations is between ten and 14 inches, and is dependent to some extent on the vehicle. If the vehicle is not capable of self-leveling, a bridge plate is necessary. The horizontal clearance, between the centerline of the track and the platform edge, should be approximately four feet, and is also dependent on vehicle type.

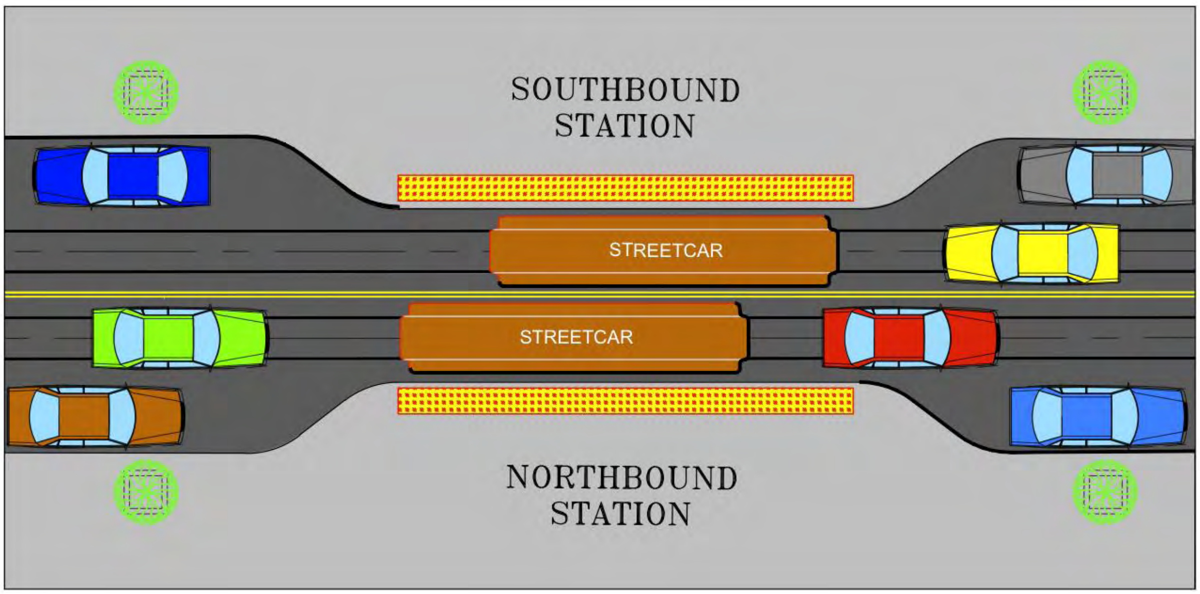
Americans with Disabilities Act (ADA) access and grade requirements must be complied with for all new construction. ADA provisions can be met on historic vehicles through a variety of retrofits; however, ADA compliance is not required. Nonetheless, consideration must be given to the type of service being provided, if historic equipment is utilized.

Figure 3-3: Elevation in Study Area



Because of the grade differential between the existing standard sidewalk and the desired level platform boarding, sidewalk reconstruction and grading work would be required at each stop. The design concept being examined includes the utilization of a bulb out from the existing sidewalk and curb line into the existing on-street parking lane to allow for platform boarding, as shown in Figure 3-4. This would typically eliminate three or four on-street parking spaces at each stop, in each direction.

Figure 3-4: Typical Streetcar Stop



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3.4 Vehicle Clearance

The minimum vertical clearance from the top of the rail to power supply wire is 13 feet, and the maximum height is 21 feet. Vertical clearance less than 18 feet requires the streetcar to be in an exclusive (no other vehicles) lane, unless a variance from the National Electrical Safety code (NESC) is obtained.

For the alignment under consideration, there is one location where the vertical clearance is a concern. This is where Atlantic Avenue crosses under the Brooklyn-Queens Expressway, as shown in Figure 3-5. The clearance is expected to be, at its lowest, between 14 feet 2 inches and 15 feet and 6 inches, on the south side of the structure. This is less than the 18-foot minimum clearance, so a variance would be required. Alternatively the streetcar could be routed under the highest point of the structure, in the middle of Atlantic Avenue. While this would eliminate the vertical clearance issue, it would require additional intersection signal modification to accommodate the left turn onto Columbia Street (for southbound streetcars) and the through movement along Atlantic Avenue (for northbound streetcars), as described in section 3.9.

Figure 3-5: Vertical Clearance on Atlantic Avenue under the Brooklyn-Queens Expressway

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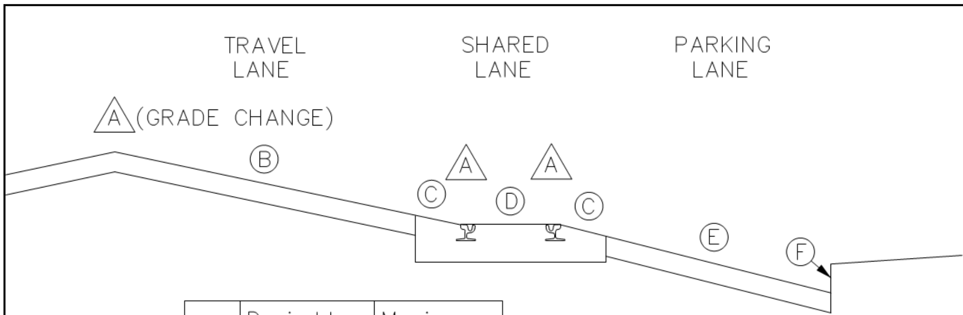
3.5 Roadway Cross Slope

Track slabs are designed to provide a flat (zero percent) slope between the rails. Any slope greater than zero percent is undesirable and can result in uneven rail and wheel wear. In typical roadway construction, the roadway is pitched downward from the centerline of the road toward the gutter to facilitate drainage. This cross section, known as crowning, would create an uneven grade between the rails, with the outside rail being lower than the inside rail. This is undesirable on straight sections of track, but is especially undesirable on a curved section of track, where the crown can produce a backward, or negative superelevation. (Superelevation is the tilting of the trackbed required to help offset centrifugal forces as the streetcar maneuvers around a curve – also defined as the difference in height of the inner and outer rail of the trackbed.)

A level streetcar track slab should be used for all tangent track, except in highly restrictive grading situations where some cross slope could be required to accommodate existing roadway cross slopes. A slight cross slope could be introduced to reduce pavement reconstruction or drainage impacts, but a better solution is to provide a zero percent cross slope between rails and to accommodate the overall cross slope by pitching the portions of the streetcar lane outside the rails between 0 and 5 percent.

Although detailed grading is not generally undertaken until final design, the above method for grading the roadway while maintaining the level track is illustrated in Figure 3-6. This track design attempts to limit roadway reconstruction to only the track slab associated streetcar travel lane. Incidental construction could be required to accommodate relocated utilities. In cases where the track is adjacent to the curb, the rail closest to the curb would be approximately 2.5 feet from the face of the curb. The area between the rail and the face of the curb is then sloped as a gutter to carry water to the nearest inlet.

Figure 3-6: Roadway Cross Section



	Desirable	Maximum
A	3%	5% (2–3% @ Cross Streets)
B	2%	5%
C	2–4%	4.5%
D	0%	1–2%
E	4–6%	7%
F	6"	4" (Curb Exposure)

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3.6 Right-of-Way

The minimum desired lane width for a streetcar track is 11 feet, which accommodates a typical nine-foot wide streetcar and a reasonable separation to adjacent travel lanes, parking, or other streetcar lanes. Adjacent parking lanes should be a minimum of eight feet in width. However, experience in areas where snow can be present, indicates that wider parking lanes (up to 11 feet wide) are preferable to accommodate snow piles. Issues arise in Philadelphia, where parking lanes are less than 11 feet wide, as described in the Case Study Report. Adjacent travel lanes should not be less than 11 feet in width to avoid "crowding" of ambient traffic next to the moving streetcar. In addition, streetcar rails should be placed off-center in the streetcar lane to keep the rails out of the vehicle wheel paths.

Using the above guidelines, the minimum typical cross section to accommodate two-way vehicular and streetcar traffic along with parking on each side is 38 feet, as shown Figure 3-7. (To accommodate 11-foot parking lanes, 44 feet would be desirable). Many of the streets along the potential alignment options are less than forty feet in width, curb to curb, and serve multiple users (i.e. moving and parked vehicles and cyclists). Streets less than 38 feet in width would require the removal of parking from one side, unless the sidewalk areas can be reconfigured to allow the road to be widened to 38 feet. During a preliminary investigation, some of the sidewalks along the potential alignment options have adequate width, and would allow for future reconfiguration.

Figure 3-7: Typical 38-Foot Right-of-Way along Van Brunt

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A 38-foot width is attainable on all of the alignment options at this point with the exception of Columbia Street between Degraw Avenue and Carroll Street. Based on the GIS data and field observation, the road in this area narrows to as little as 35 feet. In order to use this section as a bi-directional double track area, on-street parking or the sidewalk width would need to be modified. In addition, there is an additional alignment option to extend the couplet running mode between Columbia and Van Brunt Streets by traveling down Degraw Avenue to Van Brunt Street, and returning on Carroll Street.

The alignment options developed for this phase of the feasibility study also considered minimal roadway reconstruction in order to run the streetcar service. Minimal roadway excavation and shallow slab construction would be preferable to run a streetcar in the existing streets. However, some intersections would require additional civil reconstruction due to the cornering and clearance envelope of the streetcar. Moreover, some Red Hook streets would require more extensive reconstruction due to the existing street material, as shown in Figure 3-8. The alignment option on Beard Street would be considered full roadway reconstruction, since the existing road is cobblestone and would require extensive reconstruction and grading in order to build the track slab and running rail.

Figure 3-8: Typical Cobblestone Street in Red Hook

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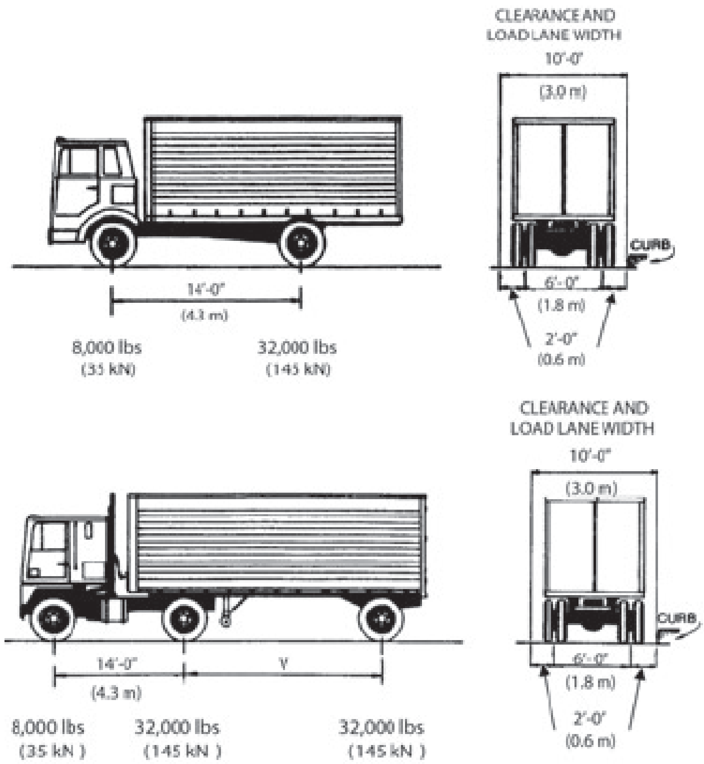
3.7 Structural Loading

Typical streetcar loading is similar to HS20 truck loading, as shown in Figure 3-9; and therefore, poses no special issue or concern in applications on City streets. Heritage vehicles, if selected for a future Brooklyn streetcar, are typically lighter than modern streetcars. During the design process, once the alignment, vehicle type, and other design considerations are determined, a structural engineer would evaluate all structures within the influence of the streetcar.

Figure 3-9: Typical H20 and HS20 Truck Loading



Sketches illustrate AASHTO-approved live loading specifications for standard H20 and HS20 trucks
AASHTO Standard Specifications for Highway Bridges

3.8 Traffic Operations / Signals

A minimum clearance of three feet and eight inches from the streetcar wire to any part of a traffic signal/mast arm or similar structure is required for Occupational Safety and Health Administration (OSHA) certified workers. If non-certified workers are responsible for maintaining lights, signals, and heads, a minimum of ten feet clearance is required. The streetcar design process should coordinate with local agencies and maintenance departments to establish trolley wire clearances. It is likely that some traffic signal equipment would have to be relocated in order to accommodate the overhead streetcar wires.

Streetcar operation is flexible and is typically similar to other vehicles in shared lanes using line of sight. As such, no additional traffic signal control is necessary. However, in certain cases, lane arrangements and geometric constraints would require special traffic signal phasing to accommodate the streetcar movements. One such movement occurs when a streetcar must turn left from the right lane at an intersection, crossing through and/or left turning traffic. This is generally handled with an exclusive signal phase, or an exclusive streetcar lane, also known as "queue jump" phasing.

Additionally, many agencies introduce transit priority movements through detection of the streetcar and the priority service of the streetcar phase, either through a pre-emption system or through a multi-phase actuated signal system. This type of priority phasing could be utilized at any of the signalized intersections throughout the route to facilitate streetcar operations. The following intersections have been identified as probable locations where signal modifications would be necessary:

- At Atlantic Avenue and Boerum Place vehicles would have to turn left from the right hand lane. A queue jump would be necessary at this intersection, and the left turn phasing would have to be made protected.

- Signal modification would be necessary where the potential alignment turns left from Atlantic Avenue to Columbia Street. Due to the geometrics of the left turn and horizontal curvature, the streetcar may need to shift into a wider left lane in order to negotiate the turn onto Columbia Street. This move would require dedicated signal and turning movements, specifically for the streetcar.

- At Boerum Place and Joralemon Street, vehicles would have to turn left from the right hand lane. A queue jump would be necessary at this intersection, and the left turn phasing would have to be made protected.

- Depending on vertical clearance, the streetcar may have to move to the center of Atlantic Avenue under the Brooklyn-Queens Expressway to cross under at the highest point. This would require intersection signal modifications to make the left turn onto Columbia Street (for southbound streetcars) and the through movement (for northbound streetcars). (Vertical clearance is further discussed in Section 3.4.)

- Crossing under the Gowanus Expressway would require signal modification where the potential alignment crosses Hamilton Avenue (at Mill Street and West 9th Street). This is due to the alignment of the streetcar through the columns that support the Gowanus Expressway above Hamilton Avenue. Currently no signal exists here as there is no vehicular crossing.

- An additional signal phase would likely be necessary at the Smith Street and 9th Street intersection in order to handle the streetcar traffic exiting the new terminal at this location.

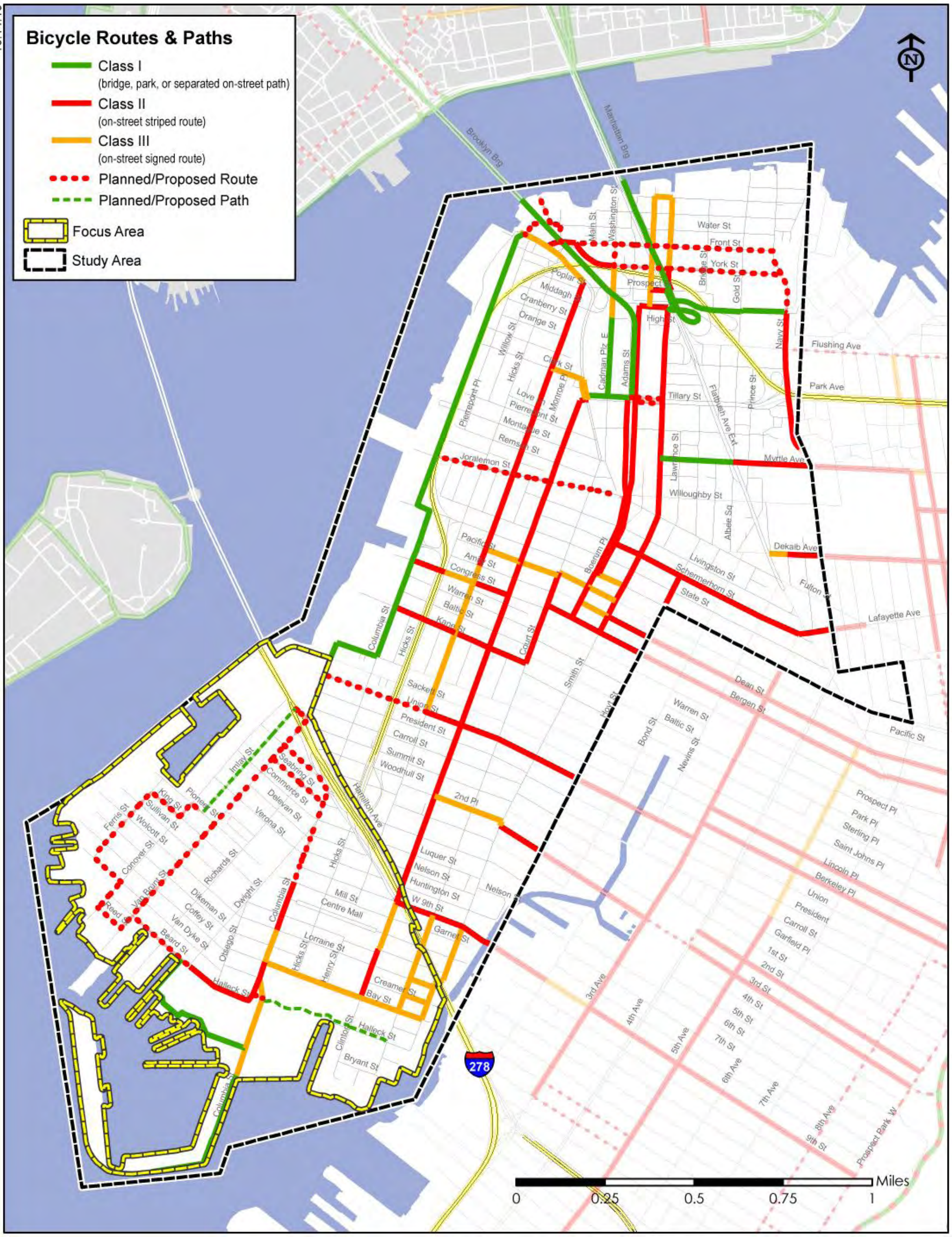
- If the route through the Centre Mall is chosen, it may be desirable to install new traffic signals at the intersections with Clinton Street and Columbia Street.

3.9 Bicycle Integration

The primary issues for bicyclist-streetcar interaction are the flange gap and angle of crossing and right running tracks. When a bicyclist is required to cross the tracks at less than a 60 degree angle, the track “catches” the wheel and the bicyclist may be thrown from their bicycle. This situation is of concern at intersections, especially where bike routes are crossing the streetcar alignment. In addition, right-running tracks present a problem, when a bicyclist riding in the right lane chooses to cross the tracks at an angle less than 60 degrees. This problem is also present at intersections and station stops.

Figure 3-10 shows the designated bike routes and lanes within the Focus Area and Study Area. As reported in the Existing Conditions Report, bicycle routes crisscross the Study Area. In the Focus Area, east-west, Class II bike routes or Class III bike paths are provided along Bay Street, Creamer Street, Lorraine Street, and 9th Street. The Class II bike route on West 9th Street could be a potential conflict with a future Brooklyn streetcar, particularly at the streetcar station stop locations. To integrate these two modes, the bike route could be relocated around the stop, taking some of the sidewalk space.

Figure 3-10: Bicycle Routes and Paths



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A future streetcar would integrate with the separated bicycle path along Columbia Street, as shown in Figure 3-11. However, a potential bicycle conflict would occur when the dedicated path converts to sharrows (or shared-lane marking, as shown in Figure 3-12) along the south section of Columbia Street, between Halleck Street and Creamer Street. In order to integrate a future streetcar with the existing bicycle use along this alignment, the on-street parking lane could be removed from Bay Street to Lorraine Street, as shown in Figure 3-13. (Sharrows shown in green.)

Figure 3-11: Bicycle Integration

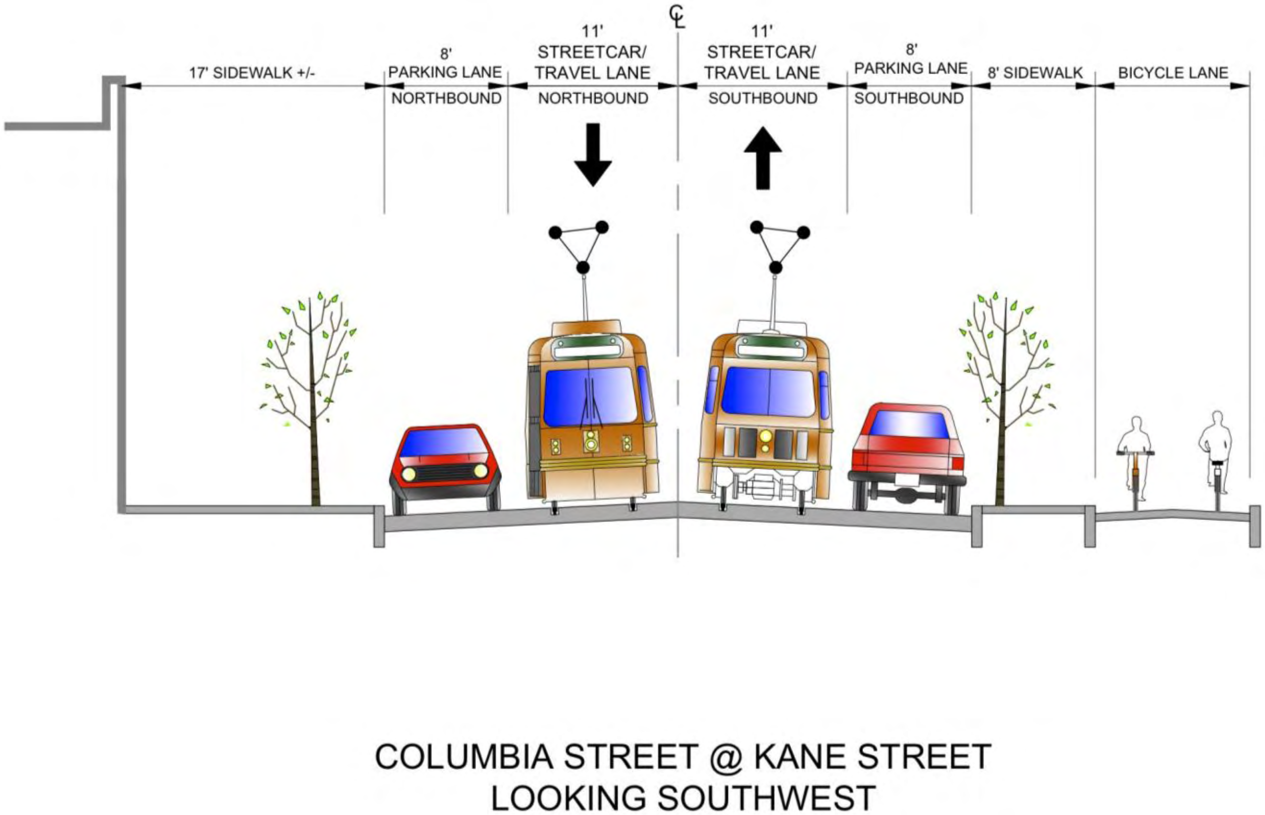

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Figure 3-12: Typical Shared-lane Marking (Sharrow) along Bay Street

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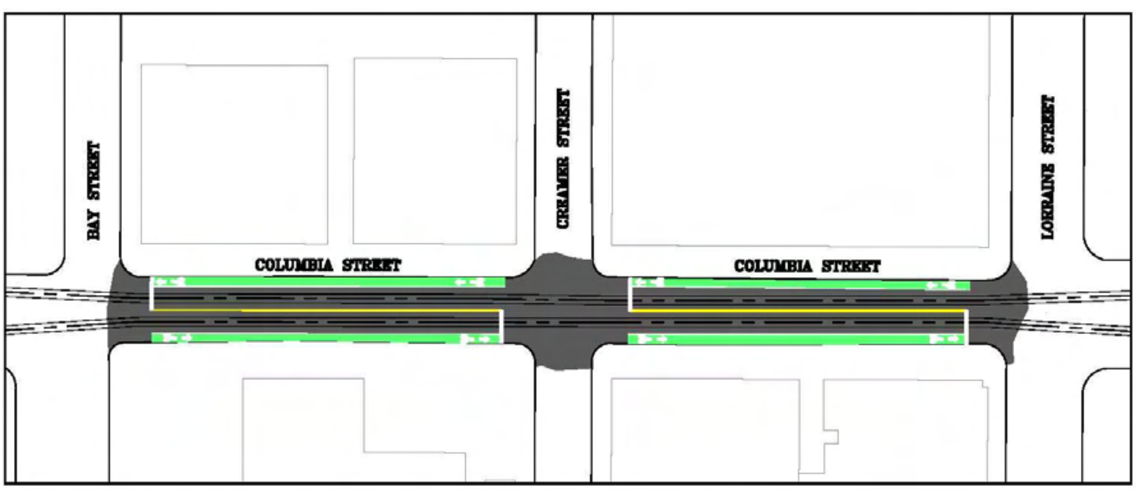
Figure 3-13: Bicycle Integration along Columbia Street



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As part of the New York City Bicycle Master Plan, new bike paths are planned in the Focus Area. Of these, the Class II bike route planned for Van Brunt Street would be a potential conflict with a future Brooklyn streetcar. Both lanes of on-street parking would need to be removed to introduce a Class II bike lane. Alternatively, the proposed Class II bike route could be rerouted to another street (i.e. Richards Street). Based on preliminary investigation of Van Brunt's street width, the latter option would be recommended, as a Class II bike lane would be difficult to integrate into the existing traffic pattern (even without a future streetcar).

3.10 Utilities

Utility clearance requirements should be established with input from the local agencies and utility companies during the early stages of design. For new construction, a utility-free zone within nine to twenty feet from the track centerline to any parallel utility is considered to be ideal. However, in most instances of construction in existing streets, the need to revise infrastructure is related to the functional needs of the individual utility companies and the municipalities involved. As discussed in the Case Study Report, in both Portland and Seattle, utility coordination was critical to successful design and on-going operations. In both cases, utility conflicts significantly increased the cost of the project.

There are several types of utility conflicts that should be resolved during the design stage of a future Brooklyn streetcar. These include:

- Parallel utility conflicts, where utilities may be too shallow to permit them to stay in place, or where the utility may be restricted due to the need to operate under the streetcar line;
- Crossings (such as water), which are typically sleeved, or the pipe is replaced with another, non-conductive material; and
- Surface conflicts where access structures, manholes, valves, etc. are in physical conflict with the streetcar tracks.

A preliminary analysis of major underground utility impacts within the potential alignments was performed based on data received from three adjacent projects within the Study Area to provide a representative sample of potential utility concerns, as well as other available sources for utility information, including:

Downtown Brooklyn Traffic Calming

Drawings were provided showing traffic calming features at certain intersections within the project area along Atlantic Avenue. These drawings indicate existing geometric information and underground utility information for the Atlantic Avenue corridor of the potential alignment.

Reconstruction of Columbia Street (Phase I)

Drawings were provided from a new water main installation and street reconstruction of Columbia Street in the northwestern quadrant of the Study Area. These drawings indicate existing geometric information and underground utility information for the Columbia Street corridor of the potential alignment.

RECONSTRUCTION OF COLUMBIA STREET AREA (PHASE II)

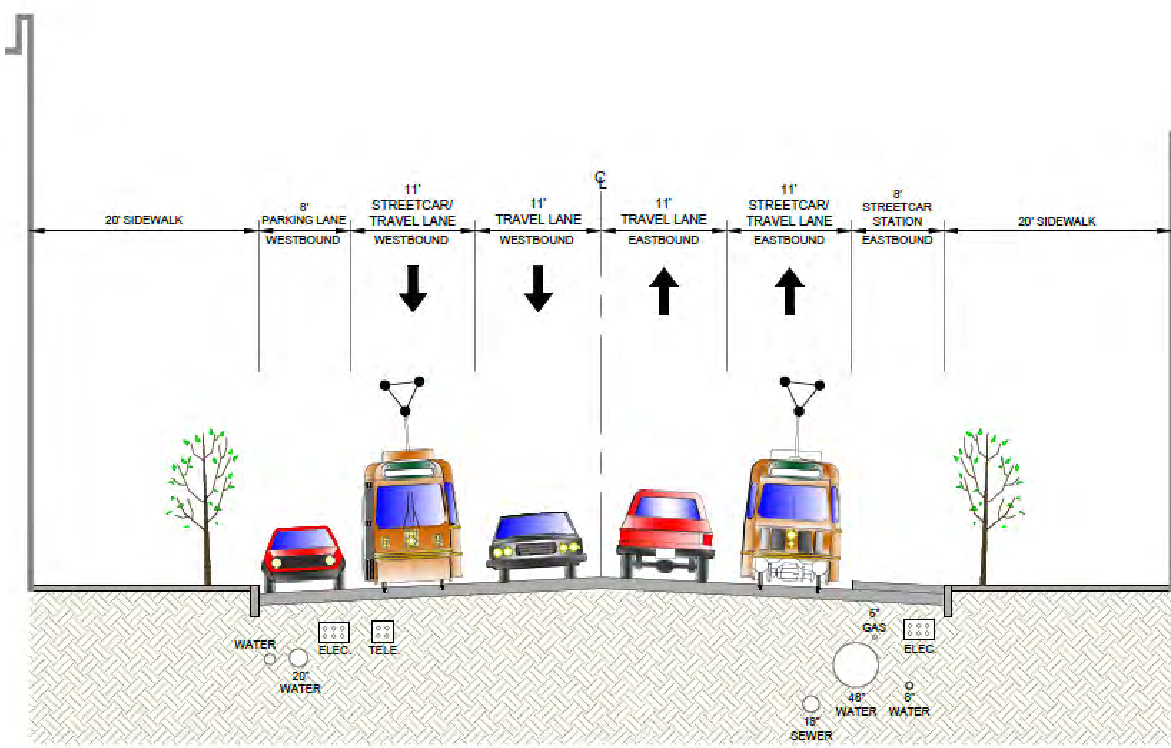
Drawings were provided from a new water main installation and street reconstruction of Van Brunt Street and Richards Street in the southwestern quadrant of the Study Area. These drawings indicate existing geometric information and underground utility information for the Van Brunt Street and Richards Street corridor of the alignment.

OTHER AREAS

Additional underground utility information was collected from the New York City Department of Environmental Protection (NYCDEP) sewer records for the rest of the Study Area. No private utility information was obtained at this early feasibility study phase.

The streetcar construction would be completed using a shallow construction technique that minimizes disruption to the underlying roadbed and utilities. However, at this stage of the feasibility study, conflicts are considered to occur whenever shallow utilities cross the line or run parallel to it, or when large utilities run parallel. Based on the available information previously discussed, a discussion of probable utility impacts at two representative locations is presented below. The cross-sections in Figures 3-14 and 3-15 show the location of existing utilities in relation to the potential streetcar trackbed.

Figure 3-14: Typical Cross Section along Atlantic Avenue (at Clinton Street)



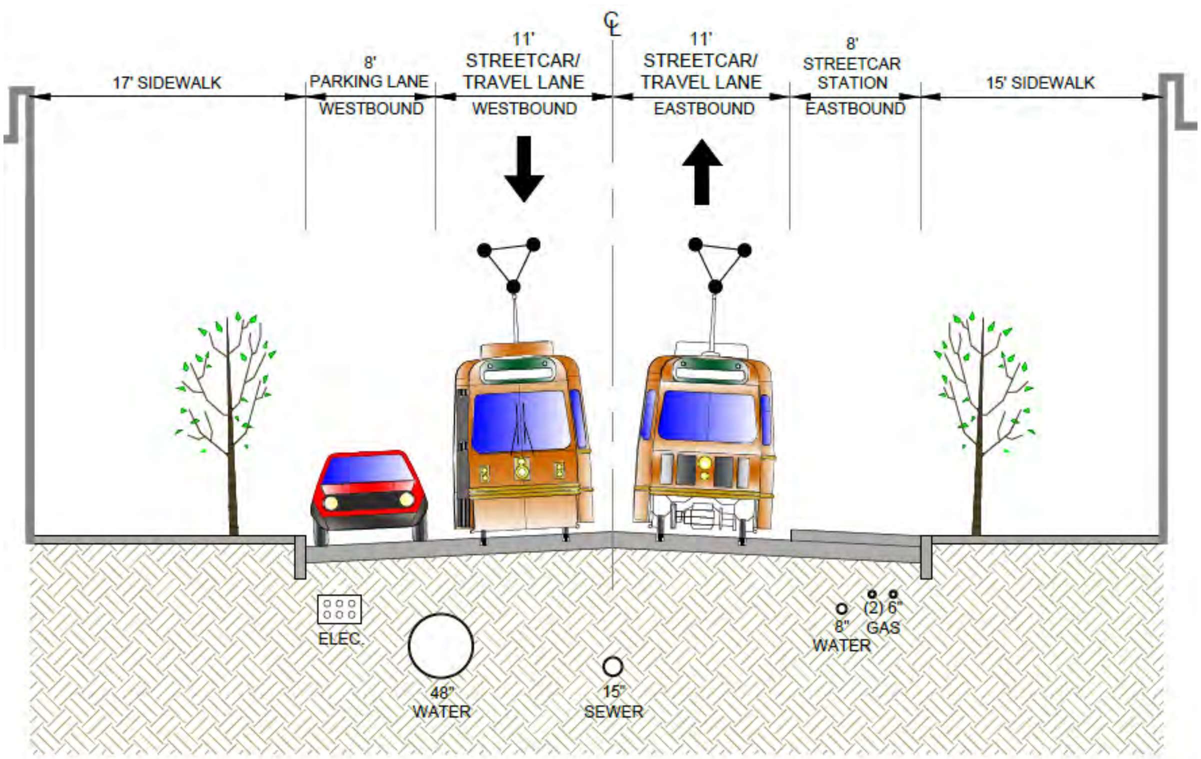
Not to scale
URS Corporation

Atlantic Avenue

Atlantic Avenue is sixty feet wide, with two travel lanes in each direction and parking on both sides of the street. The proposed streetcar alignment would run along the rightmost travel lane in each direction. This would allow the parking lane to be maintained except in areas where the sidewalk is bumped out for station stops. According to the records obtained for the Brooklyn Streetcar Feasibility Study, most of the major underground infrastructure along the Atlantic Avenue corridor is below the rightmost travel lane and parking lane, which is in conflict with the proposed streetcar location. It may therefore be necessary to relocate some of the utilities, as indicated in Figure 3-14. (Utilities shown here are not to scale, and the depths shown are estimates based on prior experience.)

Key concerns include an existing 48-inch water main, which runs just below the streetcar track alignment for a major portion of the route, as well as electrical and telephone duct banks, which are shallow and just below the road. While the entire duct bank system may not have to be relocated, most manholes and access vaults would need to be reconstructed out of the streetcar track alignment.

Figure 3-15 Typical Cross Section along Van Brunt Street (at Hamilton Avenue)



Not to scale
URS Corporation

Van Brunt Street

As shown in Figure 3-15, Van Brunt Street is 38 feet wide, with a single travel lane in each direction and parking on both sides of the street. The streetcar tracks would be placed within the travel lane, adjacent to the parking lane, which would also be utilized for station stops at bump outs in the sidewalk. Utility concerns in this area include a 48-inch water main running parallel to the southbound track alignment. According to the information provided, there are no shallow private utilities along the Van Brunt corridor that would need to be relocated.

ADDITIONAL UNKNOWN CONFLICTS

Because of the preliminary nature of this feasibility investigation, there is a possibility that there are additional utilities that may be in conflict with the proposed streetcar alignment options. However, they have not yet been specifically identified. For example, based on planning and engineering experience, it is anticipated that a number of utilities are located under the Gowanus Expressway. These could be impacted by the proposed streetcar alignment. Detailed investigations would be required to identify all potential conflicts, and an in-depth discussion would be required with City officials and utility company representatives to determine the best way to deal with these potential conflicts.

Another conflict that was not investigated at this early feasibility study stage is the presence of any building vaults that may exist below the sidewalk or in the street along the alignment options. Further study would be necessary to determine if any vaults exist attached to building along the route, and the extent of the impact they would have with the roadway and sidewalk reconstruction.

3.11 Track Structure / Pavement Reconstruction

Many track structure designs have been implemented in the various light rail transit or streetcar systems around the country. Embedded girder rail in a concrete track slab is the most common of streetcar systems in shared-use traffic lanes. A typical streetcar track slab is approximately eight feet wide by 12 inches thick, but the design varies depending on various factors (i.e. local soil conditions, pavement design life expectations, and potential utility spanning). The track slab is placed over a compacted base course on an approved subgrade, with the base course thickness varying depending on the pavement design life and bearing capacity of the subgrade.

Pavement reconstruction can be limited to three feet or less on either side of the track slab depending on the existing cross slope and profile of the roadway. This method is currently being used during the construction of Philadelphia's Route 15 Trolley extension, as shown in Figure 3-16.

Additional reconstruction or grinding/overlay could be required depending on the streetcar alignment and profile, station locations, or other special considerations. In addition to the tangent alignment reconstruction, right angle turning movements would typically require more extensive reconstruction, including sidewalk and portions of the intersection, in order to support the construction of the radius and sidewalk corner impacted by the turning movement.

Figure 3-16: Construction of Philadelphia's Route 15 Trolley Extension

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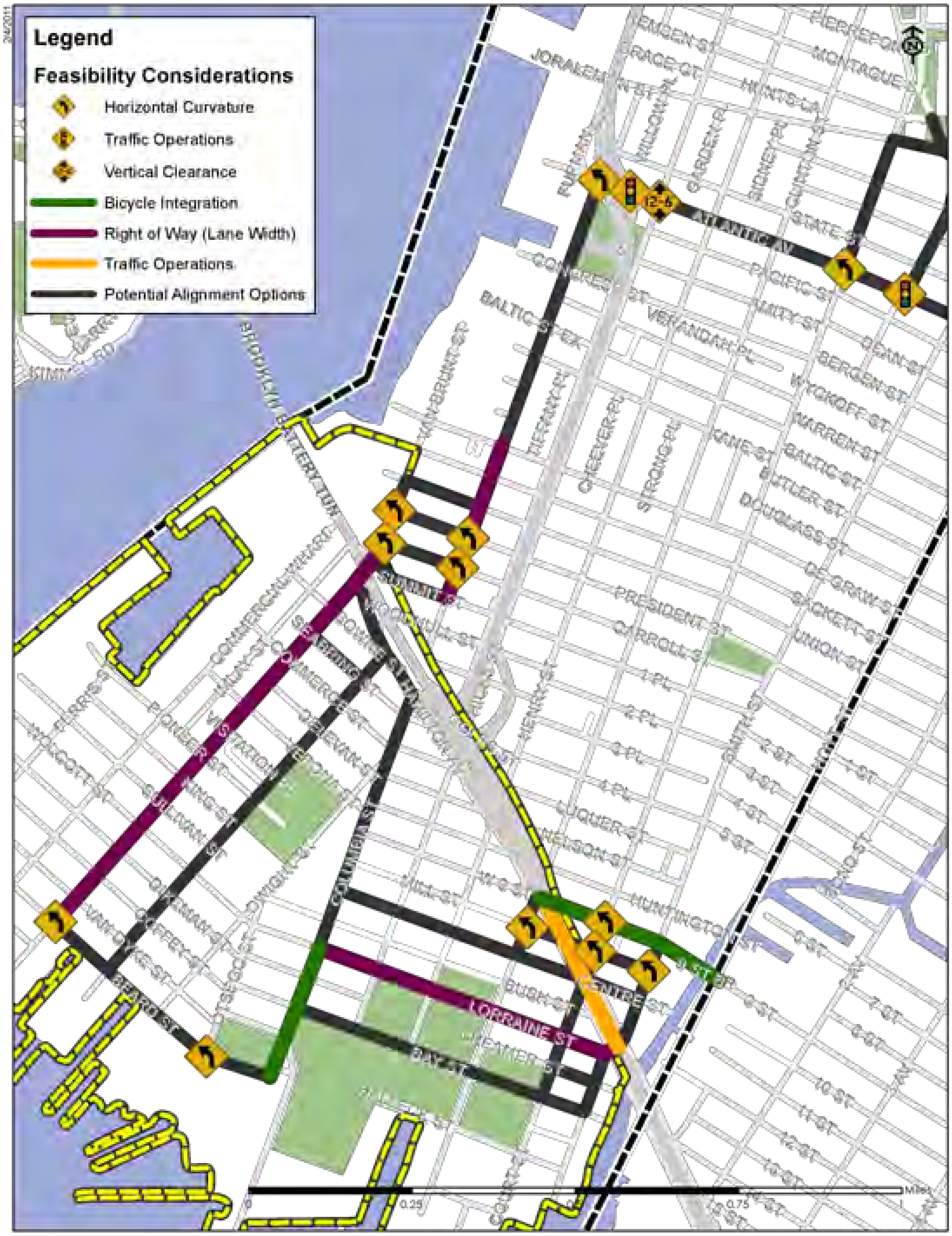
4.0 CONCLUSION AND NEXT STEPS

Based on preliminary investigations, Figure 4-1 identifies the areas of potential concern, including horizontal and vertical clearance issues and traffic operations impacts that need to be considered when evaluating the feasibility of a Brooklyn streetcar system. Additional analyses will be conducted and reported in the Brooklyn Streetcar Feasibility Study – Feasibility Report.

Figure 4-1: Feasibility Considerations



NYCDOT - BROOKLYN STREETCAR FEASIBILITY STUDY

Feasibility Considerations

7.0 FEASIBILITY REPORT

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1.0 INTRODUCTION

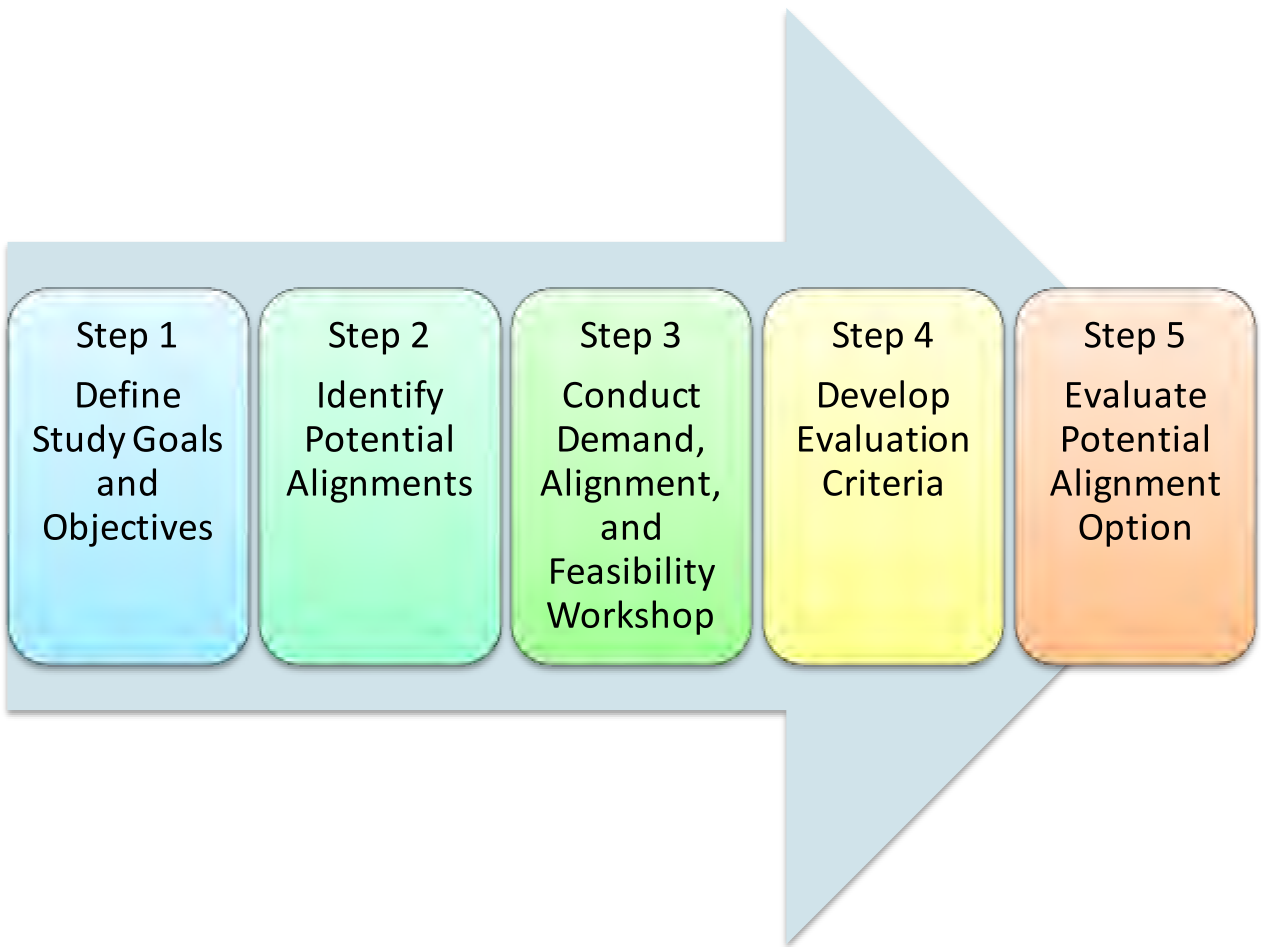
This report presents the results of a detailed evaluation on the feasibility of implementing a streetcar system in Brooklyn. This analysis draws upon the experience and lessons learned from several existing streetcar systems presented in the Case Study Report. As part of that effort, the Study Team and representatives of DOT conducted a field visit of the Philadelphia Route 15 Trolley system. In addition, a number of site investigations were performed in Red Hook and Downtown Brooklyn to identify alignment options and feasibility considerations related to clearances and turning radii, track geometry, sidewalks, bikeways, and utilities.

This detailed analysis considers constructability issues, vehicle options, and overall costs to implement and operate a streetcar system in Brooklyn. The evaluation was conducted based on the approach outlined in the Alignment Evaluation Methodology and Feasibility Considerations Technical Memorandum. In addition to feasibility from an engineering standpoint, this report also includes discussion related to DOT policy decision for a future streetcar in Red Hook. DOT's policy specifically relates to the selection and evaluation of the alignment options, feasibility considerations, expected benefits, and cost considerations.

2.0 METHODOLOGY

This section outlines the process used for selecting and evaluating potential alignments for a streetcar service in Brooklyn, as defined in the Alignment Evaluation Methodology and Feasibility Considerations Technical Memorandum, as well as the process for developing a policy decision in regard to a future streetcar in Brooklyn. The process for selecting and evaluating potential alignments for a streetcar service in Brooklyn includes defining the study's goals and objectives, identifying potential streetcar alignments, developing evaluation criteria to measure how well the alignment options satisfy the study's goals and objectives, and evaluating various alignment options in comparison to each other. This multi-step process is graphically shown in Figure 2-1.

Figure 2-1: Alignment Selection and Evaluation Process



In Step 1, study goals and objectives were discussed and developed during the initial study meetings. In Step 2, conceptual alignments were identified based on a combination of factors, including land uses that generate significant person trips, employment densities that concentrate these trip generating uses, connecting existing transit that allows for citywide access, and input from the Community Advisory Committee.

In Step 3, additional streetcar alignments were identified and reviewed during a Demand, Alignment, and Feasibility Workshop attended by DOT and members of the consultant team. Based on the input received at this workshop and considering planning factors such as existing land use, employment density, existing transit, and the roadway network, the alignments were refined to include one basic potential alignment with various alternative options. This potential alignment with options was presented at the second Community Advisory Committee meeting on December 13, 2010 for public feedback.

EVALUATION CRITERIA

Using the goals and objectives defined in Step 1, evaluation criteria were developed in Step 4 to assess how well the alignment options address the defined goals and objectives. Step 5 considers the degree to which each alignment option satisfies the defined goals and objectives using a rating scale for the developed evaluation criteria. While these measures are generally qualitative, they allow for a comparison of the order of magnitude benefits and drawbacks of each alignment option. Each of the study goals and objectives are listed below, along with a description of the evaluation criteria, which were used to evaluate the potential alignment options. Table 2-1 includes the streetcar goals and objectives and the corresponding evaluation criteria for the forthcoming evaluation of the potential alignment options.

Improve Transportation Mobility

Five objectives are related to the goal of improving transportation mobility:

- Provide transit accessibility;
- Minimize travel time;
- Provide intermodal connectivity;
- Enhance pedestrian movements; and
- Accommodate bikeways.

To evaluate whether an alignment option provides transit accessibility, population, employment, and activity centers were measured within 1/3-mile of the potential alignment options (for both directions) using Geographic Information Systems (GIS) and the New York Metropolitan Transportation Council (NYMTC) 2005 traffic analysis zone (TAZ) level population and employment data. Traffic analysis zones were considered to be within 1/3 of a mile if more than half of the zone was within 1/3-mile of the proposed alignment. For this analysis, the following activity centers were identified: Atlantic Terminal, Borough Hall, Red Hook Houses, Long Island College Hospital, Fairway, and IKEA. Alignment options with a higher concentration of population, employment, and activity centers within 1/3-mile received a higher rating than alignment options with a lower concentration.

Similarly, GIS was also used to measure route distance and potential trip time savings between the following trip generators: Atlantic Terminal, Borough Hall, Red Hook Houses, Long Island College Hospital, Fairway, IKEA, and the Smith / 9th Street subway station. Using the scheduled speed of the existing Metropolitan Transportation Authority New York City Transit Authority (MTA NYCT) B61 bus as a benchmark, alignment options that would provide shorter travel times to these trip generators, due to more streamlined routing, received a higher rating than alignment options that would result in longer travel times.[1]

To assess an alignment option's ability to provide intermodal connectivity, the existing subway and bus connections were mapped. The alignment options with a bus or subway connection within one block received a higher rating than alignment options with more distant connections or with a lack of intermodal connections. Moreover, alignment options with multiple intermodal connections were rated accordingly higher.

In terms of pedestrian movements, alignment options were examined based on potential conflicts with pedestrian movements and interference with pedestrian space. Alignment options that would require the narrowing of sidewalks or the removal of pedestrian space received a lower score for these evaluation criteria.

Similarly, alignment options were examined based on their integration with bike routes. Those that would conflict with the right-of-way of existing or planned bikeways received a lower score. In addition, alignment options that would result in unsafe bicycle/streetcar crossings (60-degree or less crossing angles) received a lower score for bicyclist-related evaluation criteria.

Provide economic opportunity and investment and enhance the community character

Three objectives are related to the goal of providing economic opportunity and investment and enhancing the community character:

- Serve proposed/projected development;
- Maintain parking supply; and
- Support neighborhood resident and local business community sentiments.

To evaluate whether an alignment option would serve proposed/projected development, locations of future developments were identified within 1/3-mile of the alignment options using GIS. Alignment options with a larger number of future developments received a higher rating than alignment options adjacent to a lesser number.

Since none of the potential alignment options would be anticipated to create an increase in parking supply, this criterion was evaluated with respect to requirements to remove on-street parking supply. Alignment options received a lower score if on-street parking removal was necessary to accommodate for the streetcar track right-of-way. The removal of on-street parking would be required at most of the potential streetcar stops. However, this would occur regardless of the alignment option selected; and therefore, was not a factor in determining the evaluation criterion score.

The support of neighborhood residents and local businesses is an important factor in developing a future streetcar route. As discussed in the Case Study Report, streetcar support in Portland, Seattle, and Philadelphia influenced the planning (and success) of each city's streetcar system. Based on initial

[1] For a conservative evaluation, this analysis assumed streetcars have no inherent travel time advantage over buses. While streetcars have a higher capacity for passenger loading and quicker acceleration, average speeds of streetcars operating in mixed traffic when traveling in dense urban settings are similar to conventional buses in a similar environment.

discussion with members of the community, the concept of a streetcar in Red Hook generally received favorable reaction. However, a public meeting is planned for the Brooklyn Streetcar Feasibility Study in May, when the alignment options will be presented to the public for their comment and input. A ranking for this criterion will be added following the public meeting, based on public input regarding the potential alignment options. To date there is no sense of consensus from the community indicating that it would welcome a future streetcar. Parts of the community have come forward and stated they would like to keep Red Hook as it is, while others have stated they would like to see additional development within the neighborhood.

Maintain traffic and delivery access

Two objectives are related to the goal of maintaining traffic and delivery access:

- Maintain curb access for unloading and loading; and
- Maintain access to Red Hook's arterial roadways and Brooklyn highways.

All proposed alignment alternatives use the existing street network as their primary route locations (with some minor exceptions). Generally, these routes are located in the rightmost travel lane of the roadway. For most of the alignment options, curbside parking is maintained except in station/stop areas, where the sidewalk 'bumps out' to align with the streetcar track for boarding, and in areas where turns preclude the possibility of parking due to the turning radius of the streetcar. For most alignment options, this curb access impact is relatively consistent.

However, there are some locations along the alignment options where the existing street width is not sufficient to maintain parking adjacent to the streetcar alignment. As a result, parking/loading areas would be restricted in these areas. The rating of the various alignment options under this criterion are based on the amount of curbside parking/loading lost due to the location of the streetcar route.

In determining the initial alignment options, impacts to major intersections, arterial streets, and highway ramps were generally avoided. Streetcar design allows the mixing of the streetcar operation with the urban automobile traffic; and therefore, street and highway access was not generally impacted by the potential routes. (For additional discussion, please see the section on traffic planning on page 3-13.)

A comparative assessment of the alternative routing on access to Red Hook's arterial roadways and Brooklyn highways was made by focusing on the potential impact on truck access to local and through truck routes. The truck routes in the Study Area were reviewed to identify any streetcar/truck route interference, including restrictions on turns, roadway geometrics, parking, loading, driveway access, and double-parking. The alignment options that would create greater interference with existing truck routes received a lower score than the alignment options that would minimize impacts on existing truck traffic patterns.

Minimize adverse impacts on the built and natural environment

Four objectives are related to the goal of minimizing adverse impacts on the built and natural environment:

- Minimize property acquisition;
- Minimize adverse impacts to historical resources;

- Minimize impacts to natural features/resources and coastal waters; and
- Minimize traffic impacts.

As a streetcar would operate in the existing street right-of-way, property acquisition would not be necessary for a majority of the streetcar track. However, at some corners, the turning radius would likely infringe on existing sidewalks, even if the minimal radius of 50 feet is utilized. Impacts on the intersection corners could include some right-of-way takings to maintain sidewalk widths. In addition, although the alignment options presented in this study avoid the actual removal of any structures, some reconfiguration of access to buildings could be required to support the revised corner geometry in a few isolated cases. It is noted that at this level of mapping precision, there is some uncertainty in the exact nature and amount of property required. However, most potential impacts have been identified. For rating purposes, the alignment options that could require property acquisition received a lower score.

Two historic districts – Cobble Hill and Brooklyn Heights – were identified in the Study Area. Alignment options within these historic districts present potential impacts, particularly visually, due to the overhead wires used for power distribution. All Northern Section alignment options travel through these districts; and thus, received a lower score for this criterion.

In addition, historic landmarks were mapped in the Study Area. The locations of historic landmarks were compared to the potential alignment options, and it was determined that none of the potential alignment options would require the acquisition of historic property. However, potential visual impacts could occur, due to the overhead wires used for power distribution. These alignment options received a lower score for this criterion.

To evaluate the adverse impacts to natural features/resources and coastal waters, the locations of parkland and coastal waters within the Focus and Study Areas were mapped. Alignment options that traverse parkland received a lower score. Similarly, alignment options adjacent to coastal waters received a lower score.

Traffic data and existing analyses from the *Downtown Brooklyn Surface Transit Circulation Study* were used to identify intersections operating at unacceptable levels of congestion. As provided in the *Highway Capacity Manual*, intersection and street operations are defined in terms of average delay experienced during peak traffic operations. The delay is expressed in terms of level of service (LOS) and is given a rating from LOS A, where delays are minimal, to LOS F, relating to an over capacity, or a jammed condition.

Generally, track alignments were identified that would minimize traffic flow disruption, and allow the streetcar to operate within established traffic lanes, controlled by existing traffic signal phases. However, in some instances, especially where streetcars were required to turn left from the right lane, the signal phasing would have to be modified to accommodate the safe movement of the streetcar, using exclusive, or 'queue jump' phasing. This would necessarily result in a reduction in capacity for the through vehicular movements. These alignment options received a lower score in these instances.

There are also some locations where the existing street operations are so poor that they would create delays to the streetcars. At locations such as these, the severity of the anticipated poor traffic flow produced a lower score than alignment options that would operate in an unobstructed manner.

Minimize streetcar capital and operating costs and impact

Three objectives comprise the goal of minimizing streetcar capital and operating costs and impact:

- Implement within a reasonable construction timeframe and cost;
- Avoid conflicts with existing and proposed infrastructure; and
- Avoid or minimize utility relocation.

To determine whether an alignment option could be implemented within a reasonable construction timeframe and cost, a preliminary assessment was made regarding the difficulty of construction, likely capital cost, rights-of-way and property issues, complexity of the route, and physical constraints. At this point in the study, many of these issues were addressed on a qualitative basis only. For example, it has been noted that an alignment option along a cobblestone pavement would be more costly and take more time than a typical asphalt pavement. (Capital costs are discussed in more detail later in section 6.1.) Alignment options that would have a longer construction timeframe or higher cost received a lower score for these criteria.

To evaluate whether the alignment options avoid conflicts with existing and proposed infrastructure, utility infrastructure was located and potential conflicts identified. The alignment options that avoid these potential infrastructure conflicts received a higher score than those alignment options that conflicted with existing infrastructure.

Utility locations are only known on a preliminary basis at this point. Although track alignment can be influenced by the location of certain utilities, it is generally necessary to set the alignment based on other factors, such as traffic movements and parking and loading requirements. As a result, certain alignment options could result in a large number of utility relocations, and would be more costly to implement. Furthermore, utility maintenance can impact streetcar operations after construction is complete. For this assessment, alignments that were in conflict with known underground utilities facilities received a lower score to reflect the likely difficulties of construction and maintenance. (Utilities are discussed in greater detail in section 3.3.)

Table 2-1:
Brooklyn Streetcar Evaluation Criteria

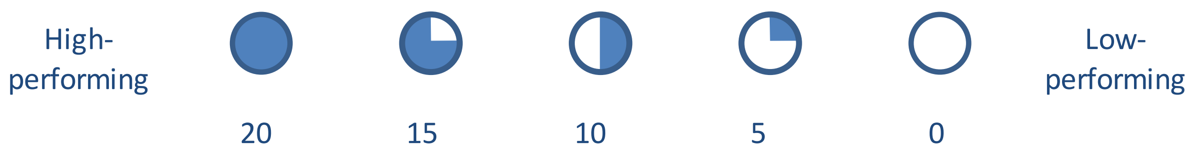
GOAL/OBJECTIVE	EVALUATION CRITERIA
IMPROVE TRANSPORTATION MOBILITY	
Provide transit accessibility	– POPULATION WITHIN 1/3–MILE OF ALIGNMENT – EMPLOYMENT WITHIN 1/3–MILE OF ALIGNMENT – ACTIVITY CENTERS WITHIN 1/3-MILE OF ALIGNMENT
Improve travel time	– TRIP TIME SAVINGS TO AND FROM VARIOUS TRIP-GENERATORS
Provide intermodal connectivity	– PROVIDES BUS CONNECTIONS – PROVIDES SUBWAY CONNECTIONS

Table 2-1:
Brooklyn Streetcar Evaluation Criteria

GOAL/OBJECTIVE	EVALUATION CRITERIA
Enhance pedestrian movements	– MINIMIZES INTERFERENCE WITH PEDESTRIAN MOVEMENTS – IMPROVE PEDESTRIAN SPACE
Accommodate bikeways	– MINIMIZES INTERFERENCE WITH EXISTING/PLANNED BIKEWAYS AND GREENWAYS – MINIMIZES IMPACTS TO BICYCLIST SAFETY
PROVIDE ECONOMIC OPPORTUNITY AND INVESTMENT AND ENHANCE THE COMMUNITY CHARACTER	
Serve proposed/projected development	– FUTURE DEVELOPMENT WITHIN 1/3–MILE OF ALIGNMENT
Maintain parking supply	– MINIMIZES CHANGES TO PARKING SUPPLY
Support neighborhood resident and local business community sentiments	– AMOUNT OF STREETCAR SUPPORT/OPPOSITION
MAINTAIN TRAFFIC AND DELIVERY ACCESS	
Maintain curb access	– MINIMIZES CHANGE IN CURB ACCESS (LINEAR FEET)
Maintain access to Red Hook's arterial roadways and Brooklyn highways	– MINIMIZES VEHICLE RESTRICTIONS TO ACCESS RED HOOK'S ARTERIAL ROADWAYS AND BROOKLYN HIGHWAYS – MAINTAIN TRUCK ACCESS TO LOCAL AND THROUGH TRUCK ROUTES
MINIMIZE ADVERSE IMPACTS ON THE BUILT AND NATURAL ENVIRONMENT	
Minimize property acquisition	– MINIMIZES PROPERTY ACQUISITION
Minimize adverse impacts to historical resources	– MINIMIZES VISUAL IMPACTS TO HISTORIC RESOURCES – MINIMIZES HISTORIC PROPERTY ACQUISITION
Minimize impacts to natural features/resources and coastal waters	– MINIMIZES INTERFERENCE WITH PARKLAND OR COASTAL WATERS
Minimize traffic impacts	– MINIMIZES NEGATIVE IMPACT ON TRAFFIC FLOW
MINIMIZE STREETCAR CAPITAL AND OPERATING COSTS AND IMPACT	
Implement within a reasonable construction timeframe and cost	– SHORTER CONSTRUCTION DURATION – LOWER CONSTRUCTION COST
Avoid conflicts with existing and proposed infrastructure	– MINIMIZES INFRASTRUCTURE CONFLICTS
Avoid or minimize utility relocation	– MINIMIZES UTILITY CONFLICTS – MAINTAIN ACCESS TO UTILITIES

RATING SCALE

The relative rating for each evaluation criterion was developed to differentiate between the performances of each alignment option. The rating scale ranges from high-performing to low-performing scores. Point values were assigned for the respective ratings of each evaluation criterion shown in Table 2-1. Below is the rating scale and point system that was designated for the respective evaluation criteria.

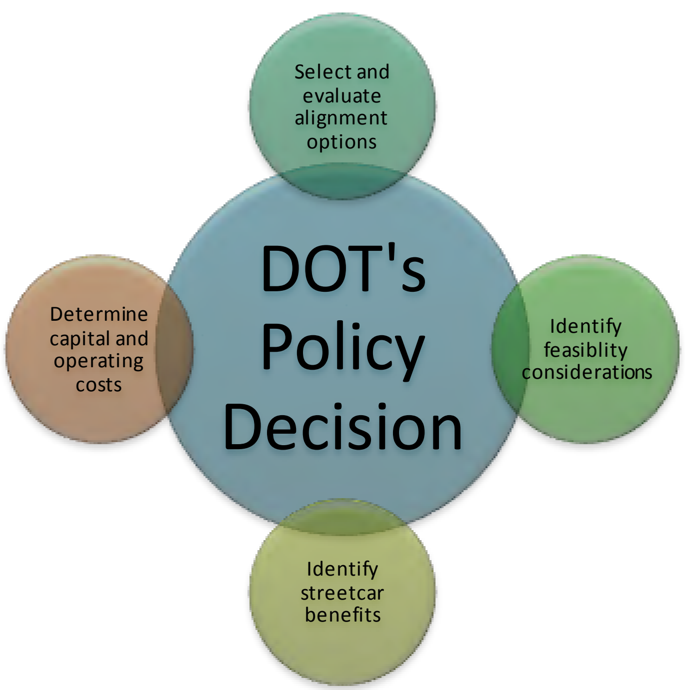


The points for all the evaluation criteria were summed to come up with a final point total for each alignment option. The alignment options were then ranked to determine the alignment(s) that best meet(s) the defined goals and objectives.

POLICY DECISION

The process for developing a policy decision for a go/no go decision for a future streetcar in Brooklyn includes the selecting and evaluating the alignment options (as described above), identifying feasibility considerations (as described in section 3.0), and determining capital and operating costs (as described in section 6.0). This multi-step process is graphically shown in Figure 2-2. DOT's policy decision also incorporates streetcar benefits, which are discussed in the Case Study Report.

Figure 2-2: Policy Decision Process



3.0 FEASIBILITY CONSIDERATIONS

This section describes general streetcar feasibility considerations typical of a streetcar operating in an urban environment, which were considered for the proposed Brooklyn Streetcar. These general considerations include alignment considerations (right-of-way, horizontal curvature, major infrastructure obstacles, station platforms, and vertical clearance), traffic planning (traffic operations and signals, parking and loading, and bicycle integration), and constructability (construction methodology, construction impacts, pavement type, and utilities). In addition to a description of each of these considerations, the related evaluation criteria are identified in relation to the applicability to streetcar feasibility. Specific areas of concern within the Study Area and an assessment of the potential future streetcar alignment options are included in section 4.0.

3.1 Alignment Considerations

RIGHT-OF-WAY

The minimum desired lane width for a streetcar track is 11 feet, which accommodates a typical nine-foot wide streetcar and a reasonable separation from adjacent travel lanes, parking, or other streetcar lanes. Adjacent parking lanes should be a minimum of eight feet in width. However, experience in areas where snow can be present, indicates that wider parking lanes (up to 11 feet wide) are preferable to accommodate snow piles. Adjacent travel lanes should not be less than 11 feet in width to avoid 'crowding' of ambient traffic next to the moving streetcar.

Based on these guidelines, the minimum typical cross section to accommodate two-way vehicular, streetcar traffic, and parking on each side is 38 feet. (To accommodate 11-foot parking lanes, 44 feet would be desirable.) Many of the streets along the potential alignment options are less than forty feet in width, curb to curb, and serve multiple users. Streets less than 38 feet in width would require the removal of parking from one side, unless the sidewalk areas could be reconfigured to allow the road to be widened to 38 feet.

This feasibility consideration impacts various evaluation criteria, including 'Minimizes interference with pedestrian movements', 'Minimizes changes to parking supply', 'Maintains truck access to local and through truck routes', and 'Minimizes property acquisition'. As such, alignment options with roadway widths of 44 feet or more received a high performing score (20) for these evaluation criteria. Similarly, alignment options with a cross section less than 44 feet, but greater than 38 feet received a mid-performing score (15 or 10), and alignment options with 38-foot roadway widths received a lower performing score (5). Finally, alignment options with a cross section less than 38 feet received a low performing score (0).

HORIZONTAL CURVATURE

The industry standard[2] for the minimum desired horizontal radius for streetcar tracks is 82 feet. However, depending on the vehicle type being utilized, the radius can be reduced to as little as 50 feet

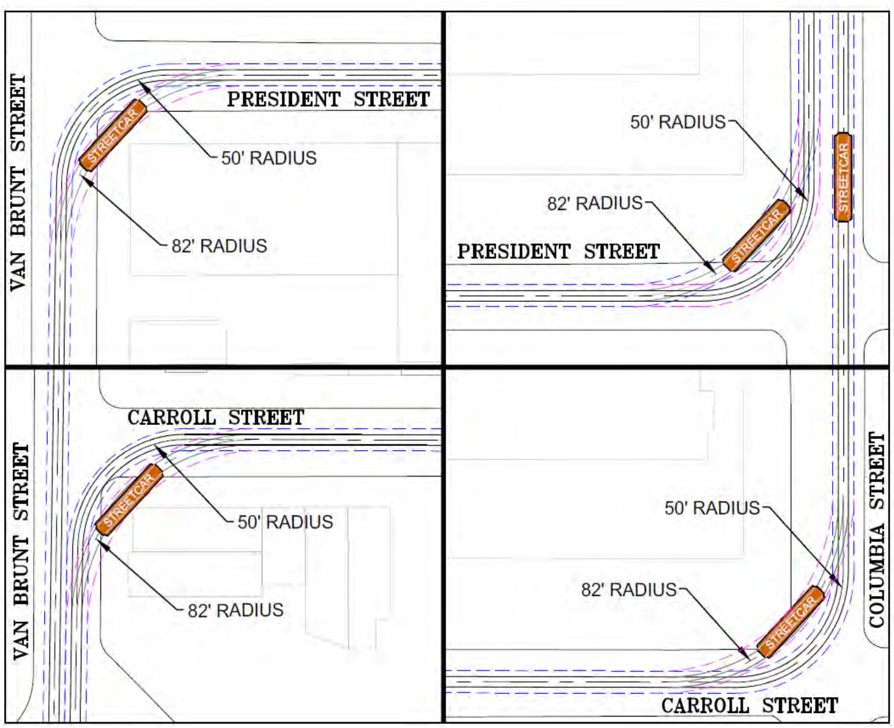
[2] TCRP Report 57 – Track Design Handbook for Light Rail Transit

to accommodate specific field conditions. In addition, horizontal curvature is related to the required operating speeds. At the low operating speeds typically found in mixed traffic service, the radius of the curve is a function of the ability of the vehicle's truck to pivot without encountering physical obstruction in the drive mechanism or car body. On tangent sections (straight track), a curve radius of 600 feet is required to achieve operation speeds of 25 miles per hour.

Based on preliminary investigation in the Study Area, and as reported in the Alignment Evaluation Methodology and Feasibility Considerations Technical Memorandum, the minimum desired horizontal radius of 82 feet would be difficult to achieve in many locations, as the track would infringe on existing sidewalks. For these locations, a turning radius of 50 feet may be necessary to avoid comprehensive intersection reconstruction.

This feasibility consideration impacts various evaluation criteria, including 'Minimizes interference with pedestrian movements', 'Minimizes changes to parking supply', and 'Minimizes property acquisition'. For example, as reported in the Alignment Evaluation Methodology and Feasibility Considerations Technical Memorandum the potential alignment options traveling between Columbia Street and Van Brunt Street (President Street and Carroll Street) would require the streetcar make difficult turns, due to the narrowness of the streets and the small existing corner radii, as shown in Figure 3-1. In order to make this turn, one or two corner on-street parking spaces would need to be removed, and minor curb adjustments would likely be required. As such, this alignment option received a low performing score (0) for the associated evaluation criteria.

Figure 3-1: Horizontal Curvature Considerations on President and Carroll Streets



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MAJOR INFRASTRUCTURE OBSTACLES

As reported in the Alignment Evaluation Methodology and Feasibility Considerations Technical Memorandum, the location of Interstate 278 (I-278) and the Brooklyn Battery Tunnel are important in terms of the constructability of a streetcar line crossing these facilities. Specifically, the Hicks Street conceptual alignment was eliminated due to its proximity to I-278. Based on this preliminary investigation, Columbia Street, which crosses I-278 east of the Brooklyn Battery Tunnel portal, would provide the most feasible option. This feasibility consideration is in accordance with the 'Minimizes infrastructure conflicts' evaluation criteria. Alignment options that would result in minimal infrastructure conflicts received a high performing score (20), and alignment options that would result in greater infrastructure conflicts received a low performing score (0) or (5), depending on the magnitude of the conflict.

STATION PLATFORMS

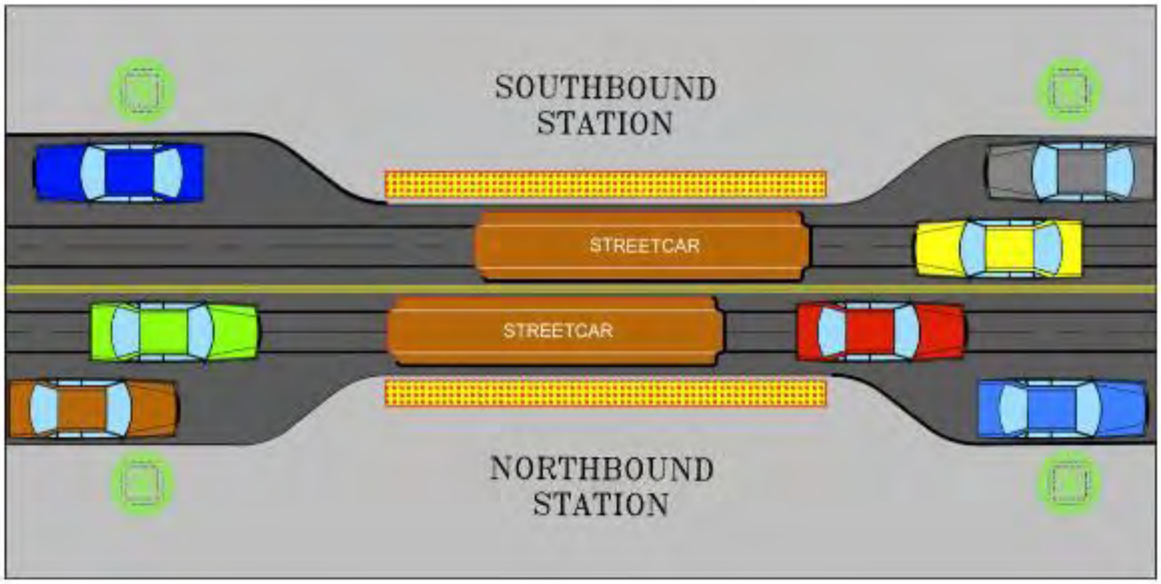
Assuming a typical modern streetcar vehicle, the length of the station platform should be between forty and sixty feet in order to provide platform access to all vehicle doors. The platform is treated as an extension of the curb and sidewalk at intersections with stops, and at a minimum, the width should be eight to 12 feet to allow for good pedestrian circulation and handicap circulation. In addition, the track alignment at the station platform should be tangent with less than a two percent grade.

The typical curb height at stations is between ten and 14 inches, and is dependent to some extent on the vehicle. If the vehicle is not capable of self-leveling, a bridge plate is necessary. The horizontal clearance, between the centerline of the track and the platform edge, should be approximately four feet, and is also dependent on vehicle type. Americans with Disabilities Act (ADA) access and grade requirements must be complied with for all new construction.

Because of the grade differential between the existing standard sidewalk and the desired level platform boarding, sidewalk reconstruction and grading work would be required at each stop. The design concept being examined includes the utilization of a bulb out from the existing sidewalk and curb line into the existing on-street parking lane to allow for platform boarding, as shown in Figure 3-2. This would typically eliminate three or four on-street parking spaces at each stop, in each direction.

Due to the elimination of on-street parking at each stop, this feasibility consideration will impact the following evaluation criteria: 'Minimizes changes to parking supply' and 'Change in curb access'. The removal of on-street parking would be required at most of the potential streetcar stops. However, this would occur regardless of the alignment option selected; and therefore, was not a factor in determining the evaluation criterion score.

Figure 3-2: Typical Streetcar Stop



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VERTICAL CLEARANCE

The minimum vertical clearance from the top of the rail to power supply wire is 13 feet, and the maximum height is 21 feet. Vertical clearance less than 18 feet requires the streetcar to be in an exclusive (no other vehicles) lane, unless a variance from the National Electrical Safety Code (NESC) is obtained. Alignment options with potential vertical clearance conflicts received a low performing score (0 to 5) for the 'Minimizes infrastructure conflicts' evaluation criteria.

3.2 Traffic Planning

TRAFFIC OPERATIONS / SIGNALS

Streetcar operation is flexible and is typically similar to other vehicles in shared lanes using line of sight. As such, no additional traffic signal control is necessary. However, in a typical urban environment, lane arrangements and geometric constraints can require special traffic signal phasing to accommodate some streetcar movements. For example, this occurs when a streetcar in the rightmost lane on a multi-lane street must turn left, crossing through and/or left turning traffic. This is generally handled with an exclusive signal phase and an exclusive streetcar lane, also known as 'queue jump' phasing.

Many cities introduce transit priority movements through detection of the streetcar and the priority service of the streetcar phase, either through a pre-emption system or through a multi-phase actuated signal system; these could be coordinated with transit signal priority systems being implemented for buses elsewhere in the city. This type of priority phasing could be utilized at any of the signalized intersections throughout the route to facilitate streetcar operations.

This feasibility consideration impacts evaluation criteria related to traffic flow 'Minimizes negative impact on traffic flow' and pedestrian movements 'Minimizes interference with pedestrian movements'. Alignment options that would not require any signal modifications received a high performing score (20) for these evaluation criteria. By contrast, alignment options that would require signal modifications received lower performing scores (5 or 0), depending on the degree of the modification.

PARKING AND LOADING

As discussed in the Right-of-Way section, parking lanes should be a minimum of eight feet in width. However, experience in areas where snow can be present indicates that wider parking lanes (up to 11 feet wide) are preferable to accommodate snow piles. This feasibility consideration impacts two evaluation criteria: 'Minimizes changes to parking supply' and 'Minimizes changes to curb access'. Alignment options with parking lanes of 11 feet or more received a high performing score (20) for these evaluation criteria. Similarly, alignment options with parking lanes less than 11 feet, but greater than 8 feet received a mid-performing score (15 or 10), and alignment options with an 8-foot parking lane received a lower performing score (5). Finally, alignment options with less than 8 feet available for parking received a low performing score (0). As detailed in the Right-Of-Way section, alignments that are too narrow to accommodate parking on both sides of the street also receive a low performing score (0) for these criteria.

BICYCLE INTEGRATION

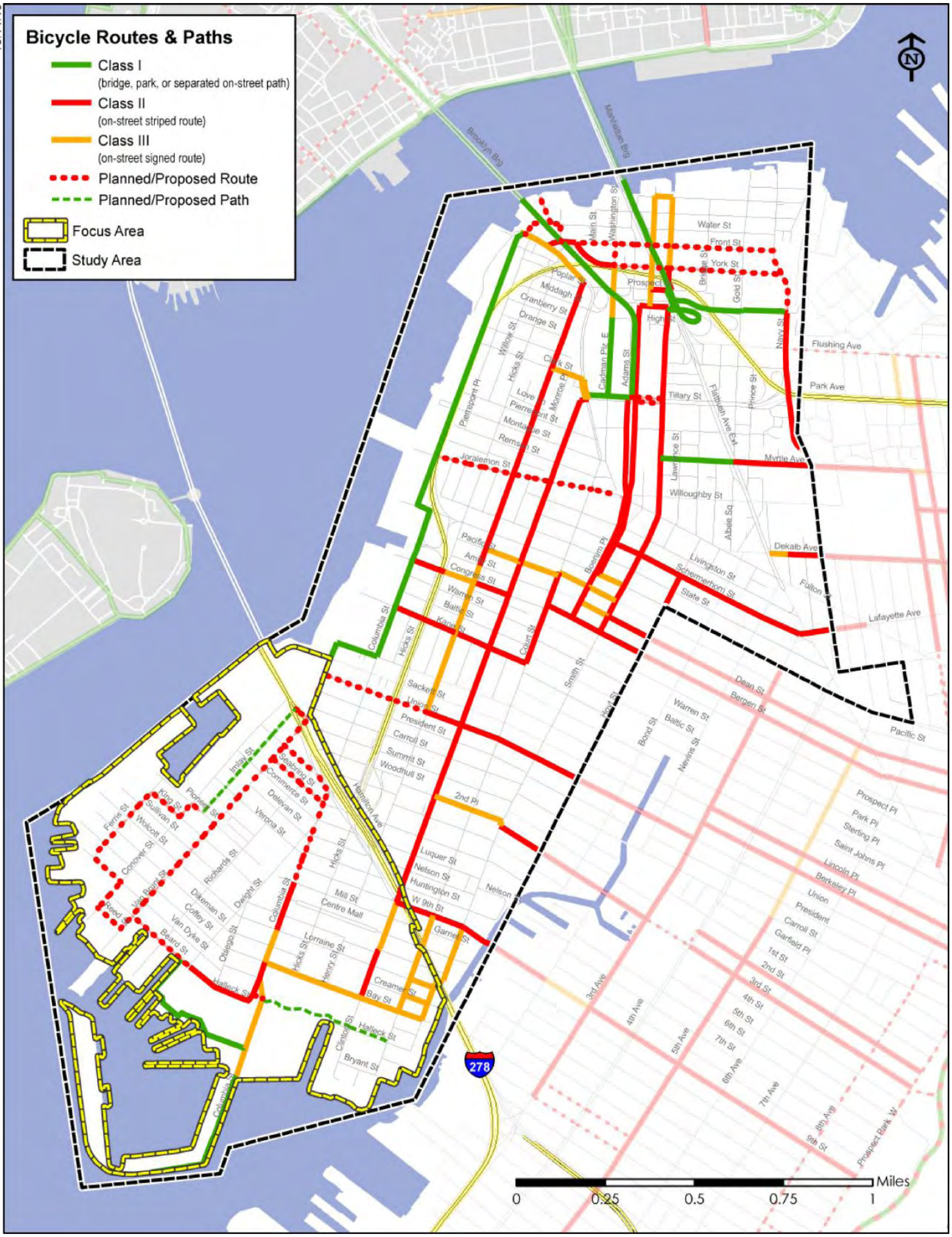
Bicycle integration comprises two components: whether the streetcar interferes with existing or planned bikeways; and whether the streetcar impacts the cyclist's safety. Figure 3-3 shows the designated bike routes and lanes within the Focus Area and Study Area. As reported in the Existing Conditions Report, bicycle routes crisscross the Study Area. In the Focus Area, Class II bike routes or Class III bike paths are provided along Bay Street, Creamer Street, Lorraine Street, and West 9th Street. Alignment options that conflict with the existing or planned bicycle routes and paths received a low performing score (0 or 5) for 'Minimizes interference with existing/planned bikeways/Greenways'.

Streetcar systems can experience safety issues with bicycle integration, as reported in the Case Study Report. Bicycle wheels and tires are susceptible to getting caught within the gap of the streetcar track flange. Specifically, this situation occurs when a bicyclist is required to cross the tracks at less than a 60-degree angle. When a track 'catches' a wheel, a bicyclist may be thrown from their bicycle. To decrease the number of accidents, streetcar infrastructure should be designed to eliminate crossings with less than 60-degree crossing angles and be designed with as close to 90-degree crossings as possible.

In addition, right-side running tracks and streetcar track curves may create instances where a bicyclist riding in the right lane chooses to cross the tracks at an angle less than 60 degrees. This configuration can lead to accidents. Center-running and left-running tracks are typically safer scenarios for bicyclists, as they avoid many of the conflicts between side running streetcars and parallel bike tracks. Signs and pavement markings can be used to assist cyclists in maneuvering around track curves at safe angles. Alignment options with 60-degree or less crossing angles received a low performing score (0 or 5) for 'Minimizes impacts to bicyclist safety'.

Figure 3-3: Bicycle Routes and Paths

10.14.10



3.3 Constructability

The constructability of a future streetcar is related to two evaluation criteria ‘Shorter construction duration’ and ‘Lower construction costs’. Alignment options with identified infrastructure or utility conflicts or longer alignment options would incur longer construction durations and consequently, greater costs. As such, these alignment options received a low performing score (0 or 5, depending on the construction impact).

PROPOSED METHODOLOGY

As described in the Case Study Report, both Portland and Seattle instituted a shallow track, single pour construction system that minimized excavation and expedited construction. Shallow slab construction would be preferable to operate a streetcar in the existing streets in Brooklyn, compared to light rail full-depth construction. As such, the alignment options developed for this phase of the feasibility study considered minimal roadway reconstruction related to utility relocation.

Following preliminary and final design of the streetcar alignment and stations, the typical construction sequence for shallow slab streetcar track construction is as follows:

1. Construction would begin with the relocation or adjustments to any private and public utility lines, manholes or structures. (Utilities are discussed in greater detail on page 3-18.)
2. The roadway pavement would be excavated to a depth of roughly 18 inches and the subgrade would be fine graded for the track slab.
3. Track drains would be installed and tied into the existing storm system.
4. Rails that have been welded at an off-site staging area would be pulled into place and set to grade, and reinforcing steel would be placed and tied.
5. The track slab concrete would be poured, finished, and cured.
6. The adjacent asphalt pavement would be milled and overlaid to the proper cross slope to restore the driving surface.
7. Following the track construction, the foundations, poles, hardware, electrical distribution system, communications equipment, overhead contact wiring, and systems for new traffic signals would be installed.
8. The construction of the streetcar station stops, fare collection devices, installation of signage, and application of pavement markings would complete the system.

In all, the major construction activities for track and roadway modifications would require approximately four weeks to complete 600 to 800 feet of track. In general, construction activities would occur during daytime hours (i.e., 7:00 AM to 7:00 PM), and all work would comply with the City of New York’s Noise Ordinance, which would likely require major noise-generating work, such as rail grinding and jack-hammering, to occur outside of late-night hours. Any nighttime construction would require and conform to a noise variance to be obtained by the project from the City of New York. All construction work would be performed in full coordination with other city agencies and would comply with all applicable safety requirements.

ENVIRONMENTAL CONSIDERATIONS

The evaluation criteria focused on construction duration and cost. However, based on the construction methodology described above, there are short-term environmental consequences that could result from construction activities of a future Brooklyn streetcar. Construction impacts would be further analyzed if the project progresses and an Alternatives Analysis and environmental review are prepared. These short-term environmental consequences include the following categories:

- Transit – DOT would coordinate with NYCT to notify riders of detours and closed/temporary bus stops related to construction.
- Traffic – at least one travel lane would be maintained in each direction at all times, and truck routes would not be eliminated during construction, but could be maintained temporarily on alternate routes (truck detour signs would be provided as necessary).
- Land Use and Socio-economic – typical construction best management practices would be employed to avoid or minimize adverse economic consequences to occupants, such as avoiding full access closures, providing temporary alternate access and signage, and timely communications with business owners.
- Neighborhoods and Community – construction would utilize standard industry practices to avoid or minimize increasing noise, the creation of dust, establishing construction zones and signage, altering or reducing access and establishing detours, and temporarily disrupting utilities as they are relocated or reinforced.
- Noise – construction would comply with the New York City Noise Ordinance, which defines hours for construction related noise.
- Air Quality – construction contractors would be required to use reasonable measures to control fugitive dust.
- Visual and Aesthetic Resources – due to their temporary nature and due to the fact that construction is a common visual element in New York City, visual impacts related to a future Brooklyn streetcar would be classified as low to moderate.
- Historic, Archaeological and Cultural Resources – unknown archaeological or cultural resources potentially encountered during construction would be protected from any adverse effect by taking some or all of the following actions, in compliance with Federal and state regulations: notification to and consultations with regulatory agencies and/or tribes; temporary work stoppage at the site; additional surveying and/or documentation; removal and preservation; other actions as appropriate.
- Parklands and Recreation Areas – temporary noise and dust related to streetcar construction is not expected to negatively affect use of nearby parks and recreation areas during the construction period.
- Hazardous Materials – prior to construction of a future Brooklyn streetcar, a Phase I (and potentially Phase II) Environmental Site Assessment (ESA) would be prepared and remedial actions would be identified, if necessary.
- Biological Resources and Endangered Species – no effect to listed aquatic species and their designated critical habitat would be expected because project activities would implement construction containment plans and BMPs.
- Water Resources – construction effects on water quality from a future Brooklyn streetcar would be negligible, as construction would follow New York City's *Erosion and Sediment Control Code*.

PAVEMENT TYPE

Some Red Hook streets would require more extensive reconstruction due to the existing street material. For example, the alignment option on Beard Street would be considered full roadway reconstruction, since the existing road is cobblestone, as shown in Figure 3-4. This would require extensive reconstruction and grading in order to build the track slab and running rail. This feasibility consideration impacts both evaluation criteria related to construction, as discussed above. Alignment options that would require more extensive reconstruction received lower performing scores (0 or 5) for the 'Shorter construction duration' and 'Lower construction costs' evaluation criteri a.

Figure 3-4: Typical Cobblestone Street in Red Hook

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UTILITIES

Utility clearance requirements should be established with input from the local agencies and utility companies during the early stages of design. For new construction, a utility-free zone within nine to twenty feet from the track centerline to any parallel utility is considered to be ideal. However, in most instances of construction in existing streets, the need to revise infrastructure is related to the functional needs of the individual utility companies and the municipalities involved. As discussed in the Case Study Report, in both Portland and Seattle, utility coordination was critical to successful design and operations. In both cases, utility conflicts significantly increased the cost of the project.

There are several types of utility conflicts that should be resolved during the design stage of a future Brooklyn streetcar. These include:

- Parallel utility conflicts, where utilities may be too shallow to permit them to stay in place, or where the utility may be restricted due to the need to operate under the streetcar line;
- Crossings (such as water), which are typically sleeved, or the pipe is replaced with another, non-conductive material;
- Surface conflicts where access structures, manholes, valves, etc. are in physical conflict with the streetcar tracks; and
- Deep parallel utilities, which would not typically need to be relocated.

Alignment options that would not result in utility conflicts received a high performing score (20), and alignment options that would result in utility conflicts received a low performing score (0 or 5), depending on the degree of conflict.

CONCLUSION

The feasibility considerations discussed will be factored into the Alignment Options Evaluation. However, in addition to helping identify the best alternative, these considerations will also inform the policy decision of whether any alignment in Red Hook is advisable for the city to pursue at this time, based on financial constraints and competing needs. Facts identified, such as right-of-way constraints, parking impacts, and bicycle impacts, would create challenges regardless of which optimal alignment is chosen. Other considerations, such as utility relocations, would impact expected costs (see section 6.0).

4.0 ALIGNMENT OPTIONS EVALUATION

This section presents the results of the evaluation of alignment options. Using the developed evaluation criteria described in section 2.0, and taking into account the streetcar feasibility considerations outlined in section 3.0, the alignment options were assigned scores for each evaluation criteria. Based on these scores, the alignment options were then compared to determine the optimal alignment option.

4.1 Focus Area East

Focus Area East includes two alignment options: Centre Street and Lorraine Street. Both alignment options extend from Columbia Street to Clinton Street. The results of the evaluation criteria ranking for these alignment options are shown in Table 4-1.

Table 4-1:
Focus Area East Evaluation Results

EVALUATION CRITERIA	CENTRE STREET	LORRAINE STREET	REASON FOR DIFFERENCE
IMPROVE TRANSPORTATION MOBILITY			
Provide transit accessibility			
Population within 1/3–mile of streetcar alignment	◔	◔	
Employment within 1/3–mile of streetcar alignment	◑	◑	
Activity centers within 1/3-mile of streetcar alignment	◑	◑	
Improve travel time			
Trip time savings to and from various trip-generators	◑	◑	
Provide intermodal connections			
Provides bus connections	○	○	
Provides subway connections	◕	◕	
Enhance pedestrian movements			
Minimizes interference with pedestrian movements	◑	◑	
Affect pedestrian space	◔	◕	*Centre Street – reduction in pedestrian space (Pedestrian Mall)*
Accommodate bikeways			
Minimizes interference with existing/planned bikeways/Greenways	◑	◑	
Minimizes impacts to bicyclist safety	◑	◑	

Table 4-1:
Focus Area East Evaluation Results

EVALUATION CRITERIA	CENTRE STREET	LORRAINE STREET	REASON FOR DIFFERENCE
PROVIDE ECONOMIC OPPORTUNITY AND INVESTMENT AND ENHANCE THE COMMUNITY CHARACTER			
Serve proposed/projected development			
Proposed developments with 1/3-mile of alignment	◕	◕	
Minimizes changes to parking supply	◑	○	*Lorraine Street – reduction in parking supply*
Support neighborhood and local business community sentiments			
Amount of streetcar support/opposition	N/A	N/A	
MAINTAIN TRAFFIC AND DELIVERY ACCESS			
Maintain curb access			
Change in curb access (linear feet)	◑	◑	
Maintain access to Red Hook's arterial roadways			
Minimizes vehicle restrictions to access Red Hook's Arterial roadways and Brooklyn highways	◑	◑	
Maintain truck access to local and through truck routes	◑	◑	
MINIMIZE ADVERSE IMPACTS ON THE BUILT AND NATURAL ENVIRONMENT			
Minimize adverse impacts to historical resources			
Minimizes visual impacts to historic resources	◑	◑	
Minimizes historic property acquisition	◑	◑	
Minimize property acquisition			
Minimizes property acquisition	◔	◑	*Centre Street – increased property acquisition due to transitway conversion*
Minimize impacts to natural features/resources and coastal waters			
Minimizes interference with parkland or coastal waters	◑	◑	
Minimize negative impact on traffic flow			
Minimizes negative impact on traffic flow	◔	◔	

Table 4-1:
Focus Area East Evaluation Results

EVALUATION CRITERIA	CENTRE STREET	LORRAINE STREET	REASON FOR DIFFERENCE
MINIMIZE STREETCAR CAPITAL AND OPERATING COSTS AND IMPACT			
Implement within a reasonable construction timeframe and cost			
Shorter construction duration	◕	◑	*Centre Street – greater flexibility during construction due to reduced vehicular conflicts*
Lower construction cost	◕	◑	*Centre Street – greater flexibility during construction due to reduced vehicular conflicts*
Avoid conflicts with existing or proposed infrastructure			
Minimizes infrastructure conflicts	◕	◑	*Centre Street – less infrastructure conflicts and horizontal curvature issues*
Avoid or minimize utility relocation			
Minimizes utility conflicts	◕	◑	*Centre Street – greater flexibility to avoid utility conflicts*
Maintain access to utilities	◕	◑	*Centre Street – greater flexibility to avoid utility conflicts*
TOTAL SCORE	255	235	

Scoring Key:

●	◕	◑	◔	○
20	15	10	5	0

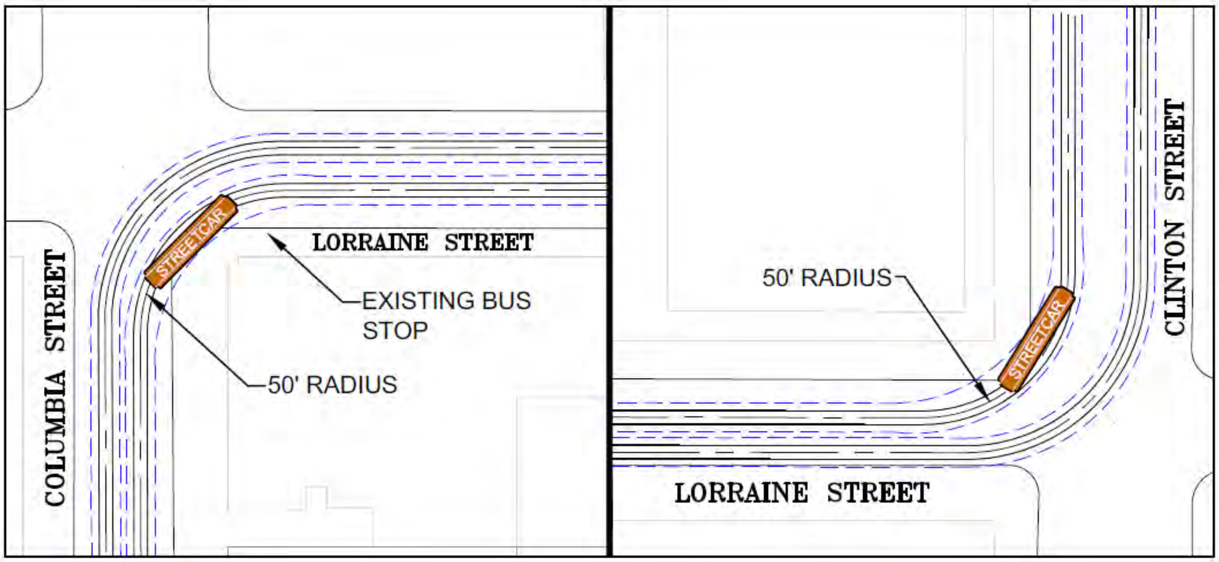
Both Focus Area East alignment options have horizontal curvature considerations. These considerations are listed below and shown in Figure 4-2:

- Court Street at West 9th Street – curb conflict at the northeast corner;
- Garnet Street at Smith Street – curb conflict and potential building conflict at the southwest corner;
- Clinton Street at Mill Street – curb conflict and potential building conflict at the southwest corner; and
- West 9th Street at Gowanus Expressway – potential conflict with viaduct columns.[3]

For example, a 50-foot radius would be necessary for the turns to and from Lorraine Street to avoid property acquisition, as shown in Figure 4-1.

[3] This potential conflict is based on GIS data and approximate location of viaduct columns. This conflict would be resolved during the design phase.

Figure 4-1: Horizontal Curvature Considerations on Lorraine Streets



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In addition to horizontal curvature, traffic operation considerations for both alignment options are listed below and shown in Figure 4-2.

- An additional signal phase would likely be necessary at the Smith Street and West 9th Street intersection in order to handle the streetcar traffic exiting the new terminal at this location.
- Crossing under the Gowanus Expressway would require signal modification where the potential alignment crosses Hamilton Avenue. This is due to the alignment of the streetcar through the columns that support the Gowanus Expressway above Hamilton Avenue. Currently no signal exists at Mill Street/Garnet Street and Hamilton Avenue, as there is no vehicular crossing. In addition, signal timing modifications could be necessary at West 9th and Hamilton Avenue.

Both Focus Area East alignment options would potentially conflict with the Class II bike route on West 9th Street, particularly at the streetcar station stop locations. To integrate these two modes, the bike route could be relocated around the stop, taking some of the sidewalk space. This solution has been successfully implemented in Portland and shown in Figure 4-3.

Figure 4-2: Focus Area East Feasibility Considerations

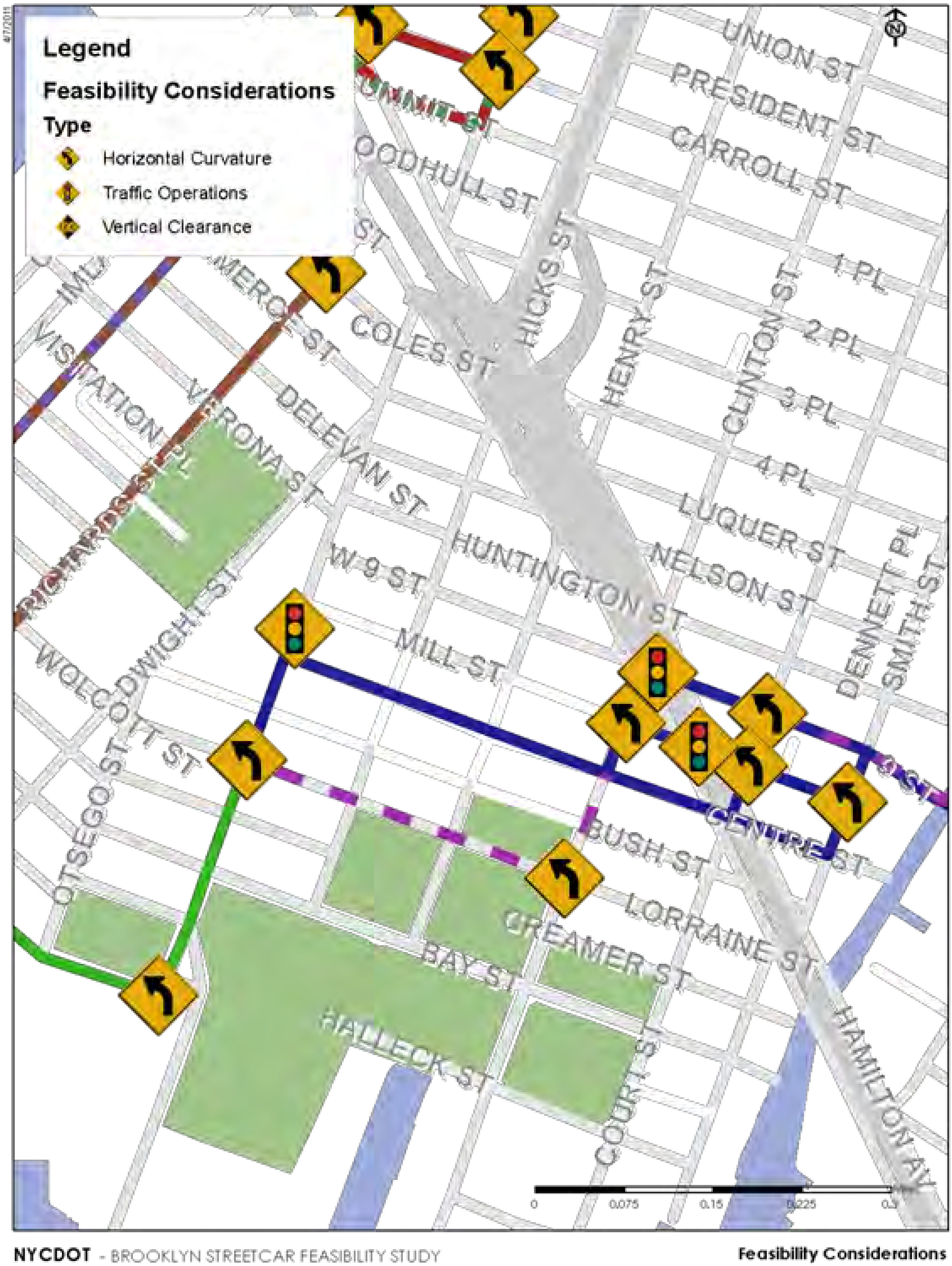

Figure 4-3: Portland Bike Integration

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Another potential bicycle conflict would occur when the dedicated lane converts to sharrows (or shared-lane markings, as shown in Figure 4-4) along the south section of Columbia Street, between Halleck Street and Creamer Street. In order to integrate a future streetcar with the existing bicycle use along this alignment, the on-street parking lane could be removed from Bay Street to Lorraine Street and a buffered curbside bike lane would run adjacent to the streetcar track, as shown in Figure 4-5.

Figure 4-4: Typical Shared-lane Marking (Sharrow) along Bay Street

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Figure 4-5: Bicycle Integration along Columbia Street

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In addition to the feasibility considerations described above, the Centre Street and Lorraine Street alignment options have feasibility considerations that are unique to the individual alignment option. These are described below. Similarly, the Centre Street alignment option has certain advantages, which further affect the evaluation criteria rating.

CENTRE STREET

For this alignment option, a signal warrant analysis would need to be conducted at the intersections with Clinton Street and Columbia Street. In addition, pedestrian space would be affected, as Centre Street is currently a pedestrian-only mall. With the addition of a streetcar, some pedestrian space would be replaced by streetcar track. However, adjacent pedestrian space would remain on both sides of the streetcar alignment. The existing pedestrian mall along Centre Street would have to be reclaimed from the New York City Housing Authority, further reducing the score for this alternative, due to property acquisition issues. However, as an advantage, construction along Centre Street would result in shorter duration and lower costs, as there is no existing vehicular traffic using the area. Initial study outreach to the Red Hook East and West Tenants' Associations has resulted in local concerns about the impacts of a streetcar in the Centre Mall. If this option were to be pursued, further discussions with the residential stakeholders would take place.

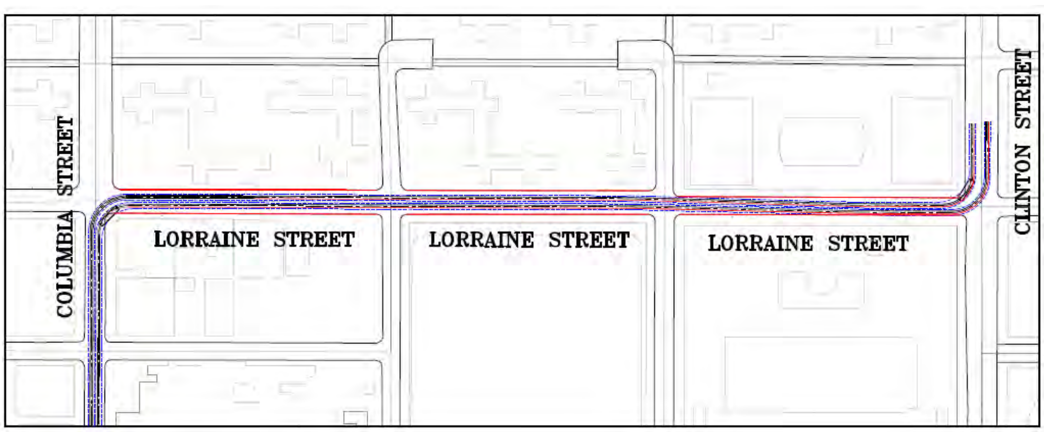
LORRAINE STREET

In addition to the horizontal curvature considerations described above, the Lorraine Street alignment has potential conflicts at the following locations:

- Columbia Street at Lorraine Street – curb conflict and potential building conflict at the southeast corner; and
- Lorraine Street at Clinton Street – curb conflict and potential building conflict at the northwest corner.

Moreover, the right-of-way along Lorraine Street is narrow (thirty feet), which would require either the removal of on-street parking or the reduction of sidewalk space, as shown in Figure 4-6. This in turn, could potentially reduce access to the curb, impacting delivery loading and unloading.

Figure 4-6: On-Street Parking Removal on Lorraine Street



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Based on the evaluation of the Focus Area East alignment options, the Centre Street option resulted in a total score of 255 and the Lorraine Street option resulted in a total score of 235. Although the Centre Street option would affect pedestrian space and result in property acquisition, the Lorraine Street option would result in a reduction in the parking supply, longer construction duration, increased construction-related costs, and reduced flexibility to avoid utility conflicts. This results in a higher ranking for the Centre Street alignment option.

4.2 Focus Area West

Focus Area West includes two alignment options extending from Beard Street to Columbia Street: a two-way track on Van Brunt Street and a one-way track traveling southbound on Van Brunt Street with a one-way track traveling northbound on Richards Street. The results of the evaluation criteria ranking for these alignment options are shown in Table 4-2.

Table 4-2:
Focus Area West Evaluation Results

EVALUATION CRITERIA	VAN BRUNT STREET	VAN BRUNT STREET / RICHARDS STREET	REASON FOR DIFFERENCE
IMPROVE TRANSPORTATION MOBILITY			
Provide transit accessibility			
Population within 1/3–mile of streetcar alignment	◔	◔	
Employment within 1/3–mile of streetcar alignment	◔	◔	
Activity centers within 1/3-mile of streetcar alignment	○	○	
Improve travel time			
Trip time savings to and from various trip-generators	◑	◑	
Provide intermodal connections			
Provides bus connections	○	○	
Provides subway connections	○	○	
Enhance pedestrian movements			
Minimizes interference with pedestrian movements	◑	◑	
Affect pedestrian space	◔	◔	
Accommodate bikeways			
Minimizes interference with existing/planned bikeways/Greenways	◑	◑	
Minimizes impacts to bicyclist safety	◑	◑	

Table 4-2:
Focus Area West Evaluation Results

EVALUATION CRITERIA	VAN BRUNT STREET	VAN BRUNT STREET / RICHARDS STREET	REASON FOR DIFFERENCE
PROVIDE ECONOMIC OPPORTUNITY AND INVESTMENT AND ENHANCE THE COMMUNITY CHARACTER			
Serve proposed/projected development			
Proposed developments with 1/3-mile of alignment	◑	◑	
Minimizes changes to parking supply	◔	◑	*Van Brunt Street – reduction in parking supply*
Support neighborhood and local business community sentiments			
Amount of streetcar support/opposition	N/A	N/A	
MAINTAIN TRAFFIC AND DELIVERY ACCESS			
Maintain curb access			
Change in curb access (linear feet)	◑	◔	*Richards Street – increased curb conflict*
Maintain access to Red Hook's arterial roadways			
Minimizes vehicle restrictions to access Red Hook's Arterial roadways and Brooklyn highways	◑	◑	
Maintain truck access to local and through truck routes	◑	◑	
MINIMIZE ADVERSE IMPACTS ON THE BUILT AND NATURAL ENVIRONMENT			
Minimize adverse impacts to historical resources			
Minimizes visual impacts to historic resources	◑	◑	
Minimizes historic property acquisition	◑	◑	
Minimize property acquisition			
Minimizes property acquisition	◑	◑	
Minimize impacts to natural features/resources and coastal waters			
Minimizes interference with parkland or coastal waters	◑	◑	
Minimize negative impact on traffic flow			
Minimizes negative impact on traffic flow	◑	◔	*Richards Street – traffic direction would be reversed*

Table 4-2:
Focus Area West Evaluation Results

EVALUATION CRITERIA	VAN BRUNT STREET	VAN BRUNT STREET / RICHARDS STREET	REASON FOR DIFFERENCE
MINIMIZE STREETCAR CAPITAL AND OPERATING COSTS AND IMPACT			
Implement within a reasonable construction timeframe and cost			
Shorter construction duration	◕	◑	*Van Brunt Street / Richards Street – construction along two streets*
Lower construction cost	◕	◑	*Van Brunt Street / Richards Street – construction along two streets*
Avoid conflicts with existing or proposed infrastructure			
Minimizes infrastructure conflicts	◑	◑	
Avoid or minimize utility relocation			
Minimizes utility conflicts	◔	◑	*Van Brunt Street / Richards Street – greater flexibility with track placement of one-way tracks*
Maintain access to utilities	◔	◑	*Van Brunt Street / Richards Street – greater flexibility with track placement of one-way tracks*
TOTAL SCORE	200	195	

Scoring Key:

●	◕	◑	◔	○
20	15	10	5	0

Both alignment options along this corridor would be impacted by the proposed bike lanes in the New York City Bicycle Master Plan. A Class II bike lane is proposed for Van Brunt Street, although DOT has no immediate plans to implement the lane. As such, for either option, on-street parking would need to be removed from both the east and west sides of the street to introduce a Class II bike lane. Alternatively, the proposed Class II bike route could be implemented on another street. Based on preliminary investigation of Van Brunt's street width, the latter option would be recommended, as a Class II bike lane would be difficult to integrate into the existing traffic pattern.

VAN BRUNT STREET

The two-way Van Brunt Street alignment option has one horizontal curvature consideration, as listed below and shown in Figure 4-7:

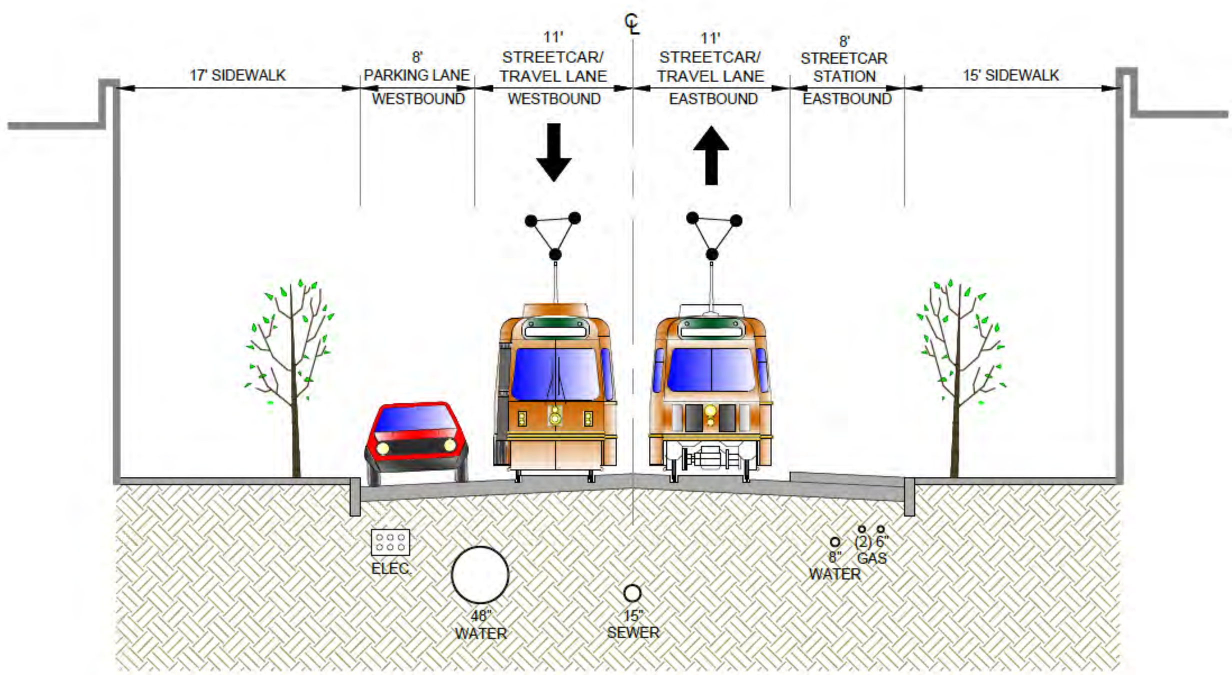
Figure 4-7: Focus Area West Feasibility Considerations

- Van Brunt Street at Beard Street – curb conflict and potential building conflict at the northeast corner.

In addition, because this alignment option is a two-way streetcar track, the existing right-of-way along Van Brunt Street would require eight foot parking lanes or a reduction in sidewalk space to accommodate the space for the streetcar track. Leaving only eight feet for parking could potentially reduce access to the curb, which could further impact delivery loading and unloading. Moreover, narrow right-of-ways could impact streetcar operations when delivery trucks (or other vehicles) double park and block the streetcar track right-of-way.

Utility concerns along Van Brunt Street include a 48-inch water main running parallel to the southbound track alignment. According to the information provided, there are no shallow private utilities along the Van Brunt Street that would need to be relocated. Figure 4-8 shows the approximate location of the utilities.

Figure 4-8: Typical Cross Section along Van Brunt Street (at Hamilton Avenue)



Not to scale
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VAN BRUNT STREET / RICHARDS STREET

The increased number of turns required for the Van Brunt Street / Richards Street couplet increases the number of curb conflicts for this alignment option. Horizontal curvature considerations for the Van Brunt Street / Richards Street alignment option are listed below and shown in Figure 4-7:

- Richards Street at Beard Street – curb conflict and potential building conflict at the northeast corner;

- Richards Street at Van Dyke Street – curb conflict and potential building conflict at the northeast and southwest corners;
- Richards Street at Seabring Street – curb conflict and potential building conflict at the southwest corner; and
- Richards Street at Van Brunt Street – curb conflict and potential building conflict at the northeast corner.

This alignment option would also have to address some of the utility conflicts along Van Brunt Street. However, greater flexibility would be available for streetcar track placement as only a one-way southbound track would be placed on Van Brunt Street. Similarly, there would be limited impact to the curb access as the existing roadway cross-section would not require the modification necessary for the Van Brunt Street alignment option. One-way couplet tracks do have some drawbacks, however. The construction duration would be longer for this alignment option and costs would be higher, as this alignment option would require two street shutdowns.

Based on the evaluation of the Focus Area West alignment options, the Van Brunt Street option resulted in a total score of 200 and the Van Brunt / Richards Street option resulted in a total score of 195. Although the Van Brunt Street option would result in a reduction to the parking supply, the Van Brunt / Richards Street option would result in curb conflicts along Richards Street and impacts to the traffic flow. Similarly, although the Van Brunt Street option could result in more utility conflicts, the Van Brunt Street / Richards Street option would result in a longer construction duration and increased construction-related costs, as this option would require one way track construction on two streets, as opposed to two way track construction on only Van Brunt Street. This results in a higher ranking for the Van Brunt Street alignment option.

4.3 Middle Section

The Middle Section includes two alignment options to connect Columbia Street and Van Brunt Street: President and Carroll Streets and Summit Street. The results of the evaluation criteria ranking for these alignment options are shown in Table 4-3.

Table 4-3:
Middle Section Evaluation Results

EVALUATION CRITERIA	COLUMBIA STREET / PRESIDENT STREET AND CARROLL STREET	COLUMBIA STREET / SUMMIT STREET	REASON FOR DIFFERENCE
IMPROVE TRANSPORTATION MOBILITY			
Provide transit accessibility			
Population within 1/3–mile of streetcar alignment	◑	◑	
Employment within 1/3–mile of streetcar alignment	◔	◔	
Activity centers within 1/3-mile of streetcar alignment	○	○	
Improve travel time			

Table 4-3:
Middle Section Evaluation Results

EVALUATION CRITERIA	COLUMBIA STREET / PRESIDENT STREET AND CARROLL STREET	COLUMBIA STREET / SUMMIT STREET	REASON FOR DIFFERENCE
Trip time savings to and from various trip-generators	◐	◐	
Provide intermodal connections			
Provides bus connections	○	○	
Provides subway connections	○	○	
Enhance pedestrian movements			
Minimizes interference with pedestrian movements	◔	◔	
Affect pedestrian space	◔	◔	
Accommodate bikeways			
Minimizes interference with existing/planned bikeways/Greenways	◐	◐	
Minimizes impacts to bicyclist safety	◐	◐	
PROVIDE ECONOMIC OPPORTUNITY AND INVESTMENT AND ENHANCE THE COMMUNITY CHARACTER			
Serve proposed/projected development			
Proposed developments with 1/3-mile of alignment	◔	◔	
Minimizes changes to parking supply	◐	◔	*Summit Street – reduction in parking supply*
Support neighborhood and local business community sentiments			
Amount of streetcar support/opposition	N/A	N/A	
MAINTAIN TRAFFIC AND DELIVERY ACCESS			
Maintain curb access			
Change in curb access (linear feet)	◐	◔	*Summit Street – Reduction in curb access*
Maintain access to Red Hook's arterial roadways			
Minimizes vehicle restrictions to access Red Hook's Arterial roadways and Brooklyn highways	◐	◐	
Maintain truck access to local and through truck routes	◐	◐	

Table 4-3:
Middle Section Evaluation Results

EVALUATION CRITERIA	COLUMBIA STREET / PRESIDENT STREET AND CARROLL STREET	COLUMBIA STREET / SUMMIT STREET	REASON FOR DIFFERENCE
MINIMIZE ADVERSE IMPACTS ON THE BUILT AND NATURAL ENVIRONMENT			
Minimize adverse impacts to historical resources			
Minimizes visual impacts to historic resources	◑	◑	
Minimizes historic property acquisition	◑	◑	
Minimize property acquisition			
Minimizes property acquisition	◑	◑	
Minimize impacts to natural features/resources and coastal waters			
Minimizes interference with parkland or coastal waters	◑	◑	
Minimize negative impact on traffic flow			
Minimizes negative impact on traffic flow	◑	◔	*Summit Street – introduction of vehicle restrictions*
MINIMIZE STREETCAR CAPITAL AND OPERATING COSTS AND IMPACT			
Implement within a reasonable construction timeframe and cost			
Shorter construction duration	◑	◕	*President Street / Carroll Street – construction along two streets*
Lower construction cost	◔	◑	*President Street / Carroll Street – construction along two streets*
Avoid conflicts with existing or proposed infrastructure			
Minimizes infrastructure conflicts	◑	◑	
Avoid or minimize utility relocation			
Minimizes utility conflicts	◑	◑	
Maintain access to utilities	◑	◑	
TOTAL SCORE	195	190	

Scoring Key:

●	◕	◑	◔	○
20	15	10	5	0

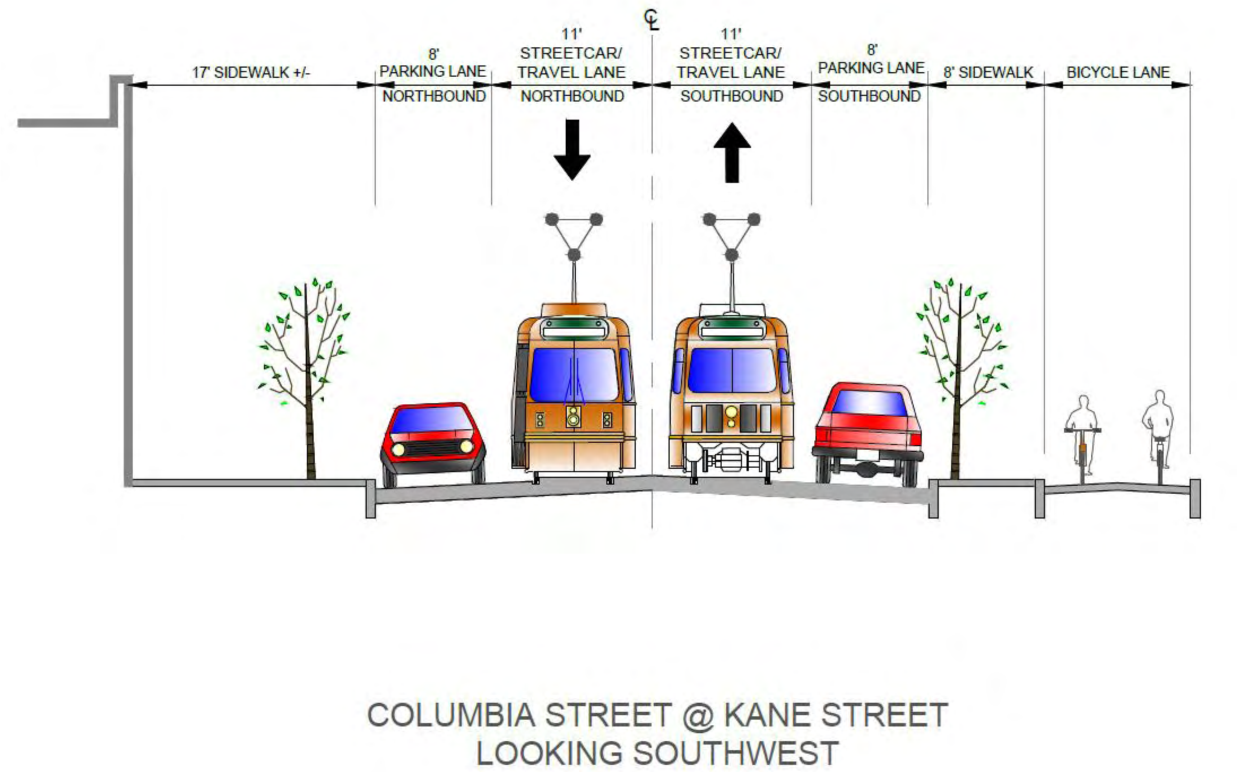
Both alignment options have horizontal curvature considerations. These considerations are shown in Figure 4-9 and listed on the following page:

- Columbia Street at President Street – curb conflict at the northeast corner;
- Columbia Street at Carroll Street – curb conflict at the northeast corner;
- President Street at Van Brunt Street – curb conflict and potential building conflict at the southwest corner; and
- Carroll Street at Van Brunt Street – curb conflict and potential building conflict at the southwest corner.

Figure 4-9: Middle Section Feasibility Considerations

A future streetcar would integrate with the separated bicycle path along Columbia Street, as shown in Figure 4-10.

Figure 4-10: Bicycle Integration



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COLUMBIA STREET / PRESIDENT STREET AND CARROLL STREET

This alignment option would have limited impact to the curb access as the existing roadway cross-section would not require the modification necessary for the two-way Columbia Street / Summit Street alignment option. As previously discussed, one-way couplet tracks do have some operational drawbacks. The construction duration would be longer for this alignment option and costs would be higher, as this alignment option would require two street shutdowns. However, President Street and Carroll Street are both short blocks (approximately 630 feet), and construction impacts would be of a short duration with limited traffic flow impacts.

COLUMBIA STREET / SUMMIT STREET

The Columbia Street / Summit Street two-way track would require more right-of-way for streetcar track placement. This would impact on-street parking, as well as curb access. In addition, the Van Brunt Street, Hamilton Street, and Summit Street intersection would require geometric changes and signal modification, and would also require Summit Street to be converted to two-way operation.

Based on the evaluation of the Middle Section alignment options, the Columbia Street / President Street and Carroll Street option resulted in a total score of 195 and the Columbia Street / Summit Street option resulted in a total score of 190. Although the Columbia Street / President Street and Carroll Street option would result in a longer construction duration and increased construction-related costs, the Columbia Street / Summit Street option would result in a reduction in the parking supply and curbside access and impact traffic flow. This results in a higher ranking for the Columbia Street / President Street and Carroll Street option.

4.4 Northern Section

The Northern Section includes three alignment options: Atlantic Avenue, Borough Hall (two-way on Boerum Place), and Borough Hall Boerum Place/Court Street Loop. The Atlantic Avenue alignment option extends along Atlantic Avenue from Columbia Street to Flatbush Avenue. The Borough Hall alignment options extend along Atlantic Avenue from Columbia Street to Boerum Place into Downtown Brooklyn. The Borough Hall / Boerum Place alignment option is a two-way streetcar track, while the Borough Hall / Boerum Place and Court Street alignment option is a one-way loop streetcar track. The evaluation criteria ranking for these alignment options are shown in Table 4-4.

Table 4-4:
Northern Section Evaluation Results

EVALUATION CRITERIA	ATLANTIC AVENUE	BOROUGH HALL / BOERUM PLACE	BOROUGH HALL / BOERUM PLACE AND COURT STREET	REASON FOR DIFFERENCE
IMPROVE TRANSPORTATION MOBILITY				
Provide transit accessibility				
Population within 1/3–mile of streetcar alignment	◕	◕	◕	
Employment within 1/3–mile of streetcar alignment	●	●	●	
Activity centers within 1/3-mile of streetcar alignment	◑	◑	◑	
Improve travel time				
Trip time savings to and from various trip-generators	◔	◑	◑	*Atlantic Avenue – existing congestion would result in delays*
Provide intermodal connections				
Provides bus connections	●	●	●	
Provides subway connections	●	●	●	
Enhance pedestrian movements				
Minimizes interference with pedestrian movements	◑	◑	◑	

Table 4-4:
Northern Section Evaluation Results

Evaluation Criteria	Atlantic Avenue	Borough Hall / Boerum Place	Borough Hall / Boerum Place and Court Street	Reason for Difference
Affect pedestrian space	◑	◔	◑	*Borough Hall / Boerum Place – reduction in pedestrian space*
Accommodate bikeways				
Minimizes interference with existing/planned bikeways/Greenways	◑	◑	◑	
Minimizes impacts to bicyclist safety	◑	◑	◑	
PROVIDE ECONOMIC OPPORTUNITY AND INVESTMENT AND ENHANCE THE COMMUNITY CHARACTER				
Serve proposed/projected development				
Proposed developments with 1/3-mile of alignment	◔	○	○	*Atlantic Avenue – Atlantic Yards development*
Minimizes changes to parking supply	◑	◑	◑	
Support neighborhood and local business community sentiments				
Amount of streetcar support/opposition	N/A	N/A		
MAINTAIN TRAFFIC AND DELIVERY ACCESS				
Maintain curb access				
Change in curb access (linear feet)	◑	◑	◑	
Maintain access to Red Hook's arterial roadways				
Minimizes vehicle restrictions to access Red Hook's Arterial roadways and Brooklyn highways	◑	◑	◑	
Maintain truck access to local and through truck routes	◑	◑	◑	
MINIMIZE ADVERSE IMPACTS ON THE BUILT AND NATURAL ENVIRONMENT				
Minimize adverse impacts to historical resources				
Minimizes visual impacts to historic resources	◔	◔	◔	
Minimizes historic property acquisition	◑	◑	◑	
Minimize property acquisition				

Table 4-4:
Northern Section Evaluation Results

EVALUATION CRITERIA	ATLANTIC AVENUE	BOROUGH HALL / BOERUM PLACE	BOROUGH HALL / BOERUM PLACE AND COURT STREET	REASON FOR DIFFERENCE
Minimizes property acquisition	◑	◑	◑	
Minimize impacts to natural features/resources and coastal waters				
Minimizes interference with parkland or coastal waters	◑	◑	◑	
Minimize negative impact on traffic flow				
Minimizes negative impact on traffic flow	○	◔	◔	*Atlantic Avenue – congested corridor*
MINIMIZE STREETCAR CAPITAL AND OPERATING COSTS AND IMPACT				
Implement within a reasonable construction timeframe and cost				
Shorter construction duration	◔	◑	◔	*Boerum Place / Court Street – construction along two streets* *Atlantic Avenue – complex construction*
Lower construction cost	◔	◑	◔	*Boerum Place / Court Street – construction along two streets* *Atlantic Avenue – complex construction*
Avoid conflicts with existing or proposed infrastructure				
Minimizes infrastructure conflicts	◑	◑	◑	
Avoid or minimize utility relocation				
Minimizes utility conflicts	◔	◑	◔	*Atlantic Avenue and Court Street – known utility conflicts*
Maintain access to utilities	◔	◑	◔	*Atlantic Avenue and Court Street – known utility conflicts*
TOTAL SCORE	240	260	245	

Scoring Key:

●	◕	◑	◔	○
20	15	10	5	0

All three of the Northern Section alignment options have one common horizontal curvature consideration. This consideration is listed below and shown in Figure 4-11:

Figure 4-11: Northern Section Feasibility Considerations

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– Atlantic Avenue at Columbia Street – curb and potential abutment conflict at the southwest corner.

In addition all three Northern Section alignment options have a feasibility consideration in regards to vertical clearance. The vertical clearance is a concern where Atlantic Avenue crosses under the Brooklyn-Queens Expressway, as shown in Figure 4-12. The clearance is estimated to be, at its lowest, between 14 feet 2 inches and 15 feet and 6 inches, on the south side of the structure. This is less than the 18-foot minimum clearance; and therefore, a variance would be required. Alternatively the streetcar could be routed under the highest point of the structure, in the middle of Atlantic Avenue. While this would eliminate the vertical clearance issue, it would require additional intersection signal modification to accommodate the left turn onto Columbia Street (for southbound streetcars) and the thru movement along Atlantic Avenue (for northbound streetcars).

Figure 4-12: Vertical Clearance on Atlantic Avenue under the Brooklyn-Queens Expressway

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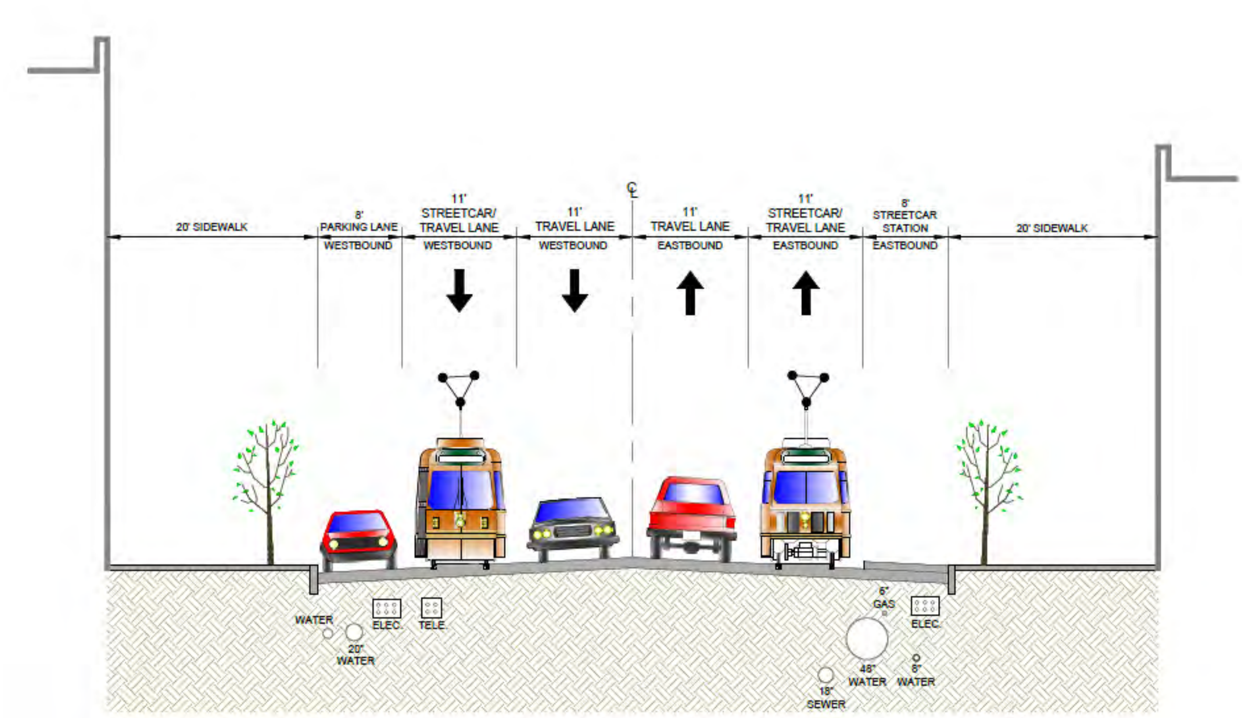
In terms of utilities, according to the records obtained for the Brooklyn Streetcar Feasibility Study, most of the major underground infrastructure along the Atlantic Avenue corridor is below the rightmost travel lane and parking lane, which is in conflict with the proposed streetcar location. Therefore, it may be necessary to relocate some of the utilities, as indicated in Figure 4-13. (Utilities shown here are not to scale, and the depths shown are estimates based on prior experience.)

Key concerns include an existing 48-inch water main, which runs just below the streetcar track alignment for a major portion of the route, as well as electrical and telephone duct banks, which are shallow and just below the road. While the entire duct bank system may not have to be relocated, most manholes and access vaults would need to be reconstructed out of the streetcar track alignment.

Figure 4-13: Typical Cross Section along Atlantic Avenue (at Clinton Street)



Not to scale
URS Corporation

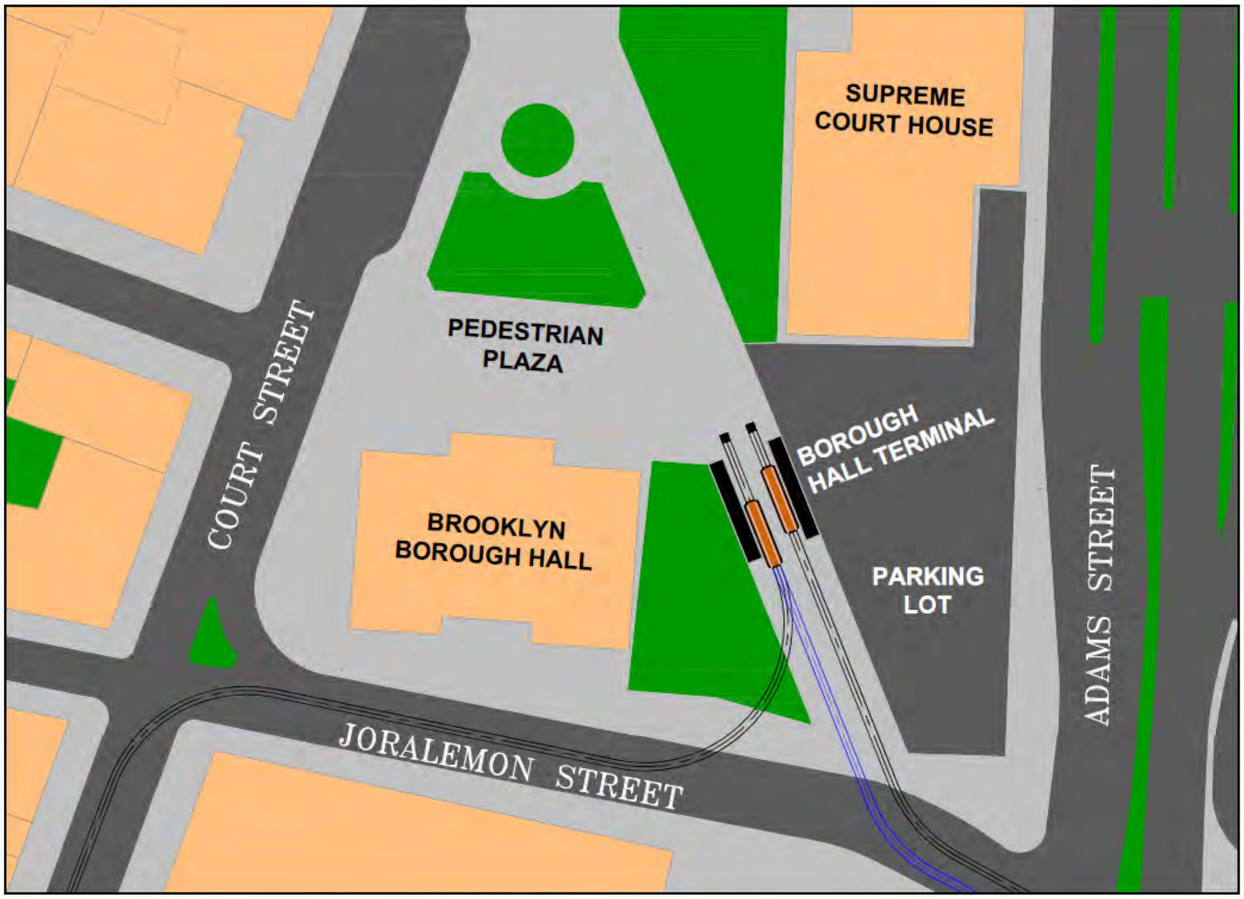
ATLANTIC AVENUE

The advantage of the Atlantic Avenue alignment option is that it would serve a greater existing population, as well as the future Atlantic Yards project. This alignment option extends along Atlantic Avenue from Boerum Place to Flatbush Avenue, which is a congested corridor with existing traffic delays. Due to this existing congestion, a streetcar track running along this corridor would likely experience travel time delays. In addition, as this alignment option is longer in length, the construction duration would be longer for this alignment option and costs would be higher. Moreover, as this alignment option would operate for a longer distance along Atlantic Avenue, the known utility conflicts would further contribute to construction duration and cost.

BOROUGH HALL / BOERUM PLACE

This alignment option would require a reduction of pedestrian space at the terminal station, as shown in Figure 4-14.

Figure 4-14: Borough Hall Terminal Station



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This alignment option would require traffic signal modification at two intersections, as shown in Figure 4-11. At Atlantic Avenue and Boerum Place vehicles would have to turn left from the right hand lane. A queue jump would be necessary at this intersection, and the left turn phasing would have to be protected. Also, at Boerum Place and Joralemon Street, vehicles would have to turn left from the right hand lane. A queue jump would be necessary at this intersection, and the left turn phasing would have to be protected.[4] This signal modification would also allow southbound contraflow streetcar movements for the Borough Hall / Boerum Place alignment option. Both intersections already have complicated, multi-phase signals. Therefore, introducing a streetcar-only phase would create greater complexity and could impact congestion levels.

[4] A median alignment along Boerum Place could be considered for a more simplified signal modification. However, the median alignment would require median reconstruction for the potential streetcar stop placement along Boerum Place. Therefore, a right-side running track was used for the alignment options evaluation.

BOROUGH HALL / BOERUM PLACE AND COURT STREET LOOP

In addition to the common horizontal curvature consideration described above, this alignment option would have an additional horizontal curvature consideration as shown in Figure 4-11 and listed below:

- Atlantic Avenue at Court Street – curb and potential building conflict at the northeast corner.

This alignment option would also require the traffic signal modification described above and shown in Figure 4-11. The construction duration would be longer for this alignment option and costs would be higher, as this alignment option would require two street shutdowns.

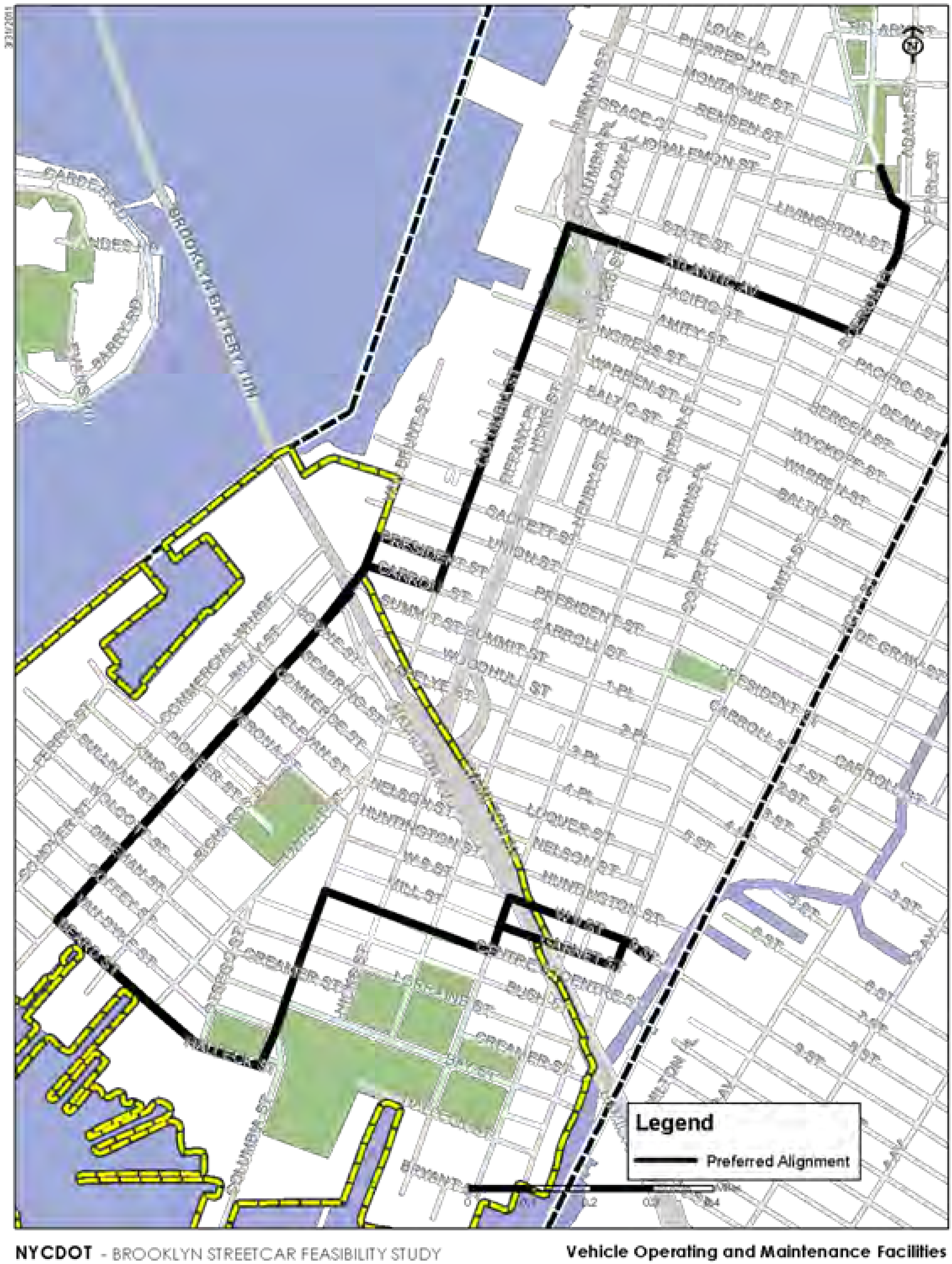
Based on the evaluation of the Northern Section alignment options, the Atlantic Avenue option resulted in a total score of 240, the Borough Hall / Boerum Place resulted in a total score of 260, and the Borough Hall / Boerum Place and Court Street option resulted in a total score of 245. Although both the Borough Hall / Boerum Place and the Borough Hall / Boerum Place and Court Street option would affect pedestrian space, these options would result in greater travel time savings and reduced impacts to traffic flow. The Atlantic Avenue option would serve proposed developments; however, the Borough Hall / Boerum Place option would result in a shorter construction duration, reduced construction-related costs, and limited utility conflicts. This results in a higher ranking for the Borough Hall / Boerum Place option.

4.5 Preferred Alignment

Based on the evaluation of alignment options, the preferred alignment for a future Brooklyn streetcar would be the Centre Street, Van Brunt Street, Columbia Street / President Street and Carroll Street, and Borough Hall / Boerum Place options. This alignment travels from Brooklyn Borough Hall to Smith Street / 9th Street Station, as shown in Figure 4-15 and travels primarily in a dual track route via:

- Boerum Place;
- Atlantic Avenue;
- Columbia Avenue;
- Van Brunt Street;
- Beard Street;
- Columbia Avenue;
- Center Mall; and
- West 9th Street.

Figure 4-15: Preferred Streetcar Alignment



5.0 OPERATING PARAMETERS

As reported in the Operations Planning Technical Memorandum, this section presents the operating parameters appropriate for a future Brooklyn streetcar by outlining the key variables that typically affect streetcar service. A summary of the assumptions of these variables is as follows:

Service Operations

- Operating hours:
  - Alternative 1 – 24-hour streetcar service; or
  - Alternative 2 – 6 AM to midnight streetcar service and midnight to 6 AM bus service
- Service frequency: 8 to 40 minute headways, depending on time of day (similar to existing bus service)
- System integration: integration with the MTA NYCT existing transit system, including fare collection and intermodal transfer points

Vehicle Characteristics

- Average speed: 10.5 miles per hour
- Layover requirements: 15 to 20 percent of trip time, approximately 6 minutes
- Number of vehicles: 8 vehicles plus additional spare vehicles, as required

Maintenance Facility

The requirements for the vehicle maintenance facility are:

- 150 feet x 150 feet facility with six tracks
- 1 to 2 acre site
- Manufacturing zoned district

Based on these maintenance facility requirements, several parcels have been identified near the preferred alignment, as shown in Figure 5-1. Utilizing New York City Department of City Planning's land use data, existing land use for each potential site was extracted and analyzed. Table 5-1 summarizes these data.

Figure 5-1: Potential Locations for Vehicle O&M Facility

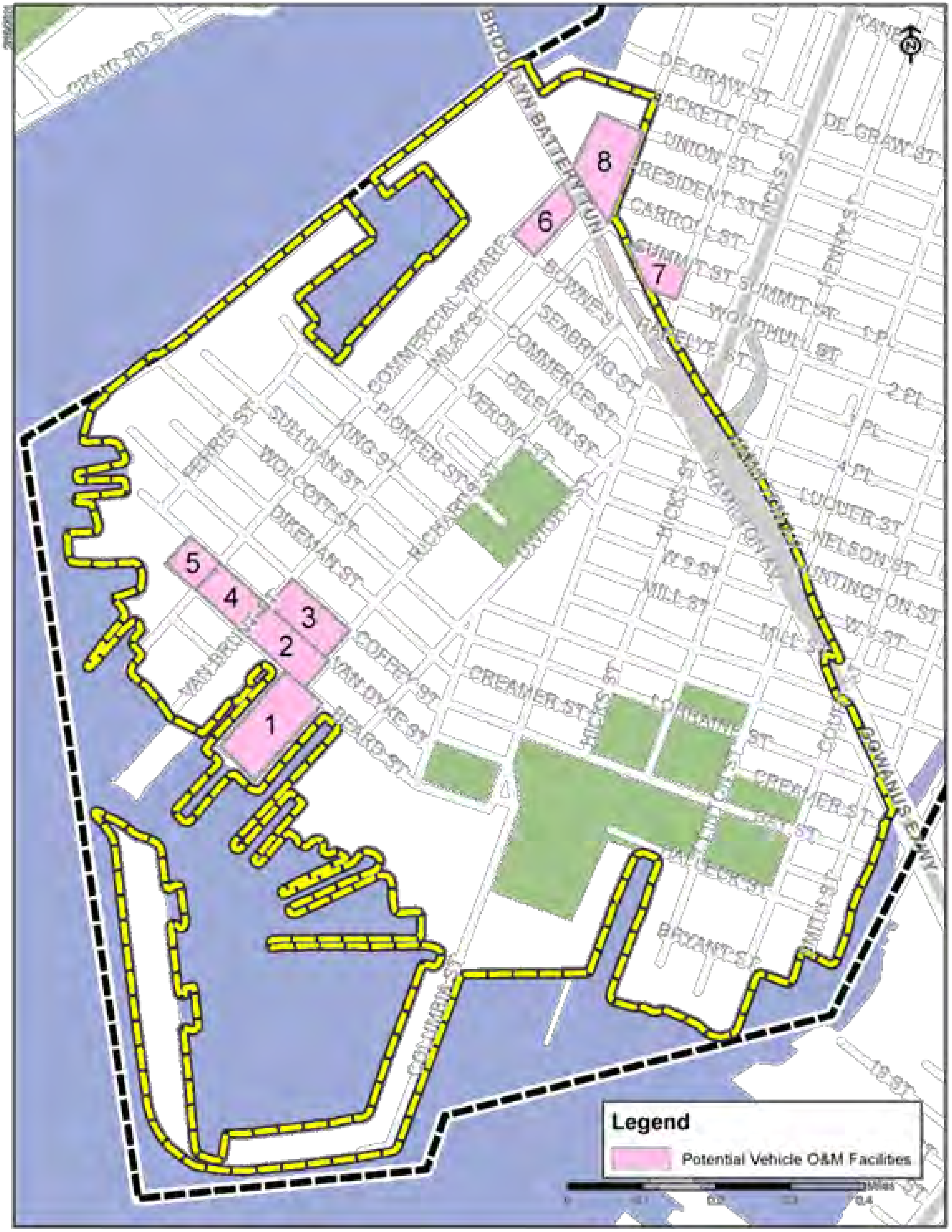


Table 5-1:
Existing Land Use Around Potential Locations for Vehicle O&M Facilities

LOCATION	ACRE	COMMERCIAL AREA	RESIDENTIAL AREA	OFFICE AREA	RETAIL AREA	FACTORY AREA	RESIDENTIAL UNITS
1*	5.71	-	-	-	-	-	-
2	3.47	105,980	7,500	7,200	-	88,000	11
3	3.31	64,550	22,897	5,500	2,350	45,600	26
4	2.71	26,925	35,599	5,203	901	4,000	38
5	1.68	17,900	3,300	5,100	-	12,800	5
6**	2.33	-	-	-	-	-	-
7	1.99	25,950	20,287	-	6,727	6,407	23
8**	4.68	-	-	-	-	-	-

*Vacant Lot
**No Data

Based on the land use data and orthophotography, several identified sites have little or no existing activity; however, several are currently active residential, commercial, or industrial sites. Depending on the location selected, additional property takings could be required. Location 1, 6, and 8 are currently vacant. However, potential developments have been discussed for location 1 and locations 6 and 8 are controlled by the PANYNJ, which would require discussion and coordination.

VEHICLE TYPE SELECTION

There are several viable options for potential streetcar vehicle types that would be appropriate to operate within the Study Area. This section describes the three most common types of streetcar vehicles: heritage (PCC), replica, and modern. A brief description of how these would be applicable to Brooklyn, along with a comparison of the advantages and disadvantages of each, is included. Recent technological advancements in streetcar vehicle types are also presented.

Heritage (PCC) cars

A wide array of streetcars fit into the heritage category (also known as vintage), from the original streetcars of the late 1800s to the single-ended, single-sided cars of the 1940s. The original streetcar first appeared on American streets near the turn of the 20th Century with the introduction of electric traction. These cars were typically built as step-entry cars with high floors, steel frames, and wooden/steel bodies. In the late 1930s, streetcar design advanced with the introduction of President's Conference Committee Cars (PCC cars), as shown in Figure 5-2. Brooklyn was the first system to receive the PCC cars, with an order of 100 cars delivered in 1936. PCC cars were typically 50 feet long and featured a rounded, streamlined steel construction. The improved ride quality and higher performance of these cars made them the model for streetcar construction.

More than 20 cities in North America used PCC cars, and many are still in use in Eastern European countries. Prior to the end of World War II, when streetcars disappeared from many cities, streetcars in North America were built with a single-ended, single-sided configuration that provided for an operator's position at one end of the car and doors on only one side. This configuration required streetcar routes to include turning loops and 'wyes' (tracks that branch off in two directions) to allow streetcars to reverse direction.

Figure 5-2: PCC Car in San Francisco, California

www.sanfrancisco.about.com

The modern use of heritage cars generally consists of rebuilt PCC cars. Philadelphia currently uses rebuilt PCC cars on its recently restored Route 15 line, as shown in Figure 5-3. The extent of rebuilding varies and may include air conditioning, ADA compliance and lately, alternating current traction motors. Most cars available for rebuild were originally constructed between 1945 and 1953. They have maximum speeds of 40 to 45 mph and seated capacities for approximately 50 passengers. These PCC cars are single ended with turning radii as low as 50 feet. The cost of a complete rebuild is approximately $1.5 to $1.8 million per car.

Figure 5-3: PCC Car in Philadelphia, Philadelphia

www.railwaypreservation.com

Replica

Replica streetcars are modern streetcars that copy heritage designs, as shown in Figure 5-4. The replica streetcars are typically based on cars constructed in the 1920-1935 (pre-PCC) period. Replicas can have new frames and bodies patterned after the original streetcars, or they can incorporate heritage components, including wheels, axles, motors, gears, brakes, and propulsion controls. The predominant supplier of replica cars, the Gomaco Trolley Company, has manufactured streetcars for service in Charlotte, Little Rock, Lowell, Memphis, Portland, and Tampa, as shown in Figure 5-5. Most of these cars use running gears from heritage streetcars imported from Milan, Italy, where many heritage cars were operating until recently. Some replica cars, including those built for New Orleans, are equipped with such modern components as wheelchair lifts and air conditioners, as well as new propulsion systems. However, the majority of replica streetcars have high floors with a step entry from the platform level to the car floor level.

Figure 5-4: Replica Streetcar in San Pedro, California

www.lightrailnow.org

Figure 5-5: Replica Streetcar in Tampa, Florida

www.lightrailnow.org

Modern

Modern streetcars feature a number of improvements to original streetcar design and function. Made in Europe (and more recently in the United States), modern streetcars have wide doors, large windows, and low floors. They also feature advanced propulsion and breaking systems. Constructed of steel or aluminum, modern streetcars incorporate materials that meet current smoke/toxicity requirements and are easy to clean and maintain. An important feature of these streetcars is the modular design, which allows individual units to be assembled into a single car using articulated or pivoting joints. Thus, the length of a modern streetcar varies (from 60 feet to almost 180 feet) increasing their ability to travel in confined urban spaces. In addition, the appearance of modern streetcars can be customized, offering standard modules in various lengths, widths, and door configurations, with custom styling.

The cities of Portland and Seattle, discussed in the Case Study Report, provide examples of modern streetcars, as shown in Figure 5-6 and Figure 5-7.

Figure 5-6: Modern Streetcar in Portland, Oregon

www.southwaterfront.com

Portland and Seattle modern streetcars are 66 feet long and comprise three modules. The modules are five inches narrower than heritage or replica cars, helping to minimize interference from parked cars. This is an important factor when considering the narrow streets of the Brooklyn Streetcar alignment. The center section has low floors with two double-width doors for boarding, where passengers step onto the car from a station platform. Wheelchair passengers enter using a bridge plate, which extends from the car to the platform and can be activated by passengers or by the operator. The low center section has few seats, allowing for wheelchairs, carriages, and bikes, alongside standing passengers.

Figure 5-7: Modern Streetcar in Seattle, Washington

www.inekon-trams.com

Table 5-2:
Vehicle Comparison

		BUS	HERITAGE STREETCAR (PCC)	REPLICA STREETCAR	MODERN STREETCAR
Car Capacity (persons)	Seated	30 to 65	40 to 66	40	60
	Standing	20 to 55	88	88	200
Vehicle Length (ft.)		35 to 60	35 to 48	35 to 40	60 to 180
Vehicle Width (ft)		8’6”	8’6”	8’6”	8’1”
ADA Accessible		Low-Floor	Onboard Lift	Onboard Lift	Low-Floor

Street Smart, Streetcars and Cities in the Twenty-First Century

Conclusion

All of the vehicle types described above are feasible for operation in a Brooklyn Streetcar system. The modern streetcar vehicle, however, offers the highest degree of flexibility, though it is more than double the cost of either a refurbished PCC car or a replica car.[5]

Modern vehicles have several key advantages. They are slightly narrower, affording a better fit on the tangent sections of the route. Additionally, the modern vehicle is best suited for disabled passengers, as it offers virtually seamless access for wheelchair-bound passengers. Finally, the modern vehicle offers the potential for much higher passenger capacity than either of the other two, due to the ability to add sections or modules and multiple door boardings. When implementing a future streetcar system in Brooklyn, consideration could be given to operating the modern streetcar in regular revenue service, but also make several PCC cars available to the system for weekends and special events, as they potentially attract great interest from both tourists and residents, as has been demonstrated in other cities.

Advancements in Modern Streetcar Technology

New streetcar type vehicles now in service in Bordeaux and Nice, France have the capacity to operate without the use of trolley overhead wire for short distances or for the complete system, depending on the type. The Bordeaux tram utilizes a technology developed by Alstom known as Alimentation par Sol (APS), a third rail system under pavement. An alternative to this system was developed by Alstom for Nice. This alternative incorporates a dual power mode for its streetcar vehicle, using electric current from overhead wires in areas where they are permitted and battery power (nickel metal hydride batteries) where overhead wires are prohibited. These systems minimize the visual disturbances caused by overhead wires used for trams in scenic or historic places. Alstom's technology has not yet been put into service in the United States.

Figure 5-8: Alstom-built 'Tram' in Nice, France

Alstom

[5] Modern vehicles typically cost approximately $4 million each, whereas both refurbished heritage and new replica vehicles cost approximately $1.5 million each. The primary reason replica streetcars are less expensive than modern vehicles is their smaller size, and their use of parts from retired heritage equipment purchased in bul k from cities around the world.

POWER SUPPLY

Streetcars are traditionally operated by electricity conveyed to the vehicle via overhead wires. The electricity is collected by a pantograph on the streetcar. Heritage, Replica, and Modern streetcars all use this method of traction power.

Battery and battery/electric methods of traction power are emerging propulsion technologies for streetcars. It is anticipated that the Brooklyn streetcar would operate using a conventional trolley wire/overhead contact system. While battery-powered and/or wireless trolley systems using underground traction power supply are emerging technologies in Europe, these newer systems remain untested in winter conditions similar to Brooklyn and most are not yet operational in North America.

A streetcar system power supply is how electricity from the local electric utility's voltage distribution network is transferred to the streetcar vehicles. The system is called the Traction Power Supply System (TPSS). This power supply includes the traction electrification system (TES) and overhead-contact system (OCS) for power distribution. The utility distributes power as alternating current (AC), while the power to the vehicle is direct current (DC). Therefore, the TES substation must contain transformers to convert the power to a usable voltage. Substations should be located along a streetcar route at approximately ½-mile intervals. Although it is possible to place substations subterranean, it is most desirable for access and cost to place them above ground in a location easily accessible to maintenance personnel.

Streetcar vehicles draw power from the OCS by either trolley pole (a spring-loaded pole with a grooved 'shoe' that straddles the wire and slides along its axis) or pantograph (a hinged frame or tube with a wide contact surface that slides along the wire and can move laterally). Two configurations are also common for the overhead wires. A trolley wire is a single wire hung from pole to pole that conducts current and provides a contact surface for the trolley pole or pantograph. A catenary is a combination of wires, including an upper 'messenger' wire and a suspended contact wire. The trolley wire creates less of a visual disturbance. However, the advantage of a catenary system includes greater overhead current distribution, greater spacing between support structures, and higher speeds.

When transferring power from the wire to the streetcar vehicles, the electricity must be grounded. Typically this is done by directing the current through the vehicle's steel axles and wheels. An insulation material is then used to ground any return current, avoiding any deterioration to nearby conductors.

The primary system elements that would be required for a Brooklyn Streetcar system are:

- Traction power supply system requirements;
- Overhead contact system infrastructure, as shown for Portland's system in Figure 5-9; and
- Streetcar operational control.

Figure 5-9: Overhead Electric Power System in Portland, OR

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The key concerns that need to be addressed when considering the TPSS for Brooklyn include: minimizing visual aesthetic impacts of the overhead contact system; minimizing the need for underground conduits and property acquisitions for substations as well as the overhead wire infrastructure; avoiding attachment of wire supports to buildings; and minimizing/controlling stray currents.

The alignment options reviewed for the Brooklyn Streetcar Feasibility Study include tracks that are located in vehicular traffic lanes, on either one-way or two-way streets, usually with parking lanes on either or both sides. The route has many traffic signal crossings for cross streets with turn lanes for vehicular access. The system would include station stops at side platforms (sidewalk platform bulb outs) for level boarding and alighting. Stops are anticipated to be located roughly every 1/3-mile along the route. The neighborhoods along the various alignment options are typically high-density urban residential and commercial areas where aesthetics are important. For this reason, the design and appearance of the OCS should consider a system that is context sensitive and blends in with the surrounding environment as much as possible to minimize any visual/aesthetic impacts associated with overhead wires.

Substation Requirements

The assumptions for a Brooklyn streetcar TPSS are based on similar types of projects, as reported in the Case Study Report, as well as the specific characteristics of the Red Hook and Downtown Brooklyn neighborhoods. The final size and spacing of the substations for Brooklyn would be determined through a detailed analysis based on the vehicle selected, the final operating plan (including frequency of service and headways), track alignment profile, and passenger station spacing, as well as the anticipated speed and power requirements measured over specific time intervals. A typical substation for the Portland Streetcar is shown in Figure 5-10.

Figure 5-10: Prefabricated Streetcar Substation in Portland, Oregon

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6.0 COST ESTIMATE

6.1 Capital Cost

A capital cost estimate was developed for the Brooklyn Streetcar Feasibility Study based on the findings from the Case Study Report, Operations Planning Technical Memorandum, and Alignment Evaluation Methodology and Feasibility Considerations Technical Memorandum. Costs for similar projects in other cities were also reviewed, and relevant adjustments were made to unit costs based on construction in the New York City market. Costs included in this memo are also based on two similar streetcar systems in construction or project development in Charlotte, North Carolina and Baltimore, Maryland.

Based on FTA Standard Cost Categories, nine major cost categories were identified as follows:

- Cost Category 10 – Guideway and Track Elements
- Cost Category 20 – Station Stops, Terminals, and Intermodals
- Cost Category 30 – Support Facilities: Yards, Shops, and Administrative Buildings
- Cost Category 40 – Sitework and Special Conditions
- Cost Category 50 – Systems
- Cost Category 60 – Right-of-Way, Land, and Existing Improvements
- Cost Category 70 – Vehicles
- Cost Category 80 – Professional Services
- Cost Category 90 – Unallocated Contingency

Costs from Baltimore were escalated by 10 percent for a labor market adjustment for work that would be conducted in New York City. In addition, there is a 20 percent allocated contingency on each cost item and a 15 percent unallocated contingency applied to the subtotal of all costs.

The preferred alignment, as described on page 4-46, was used to model this cost estimate. This alignment is approximately 6.8 route miles, primarily in dual track routes (approximately 3.4 miles in each direction from Red Hook to Downtown Brooklyn). The design assumptions used to create the concept level capital cost estimate for the Brooklyn Streetcar Feasibility Study are described below, listed for each cost category.

COST CATEGORY 10 – GUIDEWAY AND TRACK ELEMENTS

Cost associated factors (i.e. track length, intersection impacts, sitework, and signal impacts) were identified for the preferred alignment. The alignment travels from Brooklyn Borough Hall to Smith Street/9th Street Station primarily in a dual track route via:

- Boerum Place;
- Atlantic Avenue;
- Columbia Avenue;
- Van Brunt Street;
- Beard Street;
- Columbia Avenue;
- Center Mall; and
- West 9th Street.

Along this route there is approximately 18,000 linear feet of track in each direction for a total of 36,000 feet of new track bed and girder rail construction. Two embedded turnouts were assumed for connection into a future maintenance and storage facility. Three embedded crossing diamonds were also assumed, one at each terminal station for tail track turnaround and another midway along the alignment for track crossing.

COST CATEGORY 20 – STATION STOPS, TERMINALS, AND INTERMODALS

Typical streetcar stop platforms were assumed to be located along the route at intervals of approximately 1,500 feet. There are 12 standard platforms located in each travel direction for a total of 24, with two additional terminal stations. Each terminal station was assumed to be an enhanced-stop platform, containing additional amenities, and features to facilitate connections with other modes.

COST CATEGORY 30 – SUPPORT FACILITIES: YARDS, SHOPS, AND ADMINISTRATIVE BUILDINGS

Based on the Operations Planning Memo, the Maintenance and Storage Facility would be a 22,500 square-foot building on a 1.5-acre site. The structure would house typical streetcar maintenance requirements, including a wash facility and six track bays to perform repairs and maintenance. The site would also require track for access to and from the revenue tracks as well as a yard for storage and employee/operator access.

COST CATEGORY 40 – SITEWORK AND SPECIAL CONDITIONS

Based on the utility records provided for the major dual track routes of Columbia Avenue, Van Brunt Street, and Atlantic Avenue, it was assumed that some areas would require significant utility relocation or protection to allow for streetcar traffic to operate. An assumption of $600 per linear foot of dual track alignment was used to approximate utility relocation and protection costs. This accommodates the costs associated with relocating any utilities outside of the proposed alignment, as well as costs associated with protecting crossing utilities (i.e. sleeves, cathodic protection, etc.). Allowances were also included for street lighting improvements and drainage improvements due to track construction and cross slope modification.

A $30 per linear foot cost was also included as an allotment for civil reconstruction including sidewalk interface and driveway and/or parking modifications, with an additional $20,000 per turning intersection where more extensive sidewalk and curb reconstruction would be required.

An allowance of $130 per linear foot was also included for roadway reconstruction and repaving due to trackbed modification and interface. Maintenance of Traffic was allotted at 4 percent of direct construction costs. An 8 percent allocation was also added for contractor's indirect costs (i.e. mobilization).

COST CATEGORY 50 – SYSTEMS

Systems costs include all Traction Power Electrical work, OCS, and electronics associated with operation of the streetcar. A systemwide signal system for the streetcar was included at a cost of $2.5 million. There would be a need for new traffic signals at three locations (Mill Street at Hamilton Avenue, Centre Street at Clinton Street, and Centre Street at Columbia Street) within the streetcar alignment and modification of 14 existing traffic signals to allow for streetcar use. Additional equipment required to give streetcar signal priority, including both the wayside system and the in-vehicle transponders, was also included as a linear foot assumption for the length of track.

A typical fenced-in traction power substation can operate approximately one mile of dual track. A total of three substations were assumed to be installed for the 3.4 mile route. Each traction power substation is approximately a 30 feet by 10 feet prefabricated aboveground structure that is surrounded by fencing. The trolley wire OCS was priced at a linear foot cost based on dual track support (a single support system for both direction of trolley wire).

A systemwide communication system including radio communication for operators and facility was included with a lump sum of $500,000. Also, off-board fare collection machines at each station were priced at $70,000 per terminal, with 28 terminals in the system (one at each station and two at each terminal).

Cost Categories 10 through 50 are a compilation of all direct construction costs.

COST CATEGORY 60 – RIGHT-OF-WAY, LAND, AND EXISTING IMPROVEMENTS

Land purchase requirements would include the Maintenance and Support Facility site, as well as smaller purchases along the route for any geometric needs, traction power substation requirements, or possible easement for OCS to be attached to buildings on narrow streets in lieu of OCS poles.

COST CATEGORY 70 – VEHICLES

Modern streetcar vehicles as used in comparison cities cost approximately $4 million per car. Refurbished or heritage cars would be less expensive. (Philadelphia's refurbished PCC cars cost $1.5 million each.) For the purpose of this estimate modern streetcars were used to calculate a conservative estimate.

COST CATEGORY 80 – PROFESSIONAL SERVICES

Continuing project development engineering and professional services are assumed along the following schedule as a percentage of construction costs (10-50):

- Preliminary engineering (2 percent);
- Final design (6 percent);
- Project management for design and construction (4 percent);
- Construction administration and management (5 percent);
- Professional liability and other non-construction insurance (2 percent);
- Legal, permits, and review fees by other agencies, cities, etc. (2 percent);
- Surveys, testing, investigation, and inspection (2 percent); and
- Start up (2 percent).

COST CATEGORY 90 – UNALLOCATED CONTINGENCY

An unallocated contingency of 15 percent was also added to the overall cost in consideration of the current level of project development.

SUMMARY

Based on these assumptions, the total cost for the streetcar system is approximately $176 million, or approximately $26 million per mile of track. Table 6-1 compares these costs with similar systems.[6]

Table 6-1:
Capital Costs for Similar Cities

CITY	CAPITAL COSTS PER TRACK MILE (MILLIONS IN CONSTRUCTION YEAR)	YEAR
Portland Initial Implementation	$13	2001
Tampa	$20	2002
Seattle	$20	2007
Portland Streetcar Loop Project	$22	2010
Source: Case Studies Report		

6.2 *Operating and Maintenance Cost*

In order to determine the operations and maintenance (O&M) cost for the proposed Brooklyn streetcar, the O&M cost per vehicle revenue mile and hour from similar systems in Tampa, Florida, New Orleans, Louisiana, and Seattle, Washington were used. These systems were selected based on available O&M costs data as well as average bus operator hourly wage rate. These costs were obtained from the 2009 National Transit Database, which is the latest data available and are summarized below in Table 6-2.

Table 6-2:
Operating Costs for Similar Cities

CITY	O&M COSTS PER VEHICLE REVENUE HOUR	O&M COSTS PER VEHICLE REVENUE MILE
Tampa	$164	$32
New Orleans	$185	$24
Seattle	$211	$39
Source: 2009 National Transit Database, Federal Transit Administration		

The average bus operator hourly rate was used to escalate the cost of these similar systems to estimate the cost for operating and maintaining a streetcar system in New York City. The hourly rates were obtained online from the Occupational Employment Statistics Query System from the Bureau of Labor Statistics for the three comparison cities and New York City. The data are summarized below in Table 6-3.

To calculate the O&M cost for the proposed Brooklyn streetcar, a ratio of labor rates of NYC bus drivers to labor rates bus drivers in each comparison city was developed. This ratio was then applied against the respective operating and maintenance costs for each city and averaged to obtain the value for New York City. Using this method, the cost was determined to be approximately $248 per vehicle revenue hour and $42 per vehicle revenue mile, or approximately $6.2 to $7.2 million dollars annually, as shown in Table 6-4.

[6] However, these costs were based on the year of expenditure and not adjusted for inflation.

Table 6-3:
Average Hourly Bus Operator Labor Rate

CITY	AVERAGE HOURLY BUS OPERATOR LABOR RATE
Tampa	$15.56
New Orleans	$15.41
Seattle	$22.69
New York City	$23.38
Source: Occupational Employment Statistics Query System, Bureau of Labor Statistics, May 2009	

Table 6-4:
Operating Costs for Similar Cities and Projected Costs for New York

CITY	O & M COSTS PER VEHICLE REVENUE MILE	ANNUAL O & M COSTS
Tampa	$32	$2.4 million
New Orleans	$24	$10 million
Seattle	$39	$2.4 million
New York (Projected)	$42	$6.2 million to $7.2 million
Source: 2009 National Transit Database, Federal Transit Administration		

A comparison of streetcar O&M costs with NYCT bus and subway O&M costs can be misleading as the breakdown of costs per mode may differ. According to NYCT, the annual O&M costs for the B61 route are approximately $2.5 million.

7.0 ALIGNMENT FEASIBILITY CONCLUSION

This report presents the results of a detailed evaluation of the feasibility of implementing a streetcar system in Brooklyn. The analysis draws upon the experience and lessons learned from several existing streetcar systems presented in the Case Study Report, including a field visit to the Philadelphia Route 15 Trolley system. Information gathered from site investigations performed in Red Hook and Downtown Brooklyn to identify alignment options and feasibility considerations related to clearances and turning radii, track geometry, sidewalks, bikeways, and utilities were also incorporated into the evaluation. This detailed analysis considered constructability issues, vehicle options, and overall costs to implement and operate a starter system in Brooklyn. The evaluation was conducted based on the approach outlined in the Alignment Evaluation Methodology and Feasibility Considerations Technical Memorandum.

In addition to feasibility from an engineering standpoint, this report also includes discussion related to DOT's policy decisions related to a future streetcar in Red Hook. The process for developing a policy decision for a future streetcar in Brooklyn includes selecting and evaluating the alignment options (as described in section 2.0 and section 4.0), identifying feasibility considerations (as described in section 3.0), and determining capital and operating costs (as described in section 6.0). DOT's policy decision also incorporates streetcar benefits, which are discussed in the Case Study Report.

ALIGNMENT OPTIONS

Using the methodology defined in the Alignment Evaluation Methodology and Feasibility Considerations Technical Memorandum, potential alignments for a streetcar service in Brooklyn were selected and evaluated. This process included identifying potential streetcar alignments, developing evaluation criteria to measure how well the alignment options satisfy the study's goals and objectives, and evaluating various alignment options in comparison to each other. Based on this evaluation methodology, the alignment options were ranked, with the highest ranking given to those that best satisfied the goals and objectives of the project. This resulted in an individual preferred alignment. The highest ranking alignment options are shown in Figure 4-15 on page 4-47 and as follows:

- Focus Area East – Centre Street;
- Focus Area West – Van Brunt Street;
- Middle Section – Columbia Street / President Street and Carroll Street; and
- Northern Section – Borough Hall / Boerum Place.

FEASIBILITY CONSIDERATIONS

The Study Team identified general streetcar feasibility considerations typical of a streetcar operating in an urban environment. These general considerations include alignment considerations (right-of-way, horizontal curvature, major infrastructure obstacles, station platforms, and vertical clearance), traffic planning (traffic operations and signals, parking and loading, and bicycle integration), and constructability (construction methodology, construction impacts, pavement type, and utilities). These feasibility considerations contributed to various evaluation criteria, as described in section 3.0.

As demonstrated during the evaluation process, all of the alignments are feasible in a technical sense, as all of the feasibility considerations of implementing a streetcar system can be addressed during the planning, design, and construction phases of a future streetcar. However, when considering factors such as the cost effectiveness of each alignment option, there are distinct differences in the options. The evaluation process produces a ranking of the alignment options representing the most feasible alignment.

Although the Centre Street, Van Brunt Street, Columbia Street / President Street and Carroll Street, and Borough Hall / Boerum Place alignment is most feasible from an engineering standpoint, feasibility considerations, including right-of-way and intersection geometric modifications, property acquisitions, parking reductions, and signal modifications would remain. These considerations, for example the narrow right-of-ways along Van Brunt Street, could impact the operation of a future streetcar, as well as associated vehicular, bicyclist, and pedestrian movements.

COST

The Study Team has concluded that operation of a modern streetcar is technically feasible in Red Hook. However, this new transit service would require a substantial capital investment. The estimated cost based on the conceptual design of the preferred alignment amounts to approximately $176 million in 2011 dollars. Given the current economic environment, it is questionable whether the City could raise the funds for this substantial capital investment. Moreover, in light of the unfavorable feasibility considerations related to the actual operation of such a system, it is uncertain that a streetcar, while technically feasible, is the most efficient option for meeting Red Hook's transit goals today.

ADDITIONAL FACTORS

Additionally, the support of neighborhood residents and local businesses is an important factor in developing a future streetcar route. Streetcar support in Portland, Seattle, and Philadelphia influenced the planning (and success) of each city's streetcar system, as reported in the Case Study Report. A public meeting is planned for the Brooklyn Streetcar Feasibility Study in May. During this meeting, the alignment options will be presented for comment and input, and a ranking for this criterion will be added based on public input regarding the potential alignment options.

As reported in the Case Study Report, there are a multitude of planning and land use components that work together to create a successful streetcar system. Streetcars provide a historic, romantic appeal and have transformed blighted districts into vibrant areas in a number of U.S. cities. This occurred in Portland and Seattle, as both cities experienced increased development as a result of a streetcar system. However, other factors were at play that likely contributed to this growth, including local land use policies, the construction of a light rail system, urban renewal, and the ability to use tax district funds to subsidize infrastructure costs. In contrast, Philadelphia's streetcar corridor has not experienced this type of growth. Although the return of the Route 15 trolley was justified for economic redevelopment reasons, the planning process lacked a master planning approach, and redevelopment has not progressed as hoped. In summary, it is essential that a comprehensive approach be applied to the planning and design of a streetcar system.

At this time, the City of New York has no plans to change land use zoning, or use other planning tools to spur economic development in Red Hook. In fact, the New York City Department of City Planning has identified the Red Hook waterfront as a working waterfront, to be maintained in its current industrial state.[7] This conflicts with the mixed used development that typically complements a streetcar system.

It is difficult to determine the viability of the most desirable alignment options from a capital investment perspective. Are the benefits (i.e. increased transit trips, reduced congestion, reduced greenhouse gas emissions) that are expected to be realized from a modern streetcar system commensurate with the costs associated with the system from a ridership, land use, economic development, and quality of life perspective? This is particularly challenging as some benefits would be qualitative in nature, and may not necessarily be quantified from a pure cost/benefit analysis.

SUMMARY

The selection and evaluation of the alignment options, streetcar feasibility considerations, capital and operating costs, public support, zoning and land use policies in Red Hook, and expected benefits have led DOT to develop a policy decision for a future streetcar service in Red Hook, Brooklyn. DOT has determined a streetcar system would be better suited in a neighborhood with fewer physical constraints and potential conflicts (i.e. wider streets). In addition, in implementing a comprehensive planning approach, the neighborhood should be a higher density mixed-use zone, or have the potential for being made into a supportive land use. At the present time, these conditions do not exist in Red Hook.

If in the future, consensus for development becomes apparent, the neighborhood planning goals change, or as economic recovery continues, a streetcar system could become feasible. This document would then provide a resource for future planning and design of a streetcar system. In the interim, DOT and MTA NYCT are investigating other opportunities to improve transit mobility and accessibility in Red Hook that would be feasible in the short-term, and would be less costly to implement.

[7] NYC Department of City Planning identified the Red Hook waterfront as a Significant Maritime Industrial Area (SMIA) in its 1999 *Waterfront Revitalization Program*.

8.0 APPENDIX A – COMMUNITY ADVISORY COMMITTEE COMMENTS

Brooklyn Streetcar Feasibility Study
CAC Meeting #1 Summary
October 18, 2010 6:30-8:30pm

1) Introductions

The DOT's Christopher Hrones, the project manager, began the meeting by introducing himself and others working on the study, including:

- Congresswoman Nydia Velazquez, represented by Community Coordinator Dan Wiley
- Brooklyn Chamber of Commerce, represented by its CEO Carl Hum
- Lead consultant URS, including Steve Gazillo, Don Varley, Gill Mosseri, and Sagi Koborsi
- DOT staff, including Eric Beaton, Aaron Sugiura, Monty Dean of the Press Office, and Nicholas Mosquera

Community Advisory Committee (CAC) members in attendance introduced themselves

2) Background on Study and Community Advisory Committee

Hrones addressed the reasons NYCDOT is conducting a streetcar feasibility study at this time:

1. Funding ($295,000) for the five-month study was earmarked for the project by Congresswoman Nydia Velasquez, with support from the Brooklyn Chamber of Commerce.
2. The Department is interested in exploring all options with the potential to increase mobility, reduce congestion, and move towards a greener, more sustainable future.

Hrones provided several examples of how the Department is making such efforts throughout the city, including bicycle and bus lanes and Select Bus Service. The Streetcar option is one that many other cities in North America have considered and DOT also wishes to explore, but Hrones emphasized that no decision has yet been made to pursue it. The study is meant to determine only whether it looks feasible in Red Hook, a neighborhood which lacks direct rail transit. Should the study determine that streetcar is viable, and the city decide to move forward, the next step would be to complete an Alternatives Analysis, required for federal funding.

Q-George Fiala of Select Mail and Red Hook Press asked if there is funding available for this next step.
A–Hrones stated that there is not at this time.

Hrones stated that the study will choose several promising alignments and look at ridership potential, construction and maintenance obstacles, and transportation and economic development benefits, in addition to estimating costs. The result would determine streetcar's inclusion in the Alternatives Analysis.

Hrones also said that CAC members were invited to participate in a series of three meetings in order to provide the study with local expertise and that the general public could provide additional input at a meeting to be held in early 2011. The DOT will also make presentations to the Community Boards.

3) Presentation

Hrones gave the floor to Steve Gazillo of URS, after highlighting the company's expertise in streetcar projects nationwide and acknowledging the work of sub-consultants Nelson\Nygaard and AKRF.

Gazillo outlined Brooklyn's history with streetcars and explained the technical differences between streetcars and light rail transit. He explained the various streetcar vehicle types and key points related to the Portland, Seattle, and Philadelphia systems, which the project will use as case studies. Gazillo restated the goals of the study, outlined his project scope, which includes examining case study cities, projecting transit demand in Red Hook, identifying potential routes, estimating costs, and identifying other implantation issues. Gazillo further outlined the project schedule, noting that a final report is due in February 2011.

4) CAC Discussion and Input

Hrones then invited questions from CAC members.

Q – Bob Diamond of the Brooklyn Historic Railway Association stated his approval of shallow construction methods and small substations, as explained by Gazillo, but said he fears that certain vehicles choices might accelerate or decelerate too slowly to operate in fast-moving traffic, and that their operating voltage might not be compatible with the MTA's existing systems. Diamond said further that he fears an Alternatives Analysis would require much time and that the city might have trouble finding funding in a shifting political climate. He proposed that the city ask URS to begin an Alternatives Analysis immediately, making use of potential federal funds and work done as part of previous studies.
A – Hrones stated that DOT is not selecting any specific vehicle at this time, and will evaluate all options. Referring to funding, he said that DOT intends to seek out funding opportunities, but first needs to determine the feasibility of streetcar. He said the agency does not feel comfortable investing money or time in design and construction without the proper analysis.

Q – Craig Hammerman, of Community Board 6 asked what the role of the MTA would be.
A – Hrones stated that the MTA is a CAC member but was not able to attend the meeting. He also stated that in Portland and other cities, the city government initiated the streetcar projects, and that given the MTA's economic constraints, New York must be proactive and consider other channels. He confirmed that the MTA would certainly be involved in decision making going forward.

Michael Kowalski of the Kentler International Drawing Space said that he fears that bureaucracy or agency jurisdictional disagreements might slow a streetcar project. He also stated that a streetcar that is subject to traffic conditions, as buses are, would be only a tourist attraction, and that Red Hook needs predictable transit options for late nights and weekends as well as weekdays.

Q – Steve LaMorte of Red Hook Economic Development asked what the advantages of a trolley would be, if not quicker service.
A – Hrones answered that neighborhood economic development is one of the primary aims of many streetcar projects. He said that it would be possible to question the cost effectiveness of a streetcar system if one's only goal were to provide high-speed transit.

Q – Steve LaMorte of Red Hook Economic Development asked if it would be possible to run a streetcar in a dedicated lane.
A – Steve Gazillo responded that it is possible but that that is not the intent of this study. Gazillo stated further that streetcars tend to attract more riders than buses regardless of the speed difference, likely because they are permanent systems with fixed routes.

Q – Steve LaMorte of Red Hook Economic Development stated that current Red Hook bus service is not reliable, and said simply replicating that level of service would not be a viable option.
A – Steve Gazillo stated that they are looking into level of service as part of the feasibility study.

Joseph Calisi, a transportation historian seconded Steve Gazillo's preceding answers, stating that residents respond to the permanent nature of a streetcar system, and that the primary goals should be tourism and transit oriented development. Calisi also seconded the idea of running streetcars with signaling priority and dedicated lanes to speed up service.

Q - Josh Nelson of the New York City Economic Development Corporation (EDC) asked about the difference between the overall study area and the smaller focus area, which

includes only Red Hook. He also inquired about the transit demand forecasting methodology.
A – Hrones said that the study will not consider alignments that do not include Red Hook. Regarding methodology, Hrones stated that demand would be estimated using data from the Census and the MTA. He explained that certain Red Hook peer neighborhoods with indirect subway service similar to that provided by a streetcar, would be used to estimate future transit demand. Ridership data from other cities with streetcars will also be used.

Q – George Fiala of Select Mail/Red Hook Press stated that he wishes to hear more from DOT about how the streetcar would aid Red Hook residents, specifically by reducing the number of vacant storefronts. He also asked if residents should be concerned about noise, pollution, or child safety issues.
A – Hrones answered that it is by no means too late to raise such issues and that such neighborhood concerns are exactly what DOT hopes to learn from CAC members and incorporate into the study.

George Fiala of Select Mail/Red Hook Press then stated that the neighborhood would not want a system that only invites residents, but would prefer a system that encouraged commercial activity in the area.

Q – Sandy Balboza of Atlantic Avenue Betterment Association said that her organization proposes a circular route in Red Hook, as buses already provide links to the subway. She said she wishes to learn more about streetcar's potential transit connections and that the AABA has a relevant video on their website.
A – Hrones stated that the study will take all suggestions into account, and that DOT is building a Google Maps application that would allow CAC members to suggest streetcar alignments.

Q - Roy Sloane of the Cobble Hill Association stated that Red Hook is a transit challenged area, and that Cobble Hill residents support the project and its potential connections to the waterfront and Brooklyn Bridge Park. Sloane asked what the process or metric would be for determining economic development potential, and if the study would provide a specific number. He also asked about the difficulty of maintaining neighborhood mobility during streetcar construction.
A – Hrones answered that the study will not include a specific economic model but will be as comprehensive as possible, and examine the economic impacts experienced by other cities. Hrones also said that DOT will work with the Department of City Planning and the EDC to incorporate existing and upcoming projects and policies.

Q – Steve LaMorte of Red Hook Economic Development asked if the ridership evaluation would be based primarily on Census data.

A – Hrones answered that the evaluation would also incorporate numbers from other cities, New York City Transit bus ridership data, as well as other sources, all of which would be used to provide a ridership range, rather than a specific number, and be used a reality check.

Q - Tina Luongo of Red Hook Economic Development stated that Red Hook is not just a residential and small business neighborhood, but is zoned largely for industry. Luongo stated that industrial concerns need to bring employees to the neighborhood and said the study should take this into account.
A – Hrones answered that ridership data will show alightings ("offs") as well boardings ("ons"), capturing non-residents that use the bus to come into Red Hook as , and that the study will examine this issue.

George Fiala of Select Mail/Red Hook Press commented that IKEA has been busing people into the neighborhood.

Q – Jen Klein of Brooklyn Bridge Park asked if the project would incorporate studies done for as part of the IKEA traffic mitigation.
A – Hrones confirmed that they would be included.

Q - Joseph Calisi, transportation historian, asked what caused the delay since the study funding was awarded.
A – Hrones acknowledged that government sometimes moves slowly, but that DOT is moving forward with the study now. Hrones stated further that it took some time to determine the appropriate agency to manage it.

Q – Michael Kowalski of Kentler International Drawing Space asked if DOT considers it a necessity to reconstruct streets, as is being done on Columbia Street, before installing a streetcar?
A – Hrones answered that the study will consider these constructability issues and determine whether is it necessary to rebuild streets, and how this would impact costs. Hrones stated that the study would also engage the Department of Environmental Protection to discuss utility issues, and that DOT would again look to the experience of other cities.

Q – Ray Howell of the Institute for Rational Urban Mobility stated that trolley tracks had been removed from Columbia Street and asked if there are existing tracks of Richards Street that could be reused.
A – Hrones stated that DOT has a map of existing and historical streetcar tracks, but that it shouldn't be assumed that existing rails would still be usable.

Q – Craig Hammerman of Community Board 6 stated that he wants as much community participation as possible, and offered to distribute study materials to area residents. He also asked if the study will consider a Gowanus Expressway monorail or a streetcar route over the Brooklyn-Queens Expressway trench.
A – Hrones answered the study will consider many options but that one of the benefits of streetcar is its relative affordability.

Bob Diamond of the Brooklyn Historic Railway Association commented that study should emphasize transit oriented development and land use changes as the primary benefit of streetcars over buses. He also referenced the experience of Portland, Oregon, and said that streetcars can be used to significantly shrink journey times while extending the potential range of pedestrian trips.

Q - Lou Venech of the Port Authority of NY & NJ asked what the study's traffic analysis component would consist of.
A – Hrones answered that the study budget is insufficient for a detailed traffic analysis, but that once several alignments have been chosen, the consultant team will examine a streetcar's impact on several key intersections.

Q – Sue Wolfe of the Boerum Hill Association asked what the study budget is.
A – Hrones answered that the budget is $295,000.

Q - Ray Howell of the Institute for Rational Urban Mobility asked if the study would examine New Jersey's Hudson-Bergen Light Rail system, and if such a line might be applicable to Red Hook.
A – Steve Gazillo answered that the New Jersey system is unique and that the lack of certain data makes the ridership numbers difficult to study. He also stated that the New Jersey line is significantly longer than a Red Hook streetcar route would be, but that there might be some applicability.

Q – George Fiala of Select Mail/Red Hook Press asked if it's possible that DOT would complete the feasibility study and decide that streetcar is infeasible.
A – Hrones answered that yes, it is a true feasibility study, but that if streetcar is found to not be viable, the agency would remain committed to addressing Red Hook's transit needs in other ways.

5) Next Steps

Hrones concluded the meeting with a reminder that the second CAC meeting would be held in mid-December and that DOT would contact them when the study website and Google Maps routing tool and website were complete. He also invited interested parties to attend the Community Boards 2 and 6 transportation committee meetings in November, where he would be offering a similar presentation on the streetcar study.

Q – Robert Perris of Brooklyn Community Board 2 asked whether currently underutilized commercial space and its potential redevelopment were considered.
A – Hrones answered that only planned developments were documented.

John McGettrick of the Red Hook Civic Association stated that the waterfront should be a focus of the study. He believes that the 197-a plan produced by the community expressed a desire for redevelopment of the area west of Van Brunt and that such change will likely come eventually.

Q – Steve LaMorte of Red Hook Economic Development Corporation asked about the timeframe of the 160 Imlay Street project and if it was in fact the largest development planned for the area.
A – Hrones confirmed that it is the largest but that for the purposes of the streetcar study, that level of detail on individual developments was not considered.

Q – Craig Hammerman of Brooklyn Community Board 6 said that he felt the presentation was accurate and requested that all reports being produced for the study be put on the study website as soon as possible. He also seconded the notion that residential and manufacturing development that may not be allowed by existing zoning still be considered as part of the study. He believes that growth rates will increase along with the number of commercial uses serving residents and tourist traffic, and that a streetcar could serve these users.
A – Hrones confirmed that all reports would be made available shortly.

Q – Steve LaMorte of Red Hook Economic Development Corporation asked how travel times on a streetcar would differ from those on a bus and said that it might be a concern to the community if they did not decrease.
A – Hrones answered that there would not likely be huge gains, as a streetcar, like buses, would generally operate with mixed traffic on streets. Streetcars can increase the level of comfort as compared to a bus, and the study would focus on alignments that minimize congestion but travel times would not be radically improved. He added that Philadelphia, one of the case study cities chosen for the study, has experienced streetcar delays due to double-parked cars and narrow, residential streets similar to those found in Red Hook.

Q – Congresswoman Nydia Velázquez asked if the proposed Brooklyn Waterfront Greenway was considered as a possible alignment.
A – Hrones answered that it was discussed, but that a more pressing goal was to bring the alignment as close as possible to population and commercial centers such as Van Brunt and Columbia Streets. He added that the goal of the greenway is different in that it will be as close to the water as possible. There may be some segments where these goals overlap and others where they do not.

B. Transit Demand Analysis

Hrones summarized the methods for estimating the ridership of a Red Hook streetcar line. Red Hook bus ridership and the Red Hook portion of riders at the Smith-9th subway stop was tallied, and compared to other New York neighborhoods that have subway service that is less frequent or that doesn't reach one of the three main Central Business Districts. Also factored in were trips generated by the planned developments in Red Hook. The analysis predicts a 12 percent ridership increase due to streetcar and a 43 percent increase overall. This is in keeping with the median ridership increases found in other cities that have introduced streetcars. Further analysis of the ridership within the larger Study Area will be completed once potential alignments have been selected.

Q – Craig Hammerman of Brooklyn Community Board 6 asked if the NYC Economic Development Corporation (EDC) had contributed to this analysis, given that it has focused on waterfront development in the neighborhood.
A – Hrones said that the study team had met with EDC and discussed projects at Piers 11 and 7 but that the point of the demand analysis was to capture a data on the neighborhood as it exists; decision on development policy will not be made at this point.

Joshua Nelson of the EDC stated that his organization is interested in the results of the study and aware of streetcar's effects on redevelopment but that it is not yet ready to incorporate it into their economic development planning.

Q – Patrick Thrasher of the Port Authority of New York & New Jersey asked how bus ridership on the B61 compares to other city bus routes.
A – Hrones said that the route falls roughly in the middle of New York bus route ridership counts and that the study team does not expect streetcar ridership to be a radical increase over the bus line. Steve Gazillo of URS seconded this assessment and stated that the existing bus ridership is higher than some operating streetcars.

Q – Steve LaMorte of Red Hook Economic Development Corporation asked if there was a certain "critical mass" ridership number required for introduction of a streetcar.
A – Hrones answered that the DOT is considering ridership as just one factor, in addition to cost and economic development. He said there is not a specific threshold.

Q – Steve LaMorte of Red Hook Economic Development Corporation asked what coordination there had been with the Department of City Planning (DCP).
A – Hrones answered that the study team had met with DCP but reiterated that the study alone is unlikely to result in major changes in city land use policy. He added that any decision to alter zoning in the neighborhood would have to come later, and that the streetcar study would serve as input in that discussion.

Q – Norman Cox of the Columbia Waterfront Neighborhood Association asked if the demand analysis only took into account the number of individual riders as opposed to also counting return trips.
A – Hrones answered that the boarding counts should capture all users, as it is assumed that riders will return via the same transit mode. To get the total number of transit rides, one could multiply the number of riders by two.

Q – Dan Wiley of Congresswoman Velázquez's office inquired about the various other methods by which people travel to and from Red Hook, including the Ikea shuttle buses and whether a streetcar could capture some of those riders.
A – Hrones said that the study team did receive shuttle ridership data from Ikea but that they decided not to include those riders as it cannot be assumed that the retailer would terminate the service after the introduction of a streetcar, given the specific purpose the buses serve for Ikea shoppers.

Q – Robert Perris of Brooklyn Community Board 2 asked if ridership counts for the B61 bus were made before or after the multiple changes to the route that were made in 2010. He wondered if ridership increased in Red Hook because the splitting of the long route into the B61 and B62 enhanced the reliability along the line.
A – Colin Foley of the Metropolitan Transportation Authority (MTA) provided figures for Red Hook ridership that closely matched those given in the presentation and confirmed that the MTA believes ridership increased along with schedule reliability.

Q – Craig Hammerman of Brooklyn Community Board 6 asked how ridership estimates would be conducted for portions of a route through the larger Study Area.
A – Hrones stated that the study team would take an approach similar to that used in the Focus Area. Ridership in neighborhoods and portions of neighborhoods that lack subway service, such as Columbia Street and Cobble Hill, would be added to the model, as would planned developments in those areas.

C. Case Studies

Hrones summarized the key lessons learned from the study team's analysis of three case study cities: Portland, Seattle, and Philadelphia. The first two recently introduced modern streetcar service while the last reintroduced heritage streetcar service along a line that had previously been converted to bus. First, early coordination with utility providers is key, as cities experienced unexpected costs related to relocation and maintenance of underground utilities. Second, economic development only occurs in situations where stakeholders make changes in zoning and other complimentary measures. Third, fare and transfer integration with other modes of transit are necessary. Last, cities such as Portland have experienced some conflict between bicycles and streetcars, and care must be taken to ensure bike safety.

Robert Perris of Brooklyn Community Board 2 stated that wheelchair users should be taken into account as well.

Q - Ray Howell of the Institute for Rational Urban Mobility asked if it would be possible for streetcars to transport bicycles.
A – Steve Gazillo of URS said that it is possible, and can be done either within the streetcar or via an attached rack.

D. Overview of Route Alignment

Hrones provided an overview of the rationale behind the alignment proposals chosen for purposes of the feasibility study. He indicated that the choices are the beginning of the process, rather than an end, and were necessary for evaluating feasibility factors such as low clearances, complicated intersections, trip generators along the route, transit connections, and congestion, among other factors. Stakeholder suggestions were taken into account and additional alignments could be considered as part of a future alternatives analysis. As such, DUMBO, Brooklyn Bridge Park, and Smith and Court Streets were not considered, as they either didn't allow for routing along major corridors or are already served by the subway.

The proposed alignments include: the Smith-9th Street subway station via Lorraine Street or Centre Mall; Columbia Street and Beard Street; Van Brunt alone or a one-way pair with Richards Street; Summit, Carroll, or Union Street to Columbia Street; Atlantic Avenue to Boerum Place; and a terminus at either Atlantic Terminal, Borough Hall, or a loop back to Atlantic via Boreum, Joralemon Street, and Court Street. As the study continues, certain portions are expected to be withdrawn from consideration if found to be infeasible.

Q – Jennifer Posner of DCP asked if streetcars are able to make sharp turns in narrow streets.
A – Hrones answered that they can indeed make sharp turns and that the study team is not anticipating any land acquisitions or other mitigations for turning radius concerns.

Q - Colin Foley of the MTA stated that there is already much bus congestion on Joralemon Street which may make introduction of a streetcar there difficult. He said also that the narrow width of 9th Street made it hard for MTA buses to navigate the area and that there were frequent accidents as a result.
A – Hrones responded that both areas are indeed challenges and suggested that the DOT may consider changes in street infrastructure or travel direction, perhaps along Lorraine or at some of the crossings of Hamilton Avenue.

Q – Craig Hammerman of Brooklyn Community Board 6 stated that potential routes should be discussed with emergency services, including the New York Police and Fire departments, as soon as possible. He also asked if it might be possible to consider use of the

abandoned rail tunnel under Atlantic Avenue or a route over the Brooklyn-Queens Expressway trench along Hicks Street.
A – Hrones said that the goal of the study was to come up something feasible, and that such proposals would require an order-of-magnitude cost increase that would likely render them infeasible.

Q – Craig Hammerman of Brooklyn Community Board 6 stated that the DOT should take care to ensure that any proposed route maps not be misrepresented to the public as a foregone agency decision.
A – Hrones stated that the agency would work to ensure that the public understood the process and that it remains merely a feasibility discussion.

Q – Patrick Thrasher of the Port Authority of New York & New Jersey noted that the alignment travels through industrial areas with heavy truck traffic and asked if there was discussion of how a streetcar would interact with these uses.
A – Gill Mosseri answered that the city would need to make decisions on how to manage deliveries and whether to rearrange truck routes. Steve Gazillo said that there was coordination of streetcar planning with industrial uses in Portland, and that this example would be integrated into the final report.

Q – Maya Kremen of Congressman Jerrold Nadler's office asked if the number of employees at the Red Hook Marine Terminal was considered and whether travel between the various terminal sites might be factored into to ridership estimates.
A – Hrones answered that the study is using employee numbers for all of Red Hook, and that that number should take into account such trips. (Patrick Thrasher of the Port Authority estimated the number of employees to be 1200.) Steve Gazillo of URS added that there was discussion with DCP and EDC about serving such workers and DOT's Eric Beaton responded that the route suggestion is an attempt to capture both the port and commercial areas.

4) Next Steps

Hrones repeated that the individual reports on existing conditions, transit demand, case studies and alignments will be posted to the study website as they are completed, as would be the feasibility analysis and cost estimate. He added that another CAC meeting will be held in February, and that there would be one public meeting as well.

Q – Sandy Balboza of Atlantic Avenue Betterment Association stated that she supported a street-running route along Atlantic Avenue to the tunnel as it would be better for local businesses. She also asked when streetcars were discontinued and whether it was due to the declining population of Red Hook.

A – Hrones answered that, like many part of the country, New York City streetcar lines were converted to buses by the 1950s, and that the process in Red Hook was probably not specifically related to population trends.

George Haikalis of the Institute for Rational Urban Mobility stated that he supports the project and distributed a leaflet advocating introduction of a light rail line along 42nd Street in Manhattan.

Q – Ray Howell of the Institute for Rational Urban Mobility asked whether additional benefits of streetcars, including their low emissions, would be considered in the study.
A – Hrones answered that many buses are close to non-polluting themselves, but that certain factors, such as the smoothness of a streetcar ride compared to that of a bus would be taken into consideration.

Q – Craig Hammerman of Brooklyn Community Board 6 asked if there was any additional assistance CAC members could provide to the study team.
A – Hrones said that sharing the reports with member of the public after they are posted on the website would be helpful.

Q - Robert Perris of Brooklyn Community Board 2 asked what additional opportunities would exist for additional CAC input.
A – Hrones referred to the upcoming meetings and reiterated his request for CAC response to the completed reports.

Q – Dan Wiley of Congresswoman Velázquez's office asked what would come of the B61 bus if a streetcar was introduced along a similar route and asked if the MTA would consider stopping bus service in that case.
A – Colin Foley of the MTA acknowledged that his agency would consider stopping bus service in such a situation.

Brooklyn Streetcar Feasibility Study
CAC Meeting #2 Summary
December 13, 2010 6:30-8:30pm

1) Introductions

Congresswoman Nydia Velázquez began the meeting by stating that Red Hook feels disconnected from the city's transportation network but that it can benefit from the experiences of other cities that have introduced streetcars in recent years. She thanked the Department of Transportation and its commissioner, Janette Sadik-Khan, for its work towards reintegrating Red Hook and thanked Brooklyn Streetcar Feasibility Study stakeholders for their input.

The DOT's Christopher Hrones, the project manager, introduced himself, thanked Congresswoman Velázquez for her commitment of federal funds for the study, and thanked Carl Hum of the Brooklyn Chamber of Commerce for his assistance. Hrones then introduced agency and lead consultant staff in attendance, including:

- DOT employees Eric Beaton, Jessica Wurwarg, Nicole Gonzalez, and Nicholas Mosquera
- URS staff Gill Mosseri, Steve Gazillo, and Don Varley

Community Advisory Committee (CAC) members in attendance also introduced themselves.

Hrones then gave a brief overview of the meeting agenda and background on the study thus far, including: the key distinctions between streetcar and light rail; the goals and scope of the study; the schedule; and the difference between the Focus Area (Red Hook proper) and the Study Area (surrounding neighborhoods and transit nodes).

2) Presentation

A. Existing Conditions Report

Hrones summarized the lead consultant's report on the existing socio-economic and transit conditions within Red Hook and the greater Study Area. The neighborhood's population had declined between 1950 and 2000, but experienced a small rebound in the last 10 years. It has relatively low population and employment density as well as a lower median income than the borough-wide average. Two thirds of the population resides in the New York City Housing Authority-owned Red Hook Houses. Transit connections are minimal, and residents are dependent on the B61 bus, which is seen as unreliable, or long, pedestrian-unfriendly walks to subway service outside the neighborhood. Last, the neighborhood's zoning is intended to retain the working waterfront and medium-density residential areas. There are relatively few planned developments, with the exception of a residential conversion of 160 Imlay Street, and no plans to encourage high density waterfront residential development.

NEW YORK CITY DOT

Brooklyn Streetcar Feasibility Study
CAC Meeting #3 Summary
April 14, 2011 6:30-8:30pm

1) Introductions

The DOT's Christopher Hrones, the project manager, introduced himself and agency and lead consultant staff in attendance, including:

- DOT employees Eric Beaton and Ellen Zielinski
- URS staff Gill Mosseri, Stephanie Camay, Steve Gazillo, Stephen Mitchell, and Don Varley

Community Advisory Committee (CAC) members in attendance then introduced themselves.

Hrones then thanked Congresswoman Nydia Velázquez for her commitment of federal funds for the study and Carl Hum, President of the Brooklyn Chamber of Commerce, for his support and stated that they could not attend for scheduling reasons. Hrones also thanked CAC members, explained that this was the last of three meetings, and apologized for holding the final CAC meeting in April as opposed to February, as originally scheduled, citing the large amount of work that required completion.

2) Presentation

A. Study Overview

Hrones began the presentation with the Study Overview, explaining that the purpose of the project was to determine the feasibility of a streetcar linking Red Hook to surrounding areas and that related goals included identification of an optimal alignment, constraints, and costs. He also added that the DOT did not begin the study knowing whether streetcar was viable within the Study Area. He highlighted Red Hook as the Focus Area, part of the larger Study Area, encompassing various neighborhoods including Downtown Brooklyn, and the study schedule, with a summary of the work completed to date.

B. Recap of Interim Reports

Hrones then outlined the existing transit conditions in Red Hook, noting the high percentage of households without vehicles, the B61 bus ridership, distance to the nearest subway station, perceived lack of bus reliability, and the long travel times to Downtown Brooklyn. It was noted however that streetcar would not greatly decrease travel time or be more reliable than the bus route. He reviewed the projected impact of transit use of a streetcar, which would be a 12 percent increase over current transit use, with a larger increase should proposed developments in the area be built. Next, He introduced the three cases studies (Portland, Oregon, Seattle, and Philadelphia) and pointed out key lessons, including the need for incentives tied to streetcar to spur development and thus increased streetcar ridership. Portland had such incentives and prospered; Philadelphia's streetcar did not.

C. Feasibility Analysis

Hrones discussed the process of making a policy decision regarding Streetcar in the study area, which took into account the selection of an optimal route, various implementation and operational issues, costs, and benefits. He presented the alignment options unveiled at the second CAC meeting, and highlighted key evaluation criteria. He explained the route resulting from this evaluation, which would run along Centre Mall, in two directions along Van Brunt, connecting to Columbia via Carroll and President, and terminating at Borough Hall.

Hrones explained that this optimal route nevertheless had key constraints, including narrow roadways that would leave streetcar susceptible to parked cars; ; and possibly require taking of parking lanes or reconfiguring certain intersections. The turning radius of modern streetcars may require parking or sidewalk impacts at certain tight intersections. He noted that utilities within the proposed right-of-way would need to be relocated, significantly adding to the cost of the project. He reiterated that a streetcar would not alone lead to development, as demonstrated by Philadelphia, and that the Department of City Planning has no plans to rezone the industrial areas of Red Hook or upzone residential portions. Hrones also pointed out that bicycle routes would need to be reconfigured to avoid conflict with streetcar tracks and station stops. He summarized the benefits of the project as the 12 percent increase in transit use, the smoother ride, and potential development potential and provided the $176 million capital cost estimate, the largest portion of which would be needed for purchase of the vehicles. Based on this analysis of the route, costs, benefits, and key issues, Hrones stated that the DOT would not pursue a streetcar in the Study Area at this time, but stated that areas with wider streets or a policy for encouraging higher-density, mixed-use development might be more viable for streetcar. .

D. Short Term, Non-Streetcar Transit Improvements

Hrones stated that DOT, with the cooperation of MTA New York City Transit, is investigating non-streetcar improvements to Red Hook transit. These include a potential new pedestrian and vehicle crossing of Hamilton at Mill Street/Garnet Street; potential service adjustments to the B61 as well as new bus shelters; and an Urban Art project under the Gowanus Expressway as well as a pedestrian refuge at Clinton Street and Centre Mall.

3) Questions and Answers

Q – Craig Hammerman of Community Board 6 asked why Philadelphia decided to introduce a streetcar, given the lack of a development plan and how that city's plan differed from the West Coast model.
A – Steve Gazillo of URS explained that it was a top-down political decision to reintroduce the former streetcar line in Philadelphia made without much thought of development,

whereas Portland's plan was economic development and began before the streetcar was added to the project.

Q - Craig Hammerman of Community Board 6 asked whether Philadelphia's project is seen as a success or failure.
A – Hrones said that it was closer to a failure than a success given the operational difficulties and the customer perception of the service.

Q - Craig Hammerman of Community Board 6 asked if the Philadelphia streetcar makes enough money to cover operating costs.
A – Steve Gazillo of URS explained that it does not, but that no other public transit lines do either.

Q – Sandy Balboza of Atlantic Avenue Betterment Association stated that many of the key constraints, such as the narrow streets and relatively low expected ridership increase were known, and asked if the results of the study were pre-determined. She also asked whether DOT had considered a loop route that avoids some of the constrained roadways.
A – Hrones said that while it was known that certain streets were indeed narrow, it was nevertheless necessary and informative to analyze the optimal alignment in a comprehensives manner. He added that a loop route was considered, but that such a route would take longer to traverse and that Downtown Brooklyn, where such a route would travel, would also have similar operational constraints.

Q – George Fiala of Select Mail stated that the study goals appeared to have changed from one that would consider transportation options in Red Hook to one that would help spur development. He added that a short loop route from the Smith and 9th Street subway station to destinations on Beard Street might better serve the community and be a more practical project.
A – Hrones answered that the goals had not shifted, and that the study purpose had always been to analyze the feasibility of a streetcar. He added that the route options were chosen based on CAC feedback and key traffic generators and that the proposed Mill Street intersection would provide a more direct, reliable route from Red Hook to Smith and 9th station.

Q - George Fiala of Select Mail asked if the optimal streetcar route had tracks in one or both directions.
A – Hrones answered that there would be tracks in both directions, which would be needed to maintain the same frequency as the B61 bus.

Q- George Fiala of Select Mail stated that a two-mile loop streetcar system from Smith and 9th station to IKEA or Fairway would need one set of tracks, be less intrusive, and provide regular service at 20 minute intervals.

A – Hrones responded that the short route described could be traversed by a bus as well as a streetcar.

Q - George Fiala of Select Mail stated that Red Hook would gain a tremendous public relations boost and grow in popularity with tourists if it had a streetcar. He added that Downtown Brooklyn connections were not necessary.
A – Hrones responded that it would likely attract certain tourists but that the study was conceived as a transportation project for all residents.

Q – Victoria Hagman of the Realty Collective asked why the study considered an alignment where the bus already travels, and why other options weren't put forth.
A – Hrones answered that the B61 follows a logical route that serves key generators, and that if one is going to invest money in transit infrastructure, it makes the most sense to serve as many people as possible.

Q - Brian Kerr of the Columbia Waterfront Neighborhood Association asked where the 12 percent ridership increase would come from since Red Hook is already so transit dependent, adding that if one mode increases in ridership, another decreases.
A – Hrones said that the methodology was based on a comparison of neighborhoods with only bus service to those with subway and bus service. He added that Red Hook does in fact have a number of drivers, and that it could be expected that a large portion of the estimated ridership increase would be made up of drivers.

George Fiala of Select Mail proposed that the study team consider a covered, weather-proof walkway option for pedestrians between Smith and 9th station and Red Hook.

Q – Victoria Hagman of the Realty Collective stated that the short-term improvements would not be sufficient and asked why ferry options were not considered.
A – Hrones answered that the study was looking at streetcar only, not other modes, but pointed out the NYC Economic Development Corporation (EDC) is currently planning on introducing new East River ferry service. He suggested that if it was successful, it was possible that it would be extended to Red Hook.

George Fiala of Select Mail George inquired about the need for an Alternatives Analysis, prompting the discussion of the study's next steps.

4) Next Steps

Hrones stated that DOT anticipated that an Alternatives Analysis would be needed before a streetcar project could go forward, but that based on results of study, the time required for such an analysis, and the lack of available funding streams, the DOT felt it was more productive to focus on short-term improvements. He added that the Feasibility Report and Operations Memo would be posted on the study website and that DOT will receive and document public comments. He stated that though such comments may result in adjustment to Final Report, he did not foresee any major policy change. Hrones mentioned that he would give the evening's presentation to Community Boards 2 and 6; that the Public Meeting would be held on May 9th; and that DOT would continue to work on implementing the short-term improvements and would form a community-based committee as part of that process.

Q – Craig Hammerman of Community Board 6 asked if that committee would include representation from New York City Transit.
A – Colin Foley of New York City Transit said that should be possible.

Q - Craig Hammerman of Community Board 6 asked if Hrones would chose to build the streetcar if he had access to the necessary capital. He added that it was conceivable that an interested politician could secure the funding.
A – Hrones answered that while capital cost was a major consideration, there were others, including operations cost.

Q – Dan Wiley of Congresswoman Velázquez's office said that he believed the study moved the discussion of Red Hook transit access further. He added that he would like to know if the consultant could calculate whether the short loop suggestion made by George Fiala would in fact represent a reduction in cost proportion to its reduction in length, but stated that such a short route might not attract as much ridership. He added that though the study did not result in a decision to implement a streetcar, the City would now have a more substantive base for future consideration and commended the DOT for considering short-term improvements.
A – Hrones answered that the consultant's budget might not allow for such a calculation of loop route cost, but suggested that DOT might be able to do so.

A - George Fiala of Select Mail asked if the study team consulted residents of the Columbia Street Waterfront area and pointed out that numerous recent construction projects there might deter residents from welcoming the streetcar. He also suggested that the study should have considered alternate routes such as Richards Street.
A – Hrones responded that while the study did not include surveys, representatives of the neighborhood were included in the CAC, and that the study team received comments via the website as well. He added that many streets in the Study Area are narrow and would pose problems similar to those on Columbia.

Dan Wiley of Congresswoman Velázquez's office agreed that major construction projects are difficult, and that the current Columbia Street construction project is no exception. He added that completing the ongoing project as soon as possible would be an improvement on the lives of residents there.

9.0 APPENDIX B – PUBLIC COMMENTS

Brooklyn Streetcar Feasibility Study
Public Meeting Questions and Comments Summary
May 9, 2011 6:30-8:30pm

Q – Bill Harris, Atlantic Avenue Betterment Association
Is streetcar synonymous with light rail?
A – Chris Hrones, DOT
There is not always a clear cut distinction. Light rail, such as the Hudson-Bergen Light Rail, has similar technology, but is more regional and operates mostly in dedicated right-of-way. It serves lot of smaller cities in North America much the same way as the subway serves New York, providing long-haul trips to stations that are further apart. Streetcar operates more like bus, serving local stops at the neighborhood level. Streetcars are smaller, less expensive, and require less infrastructure, as well. Streetcar and trolley are synonymous terms, however.

Comment – Bill Harris, Atlantic Avenue Betterment Association
I had been picturing the potential Brooklyn streetcar as a lighter-weight, replica vehicle, rather than the large vehicles that Philadelphia and the other case study cities use.

Q – Robert Berrios
The big problem with the B61 is not length of the route, but the problem areas, such as the left turn onto Summit when blocked by cars illegally parked at the corner; traffic between Smith and 2nd Avenue; and when the drawbridge is opened up. When the Smith and 9th Street subway station is closed, shuttle buses will fight with B61, as well. There is always traffic, and the bus is often too crowded to board. The route really needs some improvement along 9th Street, which is the biggest problem.
A – Hrones
Thanks for your comments. That kind of specificity is very helpful when we're looking to make transit improvements. We may need to evaluate the parking on 9th Street.

Q – Michael Cairl, Gowanus Community Stakeholder Group
Regarding the bus turning issues at Columbia and Summit, perhaps the answer is to move the bus off of Summit and onto other streets.
A – Hrones
The issue with that is the ongoing Capital Reconstruction Project is affecting that portion of the route. With that caveat, we can look into bus routing alternatives.

Q – Michael Cairl, Gowanus Community Stakeholder Group
Were there any destination studies done as part of the streetcar study? That would have been helpful to understand how best to move people, and whether bus was their sole mode of transportation. I also think that the 4th Avenue and 9th Street subway station is overlooked as a transit point, and that it might actually provide an easier trip for some riders.
A – Hrones
We didn't do an origin/destination study, but we did look at journey to work data from the census and found that Red Hook residents were going primarily to Midtown, Lower Manhattan, and Downtown Brooklyn. Interestingly, a larger percentage were going to Lower Manhattan

than you find in many neighborhoods and that makes a potential bus route through the Brooklyn-Battery Tunnel that much more attractive.

Q – Robert Berrios
Are you planning on replacing the bricks at the pedestrian crossing of Hamilton Avenue at West 9th Street? The path is smooth on Clinton, but not at West 9th street and people trip there. Cars have also crashed into the barrier nearby and there are bent poles remaining.
A – Hrones
That pedestrian movement is not a legal crossing, but we do admit that the area is in bad shape and we want to clean it up.

Q – Candice Sering, Falconworks
Since you're going to looking at this West 9th crossing, you should look at the signal times as well. It's hard for bikes, pedestrians, and autos. San Francisco has useful diagonal crossings that might be worth looking into here. And regarding destination choice, having the B61 go to IKEA takes everyone out of their way and it seems like it's an unnecessary inconvenience, especially since IKEA has their own buses already.
A – Hrones
We can take a look at pedestrian signal timing at this location. There might still be some looping required on the route even the bus doesn't go to IKEA, but we're happy to raise your suggestion with the MTA.

Q – Candice Sering, Falconworks
Regarding the proposed Urban Art Project, you need to make sure it stays within the community and won't become an open call, city-wide. There are so many artists here, and it would be good for kids in neighborhood. It would be a disappointment if the local artistic community isn't involved.
A – Hrones
While I believe the program is technically required to be open city-wide, we are reaching out to specific organizations in the community. Dan Wiley from Congresswoman Velázquez's office is helping with this and trying to get people from neighborhood itself.

Q – Robert Berrios
Beard Street between Van Brunt Street and Richards Street is all cobblestones. The buses at Jackie Gleason Depot that serve this route are old and have to go very slow here as there is a lot of vibration that is not good for buses or riders.
A – Hrones
The Belgian blocks are an interesting case: some neighborhoods won't let the DOT take them away, but in certain situations, they're not really an asset. If there's a capital construction project involving the roadway, we'd be happy to take them away if the community wanted us

to do so. The other, more likely possibility is if or when property next to IKEA is redeveloped; the developer would likely reconstruct the streets there as IKEA did near its property.

Q – Candice Sering, Falconworks
Regarding the traffic on Van Brunt Street, is there any way to put in a stop light at the blind intersection of Van Brunt and Wolcott? It needs some daylighting. There is a stop light at Sullivan, though pedestrians can see fine there though because it's an open intersection. You need that stop sign or crosswalk at Wolcott though, as there have been multiple bike accidents and cars go too fast there.
A – Hrones
We are happy to do warrant analyses. Our traffic signals group will look into this upon request of the community and make their decision based on federal guidelines. Sullivan was warranted because of the number of school crossings there. Other intersections didn't meet those warrants, but if there are now more pedestrians or accidents, that could change. Signaling is one area where we don't have a lot of leeway, but we can look into any intersection again after 18 months.

Q - Dan Wiley, Congresswoman Velázquez's Office
Regarding stoplights, there is one at the cruise terminal nearby. How did that happen? I believe it was the first one in the area.
A – Hrones
A signal warrant analysis can take into account documented future traffic from a development. I believe that's what led to the stoplight at Bowne Street.

Q – Robert Berrios
Van Brunt is a speedway between Sullivan Street and Bowne Street. People try to race down this long strip, which has a church and a criminal justice hall. This large gap between stop lights is potentially dangerous.
A – Hrones
This concern was raised at the Red Hook Civic Association, and said we'd be happy to look at that. We want to stay involved in Red Hook and work with the community. Our hands bound somewhat by the warrants and we couldn't put in a speed hump as this a bus route, but we are willing to look into new options and will work with John McGettrick of the Civic Association on this.

Q – Candice Sering, Falconworks
Just to be clear, the streetcar idea has been tabled?
A – Hrones
Yes, we are focusing on these short-term improvements. Still, much useful information came out of the report that can be used not just for Red Hook but for the city as a whole. It's a good resource, and if there is a budget turnaround in five years or so, it will be very useful.

Brooklyn Streetcar Feasibility Study
Public Meeting Questions and Comments Summary
May 9, 2011 6:30-8:30pm

Comment - Dan Wiley, Congresswoman Velázquez's Office
With regards to Congresswoman, a lot of people have been talking about streetcar study recently, but at least putting the money towards this study means there is something people can go to in the future. There is a high price tag because of issues presented here tonight, now there is a report people can consult and do something with, for applicability here or elsewhere. This was, after all, a feasibility study and you can't anticipate answers. That said, the Congresswoman feels very strongly that need to be improvements for pedestrians and all modes in Red Hook, and this study has brought more attention to it, as has the Smith and 9th Street subway station reconstruction. We should develop these short-term recommendations and use this momentum.

Comment – Ana Ramos, State Senator Montgomery's Office
Our office received a lot of calls in support of the streetcar project. We are sad that it is not going forward at this time, but are glad that it shined a light on these other concerns, especially the bus service improvements and the art project.

Comment – Bill Harris, Atlantic Avenue Betterment Association
I don't think this study was a waste. In fact, I think expectations were unfairly raised. The city is in a very difficult situation financially and it's doubtful that the MTA could have taken it on anytime soon. Red Hook definitely needs help and this research does help us see further ahead. It's wonderful that the Congresswoman could get these funds and that we can look at it the results of the study, take neighborhood suggestions, and work with the DOT.

Public comments received by email and mail are available by contacting NYCDOT Brooklyn Borough Commissioner's Office (16 Court Street, Suite 1620, Brooklyn, NY 11211

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