

## C. DEFINITION OF ALTERNATIVES

### C.1. INTRODUCTION

The *Southern New Jersey to Philadelphia Transit Study* (October 2005) examined 28 multimodal alternatives for improving access between South Jersey and Philadelphia as well as within Philadelphia. The Feasibility Study process recommended that the potential transit investments warranted further examination in an Alternative Analysis, which was further confirmed during public outreach. Three South Jersey alternatives and two Philadelphia alternatives comprised the final short list of alternatives.

In Philadelphia, the two short-list alternatives were carried over into the Alternatives Analysis (AA) phase and were evaluated as part of the current phase of the project. This chapter identifies the alternatives considered in both phases of the project to-date as well as the transportation system management (TSM) alternative.

### C.2. FEASIBILITY STUDY ALTERNATIVES EVALUATION PROCESS

The Delaware River Port Authority (DRPA) completed the *Southern New Jersey to Philadelphia Transit Study* (Feasibility Study) in October 2005. The study evaluated the feasibility of potential transit investments in both South Jersey and Philadelphia. Two Philadelphia sub-area transit markets were considered:

- **Philadelphia Market West** – This sub-area focuses on improved connections from the existing PATCO Speedline system to the dense commercial development in Center City along Market Street west of City Hall.
- **Philadelphia Waterfront** – This sub-area focuses on connections from the existing PATCO Speedline and SEPTA bus and rail systems to waterfront destinations, including retail establishments and entertainment venues along Columbus Boulevard and Penn’s Landing.

The study identified a “long list” of alternatives (Table C-1 and Table C-2).

The Feasibility Study then evaluated the eight Market West Alternatives and the nine Waterfront Alternatives producing a “reduced list.” The process included evaluating estimated capital and operations and maintenance costs, and included input from the study’s Advisory Group, the project Steering Group, and the public. For the Market West Alternatives, all candidate improvements were eliminated because of high capital cost, duplication of service, unacceptable operational complexity or safety issues, or impacts too significant to mitigate. For the Waterfront Alternatives, four of the nine proposed improvements advanced to the reduced list (Table C-3).

Through a combination of input received at a Regional Transportation Forum and consideration by the project’s Advisory Group and Steering Group, two Waterfront Alternatives from the “reduced list” were advanced to the “final list” (Table C-4).

TABLE C-1: FEASIBILITY STUDY – MARKET WEST ALTERNATIVES (LONG LIST)

Alternative	Mode	Alignment/Location	Capital Costs	O&M Costs
<b>Alternative 1</b> PATCO Extension to 20th & Locust/Walnut	PATCO Heavy Rail	Locust or Walnut Street (underground)	High	Medium
<b>Alternative 1a</b> PATCO Extension to Schuylkill and JFK/Arch		Locust or Walnut Street (underground) and CSX* along Schuylkill River	Very High	Medium
<b>Alternative 1b</b> PATCO Extension to 30th Street Station		Locust or Walnut Street (underground), under Schuylkill River, Amtrak*	Very High	Medium
<b>Alternative 2</b> New Station on MFL	New Station	20th/21st Streets and Market Street (underground)	Medium	Low
<b>Alternative 3</b> Improvements to Pedestrian Concourse	Pedestrian	Market Street between 8th Street and Market West Area	Medium	Low-Medium
<b>Alternative 4</b> Underground Extension of Green Line Trolleys to 8th & Market	SEPTA Green Line Trolleys	Market Street (underground)	Very High	Medium
<b>Alternative 4a</b> At-Grade Extension of SEPTA's Green line Trolleys to 8th & Market		Market Street (at-grade)	High	Medium
<b>Alternative 5</b> Extension of 52nd Street Trolley to 8th & Market	Heritage or Modern Trolley	Arch, Race, 8th, and 9th Streets, Columbus Boulevard	High	Medium

Source: *Southern New Jersey to Philadelphia Transit Study* (October 2005), DRPA

\* CSX = CSX railroad ROW

Amtrak = Amtrak railroad ROW at 30th Street Station.

TABLE C-2: FEASIBILITY STUDY – WATERFRONT ALTERNATIVES (LONG LIST)

Alternative	Mode	Alignment/ Location	Capital Costs	O&M Costs
<b>Alternative 1</b> Extension of SEPTA Bus Route 33 from Penn's Landing to Pier 70	Bus	Columbus Boulevard	Low	Low
<b>Alternative 1a</b> Bus shuttle from Philadelphia Convention Center to Pier 70		11th, 12th, Arch, and Market Streets, Columbus Boulevard		
<b>Alternative 2</b> Trolley Shuttle from Philadelphia Convention Center to Pier 70	Heritage or Modern Trolley		High	Medium
<b>Alternative 3</b> Extension of Green line Trolleys from Juniper/13th & Market to Pier 70 and Spring Garden (underground)	SEPTA's Green Line Trolleys	Market Street (underground), Columbus Boulevard	Very High	
<b>Alternative 3a</b> Extension of Green Line Trolleys from Juniper/13th & Market to Pier 70 and Spring Garden (at-grade)		Market Street (at-grade), Columbus Boulevard		
<b>Alternative 4</b> Trolley Shuttle from Franklin Square to Pier 70 and Spring Garden	Heritage or Modern Trolley	Under Ben Franklin Bridge, Columbus Boulevard	High	
<b>Alternative 5</b> New PATCO Station on Ben Franklin Bridge	New Station	Eastern Ben Franklin Bridge Abutment		Low
<b>Alternative 6</b> Extension of Proposed 52nd Street Trolley to Pier 70 and Spring Garden (via 11th and 12th Streets)	Heritage or Modern Trolley	Arch, Race, 11th, and 12th Streets, Columbus Boulevard		Medium
<b>Alternative 6a</b> Extension of Proposed 52nd Street Trolley to Pier 70 and Spring Garden (via 8th and 9th Streets)		Arch, Race, 8th, and 9th Streets, Columbus Boulevard		

Source: Southern New Jersey to Philadelphia Transit Study (October 2005), DRPA

TABLE C-3: FEASIBILITY STUDY – WATERFRONT ALTERNATIVES (REDUCED LIST)

Alternative	Mode	Alignment/ Location	To Pier 70		To Spring Garden		Capital Cost
			Length	Travel Time	Length	Travel Time	
Alternative 1 Extension of SEPTA Bus Route 33 from Penn's Landing to Pier 70 (Long List Alt. 1)	Bus	Columbus Boulevard	2.5 miles	16 minutes from 8th & Market	Not applicable		\$0.3–\$0.6 million
Alternative 2 Trolley Shuttle from Franklin Square to Pier 70 and Spring Garden (Long List Alt. 4)	Heritage or Modern Trolley	Under Ben Franklin Bridge, Columbus Boulevard	3.1 miles	15 minutes	2.0 miles	5 minutes	\$250–\$450 million
Alternative 3* Trolley Shuttle from 4th Street and BFB to Pier 70 and Spring Garden (Long List Alt. 4)	Heritage or Modern Trolley and Pedestrian Walkway	Under Ben Franklin Bridge, Columbus Boulevard	2.9 miles	14+ minutes walk to Franklin Square	1.8 miles	4+ minutes walk to Franklin Square	\$200–\$300 million
Alternative 4 Extension of Green Line Trolleys from Juniper/13th & Market to Pier 70 and Spring Garden (underground) (Long List Alt. 3)	SEPTA Green Line Trolleys	Market Street (underground), Columbus Boulevard	3.4 miles	16 minutes	2.9 miles	7 minutes	\$500–\$900 million

Source: *Southern New Jersey to Philadelphia Transit Study* (October 2005), DRPA

\* Alternative 3 is a new alternative that was based on Long List Alternative 4, but is not identical to it

TABLE C-4: FEASIBILITY STUDY – WATERFRONT ALTERNATIVES (FINAL LIST)

Alternative	Mode	Alignment/ Location	To Pier 70		To Spring Garden		Capital Cost
			Length	Travel Time	Length	Travel Time	
Alternative 2 Trolley Shuttle from Franklin Square to Pier 70 and Spring Garden (Long List Alt. 4)	Heritage or Modern Trolley	Under Ben Franklin Bridge, Columbus Boulevard	3.1 miles	15 minutes	2.0 miles	5 minutes	\$250–\$450 million
Alternative 4 Extension of Green Line Trolleys from Juniper/ 13th & Market to Pier 70 and Spring Garden (underground) (Long List Alt. 3)	SEPTA's Green Line Trolleys	Market Street (underground), Columbus Boulevard	3.4 miles	16 minutes	2.9 miles	7 minutes	\$200–\$300 million

These two alternatives from Table C-4 were retained for additional study and evaluation in this AA.

### **C.3. ALTERNATIVES ANALYSIS SCREENING PROCESS**

The PATCO Philadelphia Waterfront Transit Expansion AA began with the two alternatives retained from the Feasibility Study: a trolley shuttle from Franklin Square to Pier 70 and Spring Garden Street and extending the SEPTA's Green Line Trolleys from Juniper/13th and Market to Pier 70 and Spring Garden (underground). These alternatives were labeled Alternative PA-1 and Alternative PA-3a, respectively, and followed a three-phase screening process to identify the candidate Build Alternatives.

#### **C.3.1. Phase I: Fatal-Flaw Screen**

The Phase I AA screen comprised two steps: 1) consolidate and combine recommended alternatives to eliminate duplication and 2) assess the candidate alternatives according to the project's goals and objectives. Each alternative received one of three possible grades: (P) Pass; (F) Fail; or (U) Undecided. Any alternative that received an F was eliminated from further consideration. A grade of P or U advanced the alternative to Phase II: High Level Screen.

#### **GOALS**

1. Improve mobility, access, and transit linkages to the Philadelphia Waterfront
  - Reduce congestion
  - Increase share of travel demand accommodated by transit
2. Improve mobility, access and transit linkages from New Jersey to growing commercial areas of Philadelphia
  - Reduce congestion
  - Increase share of travel demand accommodated by transit
3. Support economic development and regional competitiveness
  - Ensure alternatives support existing and future land use in Philadelphia's expanding retail, commercial, residential, and recreation areas
4. Maximize use of existing mass transportation assets
  - Maximize use of the region's existing and committed transportation infrastructure
  - Use existing in-service or out-of-service facilities, if possible
  - Develop new uses for existing transportation assets
  - Minimize disruption to the existing regional transportation system
5. Enhance regional transit linkages and connectivity
  - Provide additional transit choices
  - Provide additional transit connectivity regionwide to serve future travel patterns and markets
6. Support regional efforts to develop consistent with smart growth and sustainable principles and in compliance with federal, state, and local environmental regulations

- Comply with federal, state, city, and regional rules and aims for air quality, noise, surface and groundwater quality, stormwater management, energy consumption, environmental justice, park access, and hazardous materials
- Minimize community disruption, displacements, and relocations
- Minimize adverse impacts to parks, historic resources, visual resources, and aesthetics
- Ensure the alternatives can be implemented in conformity with FTA's New Starts criteria

### **C.3.2. Phase II: High-Level Screen**

The Phase II screen comprised both qualitative and quantitative factors in addition to reasonable engineering estimates (as shown in Table C-5). The results were reviewed by the PATCO/DRPA Project Team. Those alternatives not eliminated were advanced to Phase III: Short-List Screen.

### **C.3.3. Phase III: Short-List Screen**

The Phase III screen (as shown in Table C-6) comprised engineering and qualitative analyses to determine specifics of the remaining alternatives. Critical criteria such as final estimated capital and operations operating and maintenance (O&M) costs, ridership, and cost effectiveness were developed. Based on the results, the final alternatives were ranked using a trade-off analysis and one was selected by the project team in consultation with the TAC.

## **C.4. ALTERNATIVES ANALYSIS SCREENING RESULTS**

On January 22 and 24, 2008, the public and other interested parties were invited to review the draft alternatives, provide comments on the proposed alternatives, and suggest new alignments and concepts. The meetings were attended by 126 individuals, with 93 attendees returning the comment form, which provided an opportunity to request that additional alternatives be considered. In addition to the public open houses, the project maintained a website that received over 21,000 hits between February 2008 and March 2009. Website users received the opportunity to submit comments on the project as well as suggest alternative alignments to be reviewed by the DRPA/PATCO Project Team.

From the comments received at the open houses and from the website, in addition to solicitations from other stakeholder groups, members of the project's TAC and other interested parties, 11 potential alternative alignments were reviewed by the DRPA/PATCO Project Team.

TABLE C-5: ALTERNATIVES ANALYSIS – PHASE II: HIGH-LEVEL SCREEN

Criteria	Description
Preliminary Estimated Capital Cost	Preliminary estimate of capital cost
Construction Impacts	Severity and duration of impacts related to construction activity
Transportation System Connectivity	Degree to which alternative enhances transportation system connectivity
Transportation System Integration	Degree to which alternative would integrate into the existing transportation system
Impact on Non-Vehicular Activity	Degree of accommodation for pedestrian and bicycle facilities
Consistency with Present Land Use	Degree to which the alternative is consistent with existing land use
Consistency with Future Land Use Goals	Degree to which the alternative is consistent with future proposed land use goals as articulated by the City of Philadelphia
Adverse Impact on Parklands	Degree of potential impact to parklands and 4(f)

TABLE C-6: ALTERNATIVES ANALYSIS – PHASE III: SHORT-LIST SCREEN

Criteria	Description
Ridership	Estimated daily ridership for the alternative
Capital Cost	Estimate of the alternative's capital cost
O&M Cost	Estimate of the alternative's O&M cost
Adverse Air Quality Impacts	Adverse effect of alternative on regional air quality
Travel-Time Savings	AM peak-period travel-time savings
Peak-Period Vehicle Reduction	Estimated number of peak-period vehicles to be eliminated by the operation of the alternative
Adverse Effect on Traffic Operations	Degree to which the alternative would negatively affect traffic operations
Cost Effectiveness	Estimate how the alternative would achieve FTA goals for cost effectiveness
Adverse Effect on Historic or Archaeological Resources	Degree of potential effect on historic or archaeological resources
Implementation Challenges	Judgment based on legislative and public support for alternative as well as lack of jurisdictional obstacles
Other Significant Adverse Impacts	Degree of other significant negative effects of alternative

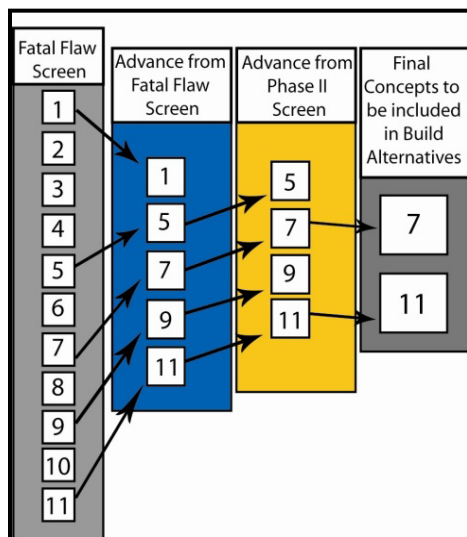
The three-phase project-review screen was applied to the following 11 alternatives.

1. Alternative PA-1 Extended
2. Modification of PA-1 Extended with the subsurface portion of the proposed line extending from City Hall to 5th Street under Independence Mall, connecting to Franklin Square underground.
3. Reorienting the east-west portion of the proposed underground line along Spring Garden Street with 9th Street as the north-west connector between Spring Garden Street and Market Street.
4. Add a new station on the Market-Frankford Line at 20th Street and extend PATCO from its terminus at 15th/16th and Locust to 20th and Market.
5. Extend service to Navy Yard and Sports Complex.
6. Extend the existing PATCO Lindenwold Line to 30th Street Station.
7. Reorient the northern terminus of the proposed line to Girard Avenue instead of Penn Treaty Park and intersect with the Girard Avenue Trolley (SEPTA Route 15).
8. Extend the proposed line to the Art Museum or the Art Museum area.
9. Extend the proposed line north of Penn Treaty Park to Allegheny Avenue.
10. Extend northern terminus of line to Bensalem.
11. Extend PA-1 above ground to 8th and Market.

#### C.4.1. Screening of Alternatives

The 11 alternatives were next subjected to the three-phase screen process (Figure C-1). Two alternatives advanced to the final list of candidate alternatives. A summary of the results of the screening process follows.

FIGURE C-1: SCREENING PROCESS



**TABLE C-7: ALTERNATIVES ANALYSIS RESULTS – PHASE I: FATAL-FLAW SCREEN**

No.	Description	Result	Comment
1	PA-1 Extended	Pass	Advances to Phase II High Level Screen
2	Modification of underground portion of PA-1 Extended	Fail	Impacts related to construction and operation are unacceptable
3	Reorienting of east-west portion of proposed underground line along Spring Garden Street with north-south portion under 9th St.	Fail	Alignment provides no connection to PATCO services
4	Add new station at 20th and Market, extend PATCO Lindenwold Line there	Fail	Alternative considered but rejected during Feasibility Study
5	Extend service to Philadelphia Navy Yard and Sports Complex	Pass	Advances to Phase II High Level Screen
6	Extend existing PATCO Line to 30th Street Station	Fail	Alternative considered but rejected during Feasibility Study
7	Reorient northern terminus to Girard Avenue instead of Penn Treaty Park	Pass	Advances to Phase II High Level Screen
8	Extend proposed line to Art Museum or Art Museum area	Fail	Beyond the scope of this phase of the project
9	Extend northern terminus beyond Fishtown/Northern Liberties	Pass	Advances to Phase II High Level Screen
10	Extend northern terminus to Bensalem	Fail	Presumed capital costs unacceptable
11	Extend PA-1 above ground to 8th and Market	Pass	Advances to Phase II High Level Screen

**TABLE C-8: ALTERNATIVES ANALYSIS RESULTS – PHASE II: HIGH-LEVEL SCREEN**

No.	Description	Result	Comment
1	PA-1 Extended	Fail	Construction impacts and operational issues (detailed in Appendix E)
5	Extend service to Philadelphia Navy Yard and Sports Complex	Pass	Advances to Phase III Short-List Screen
7	Reorient northern terminus to Girard Avenue instead of Penn Treaty Park	Pass	Advances to Phase III Short-List Screen
9	Extend northern terminus beyond Fishtown/Northern Liberties	Pass	Advances to Phase III Short-List Screen
11	Extend PA-1 above ground to 8th and Market	Pass	Advances to Phase III Short-List Screen

**TABLE C-9: ALTERNATIVES ANALYSIS RESULTS – PHASE III: SHORT-LIST SCREEN**

No.	Description	Result	Comment
5	Extend service to Philadelphia Navy Yard and Sports Complex	Fail	Eliminated as part of the minimal operating segment but warrants further investigation in future study phase
7	Reorient northern terminus to Girard Avenue instead of Penn Treaty Park	Pass	Approved to become part of all Build alternatives
9	Extend northern terminus beyond Fishtown/ Northern Liberties	Fail	Eliminated as part of the minimal operating segment but warrants further investigation in future study phase
11	Extend PA-1 above ground to 8th and Market	Pass	Approved to become a Build Alternative to be evaluated

### C.4.2. Final List Screening Results

The Phase III screen resulted in the following:

- The northern terminus of all Build Alternatives will be Girard Avenue.
- Candidate Alternative 11 was added to the final list of Build Alternatives to be evaluated.

The following Build Alternatives are evaluated in this AA report:

Name	Title for AA	Source
Franklin Square to Philadelphia Waterfront	Alternative 1	Feasibility Study
City Hall to Philadelphia Waterfront via Market Street	Alternative 2	Feasibility Study
8th and Market to Philadelphia Waterfront via Franklin Square	Alternative 3	Alternatives Screening

#### **Alternative 1**

**Description.** Alternative 1 (Figure C-2) is based on the original Alternative PA-1 from the *Southern New Jersey to Philadelphia Transit Study* (the Feasibility Study), though the northern terminus has been relocated from Spring Garden Street to Girard Avenue at North Hancock Street. The alignment would extend south from there in the middle of Columbus Boulevard to the southern terminal loop at Pier 70. The short loop to provide a more convenient connection to the Market-Frankford Line at Spring Garden Street station was eliminated as a design feature after the decision was made to connect the proposed line with SEPTA's Market-Frankford Line at the Girard Avenue MFL station stop.

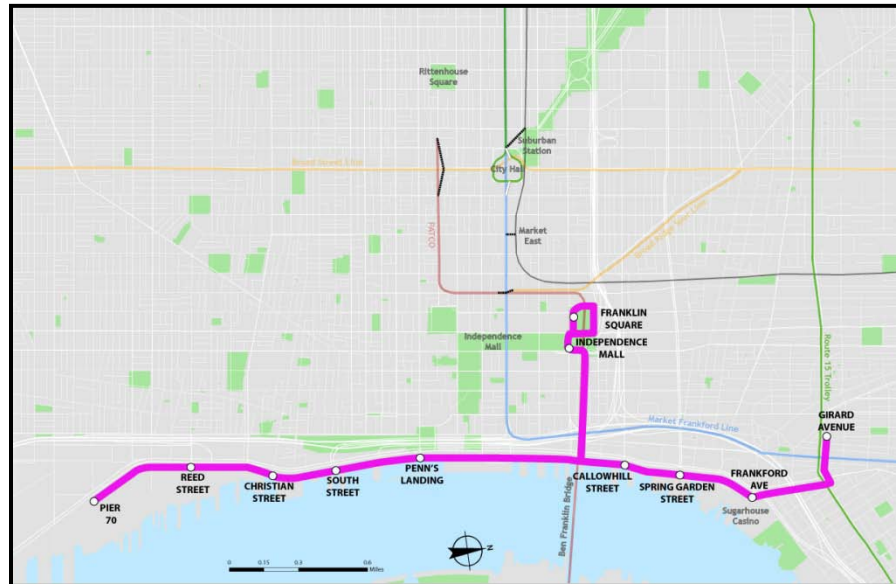
Another notable difference between the Alternative PA-1 identified in the Feasibility Study and the Alternative 1 evaluated in this AA report is that the current alternative features a switch to an alignment that turns west on the south side of the Ben Franklin Bridge approach, continuing on the surface of several small streets to just east of Franklin Square Park, where it enters Race Street operating in a contra-flow direction. The alignment allows streetcars to operate around the park in a clockwise direction with the primary stop on the diagonal portion of 7th Street where the closed-off stairs leading down to the reopened Franklin Square PATCO station are located. Leaving the primary stop, the light rail cars would continue around the park, eventually turning south on 6th Street and operating in the right curb lane to the intersection of Race Street. At 6th and Race, the track would turn east and return to Columbus Boulevard/Delaware Avenue. Three routes would be operated: the North route (Franklin Square Park to Girard Avenue and North Hancock Street), the South route (Franklin Square Park to Pier 70), and the Waterfront route (Girard Avenue to Pier 70).

**Mode.** On-Street Light Rail Vehicles

#### **Benefits.**

- Linkage between PATCO's Lindenwold Line and new waterfront transit service at Franklin Square
- Reopening of PATCO Franklin Square Station

FIGURE C-2: ALTERNATIVE 1 ROUTE MAP



### Alternative 2

**Description.** Alternative 2 (Figure C-3) is based on the original Alternative PA-3a from the Feasibility Study. The alignment linked City Hall and the Waterfront along Market Street at street level. The original Alternative PA-3 from the Feasibility Study extended SEPTA's Green Line Trolleys from its current loop terminus at City Hall. The benefit of this concept would be a potential one-seat ride created from West Philadelphia through the Waterfront via Market Street, the city's east-west transit core. Linking the Waterfront and West Philadelphia, University City, the Market West central business district, Suburban Station, the Broad Street Line at City Hall, the Pennsylvania Convention Center and Reading Terminal Market, the hotels of Market East, and Independence Mall would be beneficial. Three routes would be operated: the **North** route (City Hall Loop to Girard Avenue and North Hancock Street), the **South** route (City Hall Loop to Pier 70), and the **Waterfront** route (Girard Avenue Loop to Pier 70).

Alternative PA-3 from the Feasibility Study had two subalternatives: an underground routing (Alternative PA-3) and an on-street routing (Alternative PA-3a); however, the underground variant (Alternative PA-3) was eliminated for the following reasons:

- The complexity of constructing an underground light rail/trolley line parallel to or under SEPTA's Market-Frankford Line was likely to result in significant service impacts during the construction period, both to the MFL service and at street level.
- The capital cost was estimated at \$1.35 billion—approximately triple the cost of the on-street subalternative, with roughly the same project benefits.

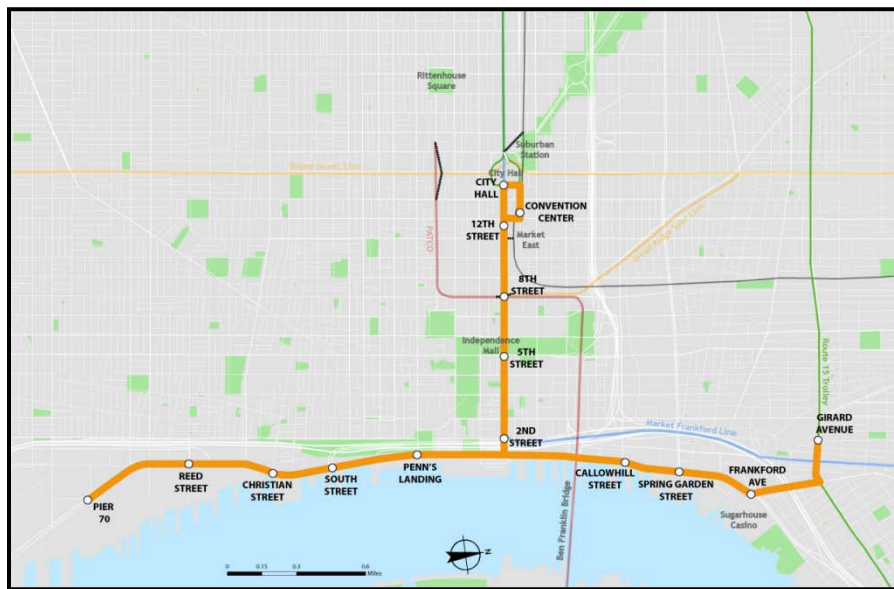
**Alternative 2** would provide access to SEPTA’s Regional Rail services at Market East; SEPTA’s Market-Frankford Line at 2nd Street, 5th Street, 8th Street, 11th Street, 13th Street and Girard Avenue; SEPTA’s Broad Street Line near City Hall; SEPTA’s Broad-Ridge Spur at 8th and Market; and the PATCO Lindenwold Line at 8th and Market.

**Mode.** On-Street Light Rail Vehicles

**Benefits.**

- Provides a direct linkage between the City’s transit core and the Waterfront.
- Utility at both peak times and off-peak times because the alignment would connect key entertainment generators such as the Pennsylvania Convention Center, the Reading Terminal Market, Independence Mall, the National Constitution Center and Penn’s Landing.
- Ridership projections on this alternative are likely to be higher than the other alternatives increasing the competitiveness of the project for Federal New Starts funding.

**FIGURE C-3: ALTERNATIVE 2 ROUTE MAP**



**Alternative 3**

**Description.** Alternative 3 (Figure C-4) emerged from combining input received at the public open houses with suggestions from the City of Philadelphia. The alignment mimics Alternative 1 from Franklin Square to the Waterfront and then accesses the Market East Concourse and Market East at 8th and Market. However, after Franklin Square, the westbound service would operate in a loop fashion south on North 7th Street, west on Cherry Street, south on 8th Street, east on Market Street, north on North 7th Street, around Franklin Square and back to Columbus Boulevard/Delaware Avenue via the route shared with Alternative 1 (Race Street, Florist Street, underneath the Ben Franklin Bridge and access the Waterfront at Race Street). Three routes would be operated: the

North route (8th and Market to Girard Avenue and North Hancock Street), the South route (8th and Market to Pier 70), and the Waterfront route (Girard Avenue East to Pier 70).

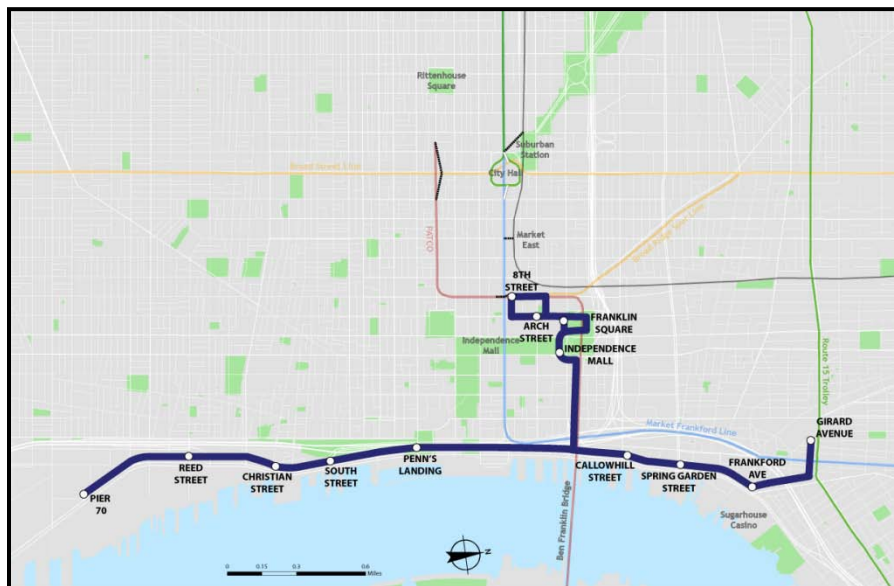
**Alternative 3** would provide access to SEPTA’s Regional Rail services at Market East; SEPTA’s Market-Frankford Line at 8th Street, SEPTA’s Broad-Ridge Spur at 8th and Market; and the PATCO Lindenwold Line at 8th and Market as well as at the re-opened PATCO Franklin Square Station.

**Mode.** On-Street Light Rail Vehicles

**Benefits.**

- Provides a linkage between 8th and Market, Franklin Square and the Waterfront without significant impacts to traffic flow on Market Street.
- Reopening of the PATCO Franklin Square Station

**FIGURE C-4: ALTERNATIVE 3 ROUTE MAP**



**Transportation System Management Alternative**

**Description.** The Transportation System Management (TSM) Alternative (Figure C-5) strives to achieve as much transit service improvement in the corridor as possible without requiring a new fixed guideway or major capital investments. TSM provides a “baseline” for comparing Build Alternatives and helps provide real-world solutions to a particular need or problem. The TSM Alternative can also serve as the first phase to accommodate incremental market development before major investment is warranted. It includes increases in bus-service frequency in the study area, as well as innovative techniques for improving overall system cost effectiveness.

Typical elements of TSM include relatively low-cost actions such as traffic-signal priority, enhanced bus service and other transit operational changes, and modest capital improvements such as reserved lanes, park-and-ride lots, and passenger stations. However, it does not include large-scale capital improvements such as new rights of way acquisitions or major infrastructure expansion.

The TSM Alternative is designed to serve the same user markets as the proposed PATCO Philadelphia Waterfront Transit Expansion AA Build Alternatives. For that purpose, three routes are proposed as the TSM Alternative: the **South** route would serve the key transit connection points in Center City, such as Franklin Square, City Hall, Market East and Suburban Regional Rail stations followed by an extension to employment, commercial and entertainment centers along the Waterfront; the **North** route would also serve the key connectivity points in Center City but would extend to Girard Avenue and North Hancock Street in the north; and **Waterfront** route would serve the Waterfront locations. All three alternatives would serve the same markets that the proposed Build Alternatives would serve.

Both North and South alignments are designed to cover the same areas of influence as the Build Alternatives. For instance, the North TSM alignment covers the Franklin Square transit riders (such as Alternatives PA-1 and PA-3) and Market Street transit riders (such as Alternative PA-2).

**Mode.** Enhanced bus

**Benefits.**

- Enhanced Bus Service – The TSM Alternative would considerably improve service frequencies and hours of service in the study corridor
- Real-Time Passenger Information – The TSM Alternative would include implementing Automated Vehicle Location (AVL) and real-time passenger information systems to allow easier, less stressful, and more reliable bus riding
- Peak Hour Signal Priority – During peak hours, the TSM Alternative would benefit from signal priority at key intersections along the route
- Overall costs to construct and operate the service would be significantly lower compared to light rail

FIGURE C-5: TSM ALTERNATIVE ROUTE MAPS



## C.5. SERVICE CONCEPT

A service concept has been developed for each Build Alternative plus the TSM Alternative described above. Each Build Alternative would operate light rail on embedded rail within the street bed in most locations within the candidate corridors. The TSM Alternative is enhanced bus service, defined for this project as a bus-based operation that uses technological improvements, to provide faster, more-convenient service.

Each alternative comprises three separate “services:” 1) North Service would operate between the terminal loop in Center City to the terminal loop at Girard Avenue and North Hancock Street in Northern Liberties; 2) South Service would operate between the terminal loop in Center City and the terminal loop at Columbus Boulevard and Pier 70 in South Philadelphia; and 3) Waterfront Service would operate in a north-south direction between the terminal loop at Girard Avenue and North Hancock Street in Northern Liberties and the terminal loop at Columbus Boulevard and Pier 70 in South Philadelphia without accessing Center City. Frequency of service can be matched to demand as necessary.

## C.6. ASSUMPTIONS AND METHODOLOGY

### C.6.1. Speed Estimate

**Build Alternatives:** Station-to-station travel time depends on speed in addition to other parameters. An average speed estimate of 9.8 miles per hour (mph) was used for all route segments except along Columbus Boulevard, where 11.2 mph was used. Both speed estimates are inclusive of dwell times.

The 9.8-mph average speed was obtained using the actual end-to-end average speeds, excluding layovers, for Route 15, Girard Avenue trolley service, provided by SEPTA using the Trapeze scheduling software. While no two routes are exactly equivalent, Route 15 was chosen because of its modal and locational similarities to the service under study here.

The 11.2-mph speed on the Columbus Boulevard segments was estimated using the actual running times for SEPTA’s Route 25 bus, the local bus service between Frankford Transportation Center and Columbus Commons, at Snyder Avenue and Columbus Boulevard. This route covers virtually all sections of Columbus Boulevard that would be traversed by the proposed PATCO LRT service.

Using average speed is a common method for determining station-to-station travel times and includes accommodations for delays caused by traffic, signals and other temporary anticipated service interruptions.

In the analysis, dwell times were estimated separately at each station to account for the differential between peak and off-peak time periods. During times of peak boardings, dwell times are greater, as it takes longer to board an increased number of passengers; therefore, a 15-second dwell time was used during the off-peak period and a 25-second dwell time was used during peak period. Typically, a 20-second dwell time is applied to the entire corridor in rail projects that do not differentiate between peak and off-peak period boardings.

**TSM Alternative:** For the TSM Alternative, the speed estimate is 8.3 mph, which is based on the current average operating speed of SEPTA’s Route 17 bus. The same operating speed is used for the peak and off-peak periods. While it is generally assumed that travel speeds are lower in the peak periods, the TSM Alternative assumes that signal preemption will be given to this bus, allowing it to maintain similar travel times as in the off-peak period. The dwell times were included in the average speed and therefore no separate account was given to the dwell times.

**C.6.2. Travel Times**

**Build Alternatives:** Travel times for the Build Alternatives were estimated by station-to-station segments. Travel time for each segment was determined using the distances between stations. Details about station-to-station distance are included in Appendix H. The distances were then converted to time using the applicable average speed. Dwell times were incorporated for intermediate stations based on peak or off-peak periods, and the one-way (terminal-to-terminal) travel time was produced for each alternative.

Round-trip travel time accounts only for actual travel time and not layovers. The round-trip travel time was derived from the one-way travel time, and cycle time was produced by including the time of each layover. Minimum layovers of 4.5 minutes at each terminal were assumed; however, layover times were allowed to vary, depending on cycle time, to permit the development of schedules with regular intervals for the policy headways.

It must be noted that the layovers required to fulfill the policy headways are sometimes quite long; however, no attempt was made to reduce the policy headways to retain comparability between the various alternatives.

**TSM Alternative:** Travel times for the TSM Alternatives were also estimated by station-to-station segments. Minimum layovers of 4.5 minutes were also assumed for the TSM Alternative.

**C.6.3. Vehicle Requirements**

**Build and TSM Alternatives:** The number of transit units required for each alternative for each time period was determined by dividing the cycle time by the headways and rounding the result up. For example, a 57-minute cycle with 20-minute headways requires exactly 2.85 vehicles, yielding 3 vehicles. The number of vehicles required is 14 or 15, depending on the alternative and time of day. This includes vehicles required for North, South, and Waterfront services. However, this does not include spare ratio vehicles which are usually assumed to be 15 percent of the peak-hour fleet. Table C-10 demonstrates the number of peak vehicles required for each of the Build Alternatives.

TABLE C-10: VEHICLES REQUIRED FOR BUILD AND TSM ALTERNATIVES

Service	Alternatives			
	1	2	3	TSM
North	4	5	4	8
South	5	5	5	9
Waterfront	5	5	5	6
<b>TOTAL</b>	<b>14</b>	<b>15</b>	<b>14</b>	<b>23</b>

**Summary Sheets.** Documentation of the results of the analyses for the Build Alternatives and the TSM Alternative are contained in Appendix H.

#### **C.6.4. Annualized Operating Data**

Annual hours of operation were determined by summing the total hours across all time periods in a day. This is the product of the number of vehicles in service and the total daily revenue hours. This result was then multiplied by the number of days in a year to estimate annual vehicle hours. For annualization purposes, there were assumed to be 252 weekdays a year and 113 weekend days. This applies to the Build Alternatives and the TSM Alternative.

Annual vehicle miles were similarly determined, summing total miles across all time periods in a day, the product of the number of vehicles in service by the total daily revenue vehicle miles. The result was then multiplied by the number of days in a year to estimate annual vehicle miles. The same assumption as above was made concerning the number of weekdays and weekend days in a year. The number of peak vehicles required for the year was determined as described above under vehicle requirements.

#### **C.7. ALTERNATIVE 1**

The proposed station locations for Alternative 1 are:

- Pier 70
- Reed Street
- Christian Street
- Penn's Landing
- Callowhill Street
- Spring Garden Street
- Frankford Avenue
- Girard Avenue
- Independence Mall
- Franklin Square

##### **C.7.1. Service Frequencies**

Policy headways were established by service and time period as shown in Table C-11. Headways for the Penn Treaty Park option are the same as for Girard Avenue.

TABLE C-11: ALTERNATIVE 1: POLICY HEADWAYS BY TIME PERIOD

Service	Weekday (in minutes)				Weekend (in minutes)	
	6:00 AM– 9:00 AM	9:00 AM– 3:00 PM	3:00PM– 7:00 PM	7:00 PM– 1:00 AM	6:00 AM– 7:00 PM	7:00 PM– 1:00 AM
Alternative 1, North	10	10	10	30	15	30
Alternative 1, South	10	15	10	30	15	30
Alternative 1, Waterfront	10	15	10	30	15	30

**C.7.2. Alignment Lengths**

One-way distances for each section of Alternative 1 are presented in Table C-12. The waterfront alternative is the longest of the three sections of the routing at 6.62 miles.

TABLE C-12: ALTERNATIVE 1: ALIGNMENT LENGTHS

Service	Alignment Length (miles)
Alternative 1, North	3.93
Alternative 1, South	5.70
Alternative 1, Waterfront	6.62

**C.8. ALTERNATIVE 2**

The proposed station locations for Alternative 2 are:

- Pier 70
- Reed Street
- Christian Street
- Penn’s Landing
- Callowhill Street
- Spring Garden Street
- Frankford Avenue
- Girard Avenue
- 2nd and Market Streets
- 6th and Market Streets
- 8th and Market Streets
- 11th and Market Streets
- Juniper and Filbert Streets
- PA Convention Center

**C.8.1. Service Frequencies**

Policy headways were established by service and time period as shown in Table C-13. Headways for the Penn Treaty Park option are the same as for Girard Avenue.

TABLE C-13: ALTERNATIVE 2: POLICY HEADWAYS BY TIME PERIOD

	Weekday (in minutes)				Weekend (in minutes)	
	6:00 AM– 9:00 AM	9:00 AM– 3:00 PM	3:00PM– 7:00 PM	7:00 PM– 1:00 AM	6:00 AM– 7:00 PM	7:00 PM– 1:00 AM
Alternative 2, North	10	10	10	30	15	30
Alternative 2, South	10	15	10	30	15	30
Alternative 2, Waterfront	10	15	10	30	15	30

### C.8.2. Alignment Length

One way distances for each section of Alternative 2 are presented in Table C-14. The waterfront alternative is the longest of the three sections of the routing at 6.62 miles.

TABLE C-14: ALTERNATIVE 2: ALIGNMENT LENGTHS

Service	Alignment Length (miles)
Alternative 2, North	6.08
Alternative 2, South	6.19
Alternative 2, Waterfront	6.62

## C.9. ALTERNATIVE 3

The proposed station locations for Alternative 3 are:

- Pier 70
- Reed Street
- Christian Street
- Penn’s Landing
- Callowhill Street
- Spring Garden Street
- Frankford Avenue
- Girard Avenue
- Independence Mall
- Franklin Square
- 8th and Market Streets
- Arch Street

### C.9.1. Service Frequencies

Policy headways were established by service and time period as shown below in Table C-15. Headways for the Penn Treaty Park option are the same as for Girard Avenue.

TABLE C-15: ALTERNATIVE 3: POLICY HEADWAYS BY TIME PERIOD

Service	Weekday (in minutes)				Weekend (in minutes)	
	6:00 AM– 9:00 AM	9:00 AM– 3:00 PM	3:00PM– 7:00 PM	7:00 PM– 1:00 AM	6:00 AM– 7:00 PM	7:00 PM– 1:00 AM
Alternative 3, North	10	10	10	30	15	30
Alternative 3, South	10	15	10	30	15	30
Alternative 3, Waterfront	10	15	10	30	15	30

### C.9.2. Alignment Lengths

One way distances for each section of Alternative 3 are presented in Table C-16. The Waterfront alternative is the longest of the three sections of the routing at 6.62 miles.

TABLE C-16: ALTERNATIVE 3: ALIGNMENT LENGTHS

Service	Alignment Length (miles)
Alternative 3, North	4.67
Alternative 3, South	6.44
Alternative 3, Waterfront	6.62

### C.10. TSM ALTERNATIVE

The proposed station locations for the TSM Alternative are:

- Pier 70
- Reed Street
- Christian Street
- Penn’s Landing
- Callowhill Street
- Spring Garden Street
- Frankford Avenue
- Girard Avenue
- 2nd and Market Streets
- 5th and Market Streets
- 8th and Market Streets
- 12th and Market Streets
- Juniper and Filbert Streets
- PA Convention Center
- Independence Mall
- Franklin Square

**C.10.1. Service Frequencies**

Policy headways were established by service and time period as shown below in Table C-17.

**TABLE C-17: TSM ALTERNATIVE: POLICY HEADWAYS BY TIME PERIOD**

Service	Weekday (in minutes)				Weekend (in minutes)	
	6:00 AM– 9:00 AM	9:00 AM– 3:00 PM	3:00PM– 7:00 PM	7:00 PM– 1:00 AM	6:00 AM– 7:00 PM	7:00 PM– 1:00 AM
TSM Alternative, North	10	10	10	30	15	30
TSM Alternative, South	10	15	10	30	15	30
TSM Alternative, Waterfront	10	15	10	30	15	30

**C.10.2. Alignment Lengths**

One way distances for each section of TSM alternative are presented in Table C-18. The waterfront alternative is the longest of the three sections of the routing at 6.62 miles.

**TABLE C-18: TSM ALTERNATIVE: ALIGNMENT LENGTHS**

Service	Alignment Length (miles)
TSM Alternative, North	8.85
TSM Alternative, South	10.0
TSM Alternative, Waterfront	6.62

