Attachment A Central Transportation Planning Staff Environmental Justice Analysis

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MEMORANDUM

DATE **April 17, 2014**

TO **Kristine Wickham-Zimmerman, Joseph Wanat, Caroline Ducas - VHB**
Matthew Ciborowski - MassDOT

FROM **Bruce Kaplan, Ying Bao**
CTPS

RE **South Station Expansion: Environmental Justice Analysis Background**

Federal guidance mandates that transportation projects should not unfairly burden low-income and minority communities, also known as "environmental justice communities". This memorandum explains the methodology employed by CTPS in its analyses of potential disproportionate burdens on environmental justice populations in the realms of environmental impacts, mobility, congestion, and accessibility to services and employment for the South Station Expansion project. A brief project description precedes the presentation of environmental justice definitions, methodology, and results.

PROJECT BACKGROUND

Four different alternatives were analyzed for the South Station Expansion project. Three distinct "Build" scenarios, described below, were modeled for the 2035 horizon year, in addition to a No-Build scenario.

Transportation Improvements Only (TIO)

In the TIO alternative, South Station would be expanded onto the adjacent 16-acre USPS property. MassDOT would acquire and demolish the USPS General Mail Facility/South Postal Annex; the 1000 jobs associated with this facility would be relocated to a new USPS facility to be constructed in South Boston. The existing South Station terminal would be expanded with an expanded passenger concourse and passenger support services, including amenities such as retail, food, and beverage outlets. Capacity improvements would include construction of seven new tracks and four platforms for a total of 20 tracks and 11 platforms. Some existing platforms, towers, and approach interlockings would be reconfigured and/or reconstructed. There would be no private development beyond what has already been programmed for the site in the 2035 Regional Long Range Transportation Plan (LRTP).

Dorchester Avenue would be restored for public and station access. Restoration of Dorchester Avenue would reconnect Dorchester Avenue to Summer Street as a public way. It would include landscaping and improved pedestrian and cycling connections and facilities (including adjacent sidewalks and crosswalks). Restoration also would include construction of a long-awaited extension of the Harborwalk along reopened Dorchester Avenue.

The TIO alternative, like the No-Build alternative, also includes all adopted highway and transit projects included in the LRTP. In terms of transit service planning changes incorporated into both TIO and No-Build alternatives, rapid transit fares and improved frequencies are assumed on the MBTA Fairmount commuter rail line. In addition, the TIO alternative includes an increase in Amtrak intercity service at South Station, rising from the existing 40 daily combined arriving and departing trains to a total of 80 daily trains. The TIO alternative also assumes South Coast Rail commuter rail service and adds additional peak period, peak direction trains on the Needham, Franklin, Providence, and Worcester/Framingham commuter rail lines.

Amtrak and South Coast Rail service are not built into the CTPS travel demand model, but rather were incorporated into the South Station Expansion travel demand forecasting using post-modeling processes. As a result, the environmental justice benefits and burdens related to these services are not directly examined as part of this analysis. Even so, any environmental justice benefits and burdens associated with improved Amtrak intercity service are expected to have a negligible impact on the results of this analysis. For a comprehensive analysis of environmental justice benefits and burdens related to and conducted for the South Coast Rail project, please refer to the CTPS memorandum "South Coast Rail Environmental Justice Study" dated October 30, 2009.

Joint/Private Development Minimum Build (MIN LU)

This alternative would include everything contained in the TIO scenario, as well as provisions for future private development at the South Station site by incorporating appropriate structural foundations into the overall station and track design. Future private development could include approximately 660,000 square feet (sf) of mixed-use development consisting of residential, office, and commercial uses, including retail and hotel uses, approximately 235 parking spaces, and with building heights ranging up to approximately 12 stories. This analysis assumes this new development will add 1,020 new service jobs, 255 new retail jobs, and 280 new households containing a population of 620 persons.

Joint/Private Development Maximum Build (MAX LU)

This alternative would include everything contained in the MIN LU scenario, but with a greater provision for future private development at the South Station site. The maximum potential for future private development would be limited by the Federal Aviation Administration's (FAA's) maximum building height limits, pursuant to the Terminal Instrument Procedures (TERPS) regulations applicable to Boston Logan International Airport. Accordingly, building heights would be limited to approximately 290 feet and an amendment to the Municipal Harbor Plan, modifying applicable Chapter 91 regulations, would be required. Future private development could include approximately 2.1 million sf of mixed-use development consisting of residential, office, and commercial uses, including retail and hotel uses, approximately 510 parking spaces, and with building heights up to approximately 26 stories. This analysis assumes this new development will add 3,000 new service jobs, 750 new retail jobs, and 830 new households containing a population of 1,830 persons.

DEFINITIONS

Recent documents such as the Federal Transit Administration (FTA)'s 2011 Title VI Circular, the FTA 2011 Environment Justice Circular, and the Federal Department of Transportation (DOT)'s 2012 Environmental Justice Order, have traditionally informed the CTPS's identification of geographic areas of minority and low-income populations (municipalities and Boston neighborhoods). Such geographic regions are determined by the demographics of the people living in a transportation analysis zone (TAZ). A TAZ is an aggregation of census geography based on population and estimated trip volumes. The Boston Region MPO regional travel demand model area is composed of 2,727 TAZs that comprise nearly all of eastern Massachusetts. It encompasses 164 cities and towns, including the 101 Boston Region MPO cities and towns and 63 additional communities[1]. The current assumed thresholds[2] for these environmental justice (EJ) populations are as follows:

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[1] For further background information on the travel demand model set, please consult Methodology and Assumptions of Central Transportation Planning Staff Regional Travel Demand Modeling: Green Line Extension New Starts Analysis, November 24, 2010. Please note that the calibration work described on pp. 11-13 have been superseded for this study. Furthermore, the horizon year has been updated to 2035 from 2030. For more information regarding the South Station Expansion project model's calibration, please see South Station Expansion: Model Year Questions, March 17, 2014.

[2] The study team requested that the Environmental Justice threshold criteria to be used were in line with those used by the Massachusetts Executive Office of Energy and Environmental Affairs (EEA). Detailed information can be found at http://www.mass.gov/anf/research-and-

• Minority –A minority (non-white or Hispanic) TAZ was defined as having a percentage of minority population greater than or equal to 25 percent, according to the 2010 US Census.

• Low income – The state median household income in 2012, based on the latest American Community Survey (ACS)'s 5-year summary data, was approximately $69,393. A low-income TAZ was defined as having a median household income at or below 60 percent of this level ($42,497).

• Linguistic Isolation –Households in which all members 14 years old and over speak a non-English language and also speak English less than "Very well" (have difficulty with English) is "linguistically isolated." A linguistically isolated TAZ was defined as having a percentage of linguistically isolated population greater than or equal to 25 percent, according to the 2012 ACS 5-year summary data.

• Disabled –A disabled TAZ was defined as having a percentage of self-reported disabled population greater than or equal to 10.4%, which is the percentage of self-reported disabled persons in the MBTA service area, according to the 2012 ACS 5-year summary data.

Based on these definitions, 913 of the 2,727 TAZs in the model set area qualify as minority (Figure 1); 400 qualify as low-income (Figure 2); 87 as linguistically isolated (Figure 3); and 1,081 as disabled (Figure 4). Figure 5 overlays the disabled populations over the other EJ populations. Figure 6 displays the 1,596 TAZs that meet at least one of these four criteria. 973 TAZs meet one criterion, 57 TAZs meet all four criteria, 148 TAZs meet three criteria, and 418 TAZs meet two criteria. Please note that for the purposes of this analysis, an "all or nothing" approach is assumed regarding TAZ population definition. That is, if a TAZ meets one or more of the aforementioned criteria, then the entire population of that TAZ is then assumed to have those characteristics (low income, minority, disabled, linguistic isolation) for analytical purposes since the subsequent analysis is performed at the TAZ level, as opposed to a finer geographic level in which differing populations might be able to be better parsed.

The future demographic forecasts used for the analysis assumed these attributes of the residential population TAZs remain the same as they were observed in the data used to determine the thresholds. Thus, the modeled

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For the disabled population threshold, the MBTA service area average was chosen instead of the statewide average, since it was more inclusive.

future-year classifications of populations solely reflect the demographic conditions represented in the 2010 Census and the 2012 ACS.

METHODOLOGY

Certain performance measures were used as indicators of benefits and burdens for EJ and non–EJ populations. The environmental justice populations were further subdivided for analysis into low-income, minority, linguistic isolation, and disabled categories, and tested separately. The tested performance measures fall into three categories: accessibility to needed services and jobs; mobility and congestion; and environmental impacts.

Accessibility Analysis

This study analyzed access to needed services and jobs in terms of average transit and highway travel times from EJ and non-EJ population zones to basic, retail, and service employment opportunities; health care; and institutions of higher education. Data related to Boston-area higher education data was gathered within the past 4 years in conjunction with CTPS's refinement of the regional travel demand model's Home-Based School trip purpose routines. Data related to the Boston area's largest concentration of hospitals was collected approximately 4 – 5 years ago. The accessibility analysis featured an examination of the number of destinations within a 40-minute transit trip and a 20-minute auto trip. The analysis of transit travel times included destinations within a 40-minute transit trip, and the analysis of highway travel times included destinations within a 20-minute auto trip. The examined accessibility performance measures were:

• The average number of basic, retail, and service jobs within a 40-minute transit trip and a 20-minute auto trip.

• The average travel time to basic, retail, and service jobs within a 40-minute transit trip and a 20-minute auto trip.

• The average number of hospital beds within a 40-minute transit trip and a 20-minute auto trip.

• The average travel time to a hospital, weighted by the number of hospital beds, within a 40-minute transit trip and a 20-minute auto trip.

• The average number of students at facilities of two- and four-year institutions of higher education within a 40-minute transit trip and a 20-minute auto trip.

• The average travel time to facilities of two- and four-year institutions of higher education, weighted by enrollment, within a 40-minute transit trip and a 20-minute auto trip.

Mobility, Congestion, and Environmental Analysis

The mobility, congestion, and environmental impacts were analyzed by comparing performance measures for EJ population zones to those for non–EJ population zones. As in the accessibility analysis, differences between the average levels of these performance measures within the two types of zones were calculated for the No-Build and Build scenarios. The results are aggregated in the same manner. The examined mobility, congestion, and environmental performance measures were:

• Congested VMT per square mile – the number of vehicle-miles traveled on congested roadways (volume/capacity>0.75) per square mile of dry land within a TAZ.

• CO per square mile – the number of kilograms of carbon monoxide emitted per square mile of dry land within a TAZ.

• Transit production time – the average door-to-door travel time for all transit trips produced in the TAZ.

• Highway production time – the average door-to-door travel time for all highway trips produced in the TAZ.

• Transit attraction time – the average door-to-door travel time for all transit trips attracted to the TAZ.

• Highway attraction time – the average door-to-door travel time for all highway trips attracted to the TAZ.

RESULTS

The tables in the appendices display that minimal or no change occurs among the alternatives across the communities of concern for accessibility to needed services and jobs, mobility and congestion, or environmental impacts. Furthermore, change is negligible for both environmental justice population zones and non–environmental justice population zones in the build scenarios compared to the no build scenario.

Statistical tests were performed to determine if the estimated differences between the changes experienced by each pair of community classifications (e.g. minority and non-minority) among the alternatives were significant. If there is a statistically significant difference, an area in one community classification is more likely to experience a larger change than an area in the other community classification; if there is not such a significant difference, an area is likely to experience about the same level of change regardless of community classification. The difference between the pair of community classifications is considered significant if the variations of the changes within the classifications are together smaller than the difference between the average changes experienced by the community classifications. Each Build alternative's categorized metrics' changes (e.g. low income average transit production time and non-low income average transit production time) was tested against those of the No-Build scenario. A two group sample t-test was used to determine if the samples in the model area of 1) minority, low-income, linguistically isolated, and disabled communities and 2) non-minority, non-low income, non-linguistically isolated, and non-disabled communities were different at the 95% confidence level. None of the metrics had statistically significant differences between the averages of the two groups. Hence none of the EJ populations (low-income, minority, linguistic isolation, disabled) experiences a greater burden than any non-EJ population as result of implementation of any of the Build alternatives.

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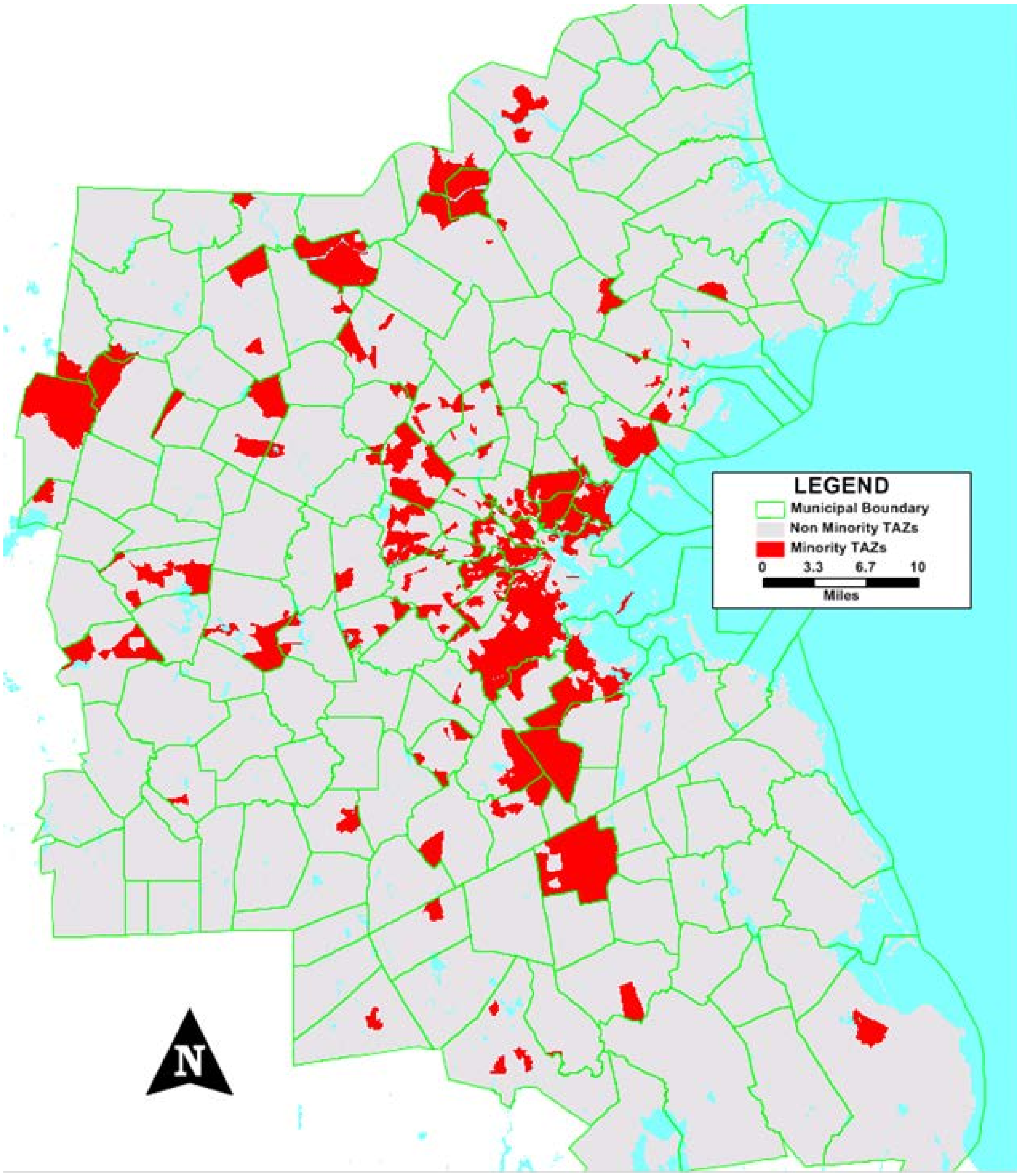

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FIGURE 1
Minority Populations
in the Boston MPO Regional Model Area

South Station Expansion Study

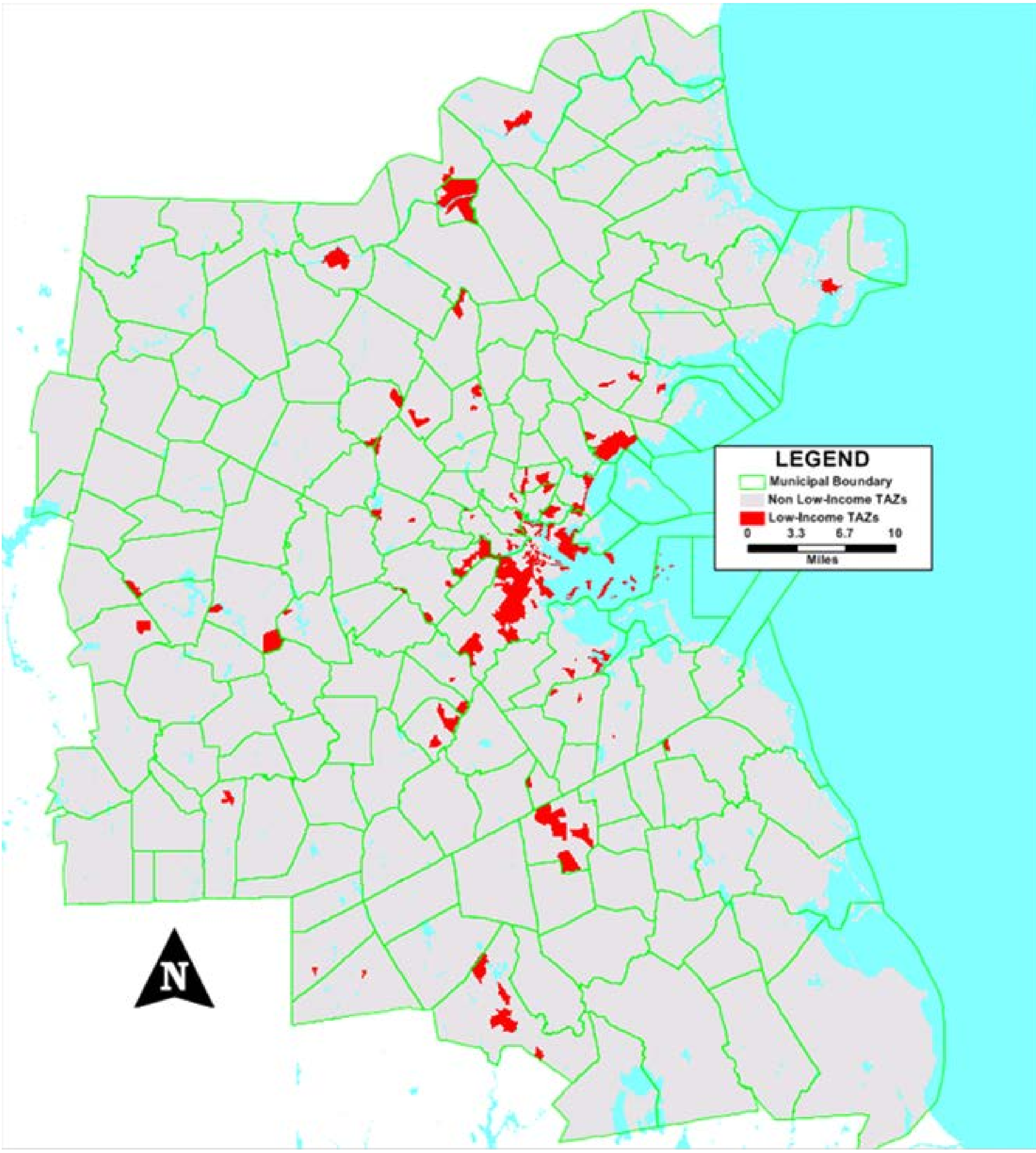

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FIGURE 2
Low Income Populations
in the Boston MPO Regional Model Area

South Station Expansion Study

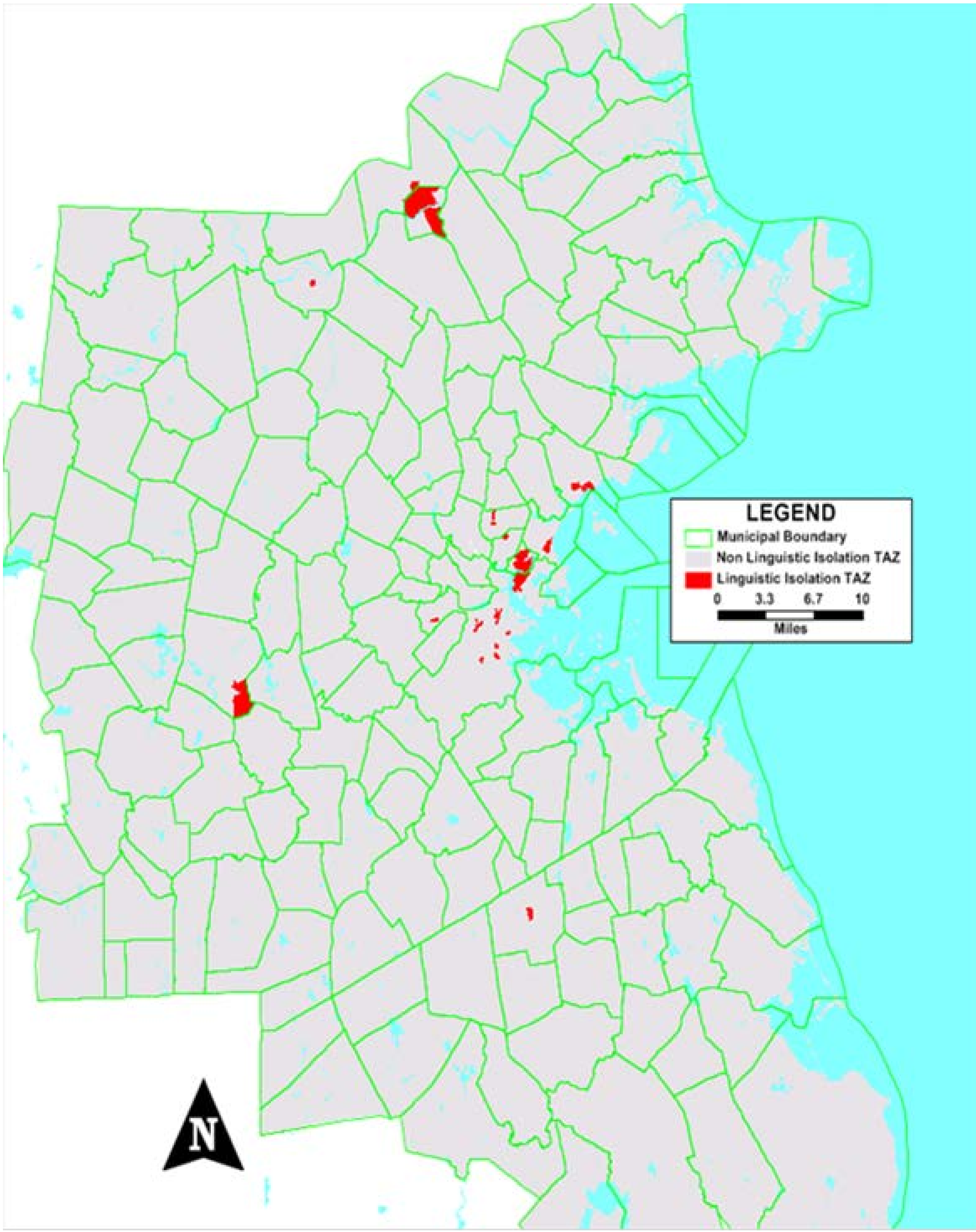

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FIGURE 3
Linguistically Isolated Populations
in the Boston MPO Regional Model Area

South Station Expansion Study

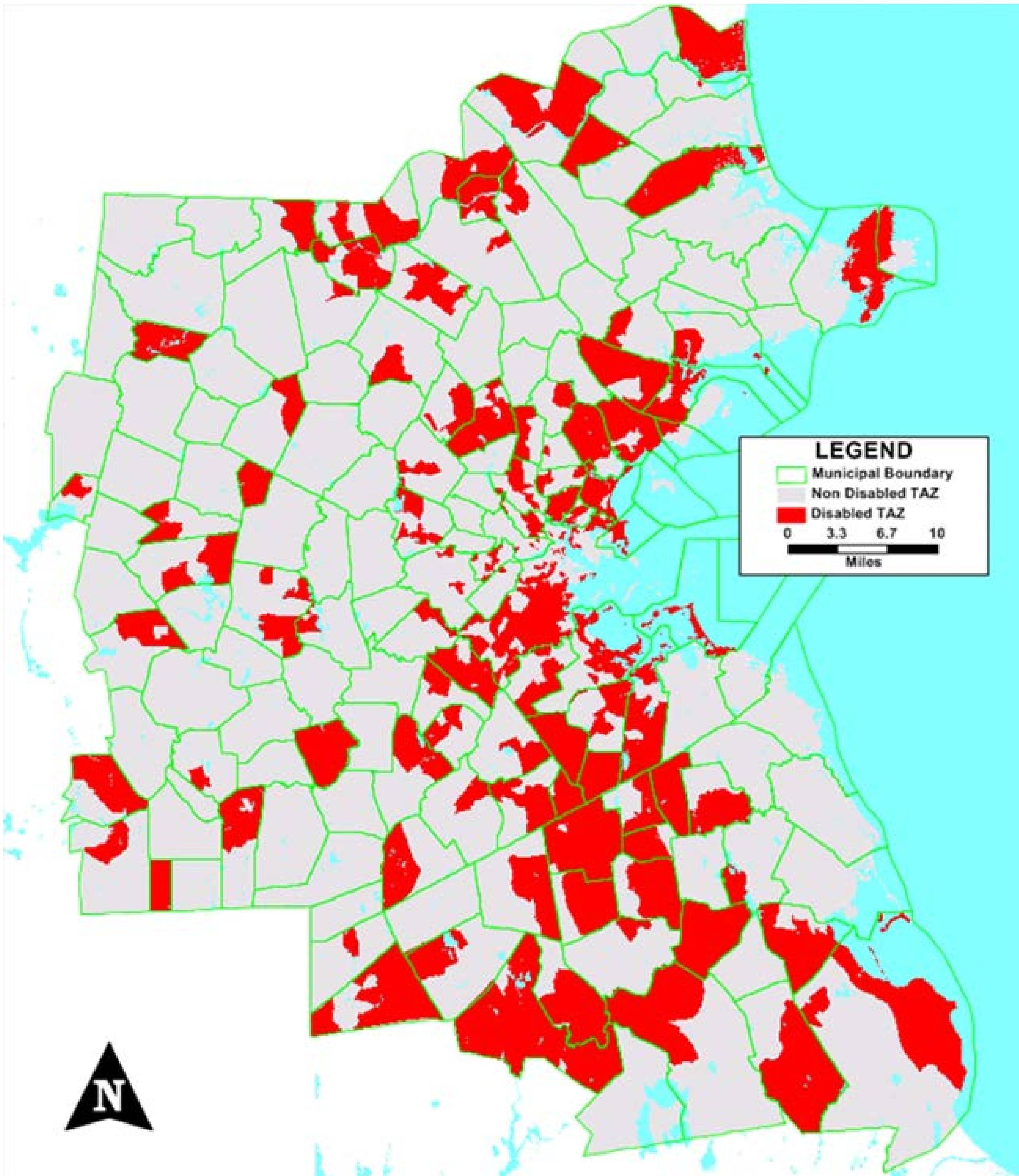

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FIGURE 4
Disabled Populations
in the Boston MPO Regional Model Area

South Station Expansion Study

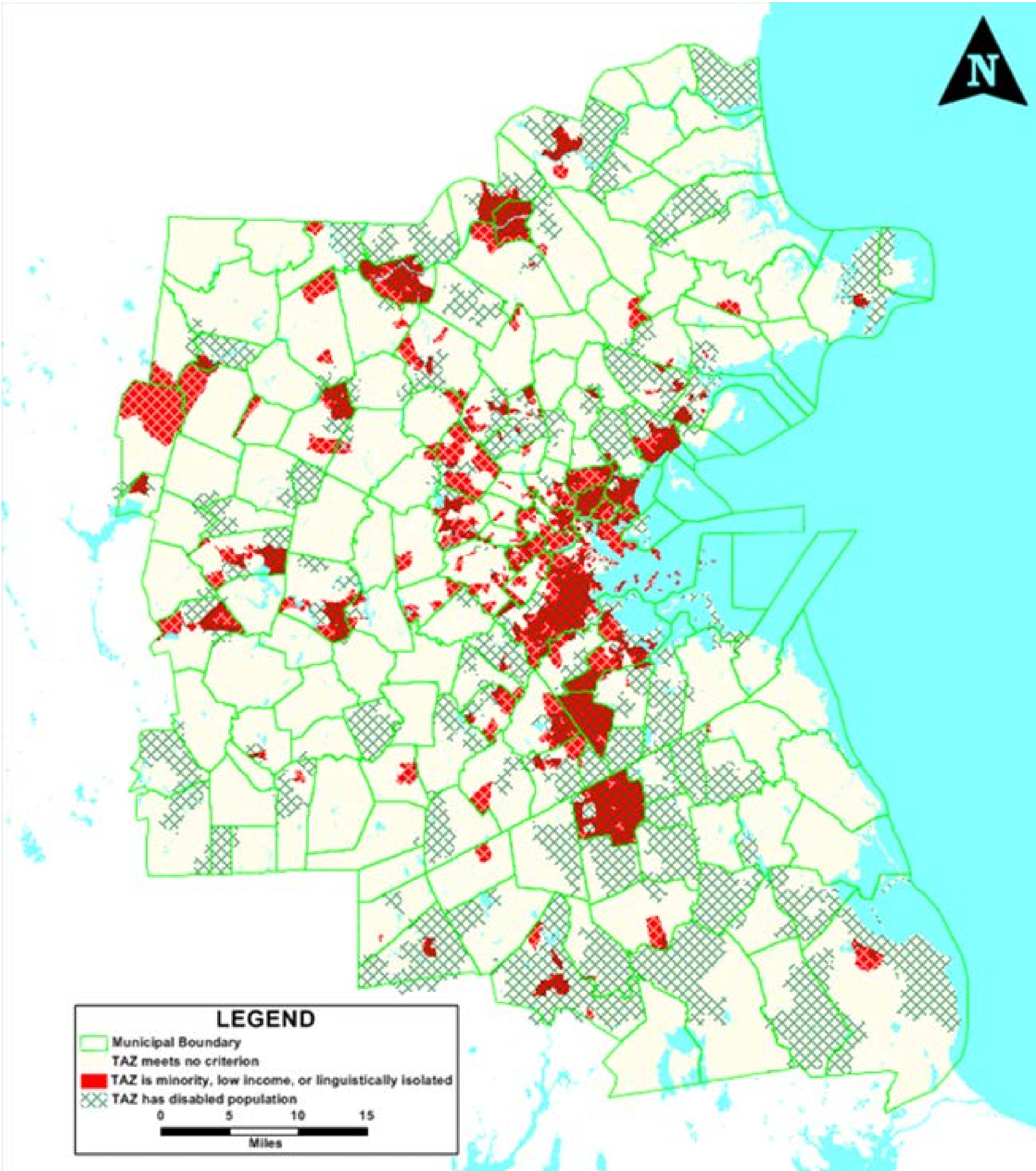

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FIGURE 5
Disabled Populations vs. Other Community of Concern Populations in the Boston MPO Regional Model Area

South Station Expansion Study

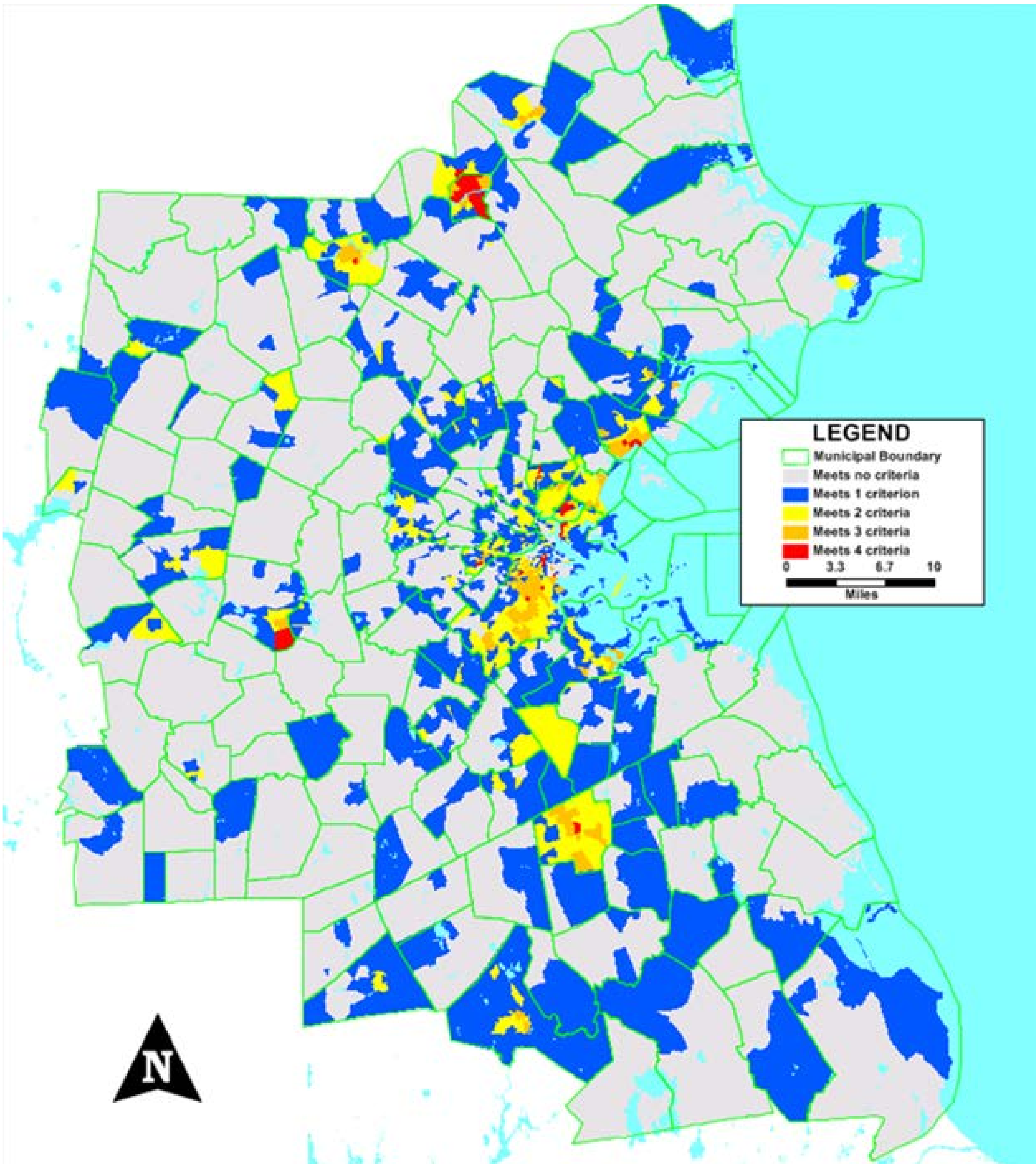

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FIGURE 6
Number of Community of Concern Criteria Met by Populations in the Boston MPO Regional Model Area

South Station Expansion Study

Appendix 1
Results - Accessibility Summary (Build Alternatives vs No Build Alternative)

1.1 Basic Employment

Low-Income Population

	Average Number of Available Basic Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Basic Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income
No Build	25,460	13,590	31.4	31.8	60,670	49,750	13.2	13.7
TIO	25,480	13,630	31.5	31.8	60,670	49,750	13.2	13.7
MIN	25,190	13,490	31.4	31.8	60,650	49,710	13.3	13.7
MAX	25,190	13,470	31.4	31.8	60,650	49,710	13.3	13.7

Percentage Change from No Build Scenario

	Average Number of Available Basic Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Basic Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income
TIO	0.1%	0.3%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%
MIN	-1.1%	-0.7%	0.0%	0.0%	0.0%	-0.1%	0.8%	0.0%
MAX	-1.1%	-0.9%	0.0%	0.0%	0.0%	-0.1%	0.8%	0.0%

Minority Population

	Average Number of Available Basic Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Basic Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority
No Build	23,130	10,260	31.9	31.7	63,610	43,810	13.7	13.7
TIO	23,160	10,310	31.9	31.6	63,610	43,810	13.7	13.7
MIN	22,840	10,250	31.9	31.6	63,570	43,760	13.7	13.7
MAX	22,840	10,220	31.9	31.6	63,570	43,760	13.7	13.7

Percentage Change from No Build Scenario

	Average Number of Available Basic Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Basic Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income
TIO	0.1%	0.5%	0.0%	-0.3%	0.0%	0.0%	0.0%	0.0%
MIN	-1.3%	-0.1%	-0.1%	-0.2%	-0.1%	-0.1%	0.0%	0.0%
MAX	-1.3%	-0.4%	-0.1%	-0.2%	-0.1%	-0.1%	0.0%	0.0%

Appendix 1 (continued)
Results - Accessibility Summary (Build Alternatives vs No Build Alternative)

1.1 Basic Employment

Linguistically Isolated Population

	Average Number of Available Basic Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Basic Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated
No Build	31,300	14,230	32.0	31.7	66,580	50,320	13.1	13.7
TIO	31,300	14,270	32.0	31.7	66,580	50,320	13.1	13.7
MIN	31,040	14,120	32.0	31.7	66,500	50,280	13.1	13.7
MAX	31,030	14,100	32.0	31.7	66,490	50,280	13.1	13.7

Percentage Change from No Build Scenario

	Average Number of Available Basic Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Basic Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated
TIO	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MIN	-0.8%	-0.8%	0.0%	0.0%	-0.1%	-0.1%	0.0%	0.0%
MAX	-0.9%	-0.9%	0.0%	0.0%	-0.1%	-0.1%	0.0%	0.0%

Disabled Population

	Average Number of Available Basic Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Basic Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled
No Build	14,240	15,450	32.0	31.6	47,350	53,760	13.5	13.8
TIO	14,260	15,500	31.9	31.6	47,350	53,760	13.5	13.8
MIN	14,110	15,340	31.9	31.6	47,330	53,700	13.5	13.8
MAX	14,100	15,320	31.9	31.6	47,330	53,700	13.5	13.8

Percentage Change from No Build Scenario

	Average Number of Available Basic Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Basic Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled
TIO	0.1%	0.3%	-0.3%	0.0%	0.0%	0.0%	0.0%	0.0%
MIN	-0.9%	-0.7%	-0.3%	0.0%	0.0%	-0.1%	0.0%	0.0%
MAX	-1.0%	-0.8%	-0.3%	0.0%	0.0%	-0.1%	0.0%	0.0%

Appendix 1 (continued)
Results - Accessibility Summary (Build Alternatives vs No Build Alternative)

1.2 Retail Employment

Low-Income Population

	Average Number of Available Retail Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Retail Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Low-Income	**Not Low-Income**	**Low-Income**	**Not Low-Income**	**Low-Income**	**Not Low-Income**	**Low-Income**	**Not Low-Income**
No Build	25,290	12,440	30.9	32.0	53,690	39,370	13.0	13.5
TIO	25,320	12,490	30.9	32.0	53,690	39,370	13.0	13.5
MIN	25,420	12,580	30.9	32.0	53,810	39,420	13.0	13.5
MAX	25,610	12,620	30.9	32.0	54,040	39,510	13.0	13.5

Percentage Change from No Build Scenario

	Average Number of Available Retail Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Retail Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Low-Income	**Not Low-Income**	**Low-Income**	**Not Low-Income**	**Low-Income**	**Not Low-Income**	**Low-Income**	**Not Low-Income**
TIO	0.1%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MIN	0.5%	1.1%	0.0%	0.0%	0.2%	0.1%	0.0%	0.0%
MAX	1.3%	1.4%	0.0%	0.0%	0.7%	0.4%	0.0%	0.0%

Minority Population

	Average Number of Available Retail Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Retail Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Minority	**Non-Minority**	**Minority**	**Non-Minority**	**Minority**	**Non-Minority**	**Minority**	**Non-Minority**
No Build	22,870	8,790	31.7	32.0	54,390	33,360	13.4	13.5
TIO	22,910	8,840	31.7	32.0	54,390	33,360	13.4	13.5
MIN	23,000	8,930	31.7	31.9	54,500	33,390	13.4	13.5
MAX	23,180	8,910	31.8	31.9	54,710	33,440	13.4	13.5

Percentage Change from No Build Scenario

	Average Number of Available Retail Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Retail Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Low-Income	**Not Low-Income**	**Low-Income**	**Not Low-Income**	**Low-Income**	**Not Low-Income**	**Low-Income**	**Not Low-Income**
TIO	0.2%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MIN	0.6%	1.6%	-0.1%	-0.3%	0.2%	0.1%	0.0%	0.0%
MAX	1.4%	1.4%	0.3%	-0.3%	0.6%	0.2%	0.0%	0.0%

Appendix 1 (continued)
Results - Accessibility Summary (Build Alternatives vs No Build Alternative)

1.2 Retail Employment

Linguistically Isolated Population

	Average Number of Available Retail Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Retail Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated
No Build	26,850	13,340	31.0	31.9	50,850	40,560	13.3	13.5
TIO	26,860	13,390	31.0	31.9	50,850	40,560	13.3	13.5
MIN	26,960	13,480	31.0	31.9	50,990	40,620	13.3	13.5
MAX	27,130	13,530	31.0	31.9	51,240	40,720	13.3	13.5

Percentage Change from No Build Scenario

	Average Number of Available Retail Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Retail Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated
TIO	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MIN	0.4%	1.0%	0.0%	0.0%	0.3%	0.1%	0.0%	0.0%
MAX	1.0%	1.4%	0.0%	0.0%	0.8%	0.4%	0.0%	0.0%

Disabled Population

	Average Number of Available Retail Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Retail Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled
No Build	12,780	14,740	32.0	31.8	38,180	43,130	13.3	13.6
TIO	12,810	14,780	32.0	31.8	38,180	43,130	13.3	13.6
MIN	12,910	14,880	32.0	31.8	38,230	43,180	13.3	13.6
MAX	12,960	14,930	32.0	31.8	38,340	43,300	13.3	13.6

Percentage Change from No Build Scenario

	Average Number of Available Retail Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Retail Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled
TIO	0.2%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MIN	1.0%	0.9%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%
MAX	1.4%	1.3%	0.0%	0.0%	0.4%	0.4%	0.0%	0.0%

Appendix 1 (continued)
Results - Accessibility Summary (Build Alternatives vs No Build Alternative)

1.3 Service Employment

Low-Income Population

	Average Number of Available Service Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Service Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income
No Build	186,400	85,810	30.4	32.0	310,670	185,200	12.8	13.7
TIO	186,590	86,130	30.4	32.0	310,670	185,200	12.8	13.7
MIN	187,020	86,320	30.4	32.0	311,140	185,410	12.8	13.7
MAX	187,780	86,650	30.4	32.0	312,050	185,790	12.8	13.7

Percentage Change from No Build Scenario

	Average Number of Available Service Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Service Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income
TIO	0.1%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MIN	0.3%	0.6%	0.0%	0.1%	0.2%	0.1%	0.0%	0.0%
MAX	0.7%	1.0%	0.0%	0.0%	0.4%	0.3%	0.0%	0.0%

Minority Population

	Average Number of Available Service Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Service Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority
No Build	169,930	55,770	31.7	31.9	304,030	139,830	13.4	13.7
TIO	170,200	56,100	31.7	31.9	304,030	139,830	13.4	13.7
MIN	170,590	56,210	31.7	31.9	304,500	139,940	13.4	13.7
MAX	171,300	56,410	31.7	31.9	305,340	140,150	13.4	13.7

Percentage Change from No Build Scenario

	Average Number of Available Service Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Service Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income
TIO	0.2%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MIN	0.4%	0.8%	0.0%	0.1%	0.2%	0.1%	0.0%	0.0%
MAX	0.8%	1.1%	0.0%	0.1%	0.4%	0.2%	0.0%	0.0%

Appendix 1 (continued)
Results - Accessibility Summary (Build Alternatives vs No Build Alternative)

1.3 Service Employment

Linguistically Isolated Population

	Average Number of Available Service Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Service Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated
No Build	186,690	93,330	30.2	31.9	291,780	195,390	13.3	13.6
TIO	186,720	93,650	30.2	31.9	291,780	195,390	13.3	13.6
MIN	186,950	93,860	30.2	31.9	292,450	195,620	13.3	13.6
MAX	187,650	94,230	30.2	31.9	293,400	196,040	13.3	13.6

Percentage Change from No Build Scenario

	Average Number of Available Service Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Service Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated
TIO	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MIN	0.1%	0.6%	0.0%	0.0%	0.2%	0.1%	0.0%	0.0%
MAX	0.5%	1.0%	0.0%	0.0%	0.6%	0.3%	0.0%	0.0%

Disabled Population

	Average Number of Available Service Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Service Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled
No Build	90,780	101,970	31.8	31.9	177,380	216,100	13.4	13.7
TIO	91,020	102,340	31.8	31.8	177,380	216,100	13.4	13.7
MIN	91,220	102,560	31.8	31.8	177,610	216,350	13.4	13.7
MAX	91,660	102,890	31.8	31.8	178,024	216,810	13.4	13.7

Percentage Change from No Build Scenario

	Average Number of Available Service Jobs within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Service Jobs within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled
TIO	0.3%	0.4%	0.0%	-0.3%	0.0%	0.0%	0.0%	0.0%
MIN	0.5%	0.6%	0.0%	-0.3%	0.1%	0.1%	0.0%	0.0%
MAX	1.0%	0.9%	0.0%	-0.3%	0.4%	0.3%	0.0%	0.0%

Appendix 1 (continued)
Results - Accessibility Summary (Build Alternatives vs No Build Alternative)

1.4 Hospital Beds

Low-Income Population

	Average Number of Available Hospital Beds within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Hospital Beds within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income
No Build	1,870	670	26.5	22.2	4,240	2,430	12.0	12.9
TIO	1,870	670	26.5	22.2	4,240	2,430	12.0	12.9
MIN	1,870	670	26.5	22.2	4,240	2,430	12.0	12.9
MAX	1,870	670	26.5	22.2	4,240	2,430	12.0	12.9

Percentage Change from No Build Scenario

	Average Number of Available Hospital Beds within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Hospital Beds within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income
TIO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MIN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MAX	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Minority Population

	Average Number of Available Hospital Beds within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Hospital Beds within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority
No Build	1,450	440	26.6	20.5	4,040	1,830	12.7	12.9
TIO	1,450	440	26.6	20.5	4,040	1,830	12.7	12.9
MIN	1,450	440	26.6	20.5	4,040	1,830	12.7	12.9
MAX	1,450	440	26.6	20.5	4,040	1,830	12.7	12.9

Percentage Change from No Build Scenario

	Average Number of Available Hospital Beds within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Hospital Beds within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority
TIO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MIN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MAX	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Appendix 1 (continued)
Results - Accessibility Summary (Build Alternatives vs No Build Alternative)

1.4 Hospital Beds

Linguistically Isolated Population

	Average Number of Available Hospital Beds within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Hospital Beds within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated
No Build	1,500	780	27.4	22.5	3,250	2,600	13.0	12.8
TIO	1,500	780	27.4	22.5	3,250	2,600	13.0	12.8
MIN	1,500	780	27.4	22.5	3,250	2,600	13.0	12.8
MAX	1,500	780	27.4	22.5	3,250	2,600	13.0	12.8

Percentage Change from No Build Scenario

	Average Number of Available Hospital Beds within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Hospital Beds within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated
TIO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MIN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MAX	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Disabled Population

	Average Number of Available Hospital Beds within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Hospital Beds within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled
No Build	740	860	23.0	22.4	2,440	2,780	12.2	13.3
TIO	740	860	23.0	22.5	2,440	2,780	12.2	13.3
MIN	740	860	23.0	22.5	2,440	2,780	12.2	13.3
MAX	740	860	23.0	22.5	2,440	2,780	12.2	13.3

Percentage Change from No Build Scenario

	Average Number of Available Hospital Beds within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available Hospital Beds within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled
TIO	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%
MIN	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%
MAX	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%

Appendix 1 (continued)
Results - Accessibility Summary (Build Alternatives vs No Build Alternative)

1.5 Colleges

Low-Income Population

	Average Number of Available College Enrollment within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available College Enrollment within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income
No Build	24,270	9,010	21.6	18.5	46,020	23,820	12.5	12.8
TIO	24,280	9,050	21.8	18.6	46,020	23,820	12.5	12.8
MIN	24,300	9,040	21.8	18.7	46,020	23,850	12.5	12.8
MAX	24,300	9,040	21.8	18.5	46,020	23,850	12.5	12.8

Percentage Change from No Build Scenario

	Average Number of Available College Enrollment within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available College Enrollment within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income
TIO	0.0%	0.4%	0.9%	0.5%	0.0%	0.0%	0.0%	0.0%
MIN	0.1%	0.3%	0.9%	1.1%	0.0%	0.1%	0.0%	0.0%
MAX	0.1%	0.3%	0.9%	0.0%	0.0%	0.1%	0.0%	0.0%

Minority Population

	Average Number of Available College Enrollment within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available College Enrollment within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority
No Build	19,890	5,520	24.3	15.8	42,320	17,230	13.4	12.5
TIO	19,930	5,550	24.4	15.8	42,320	17,230	13.4	12.5
MIN	19,930	5,550	24.4	15.8	42,390	17,230	13.4	12.5
MAX	19,930	5,550	24.4	15.8	42,390	17,230	13.4	12.5

Percentage Change from No Build Scenario

	Average Number of Available College Enrollment within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available College Enrollment within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority
TIO	0.2%	0.5%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%
MIN	0.2%	0.5%	0.4%	0.0%	0.2%	0.0%	0.0%	0.0%
MAX	0.2%	0.5%	0.4%	0.0%	0.2%	0.0%	0.0%	0.0%

Appendix 1 (continued)
Results - Accessibility Summary (Build Alternatives vs No Build Alternative)

1.5 Colleges

Linguistically Isolated Population

	Average Number of Available College Enrollment within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available College Enrollment within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated
No Build	21,430	10,270	21.6	18.8	33,860	26,000	14.2	12.7
TIO	21,430	10,310	21.6	18.8	33,860	26,000	14.2	12.7
MIN	21,430	10,310	21.6	18.8	34,220	26,010	14.2	12.7
MAX	21,430	10,310	21.6	18.8	34,220	26,010	14.2	12.7

Percentage Change from No Build Scenario

	Average Number of Available College Enrollment within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available College Enrollment within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated
TIO	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MIN	0.0%	0.4%	0.0%	0.0%	1.1%	0.0%	0.0%	0.0%
MAX	0.0%	0.4%	0.0%	0.0%	1.1%	0.0%	0.0%	0.0%

Disabled Population

	Average Number of Available College Enrollment within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available College Enrollment within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled
No Build	8,940	12,100	19.0	18.8	22,360	29,350	13.3	12.4
TIO	8,940	12,150	19.0	18.9	22,360	29,350	13.3	12.4
MIN	8,940	12,160	19.0	18.9	22,400	29,360	13.3	12.4
MAX	8,940	12,160	19.0	18.9	22,400	29,360	13.3	12.4

Percentage Change from No Build Scenario

	Average Number of Available College Enrollment within a 40-Minute Transit Trip		Average Transit Time (minutes)		Average Number of Available College Enrollment within a 20-Minute Auto Trip		Average Highway Time (minutes)	
	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled
TIO	0.0%	0.4%	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%
MIN	0.0%	0.5%	0.0%	0.5%	0.2%	0.0%	0.0%	0.0%
MAX	0.0%	0.5%	0.0%	0.5%	0.2%	0.0%	0.0%	0.0%

Appendix 2
Results
Mobility Summary (Build Alternatives vs. No Build Alternative)

2. 1 Transit

Low Income Population

	Average Transit Production Time (minutes)				Average Transit Attraction Time (minutes)			
	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income
No Build	45.1	53.2	*Compared to No Build*		41.0	42.3	*Compared to No Build*	
TIO	45.1	53.2	0.0%	0.0%	41.0	42.3	0.0%	0.0%
MIN	45.1	53.2	0.0%	0.0%	41.0	42.3	0.0%	0.0%
MAX	45.1	53.2	0.0%	0.0%	41.0	42.3	0.0%	0.0%

Minority Population

	Average Transit Production Time (minutes)				Average Transit Attraction Time (minutes)			
	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority
No Build	46.0	55.9	*Compared to No Build*		42.3	42.1	*Compared to No Build*	
TIO	46.0	55.9	0.0%	0.0%	42.3	42.1	0.0%	0.0%
MIN	46.0	55.9	0.0%	0.0%	42.3	42.1	0.0%	0.0%
MAX	45.9	55.9	-0.2%	0.0%	42.3	42.1	0.0%	0.0%

Linguistically Isolated Population

	Average Transit Production Time (minutes)				Average Transit Attraction Time (minutes)			
	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated
No Build	45.6	52.6	*Compared to No Build*		42.0	42.1	*Compared to No Build*	
TIO	45.6	52.6	0.0%	0.0%	42.1	42.1	0.2%	0.0%
MIN	45.6	52.6	0.0%	0.0%	42.1	42.1	0.2%	0.0%
MAX	45.6	52.6	0.0%	0.0%	42.1	42.1	0.2%	0.0%

Disabled Population

	Average Transit Production Time (minutes)				Average Transit Attraction Time (minutes)			
	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled
No Build	51.9	52.7	*Compared to No Build*		43.6	41.0	*Compared to No Build*	
TIO	51.9	52.7	0.0%	0.0%	43.6	41.0	0.0%	0.0%
MIN	51.8	52.6	-0.2%	-0.2%	43.6	41.0	0.0%	0.0%
MAX	51.9	52.6	0.0%	-0.2%	43.6	41.0	0.0%	0.0%

Appendix 2 (continued)
Results
Mobility Summary (Build Alternatives vs. No Build Alternative)

2.2 Auto

Low Income Population

	Average Highway Production Time (minutes)				Average Highway Attraction Time (minutes)			
	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income
No Build	12.8	14.0	*Compared to No Build*		12.6	12.5	*Compared to No Build*	
TIO	12.8	14.0	0.0%	0.0%	12.6	12.5	0.0%	0.0%
MIN	12.8	14.1	0.0%	0.5%	12.6	12.5	0.0%	0.0%
MAX	12.8	14.1	0.0%	0.5%	12.6	12.5	0.0%	0.0%

Minority Population

	Average Highway Production Time (minutes)				Average Highway Attraction Time (minutes)			
	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority
No Build	13.2	14.3	*Compared to No Build*		12.8	12.3	*Compared to No Build*	
TIO	13.2	14.3	0.0%	0.0%	12.8	12.3	0.0%	0.0%
MIN	13.2	14.3	0.1%	0.0%	12.9	12.3	0.5%	0.0%
MAX	13.2	14.3	0.1%	0.0%	12.9	12.3	0.5%	0.0%

Linguistically Isolated Population

	Average Highway Production Time (minutes)				Average Highway Attraction Time (minutes)			
	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated
No Build	13.4	13.9	*Compared to No Build*		12.5	12.5	*Compared to No Build*	
TIO	13.4	13.9	0.0%	0.0%	12.5	12.5	0.0%	0.0%
MIN	13.4	13.9	0.0%	0.0%	12.5	12.5	0.0%	0.0%
MAX	13.4	13.9	0.0%	0.0%	12.5	12.5	0.0%	0.0%

Disabled Population

	Average Highway Production Time (minutes)				Average Highway Attraction Time (minutes)			
	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled
No Build	13.7	14.0	*Compared to No Build*		11.9	12.9	*Compared to No Build*	
TIO	13.7	14.0	0.0%	0.0%	11.9	12.9	0.0%	0.0%
MIN	13.7	14.0	0.0%	0.0%	11.9	12.9	0.0%	0.0%
MAX	13.8	14.0	0.7%	0.0%	11.9	12.9	0.0%	0.0%

Appendix 3
Results
Environmental Summary (Build Alternative vs. No Build Alternative)

Low Income Population

	CO per Square Mile (kg/mile^2)				Congested VMT per Square Mile			
	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income	Low-Income	Not Low-Income
No Build	410	210	*Compared to No Build*		1,990	7,040	*Compared to No Build*	
TIO	410	210	0.0%	0.0%	1,980	7,030	-0.5%	-0.1%
MIN	410	210	0.0%	0.0%	2,000	7,050	0.5%	0.1%
MAX	410	210	0.0%	0.0%	2,000	7,050	0.5%	0.1%

Minority Population

	CO per Square Mile (kg/mile^2)				Congested VMT per Square Mile			
	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority
No Build	350	170	*Compared to No Build*		4,100	7,810	*Compared to No Build*	
TIO	350	170	0.0%	0.0%	4,100	7,800	0.0%	-0.1%
MIN	350	170	0.0%	0.0%	4,110	7,820	0.2%	0.1%
MAX	350	170	0.0%	0.0%	4,120	7,830	0.5%	0.3%

Linguistically Isolated Population

	CO per Square Mile (kg/mile^2)				Congested VMT per Square Mile			
	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated	Linguistically Isoslated	Not Linguistically Isolated
No Build	350	230	*Compared to No Build*		1,500	6,680	*Compared to No Build*	
TIO	350	230	0.0%	0.0%	1,500	6,670	0.0%	-0.1%
MIN	350	230	0.0%	0.0%	1,500	6,690	0.0%	0.1%
MAX	350	230	0.0%	0.0%	1,510	6,690	0.7%	0.1%

Disabled Population

	CO per Square Mile (kg/mile^2)				Congested VMT per Square Mile			
	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled	Disabled	Non-Disabled
No Build	240	230	*Compared to No Build*		5,280	7,370	*Compared to No Build*	
TIO	240	230	0.0%	0.0%	5,280	7,360	0.0%	-0.1%
MIN	240	230	0.0%	0.0%	5,300	7,380	0.4%	0.1%
MAX	240	230	0.0%	0.0%	5,300	7,390	0.4%	0.3%

Attachment B Demographic Profile of Study Areas

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1. South Station Study Area

1.1. Population

The one-half-mile South Station study area encompasses the Leather District and much of the Chinatown neighborhood to the west; extends to the east across the Fort Point Channel to include a portion of the South Boston Waterfront/Innovation District; and extends to the north to include a portion of the Downtown neighborhood. According to the U.S. Census, the South Station study area had a population of approximately 12,659 residents in 2010. The population in the study area is concentrated to the west of the station in the neighborhoods of Chinatown and the Leather District, with smaller populations north of the station in the Downtown neighborhood, and to the east in the South Boston Waterfront/Innovation District area.

Table 13 presents population trends for the South Station study area, neighborhoods within a one-half mile radius of South Station, Boston, Suffolk County, and Massachusetts. The population of the South Station study area and the populations of neighborhoods near South Station increased at substantially higher percentages over the 10 year period than did the populations of Boston, Suffolk County, and Massachusetts. The study area population grew by almost 55% from 2000 to 2010. All of the neighborhoods in close proximity to South Station increased their populations by more than 10%, and the populations of the Leather District and South Boston Waterfront/Innovation District neighborhoods increased by close to 200% and 300%, respectively. In comparison, from 2000 to 2010, the City of Boston's population increased by almost 5%, Suffolk County increased by slightly less than 5%, and the state population increased by slightly more than 3%.

Table 13—Population Trends, South Station Study Area, 2000-2010

Area	Population 2000	Population 2010	%Change 2000 to 2010
South Station Study Area	8,190	12,659	54.6
Chinatown	3,559	4,444	24.9
Leather District	219	639	191.8
Downtown	7,355	11,215	52.5
South Boston Waterfront	509	1,889	271.1
City of Boston	589,141	617,594	4.8
Suffolk County	689,807	722,023	4.6
Massachusetts	6,349,097	6,547,629	3.1

Sources: 2010 Census, Summary File 1, Boston Redevelopment Authority Research Division Analysis; 2010 Census

1.2. Housing

There were approximately 6,444 housing units in the South Station study in 2010. Mirroring the population characteristics in the study area, the housing units in the study area are generally concentrated to the west and north of South Station, in the neighborhoods of Chinatown, the Leather District, and Downtown, with smaller numbers in the South Boston Waterfront/Innovation District neighborhood. Of the total number of housing units, 5,443 units were occupied, indicating a 2010 housing occupancy rate of 84.5% and a vacancy rate of 15.5%.

Table 14 presents housing stock and occupancy trends for the South Station study area, neighborhoods within a one-half mile radius of South Station, Boston, Suffolk County, and Massachusetts. From 2000 to 2010, the increase in the number of housing units in the South Station study area and in the neighborhoods proximate to South Station far exceeded the growth rate of housing in the city, Suffolk County, and Massachusetts. All of the neighborhoods increased their housing stock by more than 50%

over the past decade. The data are reflective of the recent development boom in the South Boston Waterfront/Innovation District neighborhood.

Table 14—Housing Stock and Occupancy Trends, South Station Study Area, 2000-2010

Area	Housing Units 2000	Housing Units 2010	% Change 2000-2010	% Vacant 2000	% Vacant 2010	% Change 2000-2010
South Station Study Area	3,860	6,444	66.9	9.0	15.5	187.6
Chinatown	1,367	2,114	54.6	2.9	6.2	230.0
Leather District	157	377	140.1	11.5	4.0	-16.7
Downtown	3,305	5,390	63.1	11.4	21.0	201.1
South Boston Waterfront	270	1,214	349.6	8.5	15.3	708.7
City of Boston	251,935	272,481	8.2	4.9	7.3	59.4
Suffolk County	292,520	315,522	7.9	4.7	7.2	64.9
Massachusetts	2,621,989	2,808,254	7.1	6.8	9.3	46.4

Sources: 2010 Census, Summary File 1, Boston Redevelopment Authority Research Division Analysis (November 2011); Boston Redevelopment Authority, South Boston Waterfront, 2010 Census Population, March 2011.

Table 15 presents an overview of housing tenure in the South Station study area and neighborhoods proximate to South Station, in comparison to Boston, Suffolk County, and Massachusetts. With the exception of the Chinatown and Leather District neighborhoods, in 2010, the ratios of owner- and renter-occupied housing in the South Station study area and in neighborhoods proximate to South Station were similar to the housing occupancy characteristics of the City of Boston and Suffolk County. From 2000 to 2010, the percentage of owner-occupancy in the South Station study area increased by approximately 6%, from approximately 27% to 33% of all occupied housing units. Conversely, from 2000 to 2010, the percentage of renter-occupancy in the South Station study area decreased by approximately 6%, from approximately 73% to less than 67% of all occupied housing units. Similarly, the percentages of owner-occupied units increased in the City of Boston from approximately 32% in 2000, to almost 34% in 2010. In Suffolk County, the rate of owner-occupancy increased from approximately 34% in 2000 to over 35% in 2010; while the rate of renter-occupancy decreased from slightly less than 68% in 2000, to less than 65% in 2010.

Table 15—Housing Tenure, South Station Study Area, 2010

Area	Total Occupied Housing Units	Owner-occupied	% Owner-occupied	Renter-occupied	% Renter-occupied
South Station Study Area	5,443	1,805	33.2	3,638	66.8
Chinatown	1,982	133	6.7	1,849	93.3
Leather District	362	252	69.6	110	30.4
Downtown	4,258	1,620	33.2	2,638	62.0
South Boston Waterfront	1,028	388	37.7	640	62.3
City of Boston	252,699	85,791	33.9	166,908	66.1
Suffolk County	292,767	103,220	35.3	189,547	64.7
Massachusetts	2,547,075	1,587,158	62.3	959,917	37.7

Sources: 2010 Census, Summary File 1, Boston Redevelopment Authority Research Division Analysis; Boston Redevelopment Authority, Neighborhood 2010 Census Population Reports, March 2011

1.3. Housing Characteristics

Table 16 presents household characteristics in the South Station study area, in comparison to the neighborhoods proximate to South Station, Boston, Suffolk County, and Massachusetts. In 2010 the South Station study area contained approximately 5,443 households, with an average household size of approximately 1.8 residents per household. Almost 64% of the households in the study area consisted of nonfamily households, with slightly more than 36% of the households representing family households. With the exception of Chinatown, which had a roughly 50-50 split between family and nonfamily households in 2010, and an average household size greater than 2 residents per household, the neighborhoods located within one-half mile of South Station generally exhibited the same household characteristics of the study area: higher percentages of nonfamily over family households, and an average household size of less than 2 residents per household. In contrast, in Boston, Suffolk County and Massachusetts, the percentages of family households exceeded the percentages of nonfamily households in 2010, and the average household size exceeded 2 persons per household.

Table 16—Household Characteristics, South Station Study Area, 2010

Area	Total Households	Family Households	% of Total	Nonfamily Households	% of Total	Average Household Size
South Station Study Area	5,443	1,983	36.4	3,460	63.6	1.8
Chinatown	1,928	976	49.2	1,006	50.8	2.2
Leather District	362	136	37.6	226	62.4	1.7
Downtown	4,258	1,297	30.5	2,961	69.5	1.6
South Boston Waterfront	1,028	284	27.6	744	72.4	1.6
City of Boston	252,699	116,244	46.0	136,455	54.0	2.3
Suffolk County	292,767	140,412	48.0	152,355	52.0	2.3
Massachusetts	2,547,075	1,603,591	63.0	943,484	37.0	2.5

Source: 2010 Census, Summary File 1, Boston Redevelopment Authority Research Division Analysis; 2010 U.S. Census

Table 17 presents median household income for the neighborhoods encompassing or in the immediate vicinity of South Station, as estimated in the 2006-2010 ACS. Both the Downtown and the South Boston Waterfront neighborhoods had higher median household incomes than did the City of Boston or Suffolk County.

Table 17—Median Household Income, South Station Study Vicinity

Area	Estimated Median Household Income 2006-2010
Downtown (including Chinatown and Leather District)	$57,322
South Boston Waterfront	$81,126
City of Boston	$50,866
Suffolk County	$50,597
Massachusetts	$65,201

Sources: 1) Boston Redevelopment Authority Research Department, Reports #570, #573 and #574, December 15, 2003;
2) Boston Redevelopment Authority, *Boston in Context: Neighborhoods*, 3/28/2013 (American Community Survey, 2006-2010).

1.4. Employment

Table 18 presents the occupational profile of the South Station study area and surrounding areas for the civilian employed population 16 years and over, as estimated in the 2006-2010 ACS. The South Station study area and the immediate neighborhoods had substantially higher percentages of people employed in the management, business, science and arts sectors than did the, Suffolk County, and Massachusetts.

Correspondingly, the South Station study area and immediate neighborhoods had lower percentages of people employed in all other sectors.

Table 18—Estimated Occupational Profile for Residents in the South Station Study Area

Area	Estimated Percentage of Total Employment, 2006-2010[a]				
	Management, Business, Science & Arts	Service	Sales and Office	Natural Resources, Construction & Maintenance	Production, Transportation & Material Moving
South Station Study Area	58.3	16.0	20.7	0.3	4.6
Downtown[b]	59.2	15.3	20.7	0.3	4.6
South Boston Waterfront	70.5	14.1	11.8	0.7	3.0
City of Boston	44.8	21.6	22.9	4.3	6.4
Suffolk County	42.3	21.9	23.4	5.0	7.4
Massachusetts	42.8	16.6	24.2	7.4	9.1

Sources: Boston Redevelopment Authority, *Boston in Context: Neighborhoods*, 3/28/2013 (American Community Survey [ACS], 2006-2010). U.S. Census Bureau, American Fact Finder, *Selected Economic Characteristics, Suffolk County*, 2006-2010 ACS Selected Population Tables
a Total for civilian employed population 16 years and over
b The Downtown neighborhood includes Chinatown and the Leather District.

Table 19 presents the estimated commute to work percentages, as reported by the 2006-2010 ACS. In comparison to the City of Boston, Suffolk County, and Massachusetts the percentages of people in the South Station study area and proximate neighborhoods who drove alone or carpooled were lower; and the percentages who used other means to commute, including walking or bicycling were substantially higher. These data reflect the mixed-use development that characterizes the Downtown and South Boston Waterfront neighborhoods.

Table 19—Commute to Work, South Station Vicinity, 2006-2010

Area	Percentage of Total Employment[a]			
	Drove Alone	Carpool	Public Transportation	Other[b]
Downtown	18.0	2.2	21.9	57.8
South Boston Waterfront	33.5	7.7	30.3	28.5
City of Boston	40.0	7.9	34.1	18.0
Suffolk County	42.5	8.4	32.7	16.4
Massachusetts	75.6	8.6	9.4	6.4

Sources: American Community Survey, 2006-2010; Boston Redevelopment Authority, Boston in Context: Neighborhoods, 3/28/13
a Total for civilian employed population 16 years and over
b Includes taxicab, motorcycle, bicycle, walked or by other means

Table 20 presents the employment profile by industry for South Station and surrounding areas, as estimated in the 2006-2010 ACS. Percentages of people employed in the business and professional services in the South Station study area, Downtown and South Boston Waterfront neighborhoods exceeded those in the City of Boston, Suffolk County, and Massachusetts. Percentages of people employed in construction, retail trade, and education, health and social services were lower in the South Station area and proximate neighborhoods than those in the city, county, or state.

Table 20—Employment Profile by Industry of Residents in the South Station Study Area, 2010

Area	Percentage of Total Employment[a]									
	Construction	Manufacturing	Wholesale Trade	Retail Trade	Transportation, Warehousing, Utilities, Information	FIRE[b]	Business & Professional Services[c]	Education, Health, Social Services	Arts, Entertainment, Food Services[d]	Public Administration & Other[e]
South Station Study Area	1.3	5.7	2.0	6.5	5.4	17.0	19.9	22.1	12.2	7.9
Downtown[f]	1.3	5.4	0.7	6.1	4.5	18.4	20.4	24.1	11.9	7.2
South Boston Waterfront	2.3	5.1	6.7	1.8	7.7	8.2	21.3	23.2	9.5	14.2
City of Boston	3.4	4.7	1.6	8.3	6.2	9.8	15.0	30.5	11.2	9.3
Suffolk County	4.0	5.1	2.0	8.7	6.5	9.5	14.5	29.0	11.4	9.3
Massachusetts	5.9	9.9	2.7	10.7	6.4	8.1	12.7	26.7	8.0	8.9

Sources: Boston Redevelopment Authority, Boston in Context: Neighborhoods, 3/28/13; U.S. Census Bureau, American Fact Finder, *Selected Economic Characteristics, 2006-2010 American Community Survey Selected Population Tables, Suffolk County*

a Total for civilian employed population 16 years and over

b Includes finance and insurance, and real estate and rental and leasing

c Includes professional, scientific, management, and administrative and waste management services

d Includes arts, entertainment, recreation, accommodation and food services

e Includes public administration; agriculture, forestry, fishing, hunting, and mining; and other services

f The Downtown neighborhood includes Chinatown and the Leather District.

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2. Layover Facilities Study Areas

1.1. Population

All of the layover facility sites are located within existing industrial areas. The population of the one-half-mile Widett Circle study area is generally concentrated in the South End neighborhood, west of the site, and to a lesser extent, in the eastern portion of the study area in South Boston. Readville - Yard 2 is located in the Hyde Park neighborhood, with the one-half=mile study area population located primarily south and northwest of the site.

Table 21 presents population trends for the three layover facility study areas. The Widett Circle study area grew substantially more than any other study area or neighborhood. Population trends within the Beacon Park Yard study area closely resembled that of the Allston neighborhood in which it is located, growing by almost 14% between 2000 and 2010. With the exception of the Readville – Yard 2 study area, which lost population from 2000 to 2010, the growth rate of the study area populations exceeded the city, county or state growth rates over the same time period.

Table 21—Population Trends, Layover Facility Study Areas, 2000-2010

Area	Population 2000	Population 2010	%Change 2000 to 2010
Widett Circle Study Area[a]	7,405	11,299	52.6
South Boston	31,005	33,311	7.4
South End	21,911	24,577	12.2
Beacon Park Yard Study Area	16,948	19,232	13.5
Allston	25,623	29,196	13.9
Readville Yard – 2 Study Area	5,615	5,111	-9.0
Hyde Park	30,076	30,637	1.9
City of Boston	589,141	617,594	4.8
Suffolk County	689,807	722,023	4.6
Massachusetts	6,349,097	6,547,629	3.1

Sources: 2010 Census, Summary File 1, Boston Redevelopment Authority Research Division Analysis; 2010 Census
a The Widett Circle study area includes the Suffolk County House of Corrections, which had 1,512 residents in 2010.

1.2. Housing

Table 22 presents housing stock and occupancy trends in the three layover facility areas, in comparison to their neighborhoods, the City of Boston Suffolk County, and Massachusetts. Similar to population trends, housing stock in the Widett Circle study area increased substantially more than any other study area, including the neighborhoods in immediate proximity to the site, and far exceeded the housing growth rates in the City of Boston, Suffolk County, or Massachusetts. Vacancy rates in the Widett Circle study area declined substantially over the 10 year period. Housing trends in the Beacon Park Yard study area more closely aligned with the Allston neighborhood, increasing approximately 6% and seven%, respectively, between 2000 and 2010. Both the Readville – Yard 2 study area and Hyde Park experienced modest housing growth rates.

Table 22—Housing Stock and Occupancy Trends, Layover Facility Study Areas, 2000-2010

Area	Housing Units 2000	Housing Units 2010	% Change 2000-2010	% Vacant 2000	% Vacant 2010	% Change 2000-2010
Widett Circle Study Area	2,742	4,797	74.9	9.7	8.2	-15.5
South Boston	14,761	16,409	11.2	6.6	7.4	25.6
South End	12,000	13,648	13.7	5.4	6.0	25.7
Beacon Park Yard Study Area	6,274	6,667	6.3	1.4	3.1	133.7
Allston	10,373	11,095	7.0	1.4	3.4	161.0
Readville Yard – 2 Study Area	2,058	2,128	3.4	4.0	7.2	84.3
Hyde Park	11,289	11,816	4.7	3.3	6.2	97.6
City of Boston	251,935	272,481	8.2	4.9	7.3	59.4
Suffolk County	292,520	315,522	7.9	4.7	7.2	64.9
Massachusetts	2,621,989	2,808,254	7.1	6.8	9.3	46.4

Sources: 2010 Census, Summary File 1, Boston Redevelopment Authority Research Division Analysis; Boston Redevelopment Authority, Neighborhood 2010 Census Population Reports, March 2011, Boston 2010 Census Population Neighborhood Comparison, April 2011.

Table 23 presents housing tenure data for the three layover facility study areas and their immediate neighborhoods. Owner and renter occupancy percentages in the Widett Circle study area resemble the owner/renter rates of Suffolk Country, with owner-occupancy rates in the study area and neighborhoods slightly exceeding the city and county rates. The high percentage of renter-occupied units in the Beacon Park Yard study area and Allston reflects the large student population in the area. The owner-occupancy rates in the Readville - Yard 2 study area and Hyde Park exceed the Suffolk County rates, and are just slightly lower than the Massachusetts owner-occupancy rate.

Table 23—Housing Tenure, Layover Facility Study Areas, 2010

Area	Total Occupied Housing Units	Owner-occupied	% Owner-occupied	Renter-occupied	% Renter-occupied
Widett Circle Study Area	4,404	1,639	37.2	2,765	62.8
South Boston	15,191	6,108	40.2	9,083	59.8
South End	12,831	5,026	39.2	7,805	60.8
Beacon Park Yard Study Area	6,488	1,225	19.0	5,263	81.1
Allston	10,714	1,379	12.9	9,335	87.1
Readville Yard – 2 Study Area	1,975	994	50.3	981	49.7
Hyde Park	11,079	6,431	58.0	4,648	42.0
City of Boston	252,699	85,791	33.9	166,908	66.1
Suffolk County	292,767	103,220	35.3	189,547	64.7
Massachusetts	2,547,075	1,587,158	62.3	959,917	37.7

Sources: 2010 Census, Summary File 1, Boston Redevelopment Authority Research Division Analysis; Boston Redevelopment Authority, Neighborhood 2010 Census Population Reports, March 2011

1.3. Housing Characteristics

Table 24 presents household characteristics in the three layover facility study areas, in comparison to surrounding neighborhoods, the City of Boston, Suffolk County, and Massachusetts. Household characteristics in the three study areas closely align with the neighborhoods in which they are located. Nonfamily households are predominant in the Widett Circle study area and the Beacon Park Yard study area. In contrast, family households are predominant in the Readville – Yard 2 study area, exceeding the percentages of family household in the City of Boston, Suffolk County, and Massachusetts.

Table 24—Household Characteristics, Layover Facility Study Areas, 2010

Area	Total Households	Family Households	% of Total	Nonfamily Households	% of Total	Average Household Size
Widett Circle Study Area	4,404	1,764	40.1	2,640	59.9	2.2
South Boston	15,191	6,012	39.6	9,179	60.4	2.1
South End	12,831	4,370	34.1	8,461	65.9	1.8
Beacon Park Yard Study Area	6,459	1,854	28.7	4,605	71.3	2.9
Allston	10,714	2,684	25.1	8,030	74.9	2.2
Readville Yard 2 Study Area	1,975	1,267	64.2	708	35.8	2.4
Hyde Park	11,079	7,485	67.6	3,594	32.4	2.7
City of Boston	252,699	116,244	46.0	136,455	54.0	2.3
Suffolk County	292,767	140,412	48.0	152,355	52.0	2.3
Massachusetts	2,547,075	1,603,591	63.0	943,484	37.0	2.5

Source: 2010 Census, Summary File 1, Boston Redevelopment Authority Research Division Analysis; 2010 Census

Table 25 presents median household income for the neighborhoods encompassing the three layover facility sites, as estimated in the 2006-2010 ACS. With the exception of the Allston neighborhood, with a median age of approximately 25 and a predominance of students, the median household income in the neighborhoods exceeded the median household incomes of the City of Boston and Suffolk County.

Table 25—Median Household Income, Layover Facility Sites Vicinity

Area	Median Household Income 2006-2010
South Boston	$62,922
South End	$57,669
Allston	$36,617
Hyde Park	$59,502
City of Boston	$50,866
Suffolk County	$50,597
Massachusetts	$65,201

Source: Boston Redevelopment Authority, *Boston in Context: Neighborhoods*, 3/28/2013 (American Community Survey, 2006-2010).

1.4. Employment

Table 26 presents the occupational profile of the three layover facility study areas and their surrounding neighborhoods for the civilian employed population 16 years and over, as estimated in the 2006-2010 ACS. The occupational profile of the Widett Circle study area closely reflects the neighborhoods abutting the sites. Similar to the South Station study area and its immediate neighborhoods, the Widett Circle study area had higher percentages of people employed in the management, business, science and arts sectors than did the City of Boston, Suffolk County, and Massachusetts. Correspondingly, the Widett Circle study area and immediate neighborhoods had lower percentages of people employed in nearly all other sectors. The occupational profile of the Beacon Park Yard study area reflects the Allston neighborhood profile, with slightly higher percentages of people employed in the management, business, science, art, and service sectors, and a smaller percentage of people employed in the sales and office sector than the city, county or state. Relative to other study areas and city, county, and state, the Readville – Yard 2 study area had the highest percentage of people employed in the sales and office sector, and the lowest percentage of people employed in the management, business, science, and art sector.

Table 26—Occupational Profile, Layover Facility Study Areas, 2006-2010

Area	Percentage of Total Employment[a]				
	Management, Business, Science & Arts	Service	Sales and Office	Natural Resources, construction & maintenance	Production, transportation & material moving
Widett Circle Study Area	53.8	17.5	20.0	3.4	5.3
South Boston	46.9	17.1	25.8	5.4	4.7
South End	58.1	14.2	19.8	3.7	4.2
Beacon Park Yard Study Area	48.1	24.2	20.3	2.3	5.0
Allston	44.0	26.8	20.3	2.2	6.6
Readville Yard -2 Study Area	37.7	23.5	31.3	4.4	3.1
Hyde Park	34.6	25.7	25.7	6.1	7.8
City of Boston	44.8	21.6	22.9	4.3	6.4
Suffolk County	42.3	21.9	23.4	5.0	7.4
Massachusetts	42.8	16.6	24.2	7.4	9.1

Sources: Boston Redevelopment Authority, *Boston in Context: Neighborhoods*, 3/28/2013; American Community Survey, 2006-2010.
a Total for civilian employed population 16 years and over

Table 28 presents the occupational profile by industry for the civilian employed population 16 years and over within the three layover facility study areas, as estimated in the 2006-2010 ACS. White collar jobs, particularly education, health, and social service, dominated the industry profile in the three layover facility study areas, similar to the profiles for the City of Boston, Suffolk County, and Massachusetts. Also similar to the city, fewer workers in the layover facility study areas were employed in blue collar and service jobs such as construction, manufacturing, and transportation and warehousing.

Table 27 presents the commute to work for neighborhoods in the vicinity of the layover facility sites. The percentage of employees using public transportation in the Widett Circle study area generally matched that of the City of Boston, at approximately 34%. Public transportation was the dominant means of transportation to work in the Allston neighborhood. In the Hyde Park neighborhood, the percentage of employees who used public transportation was the lowest of the study area neighborhoods, less than 25% of the employed population; conversely, at over 64%, the percentage of workers who drove alone to work was the highest in the Hyde Park neighborhood.

Table 27—Commute to Work, Layover Facility Sites Vicinity, 2006-2010

Area	Percentage of Total Employment[a]			
	% Drove Alone	% Carpool	% Public Transportation	% Other[b]
South Boston	51.2	4.2	34.2	10.4
South End	27.0	3.8	34.0	35.3
Allston	20.3	6.0	48.0	25.7
Hyde Park	64.1	8.5	24.6	2.7
City of Boston	40.0	7.9	34.1	18.0
Suffolk County	42.5	8.4	32.7	16.4
Massachusetts	75.6	8.6	9.4	6.4

Source*: Boston Redevelopment Authority, Boston in Context: Neighborhoods,* 3/28/13 (2006-2010 American Community Survey).
a Total for civilian employed population 16 years and over
b Includes taxicab, motorcycle, bicycle, walked or by other means

Table 28—Employment Profile by Industry, Layover Facility Study Areas

Area	Percentage of Total Employment[a]									
	Construction	Manufacturing	Wholesale Trade	Retail Trade	Transportation, Warehousing, Utilities, Information	FIRE[b]	Business & Professional Services[c]	Education, Health, Social Services	Arts, Entertainment, Food Services[d]	Public Administration & Other[e]
Widett Circle Study Area	2.4	6.9	3.9	8.4	5.7	16.6	19.9	20.8	9.0	6.4
South Boston	4.5	5.1	2.9	5.9	8.8	14.1	18.0	23.9	7.4	9.4
South End	2.6	5.9	2.4	6.5	4.5	15.9	21.7	23.7	10.3	6.5
Beacon Park Yard Study Area	2.6	5.4	1.2	8.1	4.2	7.8	13.9	33.1	19.1	4.6
Allston	2.4	5.5	0.8	10.4	4.7	5.7	12.2	31.5	20.6	6.2
Readville – Yard 2 Study Area	4.3	1.9	1.0	11.4	4.5	9.6	9.4	32.9	14.5	10.5
Hyde Park	4.1	3.6	1.4	8.3	7.7	9.1	8.8	39.2	8.1	9.7
City of Boston	3.4	4.7	1.6	8.3	6.2	9.8	15.0	30.5	11.2	9.3
Suffolk County	4.0	5.1	2.0	8.7	6.5	9.5	14.5	29.0	11.4	9.3
Massachusetts	5.9	9.9	2.7	10.7	6.4	8.1	12.7	26.7	8.0	8.9

Sources: Boston Redevelopment Authority, Boston in Context: Neighborhoods, 3/28/13; U.S. Census Bureau, American Fact Finder*, Selected Economic Characteristics, 2006-2010 American Community Survey Selected Population Tables, Suffolk County*

a Total for civilian employed population 16 years and over

b Includes finance and insurance, and real estate and rental and leasing

c Includes professional, scientific, management, and administrative and waste management services

d Includes arts, entertainment, recreation, accommodation and food services

e Includes public administration; agriculture, forestry, fishing, hunting, and mining; and other services

Attachment C Central Transportation Planning Staff South Station Expansion Project TREDIS Methodology Demographic Profile of Study Areas

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TECHNICAL MEMORANDUM

DATE: September 3, 2014
TO: South Station Expansion Project Files
FROM: Nicholas Hart
RE: South Station Expansion Project: TREDIS® Methodology

1 BACKGROUND

CTPS staff used the Transportation Economic Development Impact System (TREDIS®) software to estimate how the impacts resulting from the proposed South Station Expansion (SSX) alternatives will translate into economic benefits for the city of Boston and the surrounding region. TREDIS® is a predictive impact model that uses information about future travel patterns, market access, and construction spending to estimate the costs, benefits, and economic impacts that flow from them. More specifically, TREDIS® incorporates Impact Analysis for Planning (IMPLAN) data into an input-output economic model to trace how changes in household spending patterns and business costs flow through the economy. These IMPLAN data sets include the economic structure of the study region, and applicable multipliers to estimate indirect and induced economic activities by industry. A glossary of the TREDIS® inputs and outputs used for this analysis is provided in Appendix A.

Using a constant dollar year of 2014, the economic impacts of four South Station expansion alternatives were estimated and compared for the year 2035. The four alternatives included a True No-Build alternative (No-Build) and three build alternatives: Transportation Improvement Only (TIO), Joint Public/Private Development Minimum Build (Min), and Joint Public/Private Development Maximum Build (Max). The results of the analyses of the three build alternatives were compared to the analysis results of the No-Build alternative (the base alternative for this analysis). The assumptions for each alternative are shown in Table 1.

TABLE 1
South Station Expansion Alternatives

Alternative	Land Use Data	Transit Service Assumption
2035 True No-Build (No-Build)	2035 population and employment adopted by MPO for LRTP	1. The Fairmount Line will incorporate the improved service plan and implement the MBTA's rapid transit fare structure (except for fares at Readville Station).
2035 Transportation Improvement Only (TIO)	Relocate Fort Point US post office facility from the South Station area to the Reserve Channel site	1. Additional peak-period, peak-direction local trains added to Worcester/ Framingham, Needham, Franklin, and Providence/Attleboro commuter rail lines. 2. South Coast Rail, Intercity Buses, and Amtrak ridership were estimated using post-modeling process. 3. The Fairmount Line will incorporate the improved service plan and implement a new rapid transit fare structure (except for fares at Readville Station).
2035 Joint Public/Private Development Minimum Build (Min)	1. Relocate Fort Point US post office facility from the South Station area to the Reserve Channel site 2. Assumes the addition of 280 households, 620 persons, 1,020 service employees, and 255 retail employees to the South Station TAZ	1. Additional peak-period, peak-direction local trains added to Worcester/ Framingham, Needham, Franklin, and Providence/Attleboro commuter rail lines. 2. South Coast Rail, Intercity Buses, and Amtrak ridership were estimated using post-modeling process. 3. The Fairmount Line will incorporate the improved service plan and implement a new rapid transit fare structure (except for fares at Readville Station).
2035 Joint Public/Private Development Maximum Build (Max)	1. Relocate Fort Point US post office facility from the South Station area to the Reserve Channel site 2. Assumes the addition of 830 households, 1,830 persons, 3,000 service employees, and 750 retail employees to the South Station TAZ	1. Additional peak-period, peak direction local trains added to Worcester/Framingham, Needham, Franklin, and Providence/Attleboro commuter rail lines. 2. South Coast Rail, Intercity Buses, and Amtrak ridership were estimated using post-modeling process. 3. The Fairmount Line will incorporate the improved service plan and implement a new rapid transit fare structure (except for fares at Readville Station).

Note: All alternatives assume that several highway and transit projects, consistent with the currently adopted Long Range Transportation Plan (LRTP), and the Silver Line Gateway project will be implemented by the year 2035.
TAZ = transportation analysis zone

CTPS applied TREDIS® to estimate the following economic impacts, by source:

- The economic value of travel efficiency gains and losses as a result of the transportation changes in the region due to the proposed transportation improvement to South Station and the permanent household population gains and permanent employment gains from the proposed joint public/private development above the station. The study region for this analysis was the entire Boston Region Metropolitan Planning Organization's (MPO) regional travel demand model area, which includes 164 municipalities located in Eastern Massachusetts, centered on the Boston Region MPO area, which has 101 municipalities. The results of this analysis present an estimation of the total travel cost savings to transportation users by the type of savings and by trip purpose for the horizon year of 2035. The results of the three build alternatives were compared to the no-build alternative (see Appendix B).
- The economic impacts of expenditure on construction. The study region for this analysis was the entire MPO model region. The results of this analysis present an estimation of changes in business output, value added, jobs, and wage income as a result of construction for each year of construction activities. The results of the three build alternatives were compared to the no-build alternative (see Appendix C).
- The economic impacts of permanent household population gains and employment gains from the proposed joint public/private development above the station, and permanent employment gains from the increase in operations and maintenance personnel from the expansion of the South Station terminal. The study region for this analysis was composed of zip code boundaries within Boston and Cambridge that were selected based on their propensity to receive business from the additional households and workers moving into the South Station transportation analysis zone (TAZ). The results of this analysis present an estimation of changes in business output, value added, jobs, and wage income for each year of the analysis period (2018–35). The results of the three build alternatives were compared to the no-build alternative (see Appendix D).

2 ESTIMATING THE ECONOMIC VALUE OF TRAVEL EFFICIENCY GAINS

To estimate user travel cost savings, TREDIS® uses the changes in vehicle-hours of travel (VHT) and vehicle-miles of travel (VMT) between different alternatives and transforms them into changes in travel time, vehicle operating cost, and other out-of-pocket expenses. These effects are then monetized to calculate the total change in user travel costs for the region.

2.1 Assumptions

This analysis relied heavily on the TREDIS® standard data assumptions and routines for estimating travel cost savings and on travel demand model output data for each of the alternatives listed in Table 1. The remaining necessary data were gathered from existing sources. The following inputs were generated by CTPS for this analysis.

2.2 Inputs

Minimal calculation was necessary to transform some key regional travel demand model outputs into inputs usable by TREDIS®. The number of vehicle-trips, VMT, and VHT were calculated from the travel demand model for each alternative's mode and purpose categories, described below. The percentages of VMT occurring on congested roadway segments, where the volume-to-capacity ratio is greater than 80 percent, were computed for the Single-Occupancy-Vehicle (SOV), High-Occupancy-Vehicle (HOV), and truck modes for each alternative. The percentage of trips occurring wholly within the model region; the percentage of trips with one end outside the model region; and the percentage of trips traversing the region with both ends outside of the region were also computed for the two automobile modes.

Modes

The transit, automobile, truck, and nonmotorized modes were investigated in this analysis. To be consistent with the travel demand model, the automobile mode was divided into two categories: SOV and HOV. The truck mode is composed of commercial vehicles in three categories: hazardous materials tanker trucks, vans/pickup trucks used for commercial purposes, and other commercial trucks. There are four transit mode categories. The rapid transit mode category includes all heavy rail, light rail, and bus rapid transit service provided by the MBTA. The bus mode category includes all MBTA local and express buses, Logan Express, private bus service, and buses operated by RTAs. The commuter rail category includes all MBTA commuter rail service. The Amtrak category includes all Amtrak service that connects to South Station; Amtrak's Downeaster service, which operates out of Boston's North Station, was not included. Ferries and shuttles were not included in this analysis. The nonmotorized modal category from the travel demand model was split into pedestrian trips and bike trips.

Purposes

TREDIS® assumes different default values of time for different trip purposes because people place a higher value on time when making mandatory trips (such as work) than when making discretionary trips. The two trip purposes assumed for the analysis are "commute" and "personal." The travel demand model's home-based work trips served as a proxy for assigning auto and nonmotorized trips to the commute category. The model's other trip purposes—home-based other, home-based school, non-home-based work, and non-home-based other—were assumed to fall under the personal category. Rapid transit, passenger bus, and Amtrak trips made during the AM and PM peak periods were assumed to be commute trips, while trips made during the rest of the day were assumed to be personal trips. For commuter rail, survey results show that approximately 90 percent of trips are commute trips; the remaining 10 percent are assumed to be personal trips.

Annualization Factors

TREDIS® requires annual figures, as opposed to daily ones, for inputs. Hence it was necessary to annualize the needed outputs from the travel demand model. CTPS developed the annual transit factors from recently collected MBTA and Amtrak data and the annual automobile and nonmotorized factors from permanent highway station count data. The numbers presented in Table 2 were applied to daily figures to achieve annual numbers.

TABLE 2
Annualization Factors by Mode

Mode	Annualization Factor
Automobile	340
Bus	298
Rapid transit	313
Bike and pedestrian	340
Commuter rail	276
Amtrak	252

Average Fare per Passenger Trip

The average fares per passenger trip were calculated from SFY 2013 MBTA revenue numbers for the rapid transit, bus, and commuter rail modes. Amtrak's fare was calculated as the average fare between Boston and Providence, accounting for both the Northeast Regional and Acela services.

Average Passenger per Vehicle

The regional survey provided data on the average number of passengers per vehicle for HOV trips within the region. The number of passengers per transit vehicle was calculated from model data for each of the four defined transit modes on a daily basis.

Average Toll per Trip

The average tolls accrued on entire vehicle journeys were calculated in SFY2013 dollars on a daily basis from model data. These calculations were performed for truck, SOV, and HOV trips.

3 ESTIMATING THE ECONOMIC IMPACTS OF CONSTRUCTION

To estimate the economic impacts of construction, TREDIS® uses an estimation of the total construction costs for each alternative. These cost inputs are transformed into an estimation of business output, value added, jobs, and wage income for the study region.

3.1 Assumptions

The study area for estimating the impacts of construction was the entire MPO model region, the same area used for estimating travel cost savings. This large area was chosen in order to increase the likelihood of capturing the location of construction offices and supply facilities and the home locations of construction workers and employees.

CTPS received capital cost estimates from the project team for the Transportation Improvement Only (TIO) alternative and joint development. The costs of the TIO alternative were added to the costs of joint development to produce the total cost of construction of the Min and Max alternatives. The costs of the TIO alternative were provided to CTPS in 2019 dollars, and were deflated at an annual rate of 4 percent to the 2014 constant dollar year required for the analysis. The cost components were itemized according to the type of cost, categorized for input by TREDIS®: property acquisition, engineering and design, right-of-way, transport structures, and terminal.

3.2 Inputs

The construction costs, derived using the assumptions described in Section 3.1, are displayed in Tables 3, 4, and 5. The costs in Table 3 were input into TREDIS® to estimate the economic impacts of constructing the TIO alternative. The costs in Table 3 and Table 4 were combined to estimate the economic impacts of constructing the entire Min alternative. Likewise, the costs in Table 3 and Table 5 were combined to estimate the economic impacts of constructing the entire Max alternative.

TABLE 3
TIO Construction Costs

Type of Cost	Component	Construction Period	Cost ($Million)
Property Acquisition	USPS facility	2018	236.7
	Widett Circle	2020	52.0
Engineering and Design	Final design	2018	65.2
Right-of-Way	USPS demolition	2020	39.2
	Urban streetscape	2020–2023	13.1
	Roadway improvements	2020–2023	24.6
Transport Structures	Signal, track, and platforms	2018–2022	268.6
	Layover facility	2020–2023	159.6
Terminal	New concourse	2020–2023	460.1
	Foundations for overbuild	2020–2021	111.3
Total			**1,430.3**

Note: Costs are in 2014 dollars.

TABLE 4
Min Joint Development Construction Costs

Type of Cost	Component	Construction Period	Cost ($Millions)
Engineering and Design	Final design	6/2020–12/2022	74.9
Right of Way	Urban streetscape	6/2020–12/2029	14.8
	Utilities infrastructure	6/2020–12/2029	5.0
	Road and access ramp	6/2020–12/2029	132.8
	Joint development plaza places	6/2020–12/2029	20.3
	Joint development open spaces	6/2020–12/2029	7.8
Terminal	Joint development 1	1/2022–12/2029	166.1
	Joint development 2	1/2022–12/2029	135.1
	Joint development 3	1/2022–12/2029	170.6
	Joint development 4	1/2022–12/2029	159.1
	Joint development 5	1/2022–12/2029	122.2
	Joint development 6	1/2022–12/2029	128.4
	Underground parking	6/2020–12/2021	85.6
Total			**1,222.5**

Note: Costs are in 2014 dollars.

TABLE 5
Max Joint Development Construction Costs

Type of Cost	Component	Construction Period	Cost ($Millions)
Engineering and Design	Final design	6/2020–12/2022	167.2
Right of Way	Urban streetscape	6/2020–12/2031	14.8
	Utilities infrastructure	6/2020–12/2031	5.0
	Road and access ramp	6/2020–12/2031	132.8
	Joint development plaza places	6/2020–12/2031	20.3
	Joint development open spaces	6/2020–12/2031	7.8
Terminal	Joint development 1	1/2022–12/2031	329.1
	Joint development 2	1/2022–12/2031	337.4
	Joint development 3	1/2022–12/2031	551.1
	Joint development 4	1/2022–12/2031	472.8
	Joint development 5	1/2022–12/2031	383.5
	Joint development 6	1/2022–12/2031	212.9
	Underground parking	6/2020–12/2021	93.6
Total			**2,728.3**

Note: Costs are in 2014 dollars.

4 ESTIMATING THE ECONOMIC IMPACTS OF PERMANENT HOUSEHOLD POPULATION GAINS AND PERMANENT EMPLOYMENT GAINS

To estimate the economic impacts of permanent household population gains and employment gains for each alternative, TREDIS® requires the user to estimate the additional household spending expected to occur within the study region from people living in the new development, and the total number of new employees (sorted by industry) working in the new development. TREDIS® then uses this information to estimate the increase in business output, value added, jobs, and wage income for the study region.

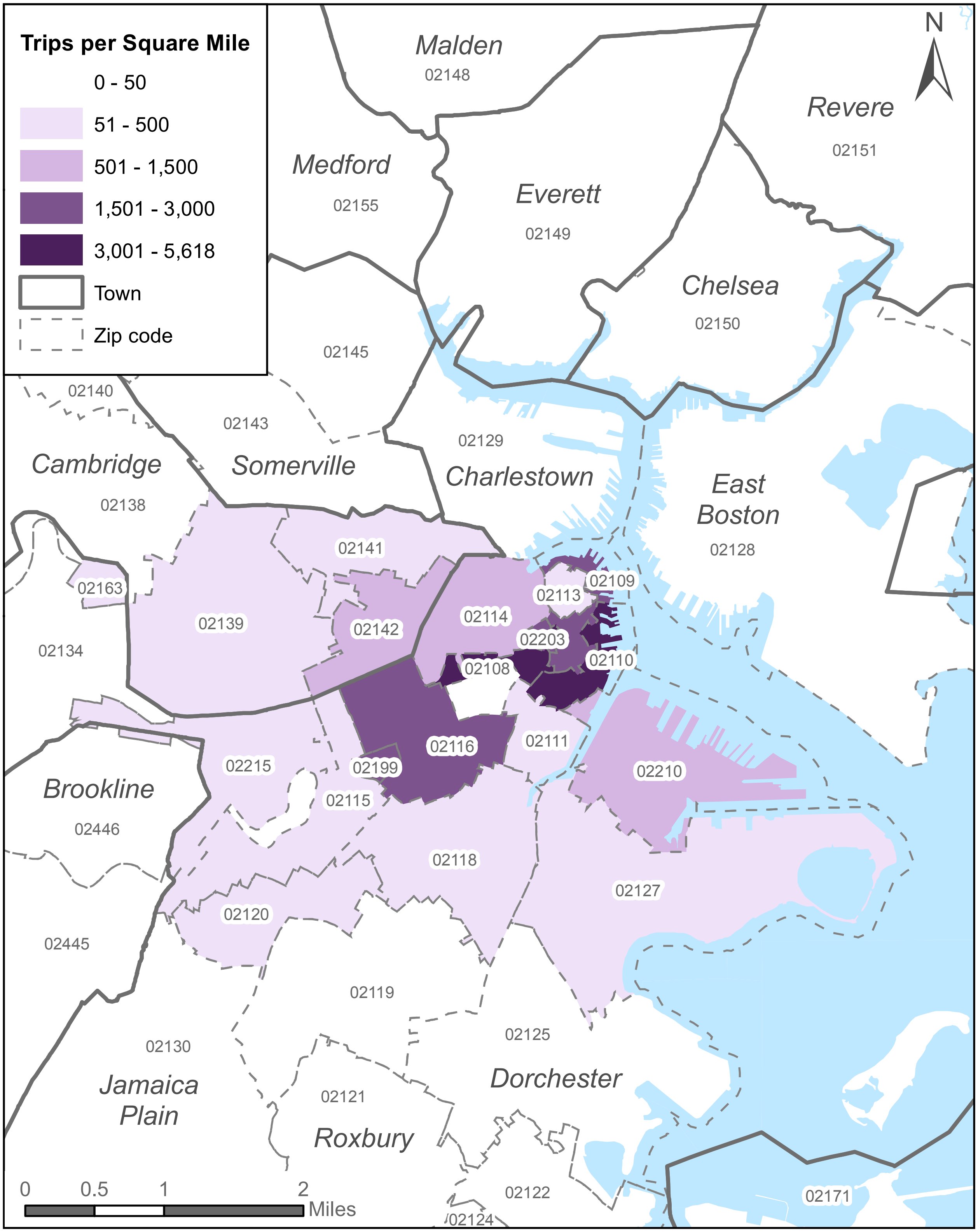
4.1 Assumptions

The study region for estimating the economic impacts of the joint public/private development is composed of zip code boundaries within Boston and Cambridge that were selected based on their propensity to receive business from the addition of new households and workers to the South Station TAZ. In order to guide the selection, the travel demand model was used to calculate the distribution of home-based trips emanating from the South Station TAZ. These trips were assigned to each zip code and were normalized by zip code area. Any zip code that received more than 50 daily home-based trips per square mile from the South Station TAZ was included in the study region. These zip codes are shown in Figure 1. Due to the location of Logan International Airport, East Boston was added to the study region, although it did not meet the threshold of 50 daily home-based trips per square mile. Figure 2 shows the complete set of 20 zip codes that form the boundary of the study region.

Cost estimations were provided by the project team for the operation and maintenance of the expanded portion of the South Station terminal, and were used to estimate the number of permanent jobs created by the expansion of this terminal. These costs were used to estimate the economic impact of the TIO alternative on the study region, and should be included together with the economic impacts of the private development above the terminal to estimate the total economic impacts of the Min and Max alternatives.

The Min and Max alternatives each assume that a certain number of “service” employees and “retail” employees will be added as part of the private development. The “service” and “retail” employment categories are used in the travel demand model. In order to input these data into TREDIS®, employees from each of these two categories had to be distributed into the 440 industry sectors used within the TREDIS® model. The industry sectors were selected using professional judgment, which accounted for the existing types of businesses in the study region. Employees were assigned proportionally to each industry sector for each alternative based on the predicted distribution within the 20-zip-code study region for the no-build alternative.

The Min and Max alternatives each assume that a certain number of households will be added as part of the private development. To incorporate the impact of new households on the 20-zip-code study region, TREDIS® requires the user to input an estimation of the total increase in household spending within the region that would result from the increase in the number of households. An increase in annual household spending was represented using an estimation of disposable income for each household. To develop this estimation, a rate of disposable income was estimated by using data from the US Bureau of Economic Analysis (BEA) for the state of Massachusetts. The total net earnings were divided by the total personal income to obtain an average statewide disposable income factor of 0.66. Using TREDIS®, the total employment and total income for the region were estimated in order to calculate the average income per employee. This was multiplied by the disposable income factor of 0.66 to obtain an estimation of disposable income per employee for the study area. Next, 2006–10 American Community Survey (ACS) data were used to calculate the average number of workers per household for the city of Boston, which was then used to estimate the disposable income per household for the study area. Finally, the number of households was multiplied by the estimation of disposable income per household, for both the Min alternative and for the Max alternative, to produce an estimation of additional household spending within the 20-zip-code study region.



CTPS

FIGURE 1
Home-Based Trips from South Station TAZ

South Station Expansion Study

FIGURE 2
Study Area: Estimating Economic Impacts of Household and Employment Gains

CTPS

South Station Expansion Study

As shown in Table 1, each alternative is contingent upon the relocation of the US Postal Service (USPS) facility that is adjacent to South Station. Although the USPS facility relocation will affect approximately 1,000 workers, the relocation site is within the 20-zip-code study region, and the new facility is assumed to house the same number of workers. Therefore, any potential impacts based on this relocation were not included in this portion of the analysis.[1]

The project team acknowledged that a significant portion of the employment and household gains associated with both the Min and Max alternatives could be redistributed from areas within the bounds of the study region, and therefore might not represent a true net increase within the 20-zip-code study region. As a result, some of the estimated economic benefits shown by the analysis may be inflated when considered in the context of the defined study region. Interpretation of the results should focus on the fact that the analysis is quantifying the economic impact of the household and employment migration that will relocate to the area near South Station.

4.2 Inputs

Tables 6 and 7 display the industries that were selected to represent “retail” and “service” employment as inputs into TREDIS®. The tables also display the percentage of employment represented by each industry within the study area, and the resulting distribution of jobs to each industry under the Min and Max alternatives.

TABLE 6
Assignment of Retail Employees

Industry	Percent of “Retail” Industry Jobs	Additional Jobs under the Min Alternative	Additional Jobs under the Max Alternative
Retail – Furniture and home furnishings	2.2%	6	16
Retail – Electronics and appliances	2.4%	6	18
Retail – Food and beverage	26.2%	67	197
Retail – Health and personal care	11.1%	28	83
Retail – Clothing and clothing accessories	27.3%	70	205
Retail – Sporting goods, hobby, book and music	6.6%	17	50
Retail – General merchandise	7.8%	20	58
Retail – Miscellaneous	8.6%	22	65
Retail – Non-store	7.8%	20	58
Total	**100%**	**255**	**750**

[1] The relocation of the USPS facility is accounted for in the travel demand model, and is therefore included in the estimation of travel cost savings.

TABLE 7
Assignment of Service Employees

Industry	Percent of "Service" Industry Jobs	Additional Jobs under the Min Alternative	Additional Jobs under the Max Alternative
Legal services	10.3%	105	309
Accounting, tax preparation, bookkeeping, and payroll services	4.9%	50	147
Architectural, engineering, and related services	5.5%	56	165
Specialized design services	0.4%	4	12
Other computer-related services, including facilities management	0.4%	4	12
Scientific research and development services	11.5%	117	344
Advertising and related services	3.3%	33	99
Office administrative services	2.3%	24	69
Facilities support services	0.5%	5	14
Business support services	1.5%	15	45
Investigation and security services	6.8%	70	205
Services to buildings and dwellings	2.3%	24	70
Other support services	0.3%	3	9
Waste management and remediation services	0.3%	3	8
Child day care services	1.0%	10	29
Individual and family services	6.8%	69	204
Other accommodations	1.6%	17	49
Food services and drinking places	34.8%	354	1,041
Personal and household goods repair and maintenance	0.1%	1	3
Personal care services	1.7%	18	52
Dry-cleaning and laundry services	0.3%	3	9
Other personal services	3.5%	35	104
Total	**100%**	**1,020**	**3,000**

Table 8 displays the derivation of TREDIS® inputs for household spending as estimated for the Min and Max alternatives.

TABLE 8
Estimation of Additional Household Spending

Item	Source	Value
Disposable income, percent of total income	BEA	66%
Income per employee	TREDIS®	$113,218
Disposable income per employee	BEA, TREDIS®	$74,724
Workers per household	ACS	1.25
Disposable income per HH	BEA, TREDIS®, ACS	$93,405
Min total new HH spending (280 HH)	BEA, TREDIS®, ACS	$26,153,000
Max total new HH spending (830 HH)	BEA, TREDIS®, ACS	$77,526,000

BEA = US Bureau of Economic Analysis (BEA)
ACS = American Community Survey
HH = household

5 CONCLUSION

This memorandum has outlined the methodology that CTPS staff used to estimate how the impacts resulting from the proposed South Station Expansion alternatives will translate into economic benefits for the city of Boston and the surrounding region. Three types of economic impacts were estimated:

- The economic value of travel efficiency gains and losses resulting from the transportation changes in the region due to the proposed transportation improvement to South Station and the transportation changes due to the travel associated with the additional jobs and households in the proposed joint public/private development above the station.
- The economic impacts of expenditure on construction.
- The economic impacts of permanent household population gains and employment gains from the proposed joint public/private development above the station, and permanent employment gains from the increase in operations and maintenance personnel from the expansion of the South Station terminal.

The results of these analyses are provided in Appendices B, C, and D.

NH/BK/nh

Appendix A: Glossary of TREDIS® Inputs and Outputs

GLOSSARY OF TREDIS® INPUTS AND OUTPUTS

The following definitions are from the “TREDIS® Data Sources and Default Values” guide made available to registered TREDIS® users by the Economic Development Research Group Inc.

Buffer Time Cost ($/hr.): The business opportunity cost, or user valuation, of lost scheduling time due to unreliable travel conditions (i.e., effect of “schedule padding”).

Crew Time Cost ($/hr. per crew member): The business cost of labor for professional drivers and paid crew (including cost of wages plus fringe benefits).

Economic Multipliers: These are region-specific factors that translate a direct economic change into total economic impacts, including indirect (inter-industry supply-chain) effects, and induced (wage spending) effects. In IMPLAN, multiplier impacts are applied with source and target industry detail, meaning that it is possible to determine the effect of direct spending in one sector (say, construction) on another (say, retail).

Employment: This is the total head count of workers in an industry, including self-employed, railroad workers, and agriculture workers. Because employment is measured as employee head count, it is important to note that a single individual with two part-time jobs is counted twice, regardless of which industries those jobs are in. Therefore, the job count is typically higher than “full-time-equivalent” employment.

Environmental Cost: Mileage-Based ($/VMT): Cost of air pollution and greenhouse gases per vehicle-mile of travel.

Freight Logistics Time Cost ($/hr. per ton): Business opportunity cost of freight delay, including shipper inventory, dock handling & consignee schedule disruption.

Income: This is total compensation (including benefits) to all employees of an industry, including business owners (proprietors).

Output: These are final sales, or total revenues, by industry. Depending on the industry, sales can be to any combination of other businesses, households, or the federal/state/local government.

Passenger Time Cost ($/hr. per occupant): The business opportunity cost, or user valuation, of the average passenger’s time. This is in addition to the passenger vehicle operating cost per hour. The same values apply for in-vehicle and out-of-vehicle time (except for transit OVTT = out-of-vehicle travel time).

Value Added: This metric describes the value of goods sold by an industry over and above the value of goods purchased by it. It is generally used as a broad measure of value creation by an industry, including wage income, employee benefits, profits, and tax payments. Summed across all industries, total regional value added is precisely "Gross Regional Product."

Vehicle Mileage-Based Operating Cost: Free Flow ($/mile): The average per-mile cost of vehicles' fuel, tires, maintenance, and depreciation for travel in free-flow conditions.

Vehicle Mileage-based Operating Cost: Congested ($/mile): The per-mile costs of roadway vehicles operating under congested roadway conditions.

Vehicle Time-Based Operating Cost: ($/hr.): the average per-hour cost of vehicles' fuel, tires, maintenance, and depreciation for travel.

Appendix B:
TREDIS® Results – Traveler Cost Savings

Traveler Cost Savings TIO vs No-Build

Generated by TREDIS 4.0.0

July 29, 2014

Project Setup

General Information

ID:
Name: SSX Traveler Cost Savings
Group: Archived Projects

Study Region(s)

MPO Model Region

Construction Period	Operation Period	Financial Factors
Start Year: 2018	Start Year: 2023	Constant Dollar Year: 2014
End Year: 2023	End Year: 2035	Discount Rate: 7.0%
	Analysis Year: 2035	
	Travel Growth Rate: 0.5%	

Inputs

Startup Costs	O&M Costs	
$1,430.3 million	$166.7 million/(all years)	

Travel Changes

	Total All	Total Business	Total Commute	Total Personal	Total Freight
Vehicle Trips	0	0	1,727,720	61,037	0
Vehicle Miles Traveled (VMT)	0	0	73,873,687	472,602	12,257,221

Vehicle Hours Traveled (VHT)	0	0	226,082	543,869	4,315,407
Vehicle Buffer-Hours	0	0	121,326	4,766	0
Passenger-Hours	0	0	-1,858,307	227,420	0
Freight US Ton-Hours	0	0	0	0	103,785,538

Results

Traveler Cost Savings - All Regions and Periods

	Total No Split	Total Business	Total Commute	Total Personal	Total Freight	All Travel
Passenger Cost	0	0	-44,041,884	2,694,929	0	-41,346,955
Crew Cost	0	0	-647,645	-678,577	116,041,294	114,715,072
Freight Cost	0	0	0	0	141,513,412	141,513,412
Reliability Cost	0	0	2,875,430	56,481	0	2,931,911
Veh. Oper. Cost	0	0	36,939,835	-1,808,441	15,824,072	50,955,466
Toll Cost	0	0	51,997	681	0	52,678
Safety Cost	0	0	10,936,043	95,067	133,683	11,164,793
Environmental Cost	0	0	2,222,717	19,277	741,562	2,983,556
Total Cost Savings	0	0	8,336,493	379,417	274,254,023	282,969,933

Traveler Cost Savings Min vs No-Build

Generated by TREDIS 4.0.0

July 29, 2014

Project Setup

General Information

ID:
Name: SSX Traveler Cost Savings
Group: Archived Projects

Study Region(s)

MPO Model Region

Construction Period	Operation Period	Financial Factors
Start Year: 2018	Start Year: 2023	Constant Dollar Year: 2014
End Year: 2023	End Year: 2035	Discount Rate: 7.0%
	Analysis Year: 2035	
	Travel Growth Rate: 0.5%	

Inputs

Startup Costs	O&M Costs	
$2,652.8 million	$166.7 million/(all years)	

Travel Changes

	Total All	Total Business	Total Commute	Total Personal	Total Freight
Vehicle Trips	0	0	1,612,307	-731,873	0
Vehicle Miles Traveled (VMT)	0	0	73,203,340	-6,238,689	12,211,601

Vehicle Hours Traveled (VHT)	0	0	122,132	-32,285	4,315,407
Vehicle Buffer-Hours	0	0	115,699	-11,436	0
Passenger-Hours	0	0	-2,308,969	-924,201	0
Freight US Ton-Hours	0	0	0	0	103,785,538

Results

Traveler Cost Savings - All Regions and Periods

	Total No Split	Total Business	Total Commute	Total Personal	Total Freight	All Travel
Passenger Cost	0	0	-54,643,383	-10,951,782	0	-65,595,165
Crew Cost	0	0	-647,645	-678,577	116,041,294	114,715,072
Freight Cost	0	0	0	0	141,513,412	141,513,412
Reliability Cost	0	0	2,742,055	-135,514	0	2,606,541
Veh. Oper. Cost	0	0	37,372,352	-3,096,986	15,765,177	50,040,543
Toll Cost	0	0	49,495	-1,883	0	47,612
Safety Cost	0	0	10,834,371	-826,475	133,185	10,141,081
Environmental Cost	0	0	2,203,260	-171,910	738,802	2,770,152
Total Cost Savings	0	0	-2,089,495	-15,863,127	274,191,870	256,239,248

Traveler Cost Savings Max vs No-Build

Generated by TREDIS 4.0.0

July 29, 2014

Project Setup

General Information

ID:
Name: SSX Traveler Cost Savings
Group: Archived Projects

Study Region(s)

MPO Model Region

Construction Period	Operation Period	Financial Factors
Start Year: 2018	Start Year: 2023	Constant Dollar Year: 2014
End Year: 2023	End Year: 2035	Discount Rate: 7.0%
	Analysis Year: 2035	
	Travel Growth Rate: 0.5%	

Inputs

Startup Costs	O&M Costs	
$4,158.5 million	$166.7 million/(all years)	

Travel Changes

	Total All	Total Business	Total Commute	Total Personal	Total Freight
Vehicle Trips	0	0	1,539,449	-1,874,081	0
Vehicle Miles Traveled (VMT)	0	0	70,288,408	-11,568,773	12,120,360

Vehicle Hours Traveled (VHT)	0	0	-59,102	-666,885	4,315,407
Vehicle Buffer-Hours	0	0	115,637	-13,465	0
Passenger-Hours	0	0	-2,511,475	-1,762,748	0
Freight US Ton-Hours	0	0	0	0	103,785,538

Results

Traveler Cost Savings - All Regions and Periods

	Total No Split	Total Business	Total Commute	Total Personal	Total Freight	All Travel
Passenger Cost	0	0	-59,285,589	-20,888,568	0	-80,174,157
Crew Cost	0	0	-647,645	-678,577	116,041,294	114,715,072
Freight Cost	0	0	0	0	141,513,412	141,513,412
Reliability Cost	0	0	2,740,601	-159,558	0	2,581,043
Veh. Oper. Cost	0	0	35,055,638	-7,705,597	15,647,385	42,997,426
Toll Cost	0	0	49,318	-2,631	0	46,687
Safety Cost	0	0	10,398,769	-1,499,453	132,190	9,031,506
Environmental Cost	0	0	2,117,110	-311,529	733,282	2,538,863
Total Cost Savings	0	0	-9,571,798	-31,245,913	274,067,563	233,249,852

Appendix C:
TREDIS® Results – Economic Impacts of Construction

Economic Impacts of Construction: TIO vs No-Build

Generated by TREDIS 4.0.0

July 29, 2014

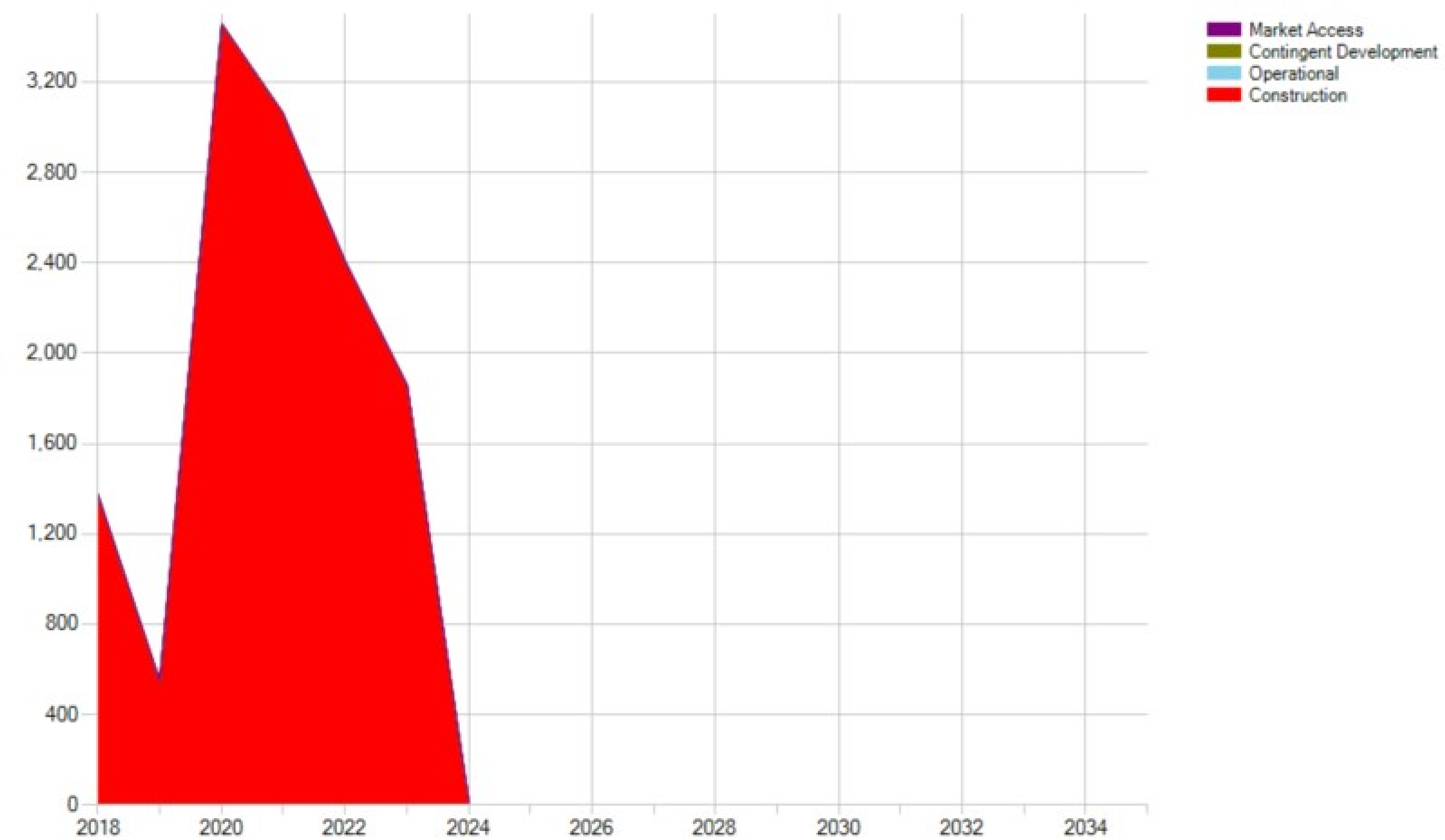
TOTAL ECONOMIC IMPACTS - BY YEAR (4b)

Analysis Year:	2035	Project:	SSX Economic Impacts of Construction
Constant $ Year:	2014	Region:	MPO Model Region
Base Alternative:	No-Build	Period:	All Periods
Project Alternative:	TIO	Impact Type:	Construction
Alternatives:	Detail	Detail Level:	Change

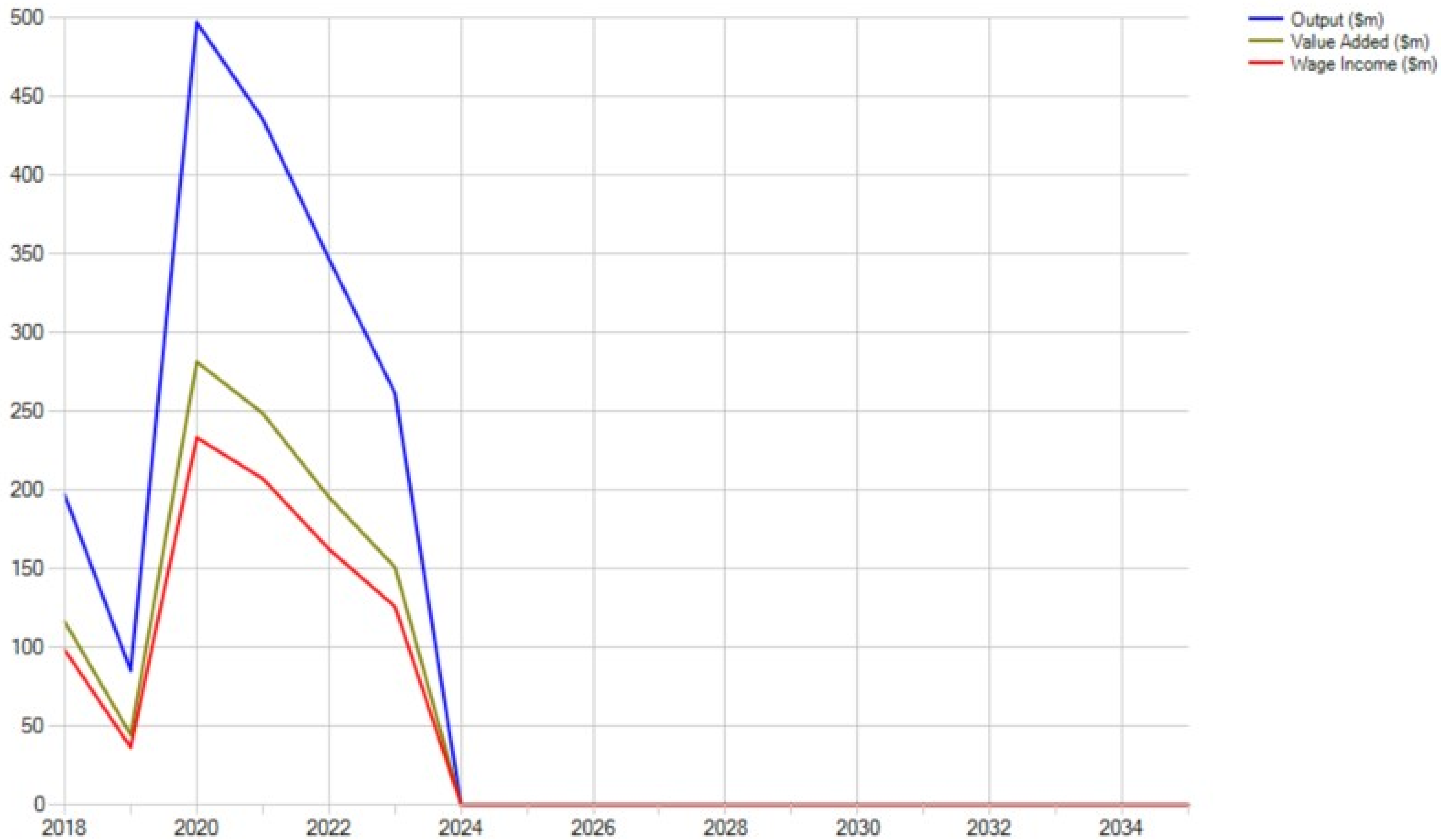
Year Count	Year	Business Output ($ mil.)	Value Added ($ mil.)	Jobs	Wage Income ($ mil.)
1	2018	197.393	116.734	1,379	98.726
2	2019	85.484	44.624	549	36.579
3	2020	497.239	281.613	3,456	233.473
4	2021	435.686	248.814	3,065	207.356
5	2022	347.028	195.615	2,409	162.579
6	2023	261.545	150.991	1,859	126.000
7	2024	0.000	0.000	0	0.000
8	2025	0.000	0.000	0	0.000
9	2026	0.000	0.000	0	0.000
10	2027	0.000	0.000	0	0.000
11	2028	0.000	0.000	0	0.000

12	2029	0.000	0.000	0	0.000
13	2030	0.000	0.000	0	0.000
14	2031	0.000	0.000	0	0.000
15	2032	0.000	0.000	0	0.000
16	2033	0.000	0.000	0	0.000
17	2034	0.000	0.000	0	0.000
18	2035	0.000	0.000	0	0.000
Sum of Impact for all Years		1,824.374	1,038.391		864.712

Economic Impact - Jobs (by source) - All Regions Aggregated



Economic Impact - Output, Value Added, and Income ($millions) - All Regions Aggregated



Economic Impacts of Construction: Min vs No-Build

Generated by TREDIS 4.0.0

July 29, 2014

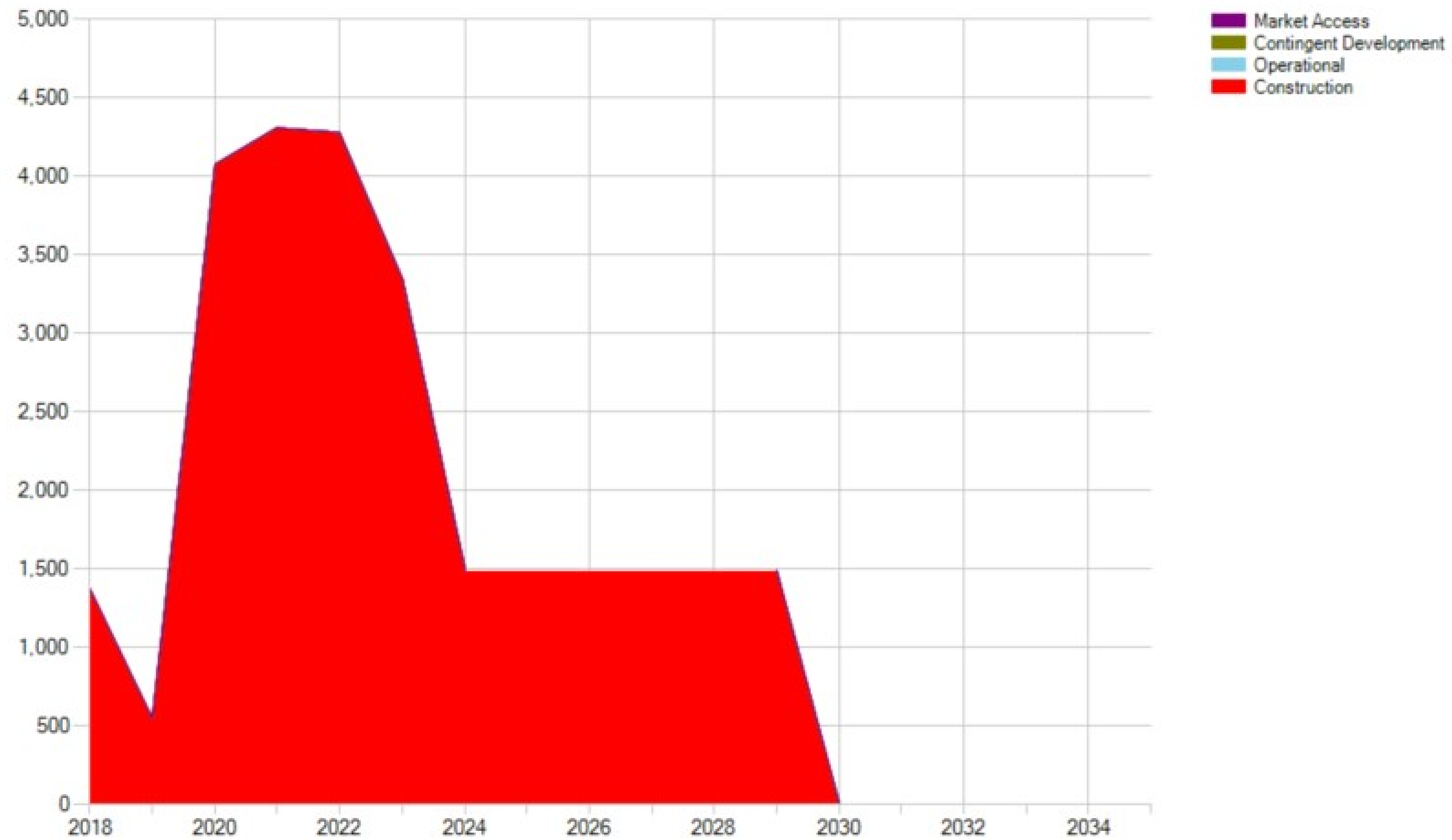
TOTAL ECONOMIC IMPACTS - BY YEAR (4b)

Analysis Year:	2035	Project:	SSX Economic Impacts of Construction
Constant $ Year:	2014	Region:	MPO Model Region
Base Alternative:	No-Build	Period:	All Periods
Project Alternative:	Min	Impact Type:	Construction
Alternatives:	Detail	Detail Level:	Change

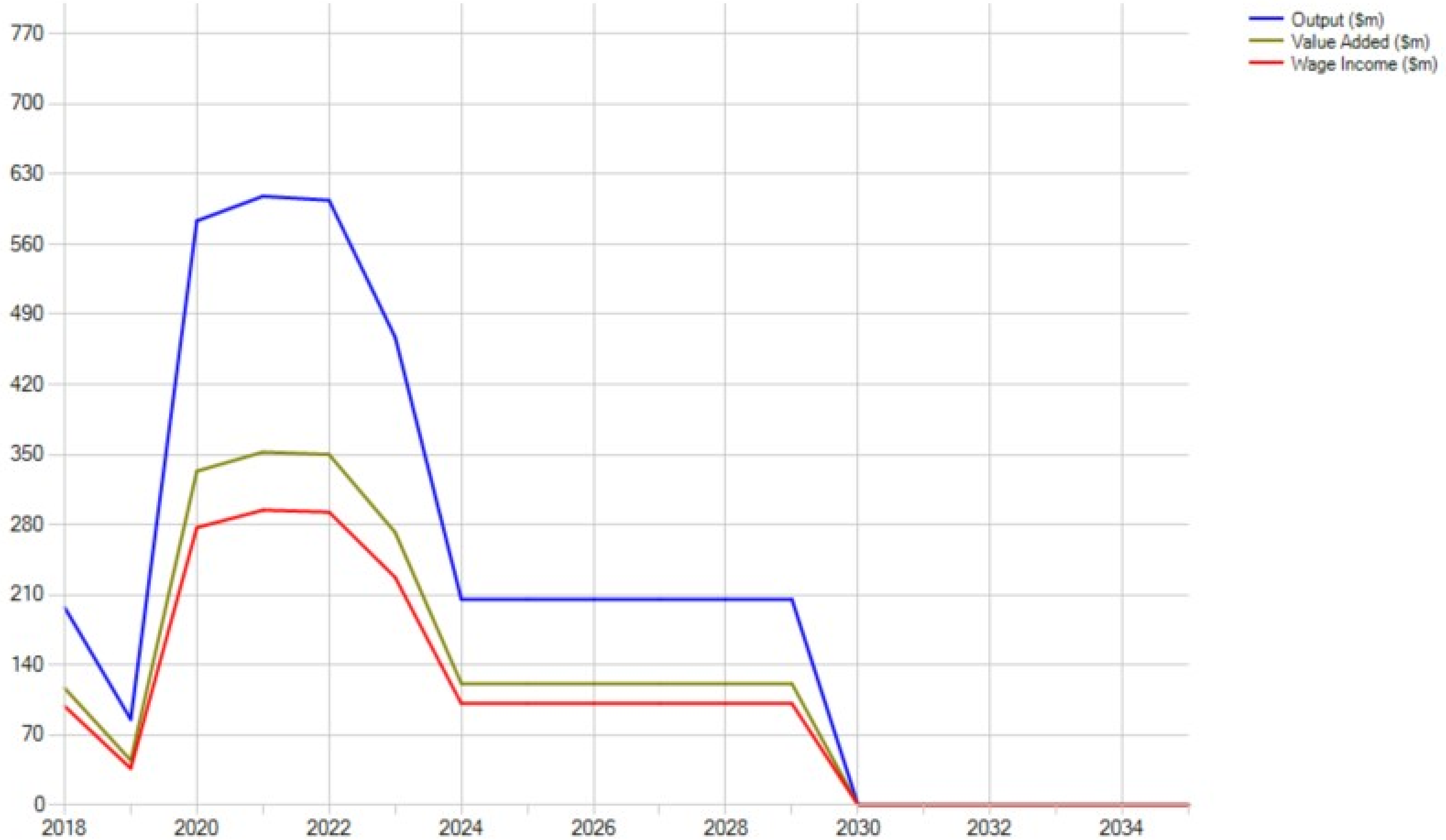
Year Count	Year	Business Output ($ mil.)	Value Added ($ mil.)	Jobs	Wage Income ($ mil.)
1	2018	197.393	116.734	1,379	98.726
2	2019	85.484	44.624	549	36.579
3	2020	583.355	333.423	4,078	277.053
4	2021	607.919	352.436	4,310	294.518
5	2022	603.897	350.022	4,280	292.486
6	2023	466.932	272.226	3,349	227.318
7	2024	205.387	121.235	1,490	101.318
8	2025	205.387	121.235	1,490	101.318
9	2026	205.387	121.235	1,490	101.318
10	2027	205.387	121.235	1,490	101.318
11	2028	205.387	121.235	1,490	101.318

12	2029	205.387	121.235	1,490	101.318
13	2030	0.000	0.000	0	0.000
14	2031	0.000	0.000	0	0.000
15	2032	0.000	0.000	0	0.000
16	2033	0.000	0.000	0	0.000
17	2034	0.000	0.000	0	0.000
18	2035	0.000	0.000	0	0.000
Sum of Impact for all Years		3,777.302	2,196.876		1,834.589

Economic Impact - Jobs (by source) - All Regions Aggregated



Economic Impact - Output, Value Added, and Income ($millions) - All Regions Aggregated



Economic Impacts of Construction: Max vs No-Build

Generated by TREDIS 4.0.0

July 29, 2014

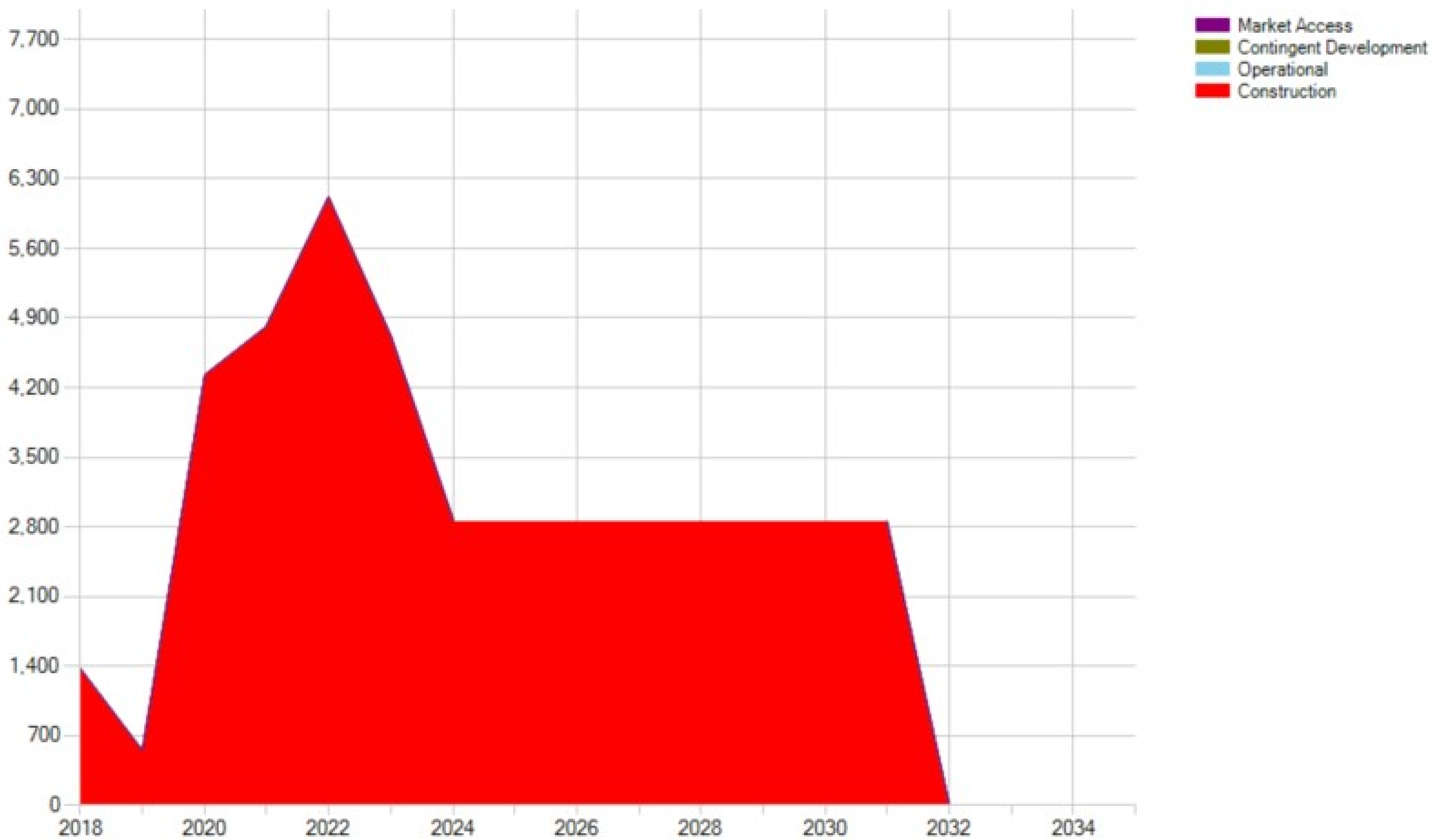
TOTAL ECONOMIC IMPACTS - BY YEAR (4b)

Analysis Year:	2035	Project:	SSX Economic Impacts of Construction
Constant $ Year:	2014	Region:	MPO Model Region
Base Alternative:	No-Build	Period:	All Periods
Project Alternative:	Max	Impact Type:	Construction
Alternatives:	Detail	Detail Level:	Change

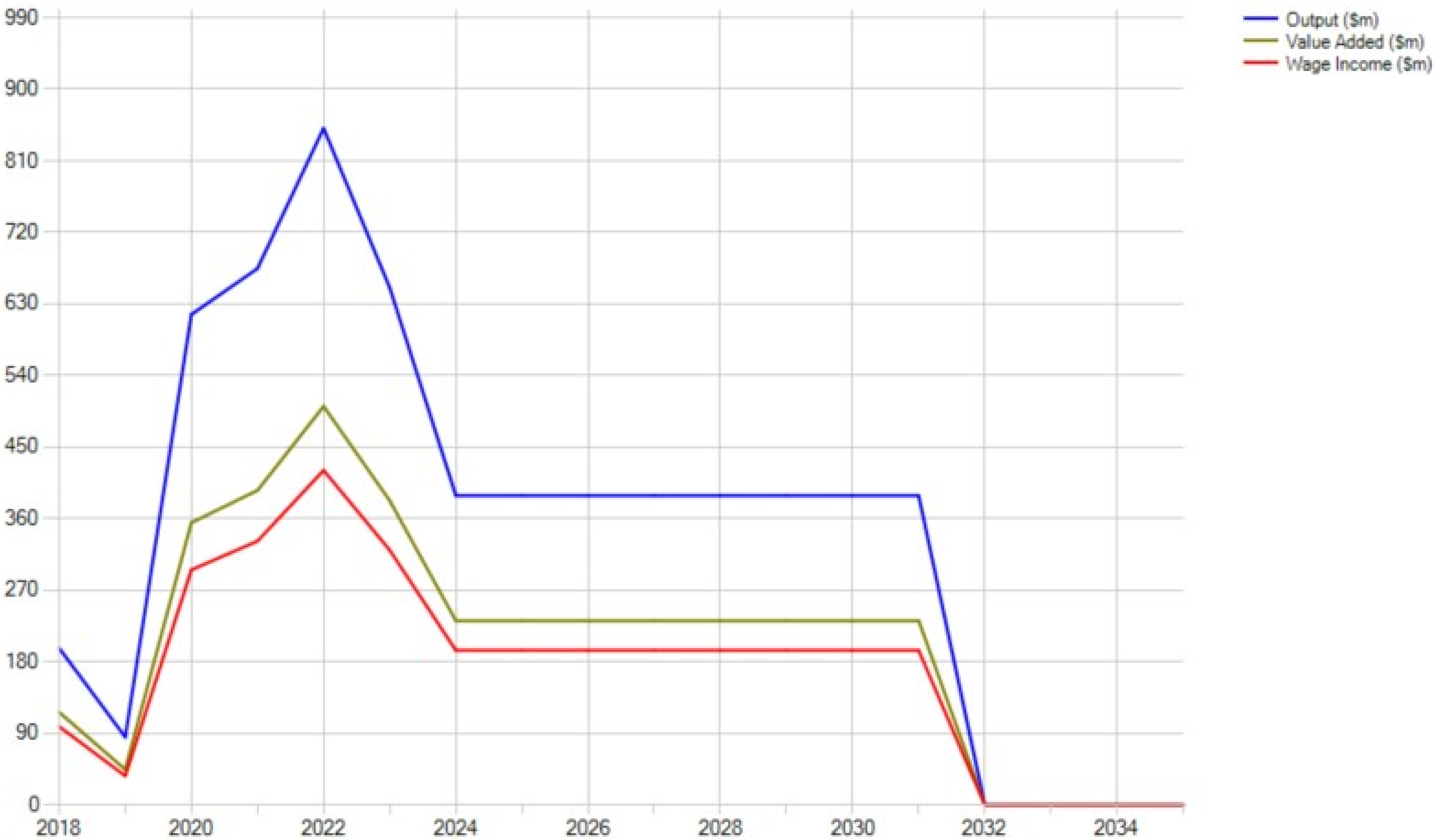
Year Count	Year	Business Output ($ mil.)	Value Added ($ mil.)	Jobs	Wage Income ($ mil.)
1	2018	197.393	116.734	1,379	98.726
2	2019	85.484	44.624	549	36.579
3	2020	616.718	355.022	4,328	295.706
4	2021	674.640	395.630	4,810	331.822
5	2022	850.873	501.379	6,115	420.830
6	2023	650.517	382.736	4,714	320.458
7	2024	388.972	231.746	2,855	194.459
8	2025	388.972	231.746	2,855	194.459
9	2026	388.972	231.746	2,855	194.459
10	2027	388.972	231.746	2,855	194.459
11	2028	388.972	231.746	2,855	194.459

12	2029	388.972	231.746	2,855	194.459
13	2030	388.972	231.746	2,855	194.459
14	2031	388.972	231.746	2,855	194.459
15	2032	0.000	0.000	0	0.000
16	2033	0.000	0.000	0	0.000
17	2034	0.000	0.000	0	0.000
18	2035	0.000	0.000	0	0.000
Sum of Impact for all Years		6,187.403	3,650.090		3,059.794

Economic Impact - Jobs (by source) - All Regions Aggregated



Economic Impact - Output, Value Added, and Income ($millions) - All Regions Aggregated



Appendix D:
TREDIS® Results – Economic Impacts of Permanent Household Population Gains and Permanent Employment Gains

Economic Impacts of Household and Employment Gains: TIO vs No-Build

Generated by TREDIS 4.0.0

July 29, 2014

TOTAL ECONOMIC IMPACTS - BY YEAR (4b)

Analysis Year:	2035	Project:	SSX Economic Impacts of Permanent Household Population Gains and Permanent Employment Gains
Constant $ Year:	2014	Region:	South Station Region (20 zip codes)
Base Alternative:	No-Build	Period:	All Periods
Project Alternative:	TIO	Impact Type:	Contingent Development
Alternatives:	Detail	Detail Level:	Change

Year Count	Year	Business Output ($ mil.)	Value Added ($ mil.)	Jobs	Wage Income ($ mil.)
1	2018	0.000	0.000	0	0.000
2	2019	0.000	0.000	0	0.000
3	2020	0.000	0.000	0	0.000
4	2021	0.000	0.000	0	0.000
5	2022	0.000	0.000	0	0.000
6	2023	21.572	6.387	177	12.443
7	2024	21.572	6.387	177	12.443
8	2025	21.572	6.387	177	12.443
9	2026	21.572	6.387	177	12.443
10	2027	21.572	6.387	177	12.443
11	2028	21.572	6.387	177	12.443

12	2029	21.572	6.387	177	12.443
13	2030	21.572	6.387	177	12.443
14	2031	21.572	6.387	177	12.443
15	2032	21.572	6.387	177	12.443
16	2033	21.572	6.387	177	12.443
17	2034	21.572	6.387	177	12.443
18	2035	21.572	6.387	177	12.443
Sum of Impact for all Years		280.437	83.027		161.753

Economic Impacts of Household and Employment Gains: Min vs TIO

Generated by TREDIS 4.0.0

September 3, 2014

TOTAL ECONOMIC IMPACTS - BY YEAR (4b)

Analysis Year:	2035	Project:	SSX Economic Impacts of Permanent Household Population Gains and Permanent Employment Gains
Constant $ Year:	2014	Region:	South Station Region (20 zip codes)
Base Alternative:	TIO	Period:	All Periods
Project Alternative:	Min	Impact Type:	Contingent Development
Alternatives:	Detail	Detail Level:	Change

Year Count	Year	Business Output ($ mil.)	Value Added ($ mil.)	Jobs	Wage Income ($ mil.)
1	2018	0.000	0.000	0	0.000
2	2019	0.000	0.000	0	0.000
3	2020	0.000	0.000	0	0.000
4	2021	0.000	0.000	0	0.000
5	2022	0.000	0.000	0	0.000
6	2023	0.000	0.000	0	0.000
7	2024	0.000	0.000	0	0.000
8	2025	0.000	0.000	0	0.000
9	2026	0.000	0.000	0	0.000
10	2027	0.000	0.000	0	0.000
11	2028	0.000	0.000	0	0.000

12	2029	0.000	0.000	0	0.000
13	2030	94.786	70.533	767	50.077
14	2031	189.572	141.067	1,534	100.154
15	2032	189.572	141.067	1,534	100.154
16	2033	189.572	141.067	1,534	100.154
17	2034	189.572	141.067	1,534	100.154
18	2035	189.572	141.067	1,534	100.154
Sum of Impact for all Years		1,042.646	775.868		550.848

Economic Impacts of Household and Employment Gains: Max vs TIO

Generated by TREDIS 4.0.0

September 3, 2014

TOTAL ECONOMIC IMPACTS - BY YEAR (4b)

Analysis Year:	2035	Project:	SSX Economic Impacts of Permanent Household Population Gains and Permanent Employment Gains
Constant $ Year:	2014	Region:	South Station Region (20 zip codes)
Base Alternative:	TIO	Period:	All Periods
Project Alternative:	Max	Impact Type:	Contingent Development
Alternatives:	Detail	Detail Level:	Change

Year Count	Year	Business Output ($ mil.)	Value Added ($ mil.)	Jobs	Wage Income ($ mil.)
1	2018	0.000	0.000	0	0.000
2	2019	0.000	0.000	0	0.000
3	2020	0.000	0.000	0	0.000
4	2021	0.000	0.000	0	0.000
5	2022	0.000	0.000	0	0.000
6	2023	0.000	0.000	0	0.000
7	2024	0.000	0.000	0	0.000
8	2025	0.000	0.000	0	0.000
9	2026	0.000	0.000	0	0.000
10	2027	0.000	0.000	0	0.000
11	2028	0.000	0.000	0	0.000

12	2029	0.000	0.000	0	0.000
13	2030	0.000	0.000	0	0.000
14	2031	0.000	0.000	0	0.000
15	2032	299.800	213.581	2,429	159.294
16	2033	599.600	427.162	4,857	318.589
17	2034	599.600	427.162	4,857	318.589
18	2035	599.600	427.162	4,857	318.589
Sum of Impact for all Years		2,098.600	1,495.066		1,115.060

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Attachment D Wind Study

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1. Introduction

The objective of the study was to evaluate the No Build Alternative as a baseline condition, to assess the effect of Alternative 3 – Joint/Private Development Maximum Build on local wind conditions in pedestrian areas around the study site and study the effect of wind control measures for minimizing adverse effects. The sensor locations used to model the No Build Alternative are shown in Figure 6. The sensor locations modeled in Alternative 3 are shown on Figure 7.

The study involved wind simulations on a 1:400 scale model of the proposed building and surroundings. The tests were conducted a boundary-layer wind tunnel, for the purpose of quantifying local wind speed conditions and comparing to appropriate criteria for wind comfort and safety in pedestrian areas. The criteria recommended by the Boston Redevelopment Authority (BRA) were used in this study (refer to Section 3). The present report describes the methods and presents the results of the wind tunnel simulations.

2. Overview

Major buildings, especially those that protrude above their surroundings, often cause increased local wind speeds at the pedestrian level. Typically, wind speeds increase with elevation above the ground surface, and taller buildings intercept these faster winds and deflect them down to the pedestrian level. The funneling of wind through gaps between buildings and the acceleration of wind around corners of buildings may also cause increases in wind speed. Conversely, if a building is surrounded by others of equivalent height, it may be protected from the prevailing upper level winds, resulting in no significant changes to the local pedestrian level wind environment. The most effective way to assess potential pedestrian level wind impacts around a proposed new building is to conduct scale model tests in a wind tunnel.

The consideration of wind in planning outdoor activity areas is important since high winds in an area tend to deter pedestrian use. For example, winds should be light or relatively light in areas where people would be sitting, such as outdoor cafes or playgrounds. For bus stops and other locations where people would be standing, somewhat higher winds can be tolerated. For frequently used sidewalks, where people are primarily walking, stronger winds are acceptable. For infrequently used areas, the wind comfort criteria can be relaxed even further. The actual effects of wind can range from pedestrian inconvenience, due to the blowing of dust and other loose material in a moderate breeze, to severe difficulty with walking due to the wind forces on the pedestrian.

3. Methodology

Information concerning the site and surroundings was derived from: site photographs; information on surrounding buildings and terrain; site plans and 3D models of the proposed development provided by the design team. While three massing options were considered for the proposed project, Alternative 3 has been selected for this analysis as it represents the largest proposed development being considered for the site. The massing configuration for Alternative 3 was studied with and without the proposed wind control features (screens and trees). The following site configurations were modeled and tested for this massing scheme:

- No Build Alternative which includes all existing surrounding buildings and the South Station Air Rights (SSAR) project; and
- Alternative 3 massing of the proposed South Station Expansion Project, Joint Development buildings (JD1 through JD6), SSAR project and all existing surroundings.

- Alternative 3 with Mitigation which includes the Alternative 3 model with wind control features, namely:
  - Six coniferous trees to the south of JD1; and
  - Wind screen at grade at the west end of the JD1.

As shown in Figures 28, 29 and 30, the wind tunnel model included the proposed development and all relevant surrounding buildings and topography within a 1,600 ft radius of the study site. The mean speed profile and turbulence of the natural wind approaching the modeled area were also simulated. The scale model was equipped with 80 specially designed wind speed sensors that were connected to the wind tunnel's data acquisition system to record the mean and fluctuating components of wind speed at a full scale height of five feet above grade in pedestrian areas throughout the study site. Wind speeds were measured for 36 wind directions, in 10 degree increments, starting from true north. The measurements at each sensor location were recorded in the form of ratios of local mean and gust speeds to the reference wind speed in the free stream above the model. The results were then combined with long term meteorological data, recorded during the years 1983 to 2013 at Boston's Logan International Airport, in order to predict full scale wind conditions. The analysis was performed separately for each of the four seasons and for the entire year.

Figures 31, 32 and 33 present "wind roses", summarizing the seasonal and annual wind climates in the Boston area, based on the data from Logan Airport. The left side wind rose in Figure 31, for example, summarizes the spring (March, April, and May) wind data. In general, the prevailing winds at this time of year are from the west northwest, northwest, west, south-southwest and southwest. In addition to these directions, strong winds are also prevalent from the northeast direction as indicated by the red and yellow color bands on the wind rose.

On an annual basis (Figure 5) the most common wind directions are those between southwest and northwest. Winds from the east and east-southeast are also relatively common. In the case of strong winds, northeast and west-northwest are the dominant wind directions.

This study involved state of the art measurement and analysis techniques to predict wind conditions at the study site. Nevertheless, some uncertainty remains in predicting wind comfort. For example, the sensation of comfort among individuals can be quite variable. Variations in age, individual health, clothing, and other human factors can change a particular response of an individual. The comfort limits used in this report represent an average for the total population. Also, unforeseen changes in the project area, such as the construction or removal of buildings, can affect the conditions experienced at the site. Finally, the prediction of wind speeds is necessarily a statistical procedure. The wind speeds reported are for the frequency of occurrence stated (1% of the time). Higher wind speeds would occur but on a less frequent basis.

4. Pedestrian Wind Comfort Criteria

The BRA has adopted two standards for assessing the relative wind comfort of pedestrians. First, the BRA wind design guidance criterion states that an effective gust velocity (hourly mean wind speed +1.5 times the root mean square wind speed) of 31 mph should not be exceeded more than 1% of the time. The second set of criteria used by the BRA to determine the acceptability of specific locations is based on the work of Melbourne[1] . This set of criteria is used to determine the relative level of pedestrian wind comfort for activities such as sitting, standing, or walking. The criteria are expressed in terms of

[1] Melbourne, W.H., 1978, "Criteria for Environmental Wind Conditions," Journal of Industrial Aerodynamics, 3 (1978) 241 - 249.

benchmarks for the 1-hour mean wind speed exceeded 1% of the time (i.e., the 99-percentile mean wind speed). They are as follows:

BRA Mean Wind Criteria*

Dangerous	> 27 mph
Uncomfortable for Walking	> 19 and ≤ 27 mph
Comfortable for Walking	> 15 and ≤ 19 mph
Comfortable for Standing	> 12 and ≤ 15 mph
Comfortable for Sitting	< 12 mph

* Applicable to the hourly mean wind speed exceeded 1% of the time.

The wind climate found in a typical downtown location in Boston is generally comfortable for the pedestrian use of sidewalks and thoroughfares and meets the BRA effective gust velocity criterion of 31 mph. However, without any mitigation measures, this wind climate is likely to be frequently uncomfortable for more passive activities such as sitting.

5. Test Results

Table 12 presents the mean and effective gust wind speeds for each season, and as represented annually. For each model configuration, Figures 34, 35 and 36 graphically depict the mean wind speeds and Figures 37, 38 and 39 depict the effective gust speeds at each wind measurement location based on the annual winds. Typically the summer and fall winds tend to be more comfortable than the annual winds, while the winter and spring winds are less comfortable than the annual winds.

A total of 80 sensors were used in the model. Note that the placement of the wind measurement locations was based on our experience and understanding of pedestrian usage of the site, and reviewed by members of the project team.

The following summary of pedestrian wind comfort is based on the annual winds for each configuration tested, except where noted below in the text.

5.1. Building Perimeter and Dorchester Avenue (Locations 1 through 22)

5.1.1. No Build Alternative

A wind comfort categorization of walking is considered appropriate for sidewalks. Lower wind speeds conducive to standing are preferred at building entrances. As shown in Figure 36, winds at all locations are comfortable for walking, standing, or sitting, annually. Uncomfortable wind speeds exist at the south end of the development site (Location 17 in Figure 36).

The effective gust criterion was met seasonally and annually at all locations.

5.1.2. Alternative 3 – Joint/Private Development Maximum Build

With the addition of the South Station Expansion project, winds at most locations are expected to remain comfortable for walking or better on an annual basis. Marginal increases in wind speeds are expected locally around building corners, with uncomfortable winds expected to the south of JD1, east of JD3 and JD6 buildings of the proposed project (Locations 12, 17, 18 and 20 in Figure 37).

Localized accelerations are also expected to yield wind speeds that could potentially exceed the effective gust criterion on windy days at two locations to the south of JD1 (Locations 17 and 18 in Figure 40). The elevated wind speeds, mainly due to winds approaching from the westerly directions, can be reduced with the aid of wind screens and vegetation that retain foliage throughout the year. The effect of these wind control elements have been assessed in the Alternative 3 with Mitigation configuration, as presented in Section 5.1.3.

5.1.3. Alternative 3 – Joint/Private Development Maximum Build with Mitigation

The following wind control elements were included in this configuration in order to mitigate the high wind activity on the south side of JD1 by the addition of the proposed Alternative 3 massing:

- Six mature coniferous trees to the south of JD1 at grade level; and
- 10' tall, 70% solid screen along the west edge of the site to the south of the JD1 at grade level.

The locations of these elements and the results pertaining to this configuration are shown in Figures 38 and 41. The addition of the trees would reduce the intensity of wind flows along the south side of JD1 and thereby mitigate the effective gust exceedance that previously predicted (Locations 17 and 18 in Figure 41). Coniferous trees were chosen as they retain foliage during the winter months. It is also recommended that tall evergreen shrubs be interspersed among the trees if the tree foliage is maintained above 6 to 10 feet above ground, in order to provide protection at pedestrian level.

Figure 1—Examples of coniferous trees – Arborvitae and Spruce

5.2. South Street, Atlantic Avenue and the East Bank of Fort Point Channel (Locations 23 through 40 and 74 through 80)

5.2.1. No Build Alternative

Wind conditions along South Street, Atlantic Avenue and the east bank of Fort Point Channel are generally comfortable for walking, standing or sitting on an annual basis, which is appropriate for pedestrian usage. Uncomfortable winds exist at the intersection of Atlantic Avenue and Essex Street and along the east bank of Fort Point Channel (Locations 38 and 77 in Figure 36).

Winds at Location 38 also exceed the annual effective gust criterion (Figure 39).

5.2.2. Alternative 3 – Joint/Private Development Maximum Build

The addition of the proposed projects is expected to result in similar or improved wind microclimate along these streets. Wind speed categorizations are very similar to those in the No Build configuration, with no change to the effective gust exceedance at Location 38 (Figures 35 and 38).

5.2.3. Alternative 3 – Joint/Private Development Maximum Build with Mitigation

The mitigation measures incorporated in the Alternative 3 configuration did not affect the findings presented in 5.2.2, as their zone of influence was limited to the immediate vicinity of the proposed JD1 and JD4 buildings.

5.3. Albany Street and Summer Street (Locations 41 through 73)

5.3.1. No Build Alternative

Winds along Albany Street and Summer Street, west of the Fort Point Channel, are generally high and fall under the categorization of walking and uncomfortable. Closer to the Fort Point Channel and along the Summer Street Bridge, wind speeds are lower and comfortable for standing or walking in general.

Wind speeds at one location on Summer Street, in front of the Federal Reserve Bank currently exceed the effective gust criterion (Location 55 in Figure 39).

5.3.2. Alternative 3 – Joint/Private Development Maximum Build

The addition of the proposed project is not predicted to significantly affect wind speeds along Albany Street and Summer Street. While there a marginal increase in wind speeds to the north of the development on Summer Street, the overall wind microclimate is expected to remain similar to that in the No Build condition. The addition of the new massing improves wind conditions on the Summer Street Bridge by providing blockage to the westerly winds.

The effective gust exceedance on Summer Street that exists in the No Build configuration is predicted to remain in this scenario as well (Location 55 in Figure 40).

5.3.3. Alternative 3 – Joint/Private Development Maximum Build with Mitigation

The mitigation measures incorporated in the Alternative 3 configuration did not affect the findings presented in 5.3.2, as their zone of influence was limited to the immediate vicinity of the proposed JD1 and JD4 buildings.

Table 12—Pedestrian Wind Comfort and Safety Categories - Multiple Seasons

Notes: 1) Wind speeds are for a 1% probability of exceedance; and,
2) % Change is based on comparison with Configuration A and only those that are greater than 10% are listed.

Configurations	Mean Wind Speed Criteria		Effective Gust Criteria	
A - No Build Alternative	**Comfortable for Sitting:**	**≤ 12 mph**	**Acceptable:**	**≤ 31 mph**
B – Alternative 3	**Comfortable for Standing:**	**> 12 and ≤ 15 mph**	**Unacceptable:**	**> 31 mph**
C – Alternative 3 with Mitigation	**Comfortable for Walking:**	**> 15 and ≤ 19 mph**		
	Uncomfortable for Walking:	**> 19 and ≤ 27 mph**		
	Dangerous Conditions:	**> 27 mph**		

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
1	A	Spring	7		Sitting	10		Acceptable
		Summer	6		Sitting	8		Acceptable
		Fall	6		Sitting	9		Acceptable
		Winter	7		Sitting	10		Acceptable
		Annual	7		Sitting	9		Acceptable
	B	Spring	8	14%	Sitting	11		Acceptable
		Summer	7	17%	Sitting	9	12%	Acceptable
		Fall	7	17%	Sitting	10	11%	Acceptable
		Winter	9	29%	Sitting	11		Acceptable
		Annual	8	14%	Sitting	10	11%	Acceptable
	C	Spring	10	43%	Sitting	13	30%	Acceptable
		Summer	8	33%	Sitting	10	25%	Acceptable
		Fall	9	50%	Sitting	11	22%	Acceptable
		Winter	10	43%	Sitting	13	30%	Acceptable
		Annual	10	43%	Sitting	12	33%	Acceptable
2	A	Spring	7		Sitting	11		Acceptable
		Summer	6		Sitting	10		Acceptable
		Fall	7		Sitting	11		Acceptable
		Winter	7		Sitting	11		Acceptable
		Annual	6		Sitting	11		Acceptable
	B	Spring	10	43%	Sitting	13	18%	Acceptable
		Summer	8	33%	Sitting	10		Acceptable
		Fall	8	14%	Sitting	12		Acceptable
		Winter	10	43%	Sitting	13	18%	Acceptable
		Annual	9	50%	Sitting	12		Acceptable
	C	Spring	10	43%	Sitting	14	27%	Acceptable
		Summer	8	33%	Sitting	11		Acceptable
		Fall	8	14%	Sitting	12		Acceptable
		Winter	10	43%	Sitting	14	27%	Acceptable
		Annual	9	50%	Sitting	13	18%	Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
3	A	Spring	11		Sitting	17		Acceptable
		Summer	9		Sitting	14		Acceptable
		Fall	10		Sitting	16		Acceptable
		Winter	12		Sitting	18		Acceptable
		Annual	11		Sitting	17		Acceptable
	B	Spring	18	64%	Walking	22	29%	Acceptable
		Summer	14	56%	Standing	17	21%	Acceptable
		Fall	15	50%	Standing	20	25%	Acceptable
		Winter	18	50%	Walking	23	28%	Acceptable
		Annual	16	45%	Walking	21	24%	Acceptable
	C	Spring	20	82%	Uncomfortable	25	47%	Acceptable
		Summer	16	78%	Walking	20	43%	Acceptable
		Fall	18	80%	Walking	22	38%	Acceptable
		Winter	21	75%	Uncomfortable	26	44%	Acceptable
		Annual	19	73%	Walking	24	41%	Acceptable
4	A	Spring	19		Walking	26		Acceptable
		Summer	14		Standing	19		Acceptable
		Fall	17		Walking	23		Acceptable
		Winter	18		Walking	25		Acceptable
		Annual	17		Walking	24		Acceptable
	B	Spring	16	-16%	Walking	23	-12%	Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	15	-12%	Standing	22		Acceptable
		Winter	17		Walking	24		Acceptable
		Annual	16		Walking	22		Acceptable
	C	Spring	16	-16%	Walking	23	-12%	Acceptable
		Summer	13		Standing	19		Acceptable
		Fall	15	-12%	Standing	22		Acceptable
		Winter	17		Walking	24		Acceptable
		Annual	15	-12%	Standing	22		Acceptable
5	A	Spring	15		Standing	22		Acceptable
		Summer	12		Sitting	17		Acceptable
		Fall	13		Standing	20		Acceptable
		Winter	15		Standing	22		Acceptable
		Annual	14		Standing	21		Acceptable
	B	Spring	11	-27%	Sitting	18	-18%	Acceptable
		Summer	9	-25%	Sitting	14	-18%	Acceptable
		Fall	10	-23%	Sitting	17	-15%	Acceptable
		Winter	11	-27%	Sitting	18	-18%	Acceptable
		Annual	10	-29%	Sitting	17	-19%	Acceptable
	C	Spring	11	-27%	Sitting	18	-18%	Acceptable
		Summer	9	-25%	Sitting	15	-12%	Acceptable
		Fall	10	-23%	Sitting	17	-15%	Acceptable
		Winter	11	-27%	Sitting	18	-18%	Acceptable
		Annual	10	-29%	Sitting	17	-19%	Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
6	A	Spring	18		Walking	25		Acceptable
		Summer	14		Standing	19		Acceptable
		Fall	16		Walking	23		Acceptable
		Winter	18		Walking	25		Acceptable
		Annual	17		Walking	23		Acceptable
	B	Spring	20	11%	Uncomfortable	29	16%	Acceptable
		Summer	15		Standing	21	11%	Acceptable
		Fall	18	12%	Walking	26	13%	Acceptable
		Winter	19		Walking	27		Acceptable
		Annual	18		Walking	26	13%	Acceptable
	C	Spring	21	17%	Uncomfortable	29	16%	Acceptable
		Summer	15		Standing	21	11%	Acceptable
		Fall	19	19%	Walking	26	13%	Acceptable
		Winter	19		Walking	27		Acceptable
		Annual	19	12%	Walking	26	13%	Acceptable
7	A	Spring	16		Walking	23		Acceptable
		Summer	13		Standing	17		Acceptable
		Fall	15		Standing	21		Acceptable
		Winter	16		Walking	23		Acceptable
		Annual	15		Standing	21		Acceptable
	B	Spring	18	12%	Walking	26	13%	Acceptable
		Summer	13		Standing	19	12%	Acceptable
		Fall	16		Walking	24	14%	Acceptable
		Winter	17		Walking	25		Acceptable
		Annual	16		Walking	24	14%	Acceptable
	C	Spring	18	12%	Walking	26	13%	Acceptable
		Summer	13		Standing	19	12%	Acceptable
		Fall	16		Walking	24	14%	Acceptable
		Winter	17		Walking	25		Acceptable
		Annual	16		Walking	24	14%	Acceptable
8	A	Spring	17		Walking	23		Acceptable
		Summer	14		Standing	18		Acceptable
		Fall	16		Walking	21		Acceptable
		Winter	17		Walking	23		Acceptable
		Annual	16		Walking	22		Acceptable
	B	Spring	13	-24%	Standing	21		Acceptable
		Summer	11	-21%	Sitting	16	-11%	Acceptable
		Fall	13	-19%	Standing	20		Acceptable
		Winter	13	-24%	Standing	21		Acceptable
		Annual	13	-19%	Standing	20		Acceptable
	C	Spring	13	-24%	Standing	21		Acceptable
		Summer	11	-21%	Sitting	17		Acceptable
		Fall	13	-19%	Standing	19		Acceptable
		Winter	13	-24%	Standing	20	-13%	Acceptable
		Annual	13	-19%	Standing	19	-14%	Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
9	A	Spring	18		Walking	24		Acceptable
		Summer	15		Standing	19		Acceptable
		Fall	16		Walking	22		Acceptable
		Winter	18		Walking	24		Acceptable
		Annual	17		Walking	22		Acceptable
	B	Spring	16	-11%	Walking	24		Acceptable
		Summer	12	-20%	Sitting	18		Acceptable
		Fall	15		Standing	22		Acceptable
		Winter	15	-17%	Standing	23		Acceptable
		Annual	15	-12%	Standing	22		Acceptable
	C	Spring	16	-11%	Walking	23		Acceptable
		Summer	12	-20%	Sitting	17	-11%	Acceptable
		Fall	14	-12%	Standing	21		Acceptable
		Winter	15	-17%	Standing	22		Acceptable
		Annual	14	-18%	Standing	21		Acceptable
10	A	Spring	15		Standing	22		Acceptable
		Summer	12		Sitting	17		Acceptable
		Fall	14		Standing	20		Acceptable
		Winter	15		Standing	21		Acceptable
		Annual	14		Standing	20		Acceptable
	B	Spring	18	20%	Walking	24		Acceptable
		Summer	13		Standing	17		Acceptable
		Fall	16	14%	Walking	22		Acceptable
		Winter	16		Walking	23		Acceptable
		Annual	16	14%	Walking	22		Acceptable
	C	Spring	17	13%	Walking	24		Acceptable
		Summer	12		Sitting	17		Acceptable
		Fall	15		Standing	22		Acceptable
		Winter	16		Walking	23		Acceptable
		Annual	15		Standing	22		Acceptable
11	A	Spring	16		Walking	22		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	15		Standing	20		Acceptable
		Winter	16		Walking	22		Acceptable
		Annual	15		Standing	20		Acceptable
	B	Spring	14	-12%	Standing	22		Acceptable
		Summer	11	-15%	Sitting	17		Acceptable
		Fall	14		Standing	20		Acceptable
		Winter	14	-12%	Standing	21		Acceptable
		Annual	13	-13%	Standing	20		Acceptable
	C	Spring	14	-12%	Standing	21		Acceptable
		Summer	11	-15%	Sitting	17		Acceptable
		Fall	13	-13%	Standing	20		Acceptable
		Winter	14	-12%	Standing	21		Acceptable
		Annual	13	-13%	Standing	20		Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
12	A	Spring	16		Walking	22		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	15		Standing	22		Acceptable
		Winter	17		Walking	23		Acceptable
		Annual	16		Walking	22		Acceptable
	B	Spring	16		Walking	24		Acceptable
		Summer	12		Sitting	18		Acceptable
		Fall	15		Standing	22		Acceptable
		Winter	16		Walking	23		Acceptable
		Annual	15		Standing	22		Acceptable
	C	Spring	16		Walking	24		Acceptable
		Summer	12		Sitting	18		Acceptable
		Fall	15		Standing	22		Acceptable
		Winter	16		Walking	23		Acceptable
		Annual	15		Standing	22		Acceptable
13	A	Spring	15		Standing	21		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	14		Standing	20		Acceptable
		Winter	15		Standing	21		Acceptable
		Annual	14		Standing	20		Acceptable
	B	Spring	15		Standing	22		Acceptable
		Summer	11	-15%	Sitting	17		Acceptable
		Fall	14		Standing	20		Acceptable
		Winter	14		Standing	22		Acceptable
		Annual	14		Standing	20		Acceptable
	C	Spring	15		Standing	22		Acceptable
		Summer	11	-15%	Sitting	17		Acceptable
		Fall	14		Standing	21		Acceptable
		Winter	14		Standing	22		Acceptable
		Annual	14		Standing	21		Acceptable
14	A	Spring	10		Sitting	16		Acceptable
		Summer	8		Sitting	12		Acceptable
		Fall	9		Sitting	14		Acceptable
		Winter	10		Sitting	16		Acceptable
		Annual	9		Sitting	15		Acceptable
	B	Spring	18	80%	Walking	26	62%	Acceptable
		Summer	15	88%	Standing	21	75%	Acceptable
		Fall	15	67%	Standing	22	57%	Acceptable
		Winter	18	80%	Walking	26	62%	Acceptable
		Annual	17	89%	Walking	24	60%	Acceptable
	C	Spring	20	100%	Uncomfortable	25	56%	Acceptable
		Summer	16	100%	Walking	21	75%	Acceptable
		Fall	17	89%	Walking	23	64%	Acceptable
		Winter	20	100%	Uncomfortable	26	62%	Acceptable
		Annual	18	100%	Walking	24	60%	Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
15	A	Spring	11		Sitting	16		Acceptable
		Summer	9		Sitting	13		Acceptable
		Fall	10		Sitting	15		Acceptable
		Winter	11		Sitting	16		Acceptable
		Annual	10		Sitting	15		Acceptable
	B	Spring	17	55%	Walking	23	44%	Acceptable
		Summer	14	56%	Standing	19	46%	Acceptable
		Fall	16	60%	Walking	22	47%	Acceptable
		Winter	16	45%	Walking	23	44%	Acceptable
		Annual	16	60%	Walking	22	47%	Acceptable
	C	Spring	22	100%	Uncomfortable	29	81%	Acceptable
		Summer	19	111%	Walking	25	92%	Acceptable
		Fall	19	90%	Walking	26	73%	Acceptable
		Winter	20	82%	Uncomfortable	27	69%	Acceptable
		Annual	20	100%	Uncomfortable	27	80%	Acceptable
16	A	Spring	12		Sitting	19		Acceptable
		Summer	10		Sitting	16		Acceptable
		Fall	11		Sitting	17		Acceptable
		Winter	10		Sitting	17		Acceptable
		Annual	11		Sitting	17		Acceptable
	B	Spring	16	33%	Walking	23	21%	Acceptable
		Summer	12	20%	Sitting	19	19%	Acceptable
		Fall	14	27%	Standing	22	29%	Acceptable
		Winter	16	60%	Walking	23	35%	Acceptable
		Annual	15	36%	Standing	22	29%	Acceptable
	C	Spring	15	25%	Standing	23	21%	Acceptable
		Summer	12	20%	Sitting	19	19%	Acceptable
		Fall	14	27%	Standing	21	24%	Acceptable
		Winter	15	50%	Standing	23	35%	Acceptable
		Annual	14	27%	Standing	22	29%	Acceptable
17	A	Spring	20		Uncomfortable	27		Acceptable
		Summer	17		Walking	22		Acceptable
		Fall	20		Uncomfortable	26		Acceptable
		Winter	22		Uncomfortable	29		Acceptable
		Annual	20		Uncomfortable	26		Acceptable
	B	Spring	25	25%	Uncomfortable	34	26%	Unacceptable
		Summer	21	24%	Uncomfortable	28	27%	Acceptable
		Fall	23	15%	Uncomfortable	32	23%	Unacceptable
		Winter	26	18%	Uncomfortable	36	24%	Unacceptable
		Annual	24	20%	Uncomfortable	33	27%	Unacceptable
	C	Spring	22		Uncomfortable	30	11%	Acceptable
		Summer	17		Walking	24		Acceptable
		Fall	19		Walking	26		Acceptable
		Winter	22		Uncomfortable	30		Acceptable
		Annual	21		Uncomfortable	28		Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
18	A	Spring	20		Uncomfortable	25		Acceptable
		Summer	16		Walking	21		Acceptable
		Fall	19		Walking	25		Acceptable
		Winter	21		Uncomfortable	27		Acceptable
		Annual	19		Walking	25		Acceptable
	B	Spring	27	35%	Uncomfortable	34	36%	Unacceptable
		Summer	23	44%	Uncomfortable	29	38%	Acceptable
		Fall	26	37%	Uncomfortable	33	32%	Unacceptable
		Winter	29	38%	Dangerous	36	33%	Unacceptable
		Annual	26	37%	Uncomfortable	34	36%	Unacceptable
	C	Spring	19		Walking	26		Acceptable
		Summer	17		Walking	22		Acceptable
		Fall	19		Walking	25		Acceptable
		Winter	20		Uncomfortable	28		Acceptable
		Annual	19		Walking	25		Acceptable
19	A	Spring	16		Walking	22		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	15		Standing	21		Acceptable
		Winter	17		Walking	24		Acceptable
		Annual	16		Walking	22		Acceptable
	B	Spring	18	12%	Walking	26	18%	Acceptable
		Summer	15	15%	Standing	21	17%	Acceptable
		Fall	18	20%	Walking	26	24%	Acceptable
		Winter	19	12%	Walking	28	17%	Acceptable
		Annual	18	12%	Walking	26	18%	Acceptable
	C	Spring	18	12%	Walking	26	18%	Acceptable
		Summer	15	15%	Standing	21	17%	Acceptable
		Fall	17	13%	Walking	25	19%	Acceptable
		Winter	19	12%	Walking	28	17%	Acceptable
		Annual	18	12%	Walking	26	18%	Acceptable
20	A	Spring	13		Standing	19		Acceptable
		Summer	11		Sitting	16		Acceptable
		Fall	13		Standing	18		Acceptable
		Winter	14		Standing	20		Acceptable
		Annual	13		Standing	19		Acceptable
	B	Spring	21	62%	Uncomfortable	29	53%	Acceptable
		Summer	18	64%	Walking	24	50%	Acceptable
		Fall	20	54%	Uncomfortable	28	56%	Acceptable
		Winter	21	50%	Uncomfortable	30	50%	Acceptable
		Annual	20	54%	Uncomfortable	28	47%	Acceptable
	C	Spring	21	62%	Uncomfortable	30	58%	Acceptable
		Summer	18	64%	Walking	26	62%	Acceptable
		Fall	20	54%	Uncomfortable	29	61%	Acceptable
		Winter	21	50%	Uncomfortable	30	50%	Acceptable
		Annual	20	54%	Uncomfortable	29	53%	Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
21	A	Spring	16		Walking	22		Acceptable
		Summer	12		Sitting	17		Acceptable
		Fall	15		Standing	21		Acceptable
		Winter	16		Walking	22		Acceptable
		Annual	15		Standing	21		Acceptable
	B	Spring	16		Walking	24		Acceptable
		Summer	13		Standing	20	18%	Acceptable
		Fall	15		Standing	22		Acceptable
		Winter	17		Walking	25	14%	Acceptable
		Annual	15		Standing	23		Acceptable
	C	Spring	13	-19%	Standing	21		Acceptable
		Summer	11		Sitting	17		Acceptable
		Fall	13	-13%	Standing	20		Acceptable
		Winter	14	-12%	Standing	22		Acceptable
		Annual	13	-13%	Standing	20		Acceptable
22	A	Spring	16		Walking	23		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	15		Standing	22		Acceptable
		Winter	17		Walking	24		Acceptable
		Annual	16		Walking	22		Acceptable
	B	Spring	13	-19%	Standing	21		Acceptable
		Summer	11	-15%	Sitting	17		Acceptable
		Fall	13	-13%	Standing	19	-14%	Acceptable
		Winter	12	-29%	Sitting	19	-21%	Acceptable
		Annual	12	-25%	Sitting	19	-14%	Acceptable
	C	Spring	13	-19%	Standing	19	-17%	Acceptable
		Summer	11	-15%	Sitting	16	-11%	Acceptable
		Fall	12	-20%	Sitting	18	-18%	Acceptable
		Winter	12	-29%	Sitting	18	-25%	Acceptable
		Annual	12	-25%	Sitting	18	-18%	Acceptable
23	A	Spring	17		Walking	26		Acceptable
		Summer	14		Standing	21		Acceptable
		Fall	16		Walking	24		Acceptable
		Winter	18		Walking	26		Acceptable
		Annual	16		Walking	24		Acceptable
	B	Spring	16		Walking	24		Acceptable
		Summer	15		Standing	21		Acceptable
		Fall	16		Walking	23		Acceptable
		Winter	17		Walking	25		Acceptable
		Annual	16		Walking	23		Acceptable
	C	Spring	16		Walking	23	-12%	Acceptable
		Summer	14		Standing	21		Acceptable
		Fall	15		Standing	23		Acceptable
		Winter	16	-11%	Walking	24		Acceptable
		Annual	16		Walking	23		Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
24	A	Spring	19		Walking	27		Acceptable
		Summer	17		Walking	24		Acceptable
		Fall	18		Walking	26		Acceptable
		Winter	19		Walking	28		Acceptable
		Annual	18		Walking	26		Acceptable
	B	Spring	18		Walking	26		Acceptable
		Summer	16		Walking	22		Acceptable
		Fall	17		Walking	25		Acceptable
		Winter	18		Walking	26		Acceptable
		Annual	17		Walking	25		Acceptable
	C	Spring	18		Walking	25		Acceptable
		Summer	15	-12%	Standing	22		Acceptable
		Fall	17		Walking	24		Acceptable
		Winter	18		Walking	25	-11%	Acceptable
		Annual	17		Walking	24		Acceptable
25	A	Spring	16		Walking	22		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	15		Standing	21		Acceptable
		Winter	17		Walking	24		Acceptable
		Annual	15		Standing	22		Acceptable
	B	Spring	13	-19%	Standing	19	-14%	Acceptable
		Summer	11	-15%	Sitting	16	-11%	Acceptable
		Fall	13	-13%	Standing	19		Acceptable
		Winter	14	-18%	Standing	21	-12%	Acceptable
		Annual	13	-13%	Standing	19	-14%	Acceptable
	C	Spring	13	-19%	Standing	20		Acceptable
		Summer	11	-15%	Sitting	16	-11%	Acceptable
		Fall	13	-13%	Standing	19		Acceptable
		Winter	14	-18%	Standing	21	-12%	Acceptable
		Annual	13	-13%	Standing	19	-14%	Acceptable
26	A	Spring	10		Sitting	17		Acceptable
		Summer	8		Sitting	14		Acceptable
		Fall	10		Sitting	16		Acceptable
		Winter	11		Sitting	18		Acceptable
		Annual	10		Sitting	16		Acceptable
	B	Spring	9		Sitting	16		Acceptable
		Summer	8		Sitting	13		Acceptable
		Fall	9		Sitting	15		Acceptable
		Winter	10		Sitting	16	-11%	Acceptable
		Annual	9		Sitting	15		Acceptable
	C	Spring	9		Sitting	16		Acceptable
		Summer	8		Sitting	13		Acceptable
		Fall	9		Sitting	15		Acceptable
		Winter	10		Sitting	16	-11%	Acceptable
		Annual	9		Sitting	15		Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
27	A	Spring	14		Standing	22		Acceptable
		Summer	12		Sitting	18		Acceptable
		Fall	14		Standing	21		Acceptable
		Winter	15		Standing	23		Acceptable
		Annual	14		Standing	21		Acceptable
	B	Spring	13		Standing	20		Acceptable
		Summer	11		Sitting	17		Acceptable
		Fall	12	-14%	Sitting	20		Acceptable
		Winter	13	-13%	Standing	21		Acceptable
		Annual	12	-14%	Sitting	20		Acceptable
	C	Spring	9	-36%	Sitting	14	-36%	Acceptable
		Summer	7	-42%	Sitting	12	-33%	Acceptable
		Fall	8	-43%	Sitting	14	-33%	Acceptable
		Winter	9	-40%	Sitting	15	-35%	Acceptable
		Annual	8	-43%	Sitting	14	-33%	Acceptable
28	A	Spring	12		Sitting	18		Acceptable
		Summer	10		Sitting	15		Acceptable
		Fall	11		Sitting	17		Acceptable
		Winter	12		Sitting	19		Acceptable
		Annual	11		Sitting	18		Acceptable
	B	Spring	11		Sitting	17		Acceptable
		Summer	9		Sitting	15		Acceptable
		Fall	10		Sitting	16		Acceptable
		Winter	11		Sitting	17	-11%	Acceptable
		Annual	10		Sitting	16	-11%	Acceptable
	C	Spring	11		Sitting	17		Acceptable
		Summer	10		Sitting	15		Acceptable
		Fall	10		Sitting	16		Acceptable
		Winter	11		Sitting	17	-11%	Acceptable
		Annual	10		Sitting	17		Acceptable
29	A	Spring	12		Sitting	18		Acceptable
		Summer	10		Sitting	15		Acceptable
		Fall	12		Sitting	18		Acceptable
		Winter	13		Standing	19		Acceptable
		Annual	12		Sitting	18		Acceptable
	B	Spring	10	-17%	Sitting	16	-11%	Acceptable
		Summer	8	-20%	Sitting	13	-13%	Acceptable
		Fall	9	-25%	Sitting	15	-17%	Acceptable
		Winter	10	-23%	Sitting	16	-16%	Acceptable
		Annual	9	-25%	Sitting	15	-17%	Acceptable
	C	Spring	10	-17%	Sitting	16	-11%	Acceptable
		Summer	8	-20%	Sitting	13	-13%	Acceptable
		Fall	10	-17%	Sitting	16	-11%	Acceptable
		Winter	10	-23%	Sitting	17	-11%	Acceptable
		Annual	10	-17%	Sitting	16	-11%	Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
30	A	Spring	16		Walking	22		Acceptable
		Summer	14		Standing	19		Acceptable
		Fall	15		Standing	21		Acceptable
		Winter	15		Standing	22		Acceptable
		Annual	15		Standing	21		Acceptable
	B	Spring	13	-19%	Standing	20		Acceptable
		Summer	11	-21%	Sitting	17	-11%	Acceptable
		Fall	12	-20%	Sitting	18	-14%	Acceptable
		Winter	12	-20%	Sitting	19	-14%	Acceptable
		Annual	12	-20%	Sitting	18	-14%	Acceptable
	C	Spring	13	-19%	Standing	20		Acceptable
		Summer	12	-14%	Sitting	17	-11%	Acceptable
		Fall	12	-20%	Sitting	19		Acceptable
		Winter	12	-20%	Sitting	19	-14%	Acceptable
		Annual	12	-20%	Sitting	19		Acceptable
31	A	Spring	13		Standing	18		Acceptable
		Summer	11		Sitting	15		Acceptable
		Fall	12		Sitting	17		Acceptable
		Winter	13		Standing	18		Acceptable
		Annual	12		Sitting	17		Acceptable
	B	Spring	9	-31%	Sitting	15	-17%	Acceptable
		Summer	8	-27%	Sitting	13	-13%	Acceptable
		Fall	9	-25%	Sitting	14	-18%	Acceptable
		Winter	9	-31%	Sitting	16	-11%	Acceptable
		Annual	9	-25%	Sitting	15	-12%	Acceptable
	C	Spring	9	-31%	Sitting	15	-17%	Acceptable
		Summer	8	-27%	Sitting	13	-13%	Acceptable
		Fall	9	-25%	Sitting	14	-18%	Acceptable
		Winter	10	-23%	Sitting	16	-11%	Acceptable
		Annual	9	-25%	Sitting	15	-12%	Acceptable
32	A	Spring	16		Walking	22		Acceptable
		Summer	14		Standing	18		Acceptable
		Fall	15		Standing	21		Acceptable
		Winter	16		Walking	22		Acceptable
		Annual	15		Standing	21		Acceptable
	B	Spring	11	-31%	Sitting	18	-18%	Acceptable
		Summer	9	-36%	Sitting	15	-17%	Acceptable
		Fall	11	-27%	Sitting	17	-19%	Acceptable
		Winter	12	-25%	Sitting	19	-14%	Acceptable
		Annual	11	-27%	Sitting	17	-19%	Acceptable
	C	Spring	9	-44%	Sitting	14	-36%	Acceptable
		Summer	7	-50%	Sitting	11	-39%	Acceptable
		Fall	8	-47%	Sitting	13	-38%	Acceptable
		Winter	9	-44%	Sitting	14	-36%	Acceptable
		Annual	8	-47%	Sitting	13	-38%	Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
33	A	Spring	8		Sitting	14		Acceptable
		Summer	7		Sitting	12		Acceptable
		Fall	8		Sitting	13		Acceptable
		Winter	9		Sitting	15		Acceptable
		Annual	8		Sitting	13		Acceptable
	B	Spring	8		Sitting	13		Acceptable
		Summer	7		Sitting	12		Acceptable
		Fall	8		Sitting	13		Acceptable
		Winter	9		Sitting	14		Acceptable
		Annual	8		Sitting	13		Acceptable
	C	Spring	8		Sitting	13		Acceptable
		Summer	7		Sitting	12		Acceptable
		Fall	8		Sitting	13		Acceptable
		Winter	8	-11%	Sitting	14		Acceptable
		Annual	8		Sitting	13		Acceptable
34	A	Spring	12		Sitting	18		Acceptable
		Summer	9		Sitting	14		Acceptable
		Fall	11		Sitting	17		Acceptable
		Winter	11		Sitting	17		Acceptable
		Annual	11		Sitting	17		Acceptable
	B	Spring	11		Sitting	17		Acceptable
		Summer	8	-11%	Sitting	13		Acceptable
		Fall	10		Sitting	15	-12%	Acceptable
		Winter	10		Sitting	16		Acceptable
		Annual	10		Sitting	15	-12%	Acceptable
	C	Spring	13		Standing	17		Acceptable
		Summer	11	22%	Sitting	14		Acceptable
		Fall	12		Sitting	17		Acceptable
		Winter	14	27%	Standing	18		Acceptable
		Annual	13	18%	Standing	17		Acceptable
35	A	Spring	14		Standing	19		Acceptable
		Summer	10		Sitting	14		Acceptable
		Fall	13		Standing	17		Acceptable
		Winter	13		Standing	18		Acceptable
		Annual	13		Standing	17		Acceptable
	B	Spring	14		Standing	19		Acceptable
		Summer	10		Sitting	14		Acceptable
		Fall	12		Sitting	17		Acceptable
		Winter	13		Standing	18		Acceptable
		Annual	12		Sitting	17		Acceptable
	C	Spring	14		Standing	19		Acceptable
		Summer	10		Sitting	13		Acceptable
		Fall	12		Sitting	17		Acceptable
		Winter	12		Sitting	17		Acceptable
		Annual	12		Sitting	17		Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
36	A	Spring	16		Walking	22		Acceptable
		Summer	11		Sitting	15		Acceptable
		Fall	14		Standing	19		Acceptable
		Winter	14		Standing	20		Acceptable
		Annual	14		Standing	19		Acceptable
	B	Spring	16		Walking	22		Acceptable
		Summer	11		Sitting	16		Acceptable
		Fall	14		Standing	19		Acceptable
		Winter	14		Standing	20		Acceptable
		Annual	14		Standing	20		Acceptable
	C	Spring	19	19%	Walking	23		Acceptable
		Summer	13	18%	Standing	16		Acceptable
		Fall	16	14%	Walking	21	11%	Acceptable
		Winter	16	14%	Walking	21		Acceptable
		Annual	16	14%	Walking	21	11%	Acceptable
37	A	Spring	17		Walking	25		Acceptable
		Summer	13		Standing	20		Acceptable
		Fall	16		Walking	24		Acceptable
		Winter	17		Walking	26		Acceptable
		Annual	16		Walking	24		Acceptable
	B	Spring	17		Walking	25		Acceptable
		Summer	13		Standing	20		Acceptable
		Fall	16		Walking	23		Acceptable
		Winter	17		Walking	26		Acceptable
		Annual	16		Walking	24		Acceptable
	C	Spring	18		Walking	25		Acceptable
		Summer	14		Standing	20		Acceptable
		Fall	16		Walking	24		Acceptable
		Winter	18		Walking	27		Acceptable
		Annual	17		Walking	25		Acceptable
38	A	Spring	27		Uncomfortable	35		Unacceptable
		Summer	23		Uncomfortable	29		Acceptable
		Fall	25		Uncomfortable	33		Unacceptable
		Winter	27		Uncomfortable	36		Unacceptable
		Annual	26		Uncomfortable	34		Unacceptable
	B	Spring	27		Uncomfortable	35		Unacceptable
		Summer	23		Uncomfortable	30		Acceptable
		Fall	26		Uncomfortable	33		Unacceptable
		Winter	27		Uncomfortable	36		Unacceptable
		Annual	26		Uncomfortable	34		Unacceptable
	C	Spring	27		Uncomfortable	35		Unacceptable
		Summer	23		Uncomfortable	29		Acceptable
		Fall	25		Uncomfortable	33		Unacceptable
		Winter	28		Dangerous	36		Unacceptable
		Annual	26		Uncomfortable	34		Unacceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
39	A	Spring	12		Sitting	20		Acceptable
		Summer	11		Sitting	18		Acceptable
		Fall	12		Sitting	19		Acceptable
		Winter	12		Sitting	20		Acceptable
		Annual	12		Sitting	19		Acceptable
	B	Spring	12		Sitting	20		Acceptable
		Summer	11		Sitting	18		Acceptable
		Fall	12		Sitting	19		Acceptable
		Winter	12		Sitting	20		Acceptable
		Annual	12		Sitting	19		Acceptable
	C	Spring	12		Sitting	20		Acceptable
		Summer	11		Sitting	18		Acceptable
		Fall	12		Sitting	19		Acceptable
		Winter	12		Sitting	20		Acceptable
		Annual	12		Sitting	19		Acceptable
40	A	Spring	19		Walking	27		Acceptable
		Summer	15		Standing	21		Acceptable
		Fall	17		Walking	25		Acceptable
		Winter	19		Walking	27		Acceptable
		Annual	18		Walking	25		Acceptable
	B	Spring	19		Walking	27		Acceptable
		Summer	15		Standing	21		Acceptable
		Fall	17		Walking	25		Acceptable
		Winter	19		Walking	27		Acceptable
		Annual	18		Walking	26		Acceptable
	C	Spring	19		Walking	27		Acceptable
		Summer	15		Standing	21		Acceptable
		Fall	17		Walking	25		Acceptable
		Winter	19		Walking	27		Acceptable
		Annual	18		Walking	26		Acceptable
41	A	Spring	18		Walking	26		Acceptable
		Summer	14		Standing	21		Acceptable
		Fall	17		Walking	25		Acceptable
		Winter	18		Walking	27		Acceptable
		Annual	17		Walking	25		Acceptable
	B	Spring	18		Walking	26		Acceptable
		Summer	14		Standing	21		Acceptable
		Fall	17		Walking	25		Acceptable
		Winter	18		Walking	27		Acceptable
		Annual	17		Walking	25		Acceptable
	C	Spring	18		Walking	26		Acceptable
		Summer	14		Standing	21		Acceptable
		Fall	17		Walking	25		Acceptable
		Winter	18		Walking	27		Acceptable
		Annual	17		Walking	25		Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
42	A	Spring	22		Uncomfortable	29		Acceptable
		Summer	19		Walking	24		Acceptable
		Fall	21		Uncomfortable	27		Acceptable
		Winter	21		Uncomfortable	28		Acceptable
		Annual	21		Uncomfortable	27		Acceptable
	B	Spring	22		Uncomfortable	29		Acceptable
		Summer	19		Walking	24		Acceptable
		Fall	20		Uncomfortable	27		Acceptable
		Winter	21		Uncomfortable	29		Acceptable
		Annual	21		Uncomfortable	27		Acceptable
	C	Spring	22		Uncomfortable	29		Acceptable
		Summer	19		Walking	24		Acceptable
		Fall	20		Uncomfortable	27		Acceptable
		Winter	21		Uncomfortable	29		Acceptable
		Annual	21		Uncomfortable	27		Acceptable
43	A	Spring	18		Walking	26		Acceptable
		Summer	14		Standing	21		Acceptable
		Fall	16		Walking	24		Acceptable
		Winter	17		Walking	26		Acceptable
		Annual	17		Walking	25		Acceptable
	B	Spring	18		Walking	26		Acceptable
		Summer	14		Standing	21		Acceptable
		Fall	17		Walking	24		Acceptable
		Winter	18		Walking	27		Acceptable
		Annual	17		Walking	25		Acceptable
	C	Spring	18		Walking	26		Acceptable
		Summer	14		Standing	21		Acceptable
		Fall	17		Walking	24		Acceptable
		Winter	18		Walking	27		Acceptable
		Annual	17		Walking	25		Acceptable
44	A	Spring	22		Uncomfortable	28		Acceptable
		Summer	19		Walking	25		Acceptable
		Fall	21		Uncomfortable	28		Acceptable
		Winter	22		Uncomfortable	29		Acceptable
		Annual	21		Uncomfortable	28		Acceptable
	B	Spring	22		Uncomfortable	29		Acceptable
		Summer	19		Walking	25		Acceptable
		Fall	21		Uncomfortable	28		Acceptable
		Winter	23		Uncomfortable	30		Acceptable
		Annual	21		Uncomfortable	28		Acceptable
	C	Spring	22		Uncomfortable	29		Acceptable
		Summer	19		Walking	25		Acceptable
		Fall	21		Uncomfortable	28		Acceptable
		Winter	23		Uncomfortable	30		Acceptable
		Annual	21		Uncomfortable	28		Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
45	A	Spring	22		Uncomfortable	29		Acceptable
		Summer	19		Walking	25		Acceptable
		Fall	21		Uncomfortable	28		Acceptable
		Winter	22		Uncomfortable	30		Acceptable
		Annual	21		Uncomfortable	28		Acceptable
	B	Spring	22		Uncomfortable	30		Acceptable
		Summer	19		Walking	25		Acceptable
		Fall	21		Uncomfortable	29		Acceptable
		Winter	23		Uncomfortable	31		Acceptable
		Annual	21		Uncomfortable	29		Acceptable
	C	Spring	22		Uncomfortable	30		Acceptable
		Summer	19		Walking	25		Acceptable
		Fall	21		Uncomfortable	29		Acceptable
		Winter	23		Uncomfortable	31		Acceptable
		Annual	21		Uncomfortable	29		Acceptable
46	A	Spring	18		Walking	27		Acceptable
		Summer	15		Standing	23		Acceptable
		Fall	17		Walking	26		Acceptable
		Winter	19		Walking	28		Acceptable
		Annual	17		Walking	26		Acceptable
	B	Spring	19		Walking	28		Acceptable
		Summer	16		Walking	24		Acceptable
		Fall	18		Walking	26		Acceptable
		Winter	19		Walking	28		Acceptable
		Annual	18		Walking	26		Acceptable
	C	Spring	18		Walking	27		Acceptable
		Summer	16		Walking	23		Acceptable
		Fall	17		Walking	26		Acceptable
		Winter	19		Walking	28		Acceptable
		Annual	18		Walking	26		Acceptable
47	A	Spring	17		Walking	25		Acceptable
		Summer	14		Standing	21		Acceptable
		Fall	16		Walking	24		Acceptable
		Winter	17		Walking	26		Acceptable
		Annual	16		Walking	24		Acceptable
	B	Spring	17		Walking	25		Acceptable
		Summer	15		Standing	21		Acceptable
		Fall	17		Walking	24		Acceptable
		Winter	18		Walking	26		Acceptable
		Annual	17		Walking	24		Acceptable
	C	Spring	17		Walking	25		Acceptable
		Summer	15		Standing	22		Acceptable
		Fall	17		Walking	25		Acceptable
		Winter	18		Walking	26		Acceptable
		Annual	17		Walking	25		Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
48	A	Spring	15		Standing	25		Acceptable
		Summer	13		Standing	20		Acceptable
		Fall	15		Standing	24		Acceptable
		Winter	16		Walking	26		Acceptable
		Annual	15		Standing	24		Acceptable
	B	Spring	15		Standing	24		Acceptable
		Summer	13		Standing	20		Acceptable
		Fall	15		Standing	24		Acceptable
		Winter	16		Walking	26		Acceptable
		Annual	15		Standing	24		Acceptable
	C	Spring	16		Walking	25		Acceptable
		Summer	13		Standing	20		Acceptable
		Fall	15		Standing	24		Acceptable
		Winter	16		Walking	26		Acceptable
		Annual	15		Standing	24		Acceptable
49	A	Spring	20		Uncomfortable	30		Acceptable
		Summer	17		Walking	25		Acceptable
		Fall	19		Walking	28		Acceptable
		Winter	19		Walking	29		Acceptable
		Annual	19		Walking	28		Acceptable
	B	Spring	20		Uncomfortable	30		Acceptable
		Summer	18		Walking	26		Acceptable
		Fall	19		Walking	28		Acceptable
		Winter	19		Walking	29		Acceptable
		Annual	19		Walking	29		Acceptable
	C	Spring	19		Walking	28		Acceptable
		Summer	16		Walking	24		Acceptable
		Fall	17	-11%	Walking	26		Acceptable
		Winter	18		Walking	27		Acceptable
		Annual	18		Walking	27		Acceptable
50	A	Spring	25		Uncomfortable	32		Unacceptable
		Summer	20		Uncomfortable	26		Acceptable
		Fall	23		Uncomfortable	30		Acceptable
		Winter	25		Uncomfortable	32		Unacceptable
		Annual	24		Uncomfortable	31		Acceptable
	B	Spring	25		Uncomfortable	33		Unacceptable
		Summer	21		Uncomfortable	26		Acceptable
		Fall	24		Uncomfortable	30		Acceptable
		Winter	25		Uncomfortable	32		Unacceptable
		Annual	24		Uncomfortable	31		Acceptable
	C	Spring	25		Uncomfortable	33		Unacceptable
		Summer	20		Uncomfortable	26		Acceptable
		Fall	23		Uncomfortable	30		Acceptable
		Winter	25		Uncomfortable	32		Unacceptable
		Annual	24		Uncomfortable	31		Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
51	A	Spring	23		Uncomfortable	32		Unacceptable
		Summer	19		Walking	27		Acceptable
		Fall	22		Uncomfortable	30		Acceptable
		Winter	23		Uncomfortable	33		Unacceptable
		Annual	22		Uncomfortable	31		Acceptable
	B	Spring	23		Uncomfortable	32		Unacceptable
		Summer	20		Uncomfortable	27		Acceptable
		Fall	22		Uncomfortable	31		Acceptable
		Winter	24		Uncomfortable	33		Unacceptable
		Annual	22		Uncomfortable	31		Acceptable
	C	Spring	21		Uncomfortable	31		Acceptable
		Summer	18		Walking	26		Acceptable
		Fall	21		Uncomfortable	29		Acceptable
		Winter	22		Uncomfortable	32		Unacceptable
		Annual	21		Uncomfortable	30		Acceptable
52	A	Spring	22		Uncomfortable	30		Acceptable
		Summer	17		Walking	23		Acceptable
		Fall	19		Walking	27		Acceptable
		Winter	21		Uncomfortable	30		Acceptable
		Annual	20		Uncomfortable	28		Acceptable
	B	Spring	23		Uncomfortable	30		Acceptable
		Summer	18		Walking	24		Acceptable
		Fall	19		Walking	27		Acceptable
		Winter	21		Uncomfortable	31		Acceptable
		Annual	20		Uncomfortable	28		Acceptable
	C	Spring	23		Uncomfortable	30		Acceptable
		Summer	17		Walking	23		Acceptable
		Fall	19		Walking	27		Acceptable
		Winter	21		Uncomfortable	30		Acceptable
		Annual	20		Uncomfortable	28		Acceptable
53	A	Spring	22		Uncomfortable	32		Unacceptable
		Summer	19		Walking	26		Acceptable
		Fall	20		Uncomfortable	30		Acceptable
		Winter	22		Uncomfortable	33		Unacceptable
		Annual	21		Uncomfortable	31		Acceptable
	B	Spring	22		Uncomfortable	32		Unacceptable
		Summer	19		Walking	26		Acceptable
		Fall	20		Uncomfortable	29		Acceptable
		Winter	22		Uncomfortable	33		Unacceptable
		Annual	21		Uncomfortable	31		Acceptable
	C	Spring	22		Uncomfortable	32		Unacceptable
		Summer	18		Walking	26		Acceptable
		Fall	20		Uncomfortable	30		Acceptable
		Winter	22		Uncomfortable	34		Unacceptable
		Annual	21		Uncomfortable	31		Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
54	A	Spring	26		Uncomfortable	33		Unacceptable
		Summer	21		Uncomfortable	26		Acceptable
		Fall	23		Uncomfortable	29		Acceptable
		Winter	27		Uncomfortable	34		Unacceptable
		Annual	24		Uncomfortable	31		Acceptable
	B	Spring	27		Uncomfortable	33		Unacceptable
		Summer	21		Uncomfortable	26		Acceptable
		Fall	23		Uncomfortable	29		Acceptable
		Winter	27		Uncomfortable	34		Unacceptable
		Annual	25		Uncomfortable	31		Acceptable
	C	Spring	26		Uncomfortable	33		Unacceptable
		Summer	21		Uncomfortable	26		Acceptable
		Fall	23		Uncomfortable	29		Acceptable
		Winter	27		Uncomfortable	33		Unacceptable
		Annual	24		Uncomfortable	30		Acceptable
55	A	Spring	26		Uncomfortable	34		Unacceptable
		Summer	21		Uncomfortable	27		Acceptable
		Fall	25		Uncomfortable	33		Unacceptable
		Winter	28		Dangerous	37		Unacceptable
		Annual	25		Uncomfortable	33		Unacceptable
	B	Spring	27		Uncomfortable	34		Unacceptable
		Summer	22		Uncomfortable	27		Acceptable
		Fall	25		Uncomfortable	33		Unacceptable
		Winter	28		Dangerous	37		Unacceptable
		Annual	26		Uncomfortable	34		Unacceptable
	C	Spring	27		Uncomfortable	34		Unacceptable
		Summer	22		Uncomfortable	28		Acceptable
		Fall	25		Uncomfortable	33		Unacceptable
		Winter	29		Dangerous	37		Unacceptable
		Annual	26		Uncomfortable	34		Unacceptable
56	A	Spring	19		Walking	23		Acceptable
		Summer	14		Standing	18		Acceptable
		Fall	17		Walking	21		Acceptable
		Winter	19		Walking	23		Acceptable
		Annual	17		Walking	22		Acceptable
	B	Spring	19		Walking	23		Acceptable
		Summer	14		Standing	17		Acceptable
		Fall	17		Walking	21		Acceptable
		Winter	18		Walking	23		Acceptable
		Annual	17		Walking	22		Acceptable
	C	Spring	18		Walking	26	13%	Acceptable
		Summer	17	21%	Walking	23	28%	Acceptable
		Fall	18		Walking	25	19%	Acceptable
		Winter	20		Uncomfortable	27	17%	Acceptable
		Annual	18		Walking	25	14%	Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
57	A	Spring	14		Standing	21		Acceptable
		Summer	11		Sitting	16		Acceptable
		Fall	13		Standing	19		Acceptable
		Winter	14		Standing	21		Acceptable
		Annual	13		Standing	20		Acceptable
	B	Spring	13		Standing	20		Acceptable
		Summer	10		Sitting	16		Acceptable
		Fall	12		Sitting	19		Acceptable
		Winter	14		Standing	21		Acceptable
		Annual	13		Standing	19		Acceptable
	C	Spring	14		Standing	21		Acceptable
		Summer	11		Sitting	16		Acceptable
		Fall	13		Standing	19		Acceptable
		Winter	14		Standing	21		Acceptable
		Annual	13		Standing	20		Acceptable
58	A	Spring	15		Standing	22		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	15		Standing	21		Acceptable
		Winter	16		Walking	23		Acceptable
		Annual	15		Standing	21		Acceptable
	B	Spring	14		Standing	20		Acceptable
		Summer	11	-15%	Sitting	16	-11%	Acceptable
		Fall	13	-13%	Standing	19		Acceptable
		Winter	15		Standing	22		Acceptable
		Annual	14		Standing	20		Acceptable
	C	Spring	15		Standing	23		Acceptable
		Summer	14		Standing	21	17%	Acceptable
		Fall	15		Standing	23		Acceptable
		Winter	16		Walking	24		Acceptable
		Annual	15		Standing	23		Acceptable
59	A	Spring	19		Walking	28		Acceptable
		Summer	15		Standing	22		Acceptable
		Fall	18		Walking	27		Acceptable
		Winter	21		Uncomfortable	30		Acceptable
		Annual	19		Walking	28		Acceptable
	B	Spring	20		Uncomfortable	29		Acceptable
		Summer	16		Walking	23		Acceptable
		Fall	19		Walking	27		Acceptable
		Winter	22		Uncomfortable	31		Acceptable
		Annual	20		Uncomfortable	28		Acceptable
	C	Spring	20		Uncomfortable	29		Acceptable
		Summer	16		Walking	23		Acceptable
		Fall	19		Walking	28		Acceptable
		Winter	22		Uncomfortable	31		Acceptable
		Annual	20		Uncomfortable	29		Acceptable

BRA Criteria			**Mean Wind Speed**			**Effective Gust Wind Speed**		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
60	A	Spring	19		Walking	28		Acceptable
		Summer	16		Walking	24		Acceptable
		Fall	19		Walking	28		Acceptable
		Winter	20		Uncomfortable	30		Acceptable
		Annual	19		Walking	28		Acceptable
	B	Spring	20		Uncomfortable	29		Acceptable
		Summer	17		Walking	24		Acceptable
		Fall	19		Walking	28		Acceptable
		Winter	21		Uncomfortable	31		Acceptable
		Annual	20		Uncomfortable	29		Acceptable
	C	Spring	20		Uncomfortable	29		Acceptable
		Summer	17		Walking	24		Acceptable
		Fall	20		Uncomfortable	29		Acceptable
		Winter	22		Uncomfortable	32		Unacceptable
		Annual	20		Uncomfortable	29		Acceptable
61	A	Spring	22		Uncomfortable	31		Acceptable
		Summer	19		Walking	27		Acceptable
		Fall	21		Uncomfortable	30		Acceptable
		Winter	23		Uncomfortable	32		Unacceptable
		Annual	22		Uncomfortable	30		Acceptable
	B	Spring	23		Uncomfortable	32		Unacceptable
		Summer	19		Walking	27		Acceptable
		Fall	22		Uncomfortable	30		Acceptable
		Winter	24		Uncomfortable	33		Unacceptable
		Annual	22		Uncomfortable	31		Acceptable
	C	Spring	23		Uncomfortable	32		Unacceptable
		Summer	20		Uncomfortable	27		Acceptable
		Fall	23		Uncomfortable	30		Acceptable
		Winter	24		Uncomfortable	33		Unacceptable
		Annual	23		Uncomfortable	31		Acceptable
62	A	Spring	19		Walking	29		Acceptable
		Summer	18		Walking	25		Acceptable
		Fall	19		Walking	28		Acceptable
		Winter	20		Uncomfortable	30		Acceptable
		Annual	19		Walking	28		Acceptable
	B	Spring	20		Uncomfortable	29		Acceptable
		Summer	19		Walking	26		Acceptable
		Fall	20		Uncomfortable	28		Acceptable
		Winter	21		Uncomfortable	31		Acceptable
		Annual	20		Uncomfortable	29		Acceptable
	C	Spring	21	11%	Uncomfortable	30		Acceptable
		Summer	19		Walking	26		Acceptable
		Fall	21	11%	Uncomfortable	29		Acceptable
		Winter	22		Uncomfortable	31		Acceptable
		Annual	21	11%	Uncomfortable	29		Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
63	A	Spring	11		Sitting	17		Acceptable
		Summer	10		Sitting	15		Acceptable
		Fall	11		Sitting	17		Acceptable
		Winter	11		Sitting	18		Acceptable
		Annual	11		Sitting	17		Acceptable
	B	Spring	12		Sitting	18		Acceptable
		Summer	11		Sitting	16		Acceptable
		Fall	11		Sitting	18		Acceptable
		Winter	12		Sitting	19		Acceptable
		Annual	11		Sitting	18		Acceptable
	C	Spring	12		Sitting	18		Acceptable
		Summer	11		Sitting	16		Acceptable
		Fall	12		Sitting	18		Acceptable
		Winter	13	18%	Standing	19		Acceptable
		Annual	12		Sitting	18		Acceptable
64	A	Spring	10		Sitting	18		Acceptable
		Summer	8		Sitting	14		Acceptable
		Fall	10		Sitting	16		Acceptable
		Winter	10		Sitting	17		Acceptable
		Annual	10		Sitting	16		Acceptable
	B	Spring	9		Sitting	15	-17%	Acceptable
		Summer	7	-12%	Sitting	11	-21%	Acceptable
		Fall	8	-20%	Sitting	14	-12%	Acceptable
		Winter	8	-20%	Sitting	15	-12%	Acceptable
		Annual	8	-20%	Sitting	14	-12%	Acceptable
	C	Spring	8	-20%	Sitting	15	-17%	Acceptable
		Summer	6	-25%	Sitting	11	-21%	Acceptable
		Fall	8	-20%	Sitting	13	-19%	Acceptable
		Winter	8	-20%	Sitting	15	-12%	Acceptable
		Annual	8	-20%	Sitting	14	-12%	Acceptable
65	A	Spring	19		Walking	28		Acceptable
		Summer	14		Standing	20		Acceptable
		Fall	17		Walking	25		Acceptable
		Winter	18		Walking	26		Acceptable
		Annual	17		Walking	25		Acceptable
	B	Spring	16	-16%	Walking	24	-14%	Acceptable
		Summer	11	-21%	Sitting	18		Acceptable
		Fall	15	-12%	Standing	23		Acceptable
		Winter	15	-17%	Standing	23	-12%	Acceptable
		Annual	14	-18%	Standing	22	-12%	Acceptable
	C	Spring	16	-16%	Walking	25	-11%	Acceptable
		Summer	12	-14%	Sitting	18		Acceptable
		Fall	15	-12%	Standing	23		Acceptable
		Winter	15	-17%	Standing	24		Acceptable
		Annual	15	-12%	Standing	23		Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
66	A	Spring	22		Uncomfortable	33		Unacceptable
		Summer	15		Standing	23		Acceptable
		Fall	20		Uncomfortable	30		Acceptable
		Winter	20		Uncomfortable	30		Acceptable
		Annual	20		Uncomfortable	30		Acceptable
	B	Spring	20		Uncomfortable	30		Acceptable
		Summer	14		Standing	21		Acceptable
		Fall	18		Walking	27		Acceptable
		Winter	18		Walking	28		Acceptable
		Annual	18		Walking	27		Acceptable
	C	Spring	20		Uncomfortable	31		Acceptable
		Summer	14		Standing	22		Acceptable
		Fall	18		Walking	28		Acceptable
		Winter	18		Walking	28		Acceptable
		Annual	18		Walking	28		Acceptable
67	A	Spring	15		Standing	25		Acceptable
		Summer	13		Standing	21		Acceptable
		Fall	14		Standing	24		Acceptable
		Winter	15		Standing	25		Acceptable
		Annual	14		Standing	24		Acceptable
	B	Spring	17	13%	Walking	26		Acceptable
		Summer	15	15%	Standing	23		Acceptable
		Fall	17	21%	Walking	25		Acceptable
		Winter	18	20%	Walking	27		Acceptable
		Annual	17	21%	Walking	25		Acceptable
	C	Spring	17	13%	Walking	26		Acceptable
		Summer	15	15%	Standing	23		Acceptable
		Fall	17	21%	Walking	26		Acceptable
		Winter	18	20%	Walking	27		Acceptable
		Annual	17	21%	Walking	26		Acceptable
68	A	Spring	14		Standing	23		Acceptable
		Summer	14		Standing	21		Acceptable
		Fall	15		Standing	23		Acceptable
		Winter	15		Standing	24		Acceptable
		Annual	15		Standing	23		Acceptable
	B	Spring	15		Standing	23		Acceptable
		Summer	14		Standing	22		Acceptable
		Fall	15		Standing	24		Acceptable
		Winter	16		Walking	25		Acceptable
		Annual	15		Standing	23		Acceptable
	C	Spring	15		Standing	24		Acceptable
		Summer	15		Standing	22		Acceptable
		Fall	16		Walking	24		Acceptable
		Winter	16		Walking	25		Acceptable
		Annual	16		Walking	24		Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
69	A	Spring	19		Walking	27		Acceptable
		Summer	14		Standing	19		Acceptable
		Fall	17		Walking	24		Acceptable
		Winter	18		Walking	25		Acceptable
		Annual	17		Walking	24		Acceptable
	B	Spring	17	-11%	Walking	25		Acceptable
		Summer	12	-14%	Sitting	18		Acceptable
		Fall	15	-12%	Standing	23		Acceptable
		Winter	16	-11%	Walking	23		Acceptable
		Annual	15	-12%	Standing	23		Acceptable
	C	Spring	18		Walking	26		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	16		Walking	23		Acceptable
		Winter	16	-11%	Walking	24		Acceptable
		Annual	16		Walking	23		Acceptable
70	A	Spring	18		Walking	24		Acceptable
		Summer	14		Standing	19		Acceptable
		Fall	16		Walking	22		Acceptable
		Winter	17		Walking	23		Acceptable
		Annual	16		Walking	22		Acceptable
	B	Spring	16	-11%	Walking	22		Acceptable
		Summer	12	-14%	Sitting	17	-11%	Acceptable
		Fall	14	-12%	Standing	21		Acceptable
		Winter	15	-12%	Standing	22		Acceptable
		Annual	14	-12%	Standing	21		Acceptable
	C	Spring	16	-11%	Walking	22		Acceptable
		Summer	12	-14%	Sitting	18		Acceptable
		Fall	14	-12%	Standing	21		Acceptable
		Winter	15	-12%	Standing	22		Acceptable
		Annual	15		Standing	21		Acceptable
71	A	Spring	19		Walking	25		Acceptable
		Summer	16		Walking	21		Acceptable
		Fall	17		Walking	23		Acceptable
		Winter	18		Walking	24		Acceptable
		Annual	17		Walking	23		Acceptable
	B	Spring	16	-16%	Walking	23		Acceptable
		Summer	13	-19%	Standing	18	-14%	Acceptable
		Fall	15	-12%	Standing	21		Acceptable
		Winter	16	-11%	Walking	22		Acceptable
		Annual	15	-12%	Standing	21		Acceptable
	C	Spring	16	-16%	Walking	23		Acceptable
		Summer	13	-19%	Standing	19		Acceptable
		Fall	15	-12%	Standing	21		Acceptable
		Winter	16	-11%	Walking	22		Acceptable
		Annual	15	-12%	Standing	21		Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
72	A	Spring	16		Walking	22		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	15		Standing	21		Acceptable
		Winter	16		Walking	22		Acceptable
		Annual	15		Standing	21		Acceptable
	B	Spring	15		Standing	21		Acceptable
		Summer	12		Sitting	17		Acceptable
		Fall	14		Standing	20		Acceptable
		Winter	15		Standing	21		Acceptable
		Annual	14		Standing	20		Acceptable
	C	Spring	15		Standing	21		Acceptable
		Summer	12		Sitting	17		Acceptable
		Fall	14		Standing	20		Acceptable
		Winter	15		Standing	21		Acceptable
		Annual	14		Standing	20		Acceptable
73	A	Spring	16		Walking	23		Acceptable
		Summer	12		Sitting	18		Acceptable
		Fall	15		Standing	22		Acceptable
		Winter	16		Walking	24		Acceptable
		Annual	15		Standing	22		Acceptable
	B	Spring	16		Walking	23		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	16		Walking	22		Acceptable
		Winter	17		Walking	25		Acceptable
		Annual	16		Walking	23		Acceptable
	C	Spring	16		Walking	23		Acceptable
		Summer	13		Standing	18		Acceptable
		Fall	16		Walking	22		Acceptable
		Winter	17		Walking	25		Acceptable
		Annual	16		Walking	23		Acceptable
74	A	Spring	17		Walking	26		Acceptable
		Summer	16		Walking	24		Acceptable
		Fall	17		Walking	26		Acceptable
		Winter	18		Walking	28		Acceptable
		Annual	17		Walking	26		Acceptable
	B	Spring	14	-18%	Standing	23	-12%	Acceptable
		Summer	13	-19%	Standing	21	-12%	Acceptable
		Fall	14	-18%	Standing	22	-15%	Acceptable
		Winter	15	-17%	Standing	24	-14%	Acceptable
		Annual	14	-18%	Standing	22	-15%	Acceptable
	C	Spring	13	-24%	Standing	20	-23%	Acceptable
		Summer	12	-25%	Sitting	19	-21%	Acceptable
		Fall	13	-24%	Standing	20	-23%	Acceptable
		Winter	13	-28%	Standing	21	-25%	Acceptable
		Annual	13	-24%	Standing	20	-23%	Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
75	A	Spring	12		Sitting	19		Acceptable
		Summer	12		Sitting	17		Acceptable
		Fall	12		Sitting	18		Acceptable
		Winter	13		Standing	20		Acceptable
		Annual	12		Sitting	19		Acceptable
	B	Spring	11		Sitting	17	-11%	Acceptable
		Summer	9	-25%	Sitting	15	-12%	Acceptable
		Fall	10	-17%	Sitting	16	-11%	Acceptable
		Winter	11	-15%	Sitting	18		Acceptable
		Annual	10	-17%	Sitting	17	-11%	Acceptable
	C	Spring	12		Sitting	19		Acceptable
		Summer	10	-17%	Sitting	16		Acceptable
		Fall	11		Sitting	18		Acceptable
		Winter	12		Sitting	19		Acceptable
		Annual	12		Sitting	18		Acceptable
76	A	Spring	18		Walking	27		Acceptable
		Summer	14		Standing	21		Acceptable
		Fall	17		Walking	25		Acceptable
		Winter	18		Walking	27		Acceptable
		Annual	17		Walking	25		Acceptable
	B	Spring	18		Walking	27		Acceptable
		Summer	14		Standing	21		Acceptable
		Fall	17		Walking	25		Acceptable
		Winter	18		Walking	26		Acceptable
		Annual	17		Walking	25		Acceptable
	C	Spring	18		Walking	26		Acceptable
		Summer	14		Standing	20		Acceptable
		Fall	17		Walking	25		Acceptable
		Winter	18		Walking	26		Acceptable
		Annual	17		Walking	25		Acceptable
77	A	Spring	21		Uncomfortable	30		Acceptable
		Summer	17		Walking	23		Acceptable
		Fall	20		Uncomfortable	28		Acceptable
		Winter	21		Uncomfortable	30		Acceptable
		Annual	20		Uncomfortable	28		Acceptable
	B	Spring	19		Walking	28		Acceptable
		Summer	15	-12%	Standing	22		Acceptable
		Fall	18		Walking	26		Acceptable
		Winter	19		Walking	28		Acceptable
		Annual	18		Walking	26		Acceptable
	C	Spring	17	-19%	Walking	26	-13%	Acceptable
		Summer	14	-18%	Standing	20	-13%	Acceptable
		Fall	16	-20%	Walking	24	-14%	Acceptable
		Winter	17	-19%	Walking	26	-13%	Acceptable
		Annual	16	-20%	Walking	25	-11%	Acceptable

BRA Criteria			Mean Wind Speed			Effective Gust Wind Speed		
Loc.	Config.	Season	Speed (mph)	%Change	RATING	Speed (mph)	%Change	RATING
78	A	Spring	14		Standing	21		Acceptable
		Summer	11		Sitting	17		Acceptable
		Fall	13		Standing	20		Acceptable
		Winter	14		Standing	22		Acceptable
		Annual	13		Standing	20		Acceptable
	B	Spring	15		Standing	22		Acceptable
		Summer	12		Sitting	18		Acceptable
		Fall	14		Standing	21		Acceptable
		Winter	15		Standing	22		Acceptable
		Annual	14		Standing	21		Acceptable
	C	Spring	15		Standing	22		Acceptable
		Summer	12		Sitting	18		Acceptable
		Fall	14		Standing	22		Acceptable
		Winter	15		Standing	23		Acceptable
		Annual	14		Standing	22		Acceptable
79	A	Spring	16		Walking	24		Acceptable
		Summer	14		Standing	19		Acceptable
		Fall	15		Standing	22		Acceptable
		Winter	16		Walking	24		Acceptable
		Annual	15		Standing	22		Acceptable
	B	Spring	16		Walking	23		Acceptable
		Summer	14		Standing	20		Acceptable
		Fall	16		Walking	22		Acceptable
		Winter	17		Walking	23		Acceptable
		Annual	16		Walking	22		Acceptable
	C	Spring	17		Walking	24		Acceptable
		Summer	15		Standing	20		Acceptable
		Fall	16		Walking	22		Acceptable
		Winter	17		Walking	24		Acceptable
		Annual	16		Walking	23		Acceptable
80	A	Spring	12		Sitting	18		Acceptable
		Summer	10		Sitting	15		Acceptable
		Fall	12		Sitting	17		Acceptable
		Winter	13		Standing	18		Acceptable
		Annual	12		Sitting	17		Acceptable
	B	Spring	12		Sitting	17		Acceptable
		Summer	10		Sitting	14		Acceptable
		Fall	11		Sitting	16		Acceptable
		Winter	12		Sitting	18		Acceptable
		Annual	11		Sitting	17		Acceptable
	C	Spring	13		Standing	19		Acceptable
		Summer	11		Sitting	16		Acceptable
		Fall	13		Standing	18		Acceptable
		Winter	13		Standing	20	11%	Acceptable
		Annual	13		Standing	18		Acceptable

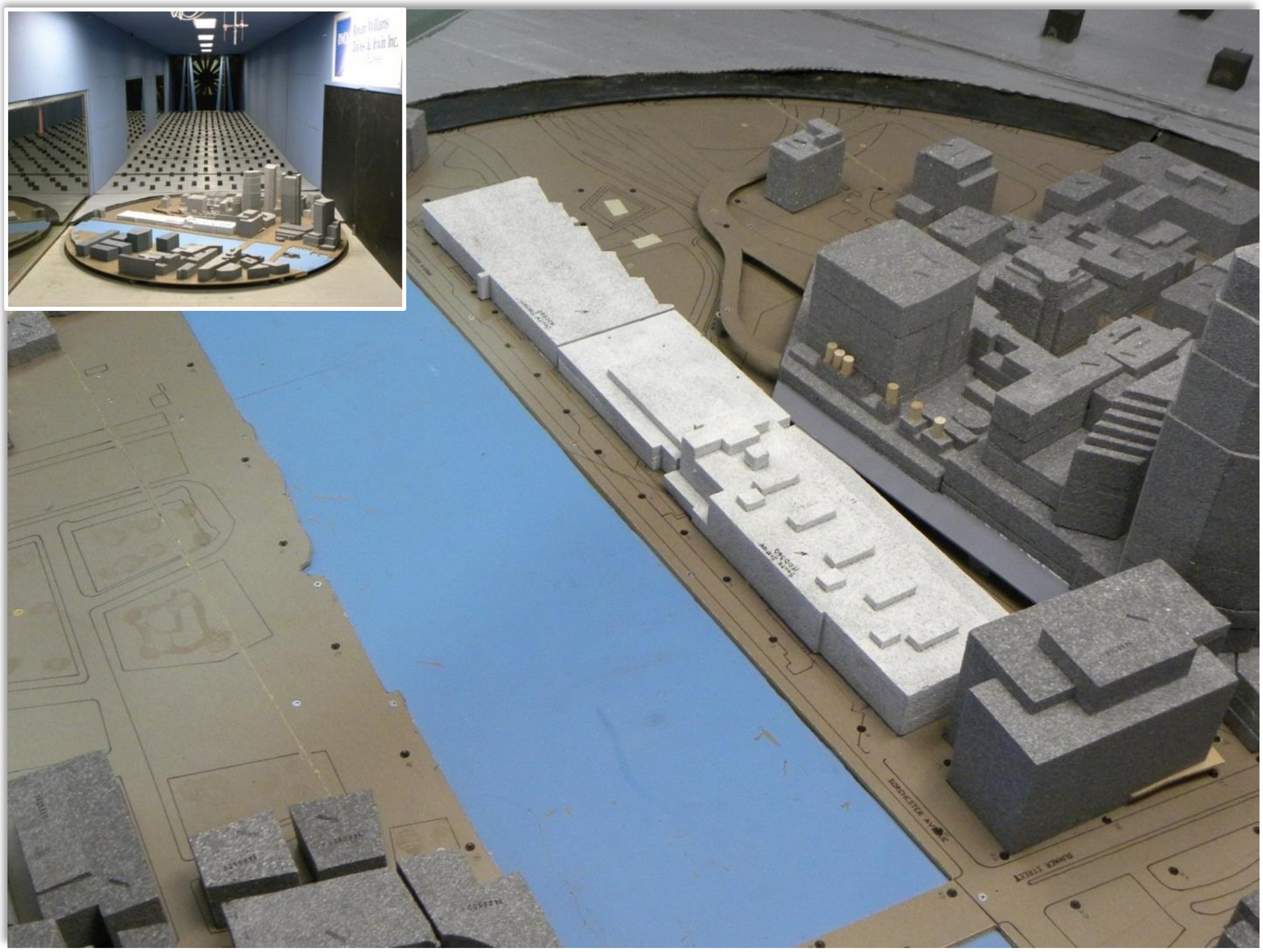


Figure 2—Wind Tunnel Study Model - No Build

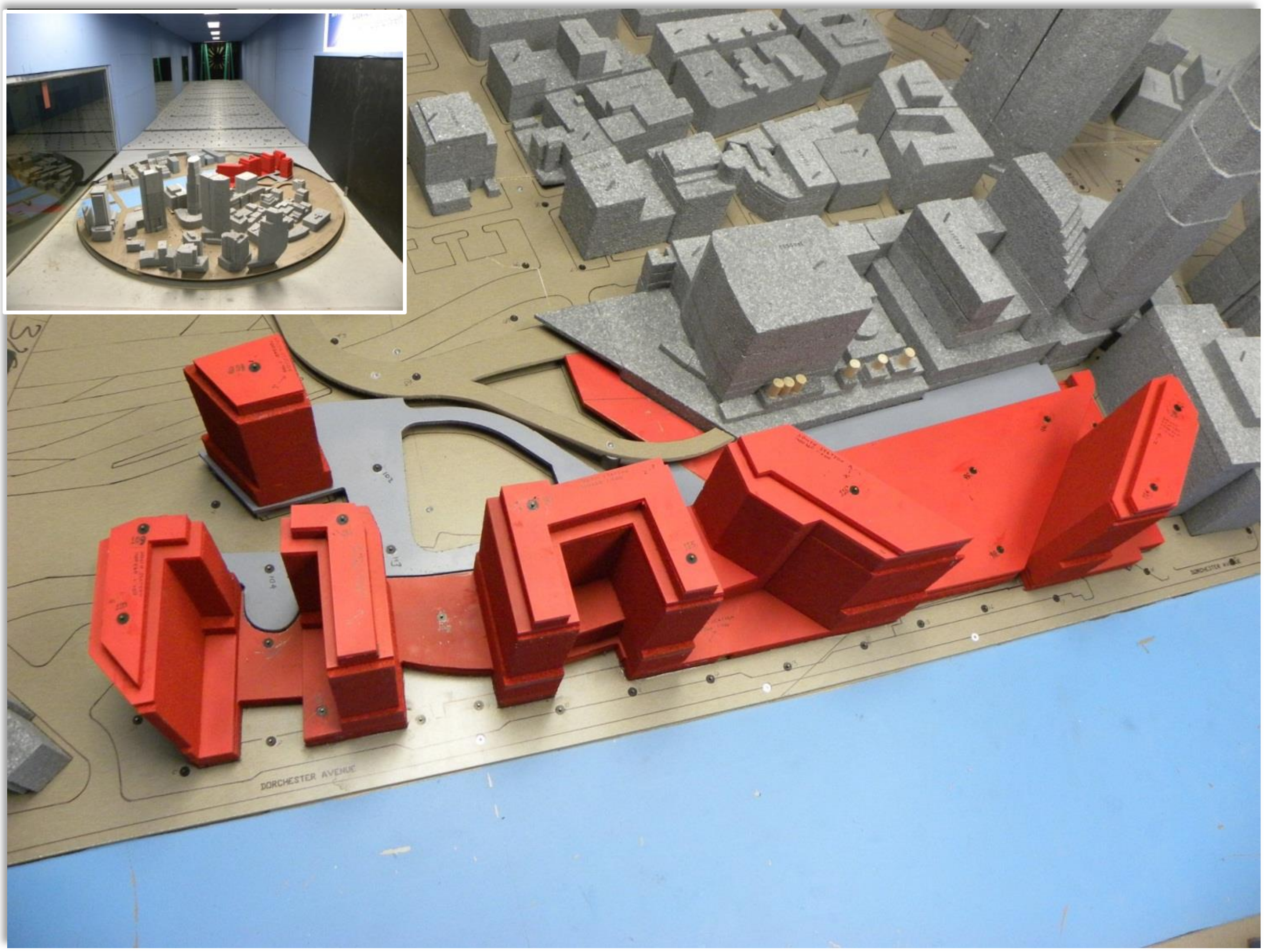


Figure 3—Wind Tunnel Study Model –Alternative 3 - Joint/Private Development Maximum Build

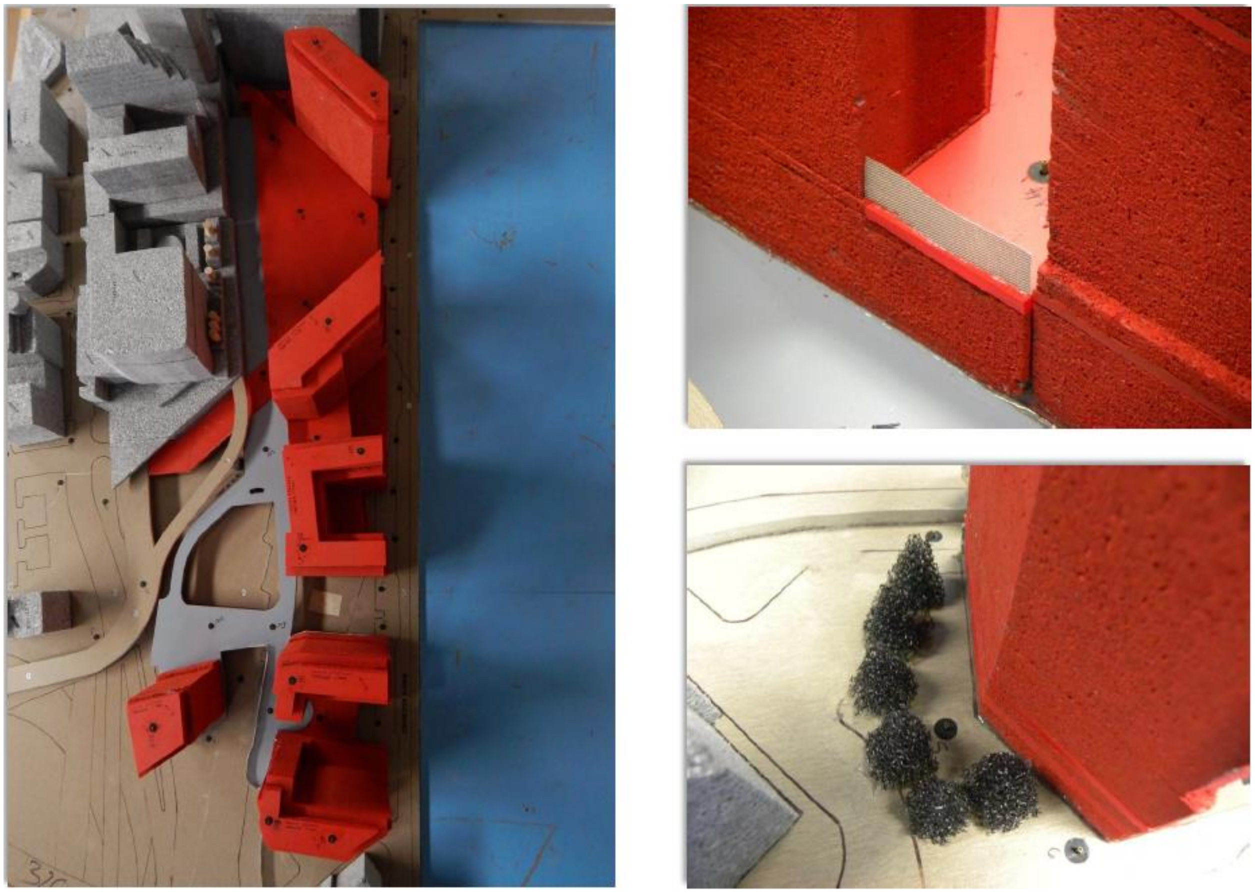
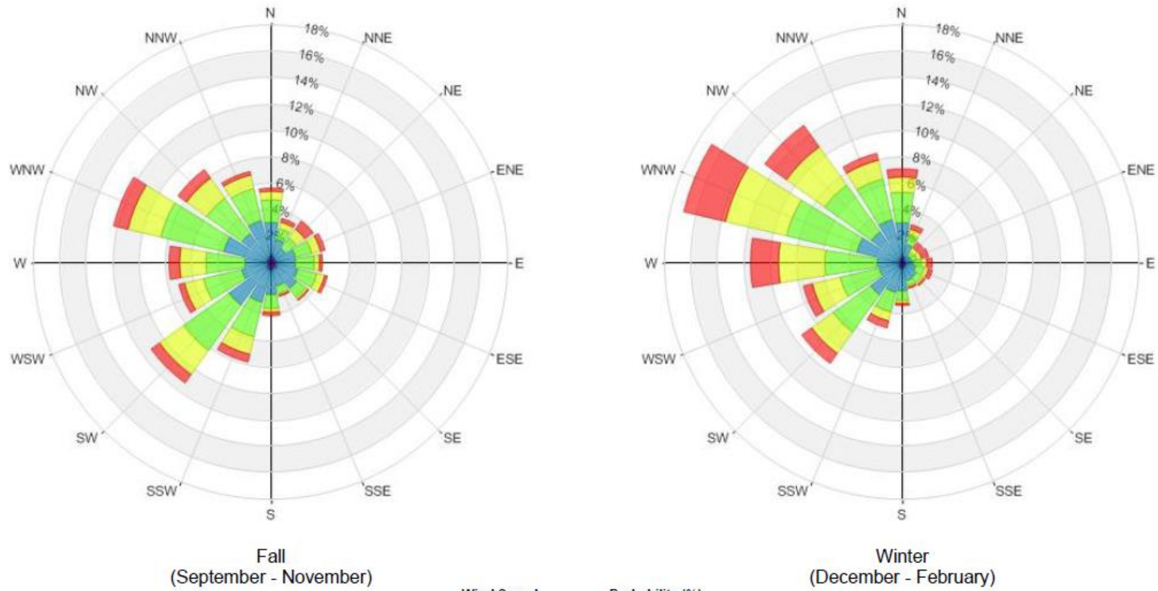


Figure 4—Wind Tunnel Study Model –Alternative 3 - Joint/Private Development Maximum Build with Mitigation

Wind Speed (mph)	Probability (%) Spring	Summer
Calm	2.0	2.1
1-5	5.5	7.4
6-10	27.5	36.6
11-15	33.5	36.4
16-20	20.7	14.6
>20	10.8	3.0

Figure 5—Directional Distribution (%) of Winds (Blowing From) Spring Summer Boston Logan International Airport (1983 - 2013)



Wind Speed (mph)	Probability (%) Fall	Probability (%) Winter
Calm	2.3	1.8
1-5	6.9	5.3
6-10	32.7	26.1
11-15	33.9	31.8
16-20	16.8	21.8
>20	7.3	13.2

Figure 6—Directional Distribution (%) of Winds (Blowing From) Fall-Winter Boston Logan International Airport (1983 - 2013)

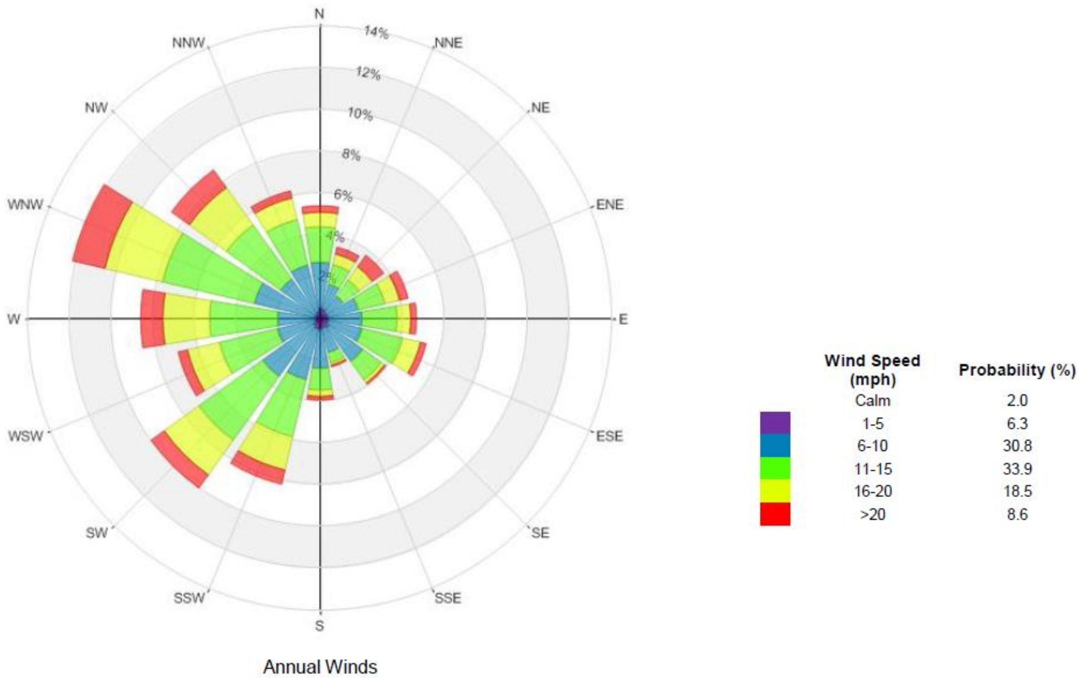


Figure 7—Directional Distribution (%) of Winds (Blowing From) Annual Winds Boston Logan International Airport (1983 - 2013)

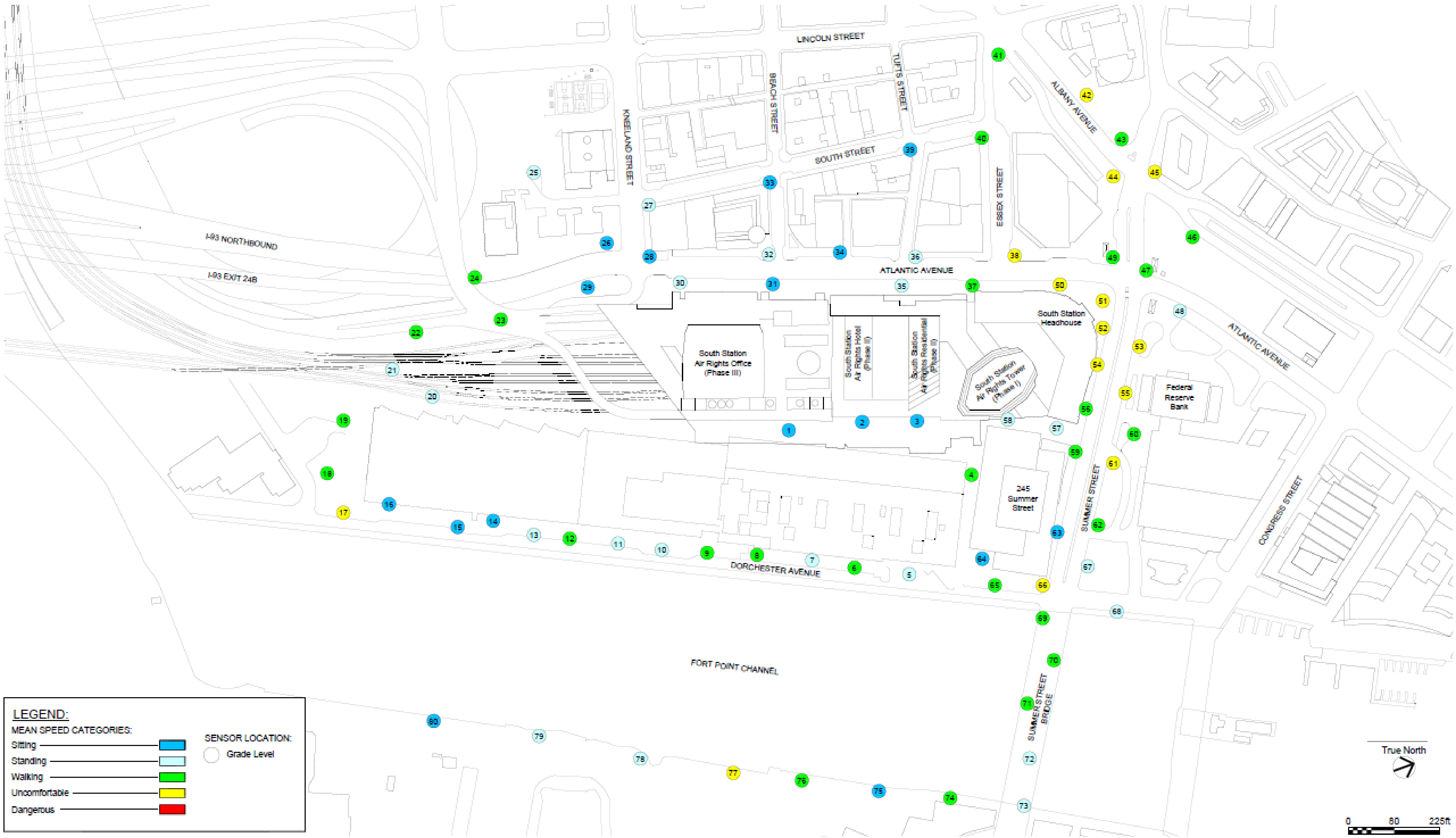


Figure 8—Pedestrian Wind Conditions - Mean Speed - No Build Alternative Annual (January to December, 0:00 to 23:00)

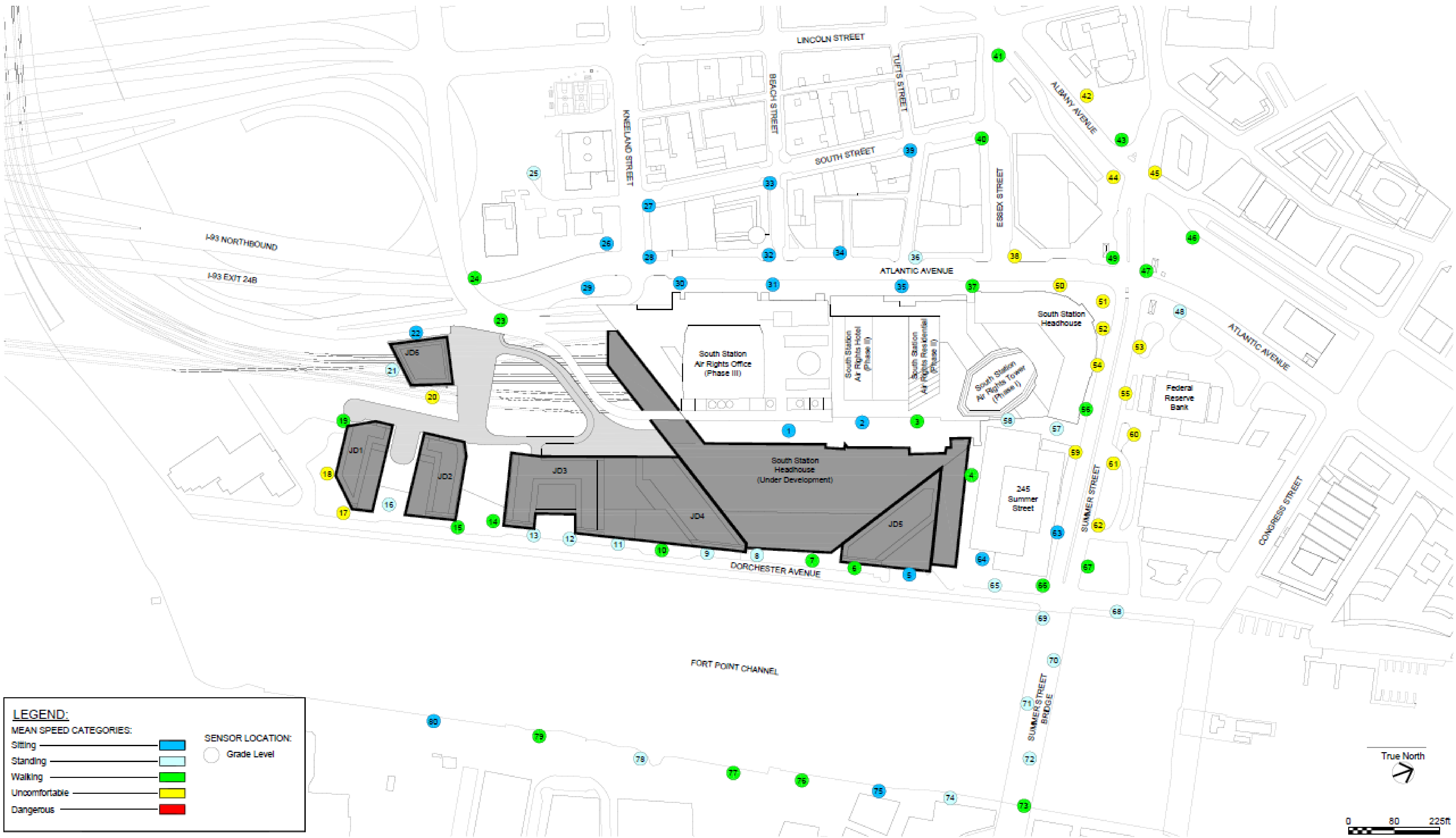


Figure 9—Pedestrian Wind Conditions - Mean Speed - Alternative 3- Joint/Private Development Maximum Build Annual (January to December, 0:00 to 23:00

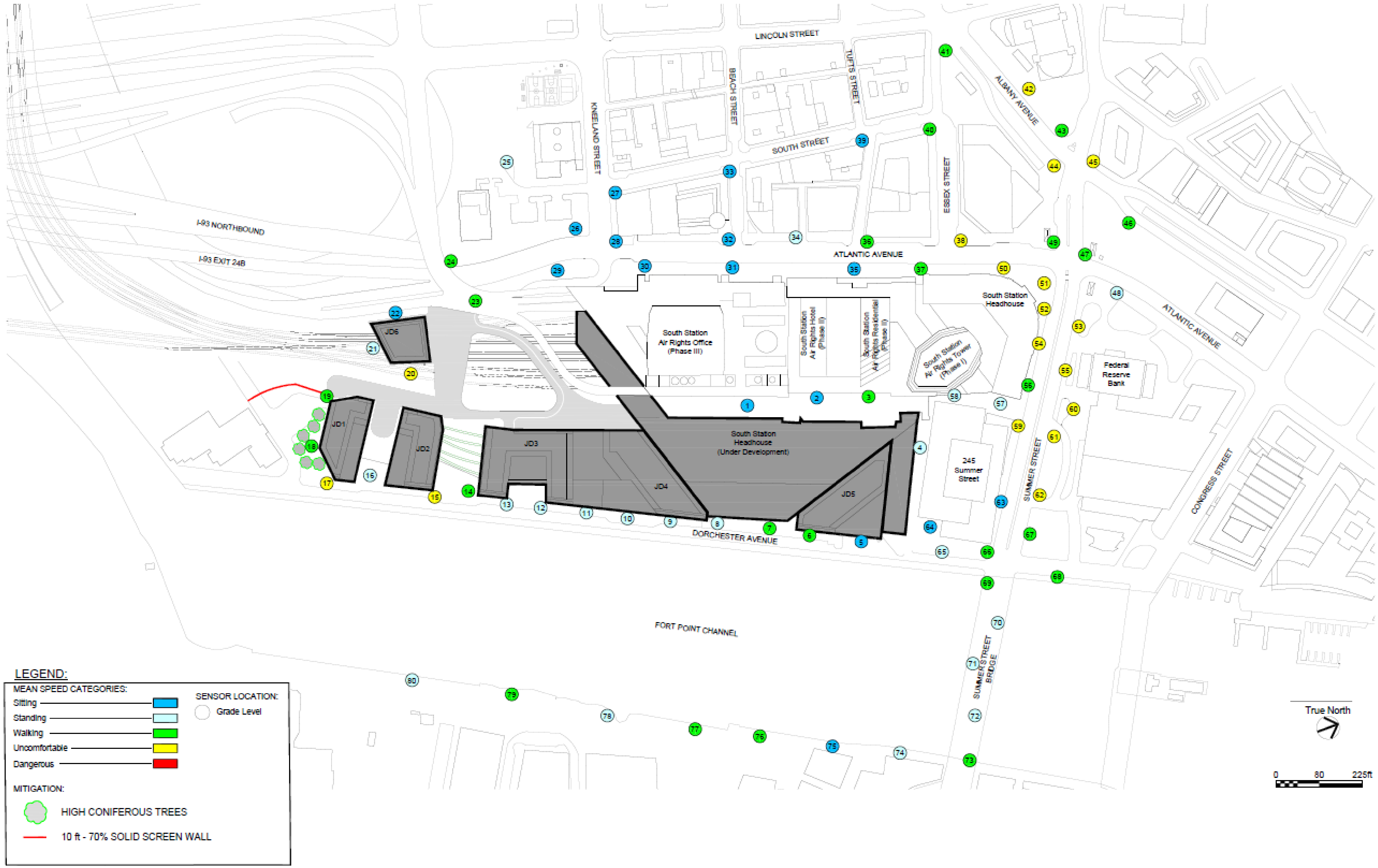


Figure 10—Pedestrian Wind Conditions - Mean Speed - Alternative 3- Joint/Private Development Maximum Build with Mitigation Annual (January to December, 0:00 to 23:00)

Figure 11—Pedestrian Wind Conditions - Effective Gust - No Build Annual (January to December, 0:00 to 23:00)

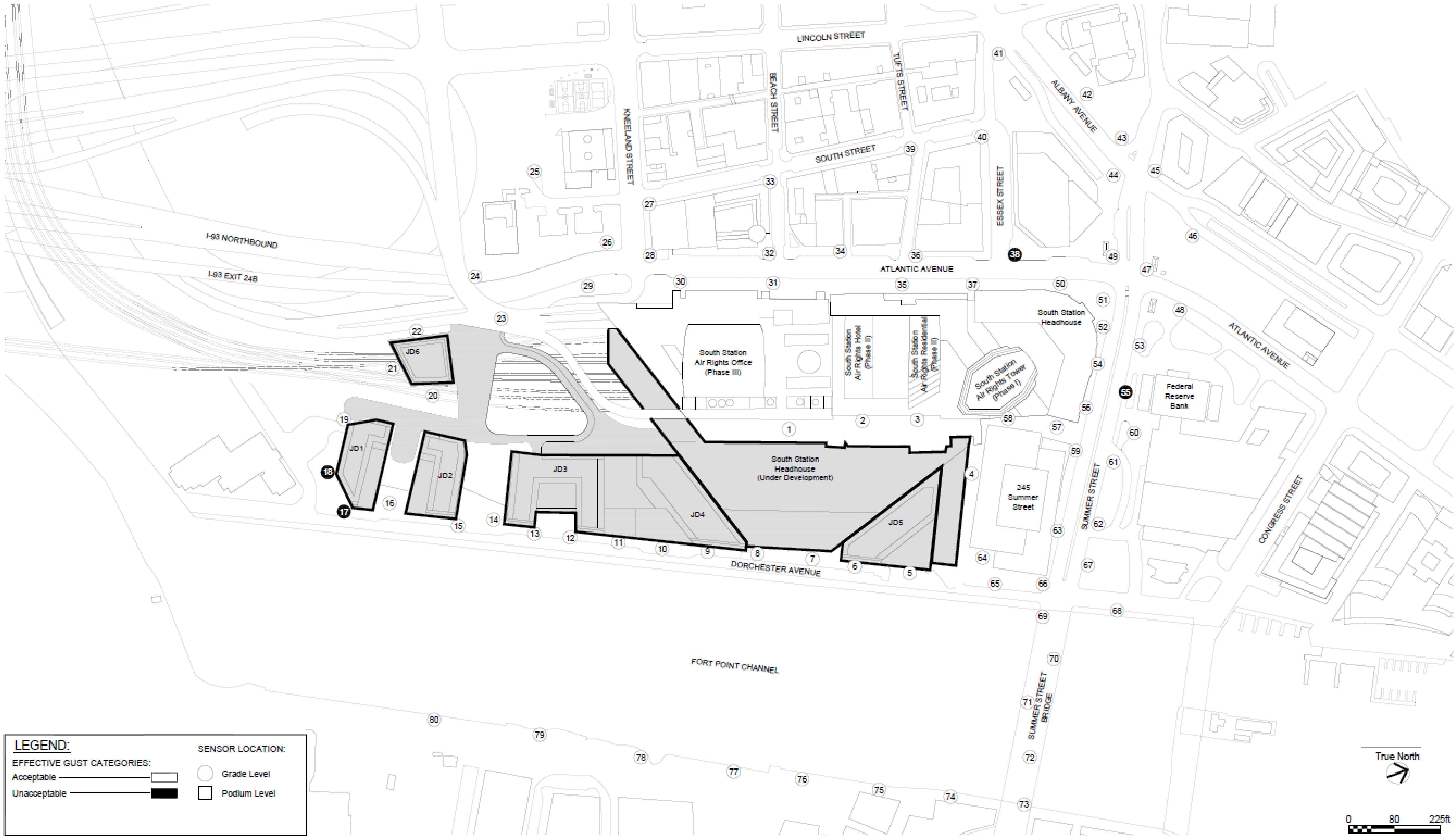


Figure 12—Pedestrian Wind Conditions - Effective Gust - JD Maximum Build Annual (January to December, 0:00 to 23:00)

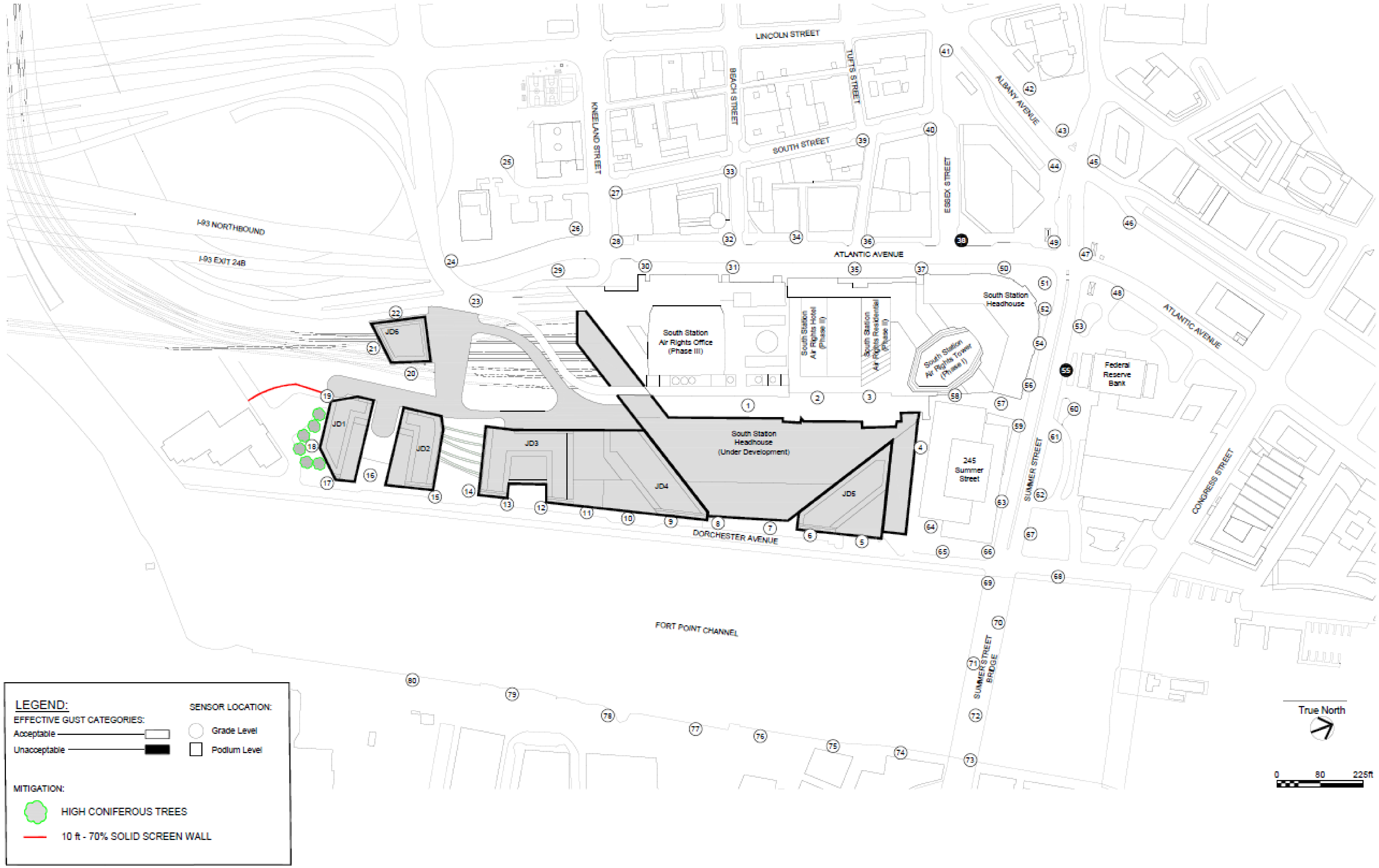


Figure 13—Pedestrian Wind Conditions - Effective Gust - JD Maximum Build with Mitigation Annual (January to December, 0:00 to 23:00)

Attachment E CTPS Travel Demand Model Methodology

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METHODOLOGY AND ASSUMPTIONS OF CENTRAL TRANSPORTATION PLANNING STAFF REGIONAL TRAVEL DEMAND MODELING

South Station Expansion Project

Central Transportation Planning Staff

State Transportation Building
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May 13, 2014

INTRODUCTION

The regional travel forecasting model set of the Central Transportation Planning Staff (CTPS) is based on procedures that have evolved over many years at CTPS. It follows the traditional four-step travel-modeling process of trip generation, trip distribution, mode choice, and trip assignment. This modeling process is employed to estimate present and future daily transit ridership and daily highway traffic volumes, primarily on the basis of demography and the characteristics of the transportation network. The model set simulates travel on the entire eastern Massachusetts transit and highway systems. When the model set is estimating future travel, the inputs include forecasts of demography and projections of transit and highway improvements.

This document provides an overview of the well-calibrated model set developed for the South Station Expansion Analysis, including some notable model features, structures, and inputs. There is a description of the calibration to current study area conditions, as well as of the future scenarios tested for the project. The appendix contains more detailed information and calibration data for each model component.

OVERVIEW OF THE MODEL'S FOUR STEPS

In the first step, trip generation, the number of trips generated by residents of the CTPS Modeling Area (the 101 cities and towns that make up the Boston Region Metropolitan Planning Organization [MPO] area, together with 63 communities outside of the MPO area, that are shown in Figure 1) is calculated using socioeconomic data and trip rates. Similarly, the number of trips attracted to different types of land use, such as employment centers, schools, hospitals, shopping centers, etc., is estimated using land use data and trip rates obtained from past household travel surveys. These aforementioned trip rates are categorized by the type of trip being made. The model contains eight distinct trip purposes: home-based work (HBW); home-based work-related (HBWR); home-based personal business (HBPB); home-based social-recreational (HBSR); home-based school (HBSC); home-based pick-up/drop-off (HBPD); non-home-based work (NHBW); and non-home-based-other (NHBO). Trip information is produced at the level of disaggregated geographic areas known as transportation analysis zones (TAZs) for each of these purposes.

In the second step, trip distribution, the model determines how the trips generated in each TAZ are distributed throughout the region. Trips are distributed based on transit and highway travel times, distances, and costs between TAZs. The relative "attractiveness" of each TAZ for activity, influenced by the number of trips generated by a TAZ, also factors into this process.

Once the number of trips of each purpose between each pair of TAZs is determined, the mode choice step of the model (step three) allocates the trips among the available modes of travel. The available modes of travel are walk/bike, auto (single-occupancy vehicle [SOV] and carpool [HOV]), and transit (subdivided by access mode: walking to transit or driving to transit). To determine the proportion of trips to allocate to each mode, the model takes into account the travel times and distances, parking availability, costs associated with each option, and potential number of transit transfers required. Other variables, such as auto ownership and household size, are also included in the model.

After estimating the number of trips by mode for each purpose for all possible TAZ combinations, the model assigns trips to their respective specific routes in trip assignment (the fourth and final step). Typically, there is often more than one highway route or transit path between a pair of TAZs.

NOTABLE FEATURES OF THE MODEL

The model developed for the South Station Expansion project uses the best component routines, networks, and input data available to CTPS at this time. It incorporates both motorized and non-motorized trips. Transit and highway travel are simulated during four time periods of a typical weekday. The model base year (2009/2010) was calibrated to adequately represent the project base year conditions (Spring 2012). The “Model Year Representation” memorandum of March 17, 2014, contains further discussion of this base year calibration issue. The project forecast horizon year is 2035.

FIGURE 1
CTPS Modeled Area – Spring 2012

MODEL INPUTS

Modeled Area

The modeled area is divided into 2,727 internal TAZs. There are 124 external stations around the periphery of the modeled area that allow for travel between the modeled area and adjacent areas of Massachusetts, New Hampshire, and Rhode Island.

Transportation Networks

The model performs its analysis on one integrated transportation network representing the Eastern Massachusetts travel network. This network includes two component networks with different attributes: transit and highway. The highway network component comprises express highways, principal and minor arterials, and local roadways. The transit network component comprises commuter rail lines, rapid transit lines, bus lines (MBTA and private carriers), and boat lines. This component contains service frequency (i.e., how often trains and buses run), routing, travel time, and fares for all lines.

- *Highway Network Component*: The regional highway network contains in excess of 40,000 links and 15,000 nodes. It is fairly dense in the study area, although like any modeled network, it does not include some local and collector streets; it does however, include HOV-only links, truck-only links, and vehicle-restricted links. Each link is coded with the appropriate free-flow speed, length, number of lanes, and lane capacity. Functional class is coded, as are various geographic flags useful for summarizing emissions.
- *Transit Network Component*: The transit network represents all regional transit agency services in eastern Massachusetts, as well as private express buses and ferries. Most-likely travel paths are built through the network; accompanying impedances for each path are calculated from associated travel times and distances, costs, and potential number of transfers. These paths and impedances are input to the trip distribution and mode choice models. After mode choice, transit trip tables by time of day are assigned to the network travel paths. For the South Station Expansion analysis, a detailed transfer link network was added to accurately represent the many options and paths that patrons have at South Station.

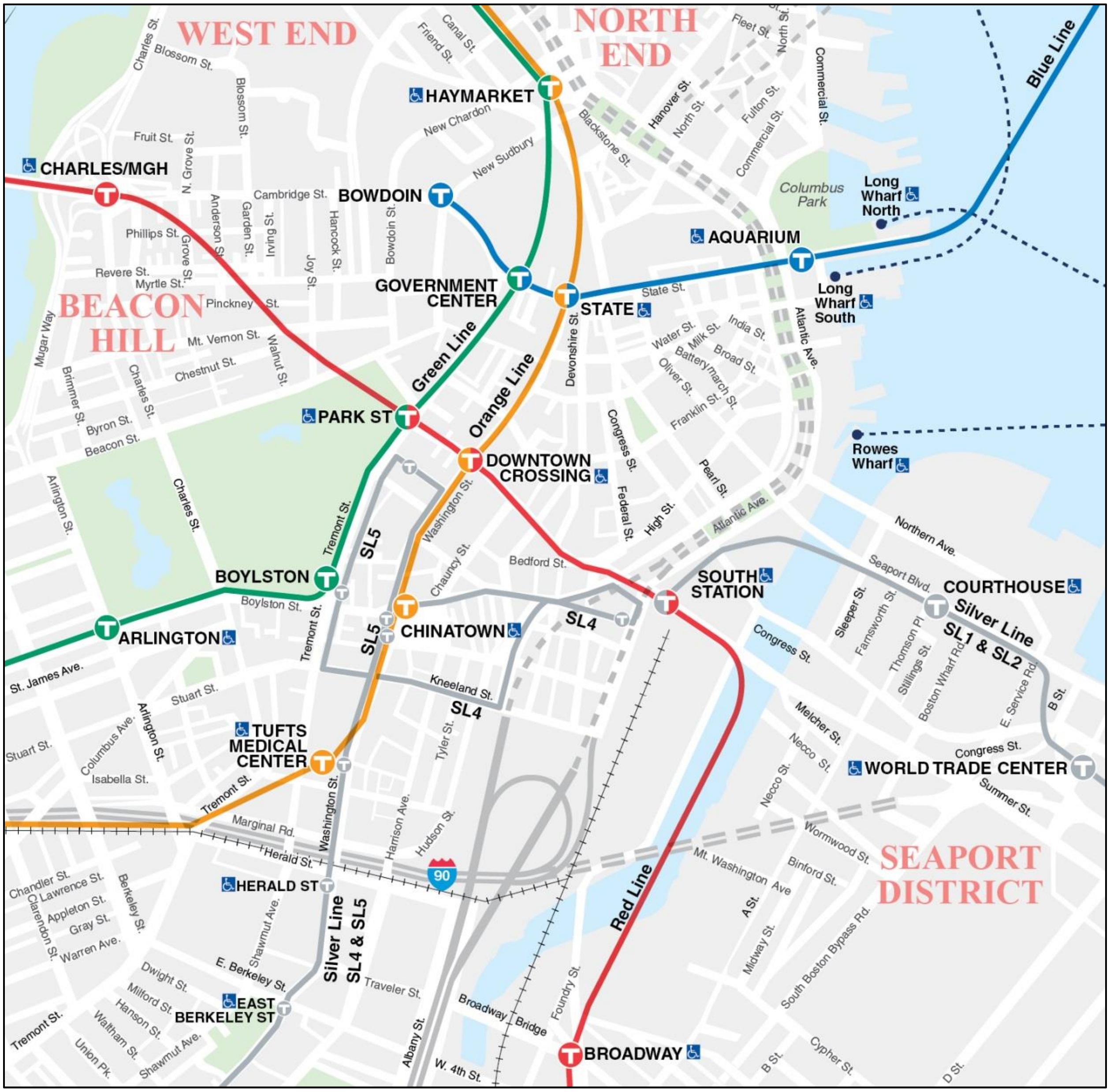
Major Data Inputs

Several major data sources underlie CTPS's travel model. Some of these were collected independently of and predate the South Station Expansion project, while others were gathered specifically for the purpose of best understanding current conditions at South Station. Particular attention was paid to the study area, shown in Figure 2, so as to be able to best represent the existing situation in the model.

Study Area Data

- *South Station Pedestrian and Passengers Counts*: A series of pedestrian and passenger counts were conducted at South Station during November, December 2012 and January 2013. This compilation included the tabulation of boardings and alightings for rapid transit, commuter rail, Amtrak, and intercity bus lines; pedestrian movements within the South Station terminal; entry to/egress from the terminal; and transfers between transit services. This enabled the calculation of a composite weekday of traveler activity in and around South Station, including the creation of a transfer matrix. For more details, please see the "South Station Counts" memorandum of January 30, 2013.
- *MBTA Rapid Transit Counts at Downtown Stations:* Automatic Fare Collection data from 2012 were used to compute and impute rapid transit boardings, alightings, and transfers at selected study area rapid transit stations.
- *Roadway Counts:* The study team collected vehicle counts on the study area roadways in September and December of 2012. Turning movements were also collected at the same time at intersections in the vicinity of South Station.
- *Development Survey*: Employment and population data for the TAZ containing South Station as well as for nearby TAZs, provided by MAPC (as described below), were carefully scrutinized to ensure that they incorporated the most up-to-date housing and job information for the study area.

FIGURE 2
South Station Expansion Study Area



General Data

- *Commuter Rail Passenger Counts:* Passenger counts were conducted on all MBTA commuter rail lines in Spring 2012.
- *MBTA Rapid Transit, Bus, and Ferry Passenger Counts:* Automatic Fare Collection data from 2012 were used to compute rapid transit ridership on the MBTA system. Additional historical passenger counts on buses and boats were used to calculate their ridership on a line basis.
- *Traffic Volumes:* Data collected by MassDOT and other agencies between 2005 and 2012 were used for highway calibration.
- *On Board Transit Passenger Survey:* CTPS surveyed passengers on all MBTA transit modes in an effort spanning the years 2008-2010. Data from this survey, specifically for transit service in the study area, were used to validate components of trip distribution and mode choice for the model.
- *2000 U.S. Census*: Various census files were used in model estimation and calibration processes. In particular, Census Journey to Work information was incorporated into the model at several stages of model development. Aggregate population estimates for the year 2009 were used to update this data for this study.
- *Site-Level Employment Database*: Employment estimates for 2000 were taken from a single, unified regional employment database based on employment data from the Department of Employment and Training and on extensive research by CTPS. Aggregate employment data for the year 2009 were used to update this database for use for the base year analysis in the regional model version used for this study.
- *Household Travel Survey*: In 1991, CTPS conducted a household travel survey. The survey took the form of an activity-based travel diary that was filled out for one weekday. Approximately 4,000 households, generating some 39,000 weekday trips, were represented in the final database. The data were used to estimate new models for trip generation, auto ownership, trip distribution, and mode choice.
- *External Cordon Survey*: Also in 1991, a survey of automobile travelers bound for the modeled area from adjacent areas was performed. Survey results were used in trip generation and distribution to update estimates of external trips.

Population, Household, and Employment Forecasts

Households and employment by type are major inputs to the travel model process: they are the variables upon which trip generation is performed. The forecasts for the region were developed by combining household and employment forecasts produced independently by the seven regional planning agencies (RPAs) in eastern Massachusetts: the Central Massachusetts Regional Planning Commission (CMRPC), Merrimack Valley Planning Commission (MVPC), Metropolitan Area Planning Council (MAPC), Montachusett Regional Planning Commission (MRPC), Northern Middlesex Council of Governments (NMCOG), Old Colony Planning Council (OCPC), and Southeastern Regional Planning and Economic Development District (SRPEDD). Future year (2035) demographic forecasts for the 101 cities and towns that make up the MAPC area (also the Boston Region MPO area) were developed by MAPC based on a scenario it has developed, known as the MetroFuture scenario, in which growth was targeted to communities' denser areas, with a focus on development around transit stations.

Employment base year estimates were developed in a different fashion than population and household estimates. CTPS examined the annual employment estimates produced by the state's Division of Employment and Training (DET). Differences in employment between 2000 and April 2008 were calculated at the town level for the region. These differences were then applied to the Boston Region MPO's year 2000 town level data and then distributed among each town's TAZ system according to the year 2000 employment distribution. The realm of "basic" employment was refined according to the extensive up-to-date manufacturing employment database maintained by CTPS. Thus, these sources were utilized to best reflect the reality of employment throughout the model area's geography in 2009. The usage of 2009 socio-economic data does not in any way compromise the accurate representation of a 2012 model base year. A further explanation of this issue can be found in the "Model Year Representation" memorandum of March 17, 2014.

Forecasts for the 63 communities in the model belonging to RPAs other than MAPC were developed in a slightly different fashion. Each RPA independently maintains its own travel demand model, TAZ system, base year estimates, and future-year forecasts. However, the Boston Region MPO's year 2000 data have long been accepted as the best possible and most refined and detailed demographics data set for the year 2000 for eastern Massachusetts, and significant faith has been invested in it.

For population and households, estimates for the 2009 base year were calculated through interpolation of the 2000 estimates and 2010 forecasts. The absolute changes between the 2010 and 2035 forecasts were calculated at each RPA's TAZ level and then, for the 63 communities outside of the Boston Region MPO, converted into the Boston Region MPO's TAZ system by use of a series of correspondence factors between the two sets of TAZs. The growth was then added to the year 2009 TAZ data for the future-year population and household forecasts.

Employment forecasts were developed differently but also pivoted off the Boston Region MPO’s year 2000 data. The base year estimate was calculated in the same fashion as for the 101 communities. However, the absolute changes between the 2010 and 2035 forecasts were then added to these numbers for the 63 communities to produce a new set of 2035 employment forecasts.

This combination of forecasts ensured the accuracy of the Boston Region MPO’s widely accepted demographic data sets while still capturing and respecting much of the growth expressed and projected by the individual RPAs for the other 63 communities.

Time-of-Day Considerations

The mode choice and transit assignment steps of the modeling process are conducted on the basis of time periods. The four time periods modeled are an AM peak period (6:00 AM–9:00 AM), a midday period (9:00 AM–3:00 PM), a PM peak period (3:00 PM–6:00 PM), and a nighttime period (6:00 PM–6:00 AM). The trip generation model, however, is based on daily trips. The trip distribution model considers two time periods: peak (the AM peak and PM peak periods) and non-peak.

The trip volumes produced by the trip generation model are split into peak and off-peak period trips, the trip tables produced by the trip distribution model are split into the four time periods defined above, and the highway vehicle trips and transit person trips created by the mode choice model are converted from production/attraction format to an origin/destination format, based upon factors created from the data collected in the 1991 Household Travel Survey.

The final trip tables created for each time period reflect observed levels of congestion on the highway system. The results of the four assignments are summed to obtain daily (average weekday traffic [AWDT]) results.

CALIBRATION OF THE MODEL

Calibration is the process in which model results or outputs are compared with observed data in order to assess the accuracy of a model. The travel model results were compared with and validated against the aforementioned base year data sources. CTPS established benchmarks for these data sources that we strived to match in the model results, and succeeded in most instances. The benchmarks focused on systemwide and study area transit measures. Special attention was paid to getting the transit services and stations within and close to the study area, even more accurate than these threshold measures.

The benchmarks below are compared against the post-calibrated model results.

The systemwide transit measures consist of:

- Daily unlinked transit trips (+/-10%), achieved +9%
- Daily commuter rail boardings (+/-10%), achieved +5%
- Daily rapid transit boardings (+/-10%), achieved +7%
- AM mode for transit access via walk/bike, (+/-15%), achieved -8%
- AM mode for transit egress via walk/bike, (+/-15%), achieved -7%
- AM mode for transit access via drive, (+/-15%), achieved -5%
- AM mode for transit access via transfers, (+/-15%), achieved +13%
- AM mode for transit egress via transfers, (+/-15%), achieved +13%
- AM transit trip destinations for Boston (+/-10%), achieved –3%
- AM transit trip destinations for Cambridge (+/-10%), achieved +1%
- AM home-based-work transit trips (+/-10), achieved +3%
- AM home-based-other transit trips (+/-10), achieved +4%
- AM home-based-school transit trips (+/-10), achieved 0%

The project specific transit measures consist of:

- Daily South Station transit boardings (all modes) (+/-20%), achieved +5%
- Daily South Station transfers (+/-15%), achieved 0%
- Daily boardings at other downtown rapid transit stations (+/-20%), achieved -21%
- Daily ridership on south side commuter rail lines (+/-10), achieved 0%
- Daily ridership for key MBTA bus routes serving South Station (+/-20%), achieved +19%

TESTED SCENARIOS

Four different alternatives were analyzed for the South Station Expansion project. Three distinct “Build” scenarios, described below, were modeled for the 2035 horizon year, in addition to a No-Build scenario. A development survey, similar to that one conducted for the base year, was performed for the South Station area in the 2035 horizon year to ensure that the proper demographic assumptions were accounted for and all projects properly incorporated in the MetroFuture socio-economic projections.

Transportation Improvements Only (TIO)

In the TIO alternative, South Station would be expanded onto the adjacent 16-acre USPS property. MassDOT would acquire and demolish the USPS General Mail Facility/South Postal Annex; the 1,000 jobs associated with this facility would be relocated to a new USPS facility to be constructed in South Boston. The existing South Station terminal would be expanded with an expanded passenger concourse and passenger support services, including amenities such as retail, food, and beverage outlets. Capacity improvements would include construction of seven new tracks and four platforms for a total of 20 tracks and 11 platforms. Some existing platforms, towers, and approach interlockings would be reconfigured and/or reconstructed. There would be no private development beyond what has already been programmed for the site in the 2035 Regional Long Range Transportation Plan (LRTP).

Dorchester Avenue would be restored for public and station access. Restoration of Dorchester Avenue would reconnect Dorchester Avenue to Summer Street as a public way. It would include landscaping and improved pedestrian and cycling connections and facilities (including adjacent sidewalks and crosswalks). Restoration also would include construction of a long-awaited extension of the Harborwalk along reopened Dorchester Avenue.

The TIO alternative, like the No-Build alternative, also includes all adopted highway and transit projects included in the LRTP. In terms of transit service planning changes incorporated into both TIO and No-Build alternatives, rapid transit fares and improved frequencies are assumed on the MBTA Fairmount Line. In addition, the TIO alternative includes an increase in Amtrak intercity service at South Station, rising from the existing 40 daily combined arriving and departing trains to a total of 80 daily trains. The TIO alternative also assumes South Coast Rail commuter rail service and adds additional peak period, peak direction trains on the Needham, Franklin, Providence, and Worcester/Framingham commuter rail lines.

Joint/Private Development Minimum Build (MIN LU)

This alternative would include everything contained in the TIO scenario, as well as provisions for future private development at the South Station site by incorporating appropriate structural foundations into the overall station and track design. Future private development could include approximately 660,000 square feet (sf) of mixed-use development consisting of residential, office, and commercial uses, including retail and hotel uses, approximately 235 parking spaces, and with building heights ranging up to approximately 12 stories. This analysis assumes this new development will add 1,020 new service jobs, 255 new retail jobs, and 280 new households containing a population of 620 persons.

Joint/Private Development Maximum Build (MAX LU)

This alternative would include everything contained in the MIN LU scenario, but with a greater provision for future private development at the South Station site. The maximum potential for future private development would be limited by the Federal Aviation Administration's (FAA's) maximum building height limits, pursuant to the Terminal Instrument Procedures (TERPS) regulations applicable to Boston Logan International Airport. Accordingly, building heights would be limited to approximately 290 feet and an amendment to the Municipal Harbor Plan, modifying applicable Chapter 91 regulations, would be required. Future private development could include approximately 2.1 million sf of mixed-use development consisting of residential, office, and commercial uses, including retail and hotel uses, approximately 510 parking spaces, and with building heights up to approximately 26 stories. This analysis assumes this new development will add 3,000 new service jobs, 750 new retail jobs, and 830 new households containing a population of 1,830 persons.

POST-MODEL PROCESSES FOR TRANSIT SERVICES

A number of important elements related to the South Station Expansion travel demand forecasting effort are not built into the CTPS travel demand model. These include Amtrak, intercity bus, and components of South Coast Rail service located outside of the Eastern Massachusetts model region. Hence, it was necessary to incorporate ridership related to these elements into the forecasting using post-modeling processes. Ridership produced by the Silver Line Gateway project, which was not present in the future regional model network, was also added via post-model processing.

APPENDIX

THE FOUR STEPS OF THE TRAVEL DEMAND MODELING PROCESS

Figure 1 displays a schematic overview of the travel demand forecasting process. For reference, the modeled area encompasses 164 cities and towns in eastern Massachusetts, which includes the 101 Boston Region MPO cities and towns and 63 additional communities, as shown in Figure 2. The figure also shows the boundaries of five concentric rings into which the modeled area is divided for model estimation and calibration purposes. These rings will be referred to in subsequent discussions.

TRIP GENERATION

The first step in the travel forecasting process is performed by the model set's trip generation model. This model uses socioeconomic characteristics of the region's population and information about the region's transportation infrastructure, transportation services, and geography to predict the amounts of travel that will be produced by and attracted to each of the TAZs within the region.

The trip generation model is composed of seven parts:

- Base year detailed inputs
- Future-year inputs
- Estimation of detailed input requirements for future years
- Estimation of detailed socioeconomic characteristics
- Estimation of vehicle ownership
- Estimation of trip productions and attractions
- Balancing of trip productions and attractions

A description of each of these parts is presented following the two aforementioned figures.

FIGURE 1
The Four-Step Demand Modeling Process

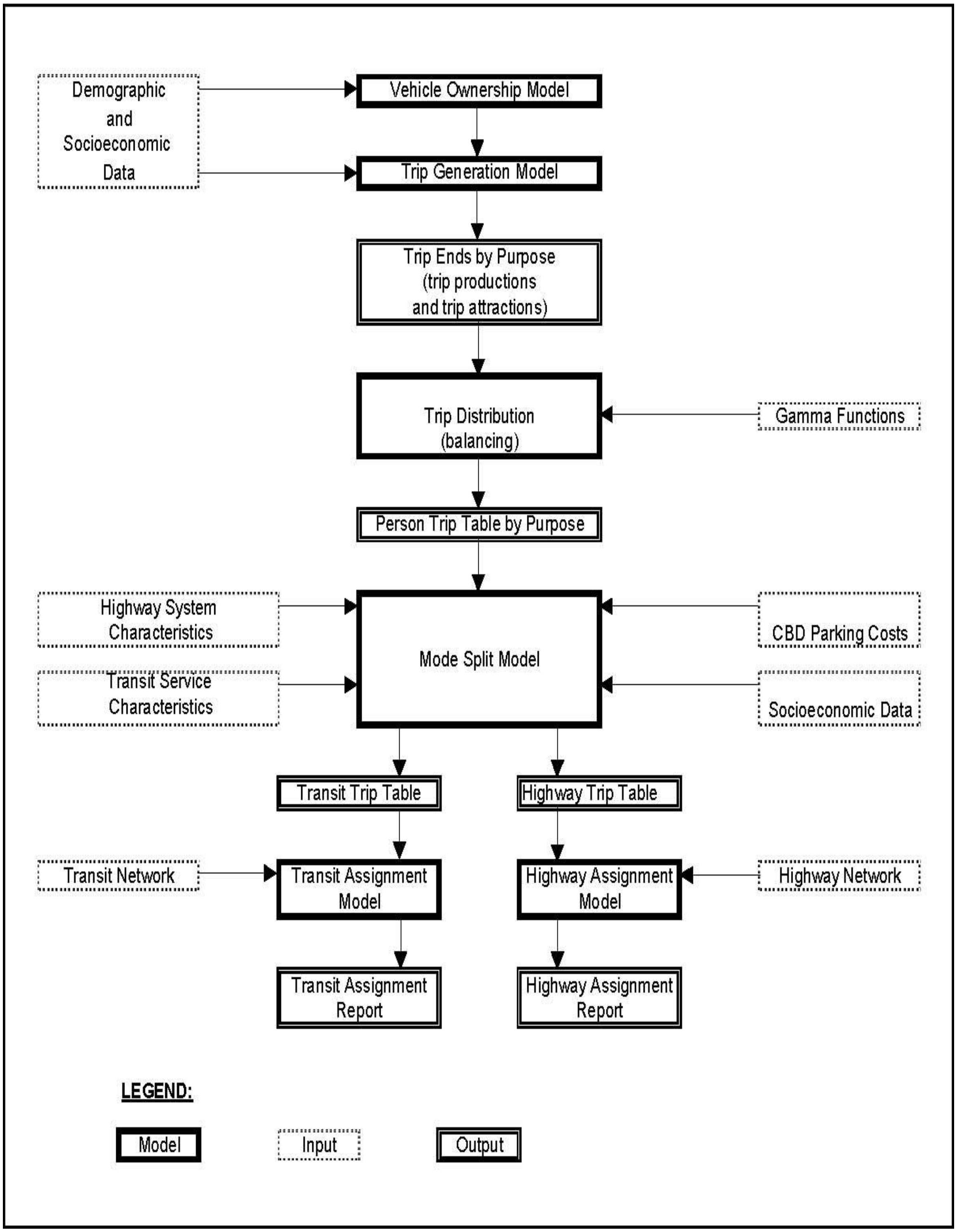


FIGURE 2
CTPS Modeled Area and Ring Boundaries

Base Year Detailed Inputs

The base year inputs required for the trip generation model are presented in Table 1.

Future-Year Inputs

The future-year input requirements for the trip generation model, some of which are the same as for the base year, are:

- Total TAZ households
- Total TAZ population
- Total TAZ group quarters population
- Total community population by age
- TAZ employment in basic industries
- TAZ retail trade employment
- TAZ employment in service industries
- Regional labor participation rates
- External trip production and attraction growth factors
- Transit walk-access factors

Estimation of Detailed Input Requirements for Future Years

Various procedures are used to prepare the trip generation model input data for future years. The variables that are estimated in these procedures are listed below. A description of how future-year estimations for these variables are made follows the list.

- Households by household size
- Households by income quartile
- Resident workers
- Households by workers per household
- School employment (K-12 and college)
- Dorm population
- External person trips
- Attraction and production terminal times

TABLE 1
Trip Generation Model: Base Year Input Requirements

Data	Source	Geographic Level
Population	2009 estimates	TAZ (census block)
Group Quarters Population	2009 estimates	TAZ (census block)
Household Size, Income, Workers, Vehicles	2009 estimates	TAZ (census block)
Population Age	2009 estimates	City or town
Basic, Retail, Service Employment	2009 estimates	TAZ
Public K-12 Employment	2009 estimates	TAZ
Private K-12 Employment	2009 estimates	TAZ
College Employment	2009 estimates	TAZ
Resident Workers	2009 estimates	TAZ (census block group)
Dorm Population	2009 estimates	TAZ (census block)
Labor Participation Rate by Age Group	Bureau of the Census	Region
Land Area	CTPS regional database	TAZ
Geographical Ring	CTPS regional database	TAZ
Public Use Microdata Areas	CTPS regional database	Public Use Microdata Areas
External Trip Productions and Attractions	1991 External Travel Survey, 2000 U.S. Census, and 2009 traffic counts	External station
External Growth Factors	RPA and CTPS forecasts	External station
Transit Walk Access Factor	Transit network	TAZ
External Attraction and Production Terminal Times	1991 External Travel Survey	External station

Household Size

The change in TAZ average household size is implied in the base year inputs and future-year forecasts (total population minus group quarters population divided by total households). The distribution of future-year households by household size is estimated by the following procedure:

First, the future-year households are distributed among the household size categories in the same proportions as in the base year. It is then assumed that all households capable of making the implied change (households of two or more for household size reductions; all households for household size increases) will have the same probability of changing in size by one person. This probability of changing is set equal to the extent needed to match the forecasted change in household size, and the resulting distribution of households by household size is used for the future-year scenario.

As an example, suppose that in the base year the numbers of 1-person, 2-person, 3-person, 4-person, 5-person, and 6+-person households, totally 390 base year households, are, respectively, 100, 200, 50, 25, 10, and 5, with a total household population of 835. This represents an average household size of 2.141. If there were 780 future-year households, they would initially be distributed as 200, 400, 100, 50, 20, and 10 1-person, 2-person, 3-person, 4-person, 5-person, and 6+-person households, respectively.

However, if the future-year average household size were 2.000, then the households with 2 or more persons would have a 19 percent [(2.141 - 2) * 780/580] probability of dropping in size by one. The resulting distribution would thus be estimated as follows:

276 1-person households [200 + (.19 * 400)]

343 2-person households [400 – (.19 * 400) + (.19 * 100)]

90.5 3-person households [100 – (.19 * 100) + (.19 * 50)]

44.3 4-person households [50 – (.19 * 50) + (.19 * 20)]

26.2 5+-person households [20 – (.19 * 20) + 10]

In the case of TAZs with no households in the base year, the proportional distribution of households by household size at the community level is used for the base year in these calculations.

Household Income

The future-year distribution of households by household income quartile is estimated by assuming that the proportional distribution of households by income quartile remains constant within each TAZ. In the case of TAZs with no households in the base year, the proportional distribution of households by household income at the community level is used for the base year.

Resident Workers per Household

The change in the number of resident workers at the community level is obtained by multiplying the base year and future-year estimates of over-age-15 population by labor force participation rates by age cohort. Dividing the base year and future-year estimates of community-level resident workers by the base year and future-year numbers of households in the community, respectively, produces estimates of the base year and future-year average workers per household. All of the TAZs within each community are assumed to have the proportional change in workers per household implied by these base year and future-year community-level estimates. Multiplying the resultant estimate of resident workers per household by the forecasted number of households yields the forecasted number of resident workers by TAZ.

For example, assume that a community's 2000 and 2010 populations are distributed by age as follows: 1,000 and 1,200, 10,000 and 11,000, 2,000 and 2,500, and 500 and 600, respectively, in the 16-24, 25-54, 55-64, and 65+ age ranges. If the applicable labor force participation rates are applied (see Table 2), the estimated numbers of community resident workers become 10,317 and 11,785 for 2000 and 2010, respectively. If the estimated numbers of community households were 5,500 and 6,000 for 2000 and 2010, respectively, the community average workers per household for 2000 and 2010 would be 1.88 and 1.96, respectively. As 1.96 is 4.3% greater than 1.88, all of the TAZs in that community would be assumed to have a 4.3% increase in workers per household between 2000 and 2010.

TABLE 2
Labor Force Participation Rates

Age	2000	2010	2025	2030
16-24	65.9%	63.9%	63.4%	63.4%
25-54	84.1%	84.7%	85.1%	85.0%
55-64	59.2%	64.4%	63.6%	63.7%
65+	12.8%	15.2%	15.6%	14.5%

Household Workers

The future-year number of households per TAZ within each category of number of workers per household is estimated by using workers-per-household distribution curves developed by CTPS from the 1990 U.S. Census. These curves, summarized in Table 3 below, indicate a default percentage distribution of households for the base year and future-year TAZ estimates of average workers per household. The proportional changes in the default number of households within each category of workers per household implied by this comparison are applied to the actual base year TAZ distribution of households to obtain the distribution of households by workers per household to be used for the future scenario. The average number of workers per household at the community level is used for the base year in TAZs with no households in the base year.

For example, if the average number of workers per household changes from 1.7 to 1.8, the default distribution of households among the categories 0-worker, 1-worker, 2-worker, and 3+-worker would change from 7%, 32%, 45%, and 16% to 5%, 29%, 47%, and 19%, respectively. If the actual base year distribution of households among those categories is 8%, 31%, 44%, and 17%, the changes in the default distributions indicate a future-year distribution of households of 6%, 28%, 46%, and 20% 0-worker, 1-worker, 2-worker, and 3+-worker households, respectively.

School Employment

- K-12

  The level of employment in schools providing education up to the 12th grade is assumed to be proportional to the number of community residents of ages 5-19.

- College

  The level of employment at all colleges and technical schools within the region is assumed to be proportional to the number of regional residents of ages 20-24

TABLE 3
Workers per Household Diversion Curves

Avg. Workers per HH	Households by Number of Workers				
	0	**1**	**2**	**3+**	**Total**
<=.45	58%	40%	2%	0%	100%
.45 - .55	52%	46%	2%	0%	100%
.55 - .65	47%	46%	6%	1%	100%
.65 - .75	43%	46%	10%	1%	100%
.75 - .85	38%	46%	13%	3%	100%
.85 - .95	34%	46%	16%	4%	100%
.95 - 1.05	30%	45%	20%	5%	100%
1.05 - 1.65	65% - (35% * Avg)	60% - (16% * Avg)	(36% * Avg) - 15%	(15% * Avg) - 10%	100%
1.65 - 1.75	7%	32%	45%	16%	100%
1.75 - 1.85	5%	29%	47%	19%	100%
1.85 - 1.95	4%	26%	48%	22%	100%
1.95 - 2.05	3%	22%	48%	27%	100%
2.05 - 2.15	2%	18%	49%	31%	100%
2.15 - 2.25	1%	14%	49%	36%	100%
2.25 - 2.35	1%	10%	49%	40%	100%
2.35 - 2.45	1%	4%	50%	45%	100%
2.45 - 2.55	1%	4%	50%	45%	100%
> 2.55	0%	5%	50%	45%	100%

Dorm Population

The dorm population within a TAZ is assumed to be proportional to the total group quarters population within a TAZ.

External Person Trips

Base year external person trips are adjusted to produce traffic volumes at the external stations that match the observed counts for the base year. These base year external person trips are then adjusted according to growth factors for the vehicle volumes at each external station. These growth factors are presently based upon an analysis of historical trends.

Attraction and Production Terminal Times

The attraction and production terminal times (the time it takes to walk between a parked vehicle and the trip origin or destination) are estimated through the application of a model developed at CTPS. This model first estimates terminal times as a function of household density (see Table 4). An alternative estimate of the production and attraction terminal times for each TAZ is based on employment density ranges (see Table 5). For regional modeling, the larger of the two estimates is assigned to a TAZ. Several TAZs with regionally unique characteristics (locations of major generators such as airports or large colleges) were assigned terminal times in the base year different from those estimated by the terminal-time model. In these cases, the model is used to estimate changes in terminal times.

TABLE 4
Household Terminal Time

Household Density (HH per acre)	Production (minutes)	Attraction (minutes)
0 - 5	1	1
5 - 10	2	2
10 - 15	3	3
15 - 25	4	4
> 25	5	5

TABLE 5
Employment Terminal Time

Employment Density (employees per acre)	Production (minutes)	Attraction (minutes)
0 - 5	0	0
5 - 10	1	1
10 - 25	2	2
25 - 50	3	3
50 - 100	4	4
100 - 200	5	5
> 200	6	6

Estimation of Detailed Socioeconomic Characteristics

A three-way distribution of the households within each TAZ by household size, income, and workers is required in order to estimate the distribution of households by vehicle ownership levels. While this is available from the U.S. Census at the subregional level, such distributions at the TAZ level are estimated through iterative proportional fitting techniques. Using the appropriate subregional matrix as a seed, the cell values are adjusted through 10 iterations to match row and column totals to the estimated TAZ-level totals in order to produce an estimated three-way distribution of households for each TAZ.

Estimation of Vehicle Ownership

Base year households are distributed by vehicle ownership based on data from the 2000 U.S. Census. The distribution of future-scenario households by vehicle ownership is estimated through the application of a set of models developed by CTPS.

The CTPS vehicle ownership model was estimated as a set of four multinomial logit disaggregate choice models, one for each of four income categories, in which the decision maker was the household unit and the set of alternatives was the ownership, by the household, of 0, 1, 2, or 3-or-more vehicles. In this model, households are segmented into four income categories, since income is believed to be the most significant variable in vehicle-ownership choice. Other variables included in the model are household size, workers per household, household density, employment density, household location, and transit walk-access factors. The data set used to estimate this model contained 3,504 observations. Once estimated, the model was validated to observed vehicle ownership data. The models, one for each household income quartile, are presented in Table 6.

Estimation of Trip Productions and Attractions

The number of trip productions and trip attractions within a TAZ are estimated through the application of a set of models developed at CTPS. These models estimate the number of trip productions and attractions as a function of household size, workers per household, vehicles per household, income, household location, number of households, basic employment, retail employment, college employment, school employment, and service employment. The trip production models for the home-based purposes (home-based work ([HBW], home-based work-related [HBWR], home-based personal business [HBPB], home-based social-recreational [HBSR], home-based school [HBSC], and home-based pick-up/drop-off [HBPD]) are presented in Table 7, and the trip production models for the non-home-based purposes (non-home-based work [NHBW] and non-home-based-other [NHBO]) and the trip attraction models for all purposes are presented in Table 8.

TABLE 6
Summary of Vehicle Ownership Model

	Constant	HH Size	Workers per HH	HHs per Acre	Employ per Acre	High-Density	Low-Density	Ring01	Transit Walk-Accessibility
Low-Income Household Model									
0 Vehicles	-0.0474	-0.1692	-0.1312	0.0239		0.7136			
1 Vehicle									
2 Vehicles	-3.139	0.6182	0.4414	-0.0424					
3+ Vehicles	-5.074	0.7968	0.6927	-0.2232					
Medium-Low-Income Household Model									
0 Vehicles	-1.573	-0.1874	-0.3417	0.05		0.5716		0.5392	
1 Vehicle									
2 Vehicles	-1.745	0.5202	0.4279	-0.0627	-0.0334				-0.0056
3+ Vehicles	-5.101	0.7371	1.112	-0.0627	-0.0693				
Medium-High-Income Household Model									
0 Vehicles	-2.63			0.0459		0.7704			
1 Vehicle									
2 Vehicles	-1.223	0.6609	0.2377	-0.0391			0.4026	-0.5962	-0.0054
3+ Vehicles	-4.572	0.7899	1.289	-0.0779				-1.223	-0.0073
High-Income Household Model									
0 Vehicles	-2.793			0.0349					
1 Vehicle									
2 Vehicles	0.5049	0.3475	0.2688	-0.06	-0.0154				-0.0074
3+ Vehicles	-3.807	0.5717	1.628	-0.136	-0.0468				-0.0077

High-Density = 1 if HH/acre > 6 or Employ/acre > 7
Low-Density = 1 if HH/acre < 0.5 and Employ/acre< 0.7
Ring01 = 1 if TAZ is in Ring 0 or Ring 1
Transit Walk-Accessibility = Portion of TAZ within walk-access distance of transit service

Balancing of Trip Productions and Attractions

Connecting a trip production with a trip attraction of the same trip purpose forms a trip. As a result, the number of productions and attractions for each trip purpose must be equal. In order to achieve this, the trip productions and attractions are balanced.

For most trip purposes, the number of regional attractions is the least reliable estimate. Therefore, the normal balancing procedure is to set the total number of regional attractions equal to the difference between the grand total of productions and the total number of external attractions.

TABLE 7
Home-Based Trip Production Rate Models

Home-Based Work Trip Production Rates

Workers per HH	HH Size	Vehicles per HH 0	1	2+
1	*1*	0.94	1.17	1.11
1	*2*	1.01	1.23	1.18
1	*3*	1.15	1.38	1.32
1	*4*	1.48	1.70	1.65
1	*5+*	1.56	1.78	1.71
2	*2*	2.47	2.66	2.47
2	*3*	2.64	2.81	2.61
2	*4*	2.68	2.84	2.64
2	*5+*	2.83	2.99	2.79
3+	*3*	2.72	3.14	3.68
3+	*4*	2.75	4.02	4.55
3+	*5+*	2.88	4.15	4.68

Home-Based Personal Business Trip Production Rates

Workers per HH	HH Size	Vehicles per HH 0	1	2	3+
0	*1*	1.19	1.95	2.11	2.87
0	*2*	2.91	3.32	3.50	4.24
0	*3*	3.29	3.70	3.88	4.62
0	*4*	4.16	4.58	4.73	5.49
0	*5+*	1.56	4.71	4.87	5.63
1	*1*	0.50	1.01	1.20	1.27
1	*2*	1.85	2.35	2.55	2.62
1	*3*	2.25	2.82	3.04	3.11
1	*4*	2.52	2.91	3.08	3.13
1	*5+*	2.55	2.93	3.15	3.23
2	*2*	1.04	1.50	1.63	2.12
2	*3*	1.40	1.87	1.99	2.48
2	*4*	2.37	2.83	2.95	3.45
2	*5+*	2.44	2.91	3.03	3.52
3+	*3*	1.43	1.96	2.24	2.49
3+	*4*	2.00	2.75	3.14	3.49
3+	*5+*	2.34	3.20	3.67	4.08

HB Work-Related Trip Production Rates

HH Size	Workers per HH 1	2	3+
1	0.12		
2	0.10	0.18	
3	0.10	0.20	0.28
4	0.18	0.23	0.35
5+	0.21	0.29	0.41

TABLE 7 (cont.)
Home-Based Trip Production Rate Models

Home-Based School Trip Production Rates					
	HH	**Household Income Quartile**			
Ring	**Size**	**Low**	**Med-low**	**Med-high**	**High**
0 & 1	*1*	0.20	0.12	0.08	0.06
0 & 1	*2*	1.22	0.56	0.28	0.26
0 & 1	*3*	1.82	1.42	0.51	0.51
0 & 1	*4*	2.53	1.82	1.77	1.72
0 & 1	*5+*	5.07	4.05	3.04	2.53
2	*1*	0.15	0.03	0.02	0
2	*2*	0.41	0.18	0.13	0.05
2	*3*	1.30	0.92	0.35	0.25
2	*4*	2.01	1.55	1.47	1.19
2	*5+*	2.57	2.28	2.11	2.06
3 & 4	*1*	0.01	0.04	0.04	0.02
3 & 4	*2*	0.06	0.25	0.05	0.04
3 & 4	*3*	0.54	0.41	0.41	0.41
3 & 4	*4*	0.90	1.07	1.02	0.97
3 & 4	*5+*	1.35	2.53	2.24	1.85

HB Social/Recreational Trip Production Rates				
HH	**Workers per Household**			
Size	**0**	**1**	**2**	**3+**
1	0.88	0.70		
2	1.79	1.13	1.17	
3	1.79	1.49	1.68	2.24
4	2.02	1.95	2.14	2.87
5+	3.58	3.50	3.85	3.94

HB Pick-up/Drop-off Trip Production Rates				
HH	**Vehicles per Household**			
Size	**0**	**1**	**2**	**3+**
1	0.04	0.04	0.04	0.04
2	0.10	0.22	0.13	0.13
3	0.30	0.41	0.36	0.28
4	0.36	0.58	1.07	0.42
5+	0.85	1.73	1.58	1.08

TABLE 8
Trip Attraction Rates and Non-Home-Based Trip Production Rates

	Households	Basic Employment	Retail Employment	Service Employment College	K-12	Other
			Production Rate Models			
Non-Home-Based Work	0.07	0.47	1.78	1.86	0.93	0.93
Non-Home-Based Other	0.57		1.74	2.49	0.28	0.28
			Attraction Rate Models			
Home-Based Work		1.42	1.64	1.23	1.23	1.23
Home-Based Work-Related		0.06	0.35	0.27	0.08	0.08
Home-Based Personal Business	1.25		4.17			
Home-Based Social/Recreational	1.28		1.34	1.13		
Home-Based School				3.30	9.25	
Home-Based Pick-Up/Drop-Off	0.13	0.04	0.04	0.04	4.25	0.04
Non-Home-Based Work	0.11	0.32	2.36	1.85	0.79	0.79
Non-Home-Based Other	0.59		1.91	2.01	0.22	0.22

However, more information is available about regional patterns for the home-based work (HBW) trip during the base year. In order to produce base year home-based work trip ends that reflect the observed patterns, the following changes are made as part of the base year balancing procedure:

- Total regional HBW attractions are adjusted to match the base year ratio of total regional HBW attractions to total regional HBW productions with the ratio from the 2000 U.S. Census Journey to Work data (1.077).
- Total external HBW attractions are adjusted to match the base year ratio of total external HBW attractions to total regional HBW productions with the ratio from the 2000 U.S. Census Journey to Work data (.0442).
- Total external HBW productions are set equal to the difference between the grand total of HBW attractions and the regional HBW productions.

In addition, forecasts of future regional employment (the determinant of home-based work trip regional attractions) are available, so the estimates of future external HBW productions and attractions are less reliable than the estimates of future regional HBW productions and attractions. The model assumes that the number of external HBW productions will satisfy the forecasted employment within the region, so the HBW external productions are set equal to the difference between the total HBW attractions and the regional HBW productions.

TRIP DISTRIBUTION

The trip distribution model performs the second step in the travel forecasting process. It combines the estimated trip productions and trip attractions prepared by the trip generation model (combining the HBW and HBWR purposes into a new HBW purpose) into: an interregional vehicle trip table and an intraregional pick-up/drop-off vehicle trip table, to be used as input into the highway assignment model; and intraregional person trip tables to be used as inputs into the mode choice model.

The trip distribution model is made up of three components: a set of internal-external trip distribution models and two sets of intraregional trip distribution models (one for peak travel periods and the other for non-peak travel periods). An overview of the model is presented below.

Internal-External Trip Distribution

Internal-external trip distribution refers to a process in which all internal and external average weekday (AWD) trip ends (trip productions and attractions) are combined into trips using AWD highway impedances, but only the trips with one end in an internal zone and the other end in an external zone are retained. The resultant internal-external trip tables are used as inputs to the highway assignment model. The remaining trip ends are used as inputs to the intraregional trip distribution model.

The model includes a separate process for each of seven trip purposes: home-based work, home-based personal business, home-based social/recreational, home-based school, home-based pick-up/drop-off, non-home-based work, and non-home-based other. The process undertaken for each purpose consists of the following five steps:

- Convert highway travel times from time period origin-destination format to AWD production-attraction format
- Apply gamma functions to create an initial trip table estimate
- Initiate a three-dimensional balancing process, adjusting the initial trip table to match trip productions, trip attractions, and a trip-length frequency distribution
- Create internal/external vehicular trip tables
- Create intraregional person trip table productions and attractions

Each of these steps is described below.

Conversion of Highway Travel Times

Estimates of highway travel times are prepared using the highway assignment model on an origin-destination basis for each time period. In order to use these estimates with the trip productions and attractions from the trip generation model, the estimates from origin TAZ to destination TAZ and from destination TAZ to origin TAZ produced by the highway assignment are combined for each trip purpose based upon temporal directional factors developed for each trip purpose from the latest regional household travel survey.

Application of Gamma Functions

Interregional gamma functions are estimated using linear regression fitting to reflect the relationship between base year highway travel time estimates and survey trip tables. These functions are used to provide an estimate of the number of trips within each cell of the trip table for a future scenario based upon the highway travel times for that future scenario.

The resultant trip table is referred to as the seed trip table. A trip length frequency distribution is imposed upon the seed trip table by dividing the table into classes of zone pairs. The zone pairs within each class connect a common pair of districts (forming an “interchange”) and fall within a designated range of trip lengths (or “class”). A separate gamma function is used for each interchange. The number of interchanges and classes used for each trip purpose is presented in Table 9.

TABLE 9
Number of Interchanges and Classes Used for Each Trip Purpose

	Internal-External		Intraregional Peak		Intraregional Non-Peak	
Trip Purpose	**Interchanges**	**Classes**	**Interchanges**	**Classes**	**Interchanges**	**Classes**
HBW	36	250	36	250	36	250
HBPB	36	250	34	228	36	246
HBSR	35	247	33	227	36	244
HBSC	24	229	16	218	16	224
HBPD	25	241	4	49	4	51
NHBW	36	250	36	250	36	249
NHBO	25	244	33	226	36	249

Three-Dimensional Balancing

The seed trip table is adjusted through an iterative process in order to match its subtotals as closely as possible to the estimated trip productions, trip attractions, and trip length frequency distribution. Each iteration consists of adjusting all the cells within a dimension (row, column, or class) by the factor needed to match the sum of that dimension to the estimated subtotal in that dimension (productions for row, attractions for column, trip length range trips for class) and then performing the same calculations for the other two dimensions. Since there is more confidence in trip production estimates than in the trip attraction or trip length frequency estimates, the iterative process ends with an exact matching of the trip table production totals to the input trip productions for each purpose.

Internal-External Trip Tables

The portions of the resultant trip table connecting external stations and regional TAZs are saved and adjusted for use in the highway assignment model. Vehicle occupancy data from the latest external travel survey are used to convert the person trips to vehicle trips. Temporal and directional factors from the latest external travel survey are then used to convert the trips from one matrix of AWD trips from production zone to attraction zone to four matrices of time period trips from origin zone to destination zone.

Intraregional Productions and Attractions

The portions of the resultant trip table connecting a pair of regional TAZs are summed by TAZ of production and TAZ of attraction for use in the Intraregional Trip Distribution Model. Data from the latest household travel survey are used to split these trip production and trip attraction files into peak-period and non-peak-period files.

Intraregional Trip Distribution (Peak and Non-Peak)

Intraregional trip distribution refers to a process in which all peak-period and non-peak-period intraregional trip ends are separately combined into trips using composite impedances from the mode choice model. The resultant peak and non-peak intraregional trip tables are used as inputs to the mode choice model and highway assignment model.

The model includes a separate process for each of seven trip purposes: home-based work, home-based personal business, home-based social/recreational, home-based school, home-based pick-up/drop-off, non-home-based work, and non-home-based other. Similarly to the Internal-External Trip Distribution Model, the process undertaken for each purpose consists of the following three steps:

- Convert composite impedance estimates from time period to peak and non-peak format
- Apply gamma functions to create an initial trip table estimate

- Initiate a three-dimensional balancing process, adjusting the initial trip table to match trip productions, trip attractions, and a trip-length frequency distribution

The results of these steps are then processed to final form in the following two steps:

- Create pick-up/drop-off vehicular trip tables
- Create intraregional person trip tables

The five steps are described below.

Conversion of Composite Impedances

Estimates of purpose-specific composite impedances are prepared using the mode choice model for origin-destination TAZ pairs for each time period. In order to use these with the intraregional trip productions and attractions from the Internal-External Trip Distribution Model, the composite impedance estimates produced by the mode choice model are adjusted for production-attraction TAZ pairs for each trip purpose by temporal factors for each trip purpose from the latest regional household travel survey.

Application of Gamma Functions

Intraregional gamma functions are estimated using linear regression fitting to reflect the relationship between base year composite impedance estimates and survey trip tables. These functions are used to provide an estimate of the number of trips within each cell of the trip table for a future scenario based upon the composite impedances for that future scenario.

The resultant trip table is referred to as the seed trip table. A trip length frequency distribution is imposed upon the seed trip table by dividing the table into classes of zone pairs. The zone pairs within each class connect a common pair of districts (forming an “interchange”) and fall within a designated range of trip lengths (or “class”). A separate gamma function is used for each interchange. The number of interchanges and classes used for each trip purpose is presented in Table 9 (above).

Three-Dimensional Balancing

The seed trip table is adjusted through an iterative process to match its subtotals as closely as possible to the estimated trip productions, trip attractions, and composite impedance range frequency distribution. This process is the same as the one used in the Internal-External Trip Distribution Model. Since there is more confidence in trip production estimates than in the trip attraction or trip length frequency estimates, the iterative process ends with an exact matching of the trip table production totals to the input trip productions for each purpose.

Pick-Up/Drop-Off Vehicular Trip Tables

Since all trips for the home-based pick-up/drop-off purpose are assumed to be vehicular trips, the resultant trip tables for that purpose are converted directly to vehicular trip tables so that they can be used in the highway assignment model. Vehicle occupancy data from the latest household travel survey are used to convert the person trips to vehicle trips. Temporal and directional factors from the latest household travel survey are then used to convert the trips from matrices of peak-period and non-peak-period trips from production zone to attraction zone to matrices of time period trips from origin zone to destination zone.

Intraregional Person Trip Tables

The resultant trip tables for the other purposes are then prepared. Data from the latest household travel survey are used to split these peak-period and non-peak-period files into person trip tables for each time period. These trip tables are then used as inputs to the mode choice model.

MODE CHOICE

Overview

Mode choice is the third step in travel demand forecasting and in CTPS's regional travel demand model. It is the process in which the trips from distribution are split between the various available modes of the transportation network.

CTPS developed multinomial logit mode choice models by trip purpose using 1991 Household Travel Survey data, travel impedances obtained from highway and transit networks, 1990 and 2000 U.S. census data, and a variety of other data sources. The mode choice models estimate modal splits for four trip purposes: HBW, HBO (which includes HBPB and HBSR), HBSC, and NHB. These models have been calibrated and validated. The mode choice models are applied, by purpose, to the intraregional person trip tables that result from the trip distribution model.

The mode choice models split the trips for each purpose among six modes: 1) walk-access transit, 2) drive-access transit, 3) single-occupancy vehicles, 4) high-occupancy vehicles with two persons, 5) high-occupancy vehicles with three or more persons (for the HBW trip purpose only), and 6) a pure walk mode. The stations used in the execution of drive-access transit trips are identified using a special component of the mode choice model: a station choice model. Specific sub-mode selection (i.e., local bus, express bus, light rail, commuter rail, etc.) occurs during the transit assignment process.

The mode choice models estimate mode splits for intraregional trips only (trips contained within the model boundaries). They estimate mode shares for both inter-zonal trips (from one zone to another zone) and intra-zonal trips (from and to the same zone); however, intra-zonal trips are only split between the walk and auto modes.

Factors based upon the latest household travel survey are used to divide the trip tables produced by the trip distribution models into two trip tables: one for the trips made from production TAZ to attraction TAZ, the other for the trips made from attraction TAZ to production TAZ. The mode choice models are applied to these trip tables in two stages: first for the trips made from production TAZ to attraction TAZ (using the origin-destination input matrices), then for the trips made from attraction TAZ to production TAZ (using the inverse of the origin-destination input matrices).

Variables

The following are brief descriptions of the variables the mode choice models use to estimate mode splits:

- *Nest coefficient*: Represents the degree of interactivity between the modes within the nest and other modes or nests. The value ranges between 0 and 1, with 1 indicating that switches to and from other modes are as likely as switches to and from modes within a nest. A value of 0 indicates there would be no switching between the nest modes and other modes.
- *In-vehicle travel time (IVTT)*: Represents time spent in the modal vehicle during a given trip.
- *Out-of-vehicle time*: Includes all walk, boarding, and wait time.
- *Drive-access time*: Represents driving time between a trip end and a transit station parking lot.
- *Terminal time*: Represents the time it takes to travel between a vehicle and the trip origin or destination.
- *Fare*: Represents the transit fare, in dollars, a transit rider will pay to use the system. Also included is one-half of any applicable parking costs (one-half because such costs are calculated on the basis of a one-way trip) at a transit station parking facility.
- *Auto cost*: Represents auto operating and toll costs. Also included is one-half of any applicable parking costs (one-half because such costs are calculated on the basis of a one-way trip) on the street or in a parking

facility. Also, for shared-ride modes, total auto costs are divided by the appropriate auto occupancy.

- *Household size*: Represents the number of persons per household. This estimate is obtained from the trip generation model.
- *Vehicles/person*: Represents the total number of vehicles per person in a household. Vehicles are estimated using the vehicle availability model described earlier.
- *Population density*: Represents total population per acre of dry land.
- *Percent transit origins/destinations*: Represents the AM peak period transit share of work trip ends within a TAZ, as computed by the home-based-work mode-choice model.

The Four Trip Purposes and the Station Choice Model

Home-Based Work Model

Home-based work (HBW) is the only trip purpose for which the mode choice models distinguish between two-person carpools (HOV2) and three-or-more-person carpools (HOV3+). The model specifications are shown in Table 10.

A transit nest is incorporated into the model on the basis that the decision to take transit over the other modes is made before selection of a particular transit mode. The transit coefficients are the same for both walk access (WAT) and drive access (DAT) and include coefficients for in-vehicle, initial wait, transfer wait, and total walk time. Drive-access time and production terminal times are included in DAT as one parameter.

The WAT fare includes the transit fare in dollars. For DAT, costs include the transit fare and half of any parking cost. Population density by traffic zone, in people per acre, is included in walk-access transit, and it is positively correlated: the greater the density, the more likely a traveler is to choose this mode. The zones with high population densities also have more transit stops. Vehicles per worker is a socioeconomic input unique to this trip purpose for DAT. It is also positively correlated, since a higher vehicles-per-worker ratio increases the likelihood of a vehicle’s being available for a trip to a park-and-ride lot.

The auto times and cost coefficients are the same for the three auto modes. For HOV2 and HOV3+ the auto cost is divided by the average vehicle occupancies to reflect the sharing of costs between vehicle occupants. Household size is included as a positively correlated variable for the shared-ride modes and has a somewhat greater impact for HOV3+ than HOV2.

TABLE 10
Home-Based-Work Mode Choice Model Specifications

		Impedance Variable									Socioeconomic Variable		
	Nest Coeff	IVTT	Terminal Time	Walk Time	Initial Wait	Transfer Wait	Auto Access	Boarding Time	Fare ($)	Auto Cost ($)	Population Density	Vehicles/ Worker	HH Size
Drive-Alone													
Top Level	1	-0.05466	-0.292							-0.32			
Application Level		-0.05466	-0.292							-0.32			
Ratio to IVTT ($/hr)		1	5.34211							$ 10.25			
HOV2													
Top Level	1	-0.05466	-0.292							-0.32			0.07322
Application Level		-0.05466	-0.292							-0.32			0.07322
Ratio to IVTT ($/hr)		1	5.34211							$ 10.25			-1.33955
HOV3+													
Top Level	1	-0.05466	-0.292							-0.32			0.2168
Application Level		-0.05466	-0.292							-0.32			0.2168
Ratio to IVTT ($/hr)		1	5.34211							$ 10.25			-3.96634
Walk													
Top Level	1			-0.1007									
Application Level				-0.1007									
Ratio to IVTT ($/hr)													
Walk-Access Transit													
Top Level	0.6791	-0.05466		-0.1007	-0.11292	-0.11292		-0.05466	-0.32		0.01889		
Application Level		-0.08049		-0.14828	-0.16628	-0.16628		-0.08049	-0.47121		0.02781		
Ratio to IVTT ($/hr)		1		1.8423	2.06593	2.06593		1	$ 10.25		-0.34551		
Drive-Access Transit													
Top Level	0.6791	-0.05466	-0.292	-0.1007	-0.11292	-0.11292	-0.13665	-0.05466	-0.32	-0.32		0.2897	
Application Level		-0.08049	-0.42998	-0.14828	-0.16628	-0.16628	-0.20122	-0.08049	-0.47121	-0.47121		0.4266	
Ratio to IVTT ($/hr)		1	5.34211	1.8423	2.06593	2.06593	2.5	1	$ 10.25	$ 10.25		-5.30011	

Home-Based Other Model

The home-based other (HBO) mode choice model combines the home-based shopping and home-based recreational trip tables output from the trip distribution process into a single HBO trip table. The model specifications are shown in Table 11. The model is similar to the HBW mode choice model, except for the following three differences. First, since there is only one shared-ride mode, HOV2+, household size is only a parameter for this one mode. Second, the vehicles per person in a household is used, as opposed to vehicles per worker. Finally, a distance dummy equal to one if the trip distance is less than a mile and zero otherwise is added to the walk mode. This reflects the fact that people taking short trips for this purpose are more likely to walk than choose another mode.

Non-Home-Based Model

The non-home-based (NHB) model splits work trips and non-work trips. The model specifications are shown in Table 12. There is a work dummy variable in the two auto modes which is equal to one if the trip is a non-home-based work trip and zero otherwise. The coefficient is positive for SOV and negative for HOV, indicating that the SOV mode is more likely on work-related trips than on non-work trips. The percentage of trips attracted to the origin and destination zones that is SOV is a variable in the drive-alone mode. The percentage is taken from the results of the HBW mode choice model and is positively correlated. Finally, the distance dummy in the walk mode is equal to one if the distance is less than a mile. It has a positive coefficient.

Home-Based School Model

The home-based school (HBSC) model was re-estimated and restructured in 2004 to allow for compatibility of the HBSC purpose with the Federal Transit Administration's Summit program. The previous HBSC model had one nest comprising all motorized modes. The revised HBSC model has two nests, transit and highway. The revised HBSC model specifications are shown in Table 13.

Station Choice Model

The final part of the mode choice model is the assignment of drive-access transit trips to transit stations in the station choice model. This model uses estimates of highway travel times and costs from the highway assignment model, estimates of transit impedances from the walk-access transit assignment model, and estimated transit parking lot capacities to distribute drive-access transit trips among the transit stations with parking lots. The model also estimates the impedances associated with the drive-access transit trips between each TAZ pair and, if parking at the transit parking lots is constrained, reassigns demand for full parking lots to other parking lots or to other modes of transportation.

TABLE 11
Home-Based-Other Mode Choice Model Specifications

		Impedance Variable									Socioeconomic Variable			
	Nest Coeff	IVTT	Terminal Time	Walk Time	Initial Wait	Transfer Wait	Auto Access	Boarding Time	Fare ($)	Auto Cost ($)	Population Density	Vehicles/ Worker	HH Size	Distance Dummy
Drive-Alone														
Top Level	1	-0.01965	-0.2308							-0.22378				
Application Level		-0.01965	-0.2308							-0.22378				
Ratio to IVTT ($/hr)		1	11.7463							$ 5.27				
HOV2+														
Top Level	1	-0.01965	-0.2308							-0.22378			0.1976	
Application Level		-0.01965	-0.2308							-0.22378			0.1976	
Ratio to IVTT ($/hr)		1	11.7463							$ 5.27			-10.0566	
Walk														
Top Level	1			-0.05895										0.9005
Application Level				-0.05895										0.9005
Ratio to IVTT ($/hr)														-15.2757
Walk-Access Transit														
Top Level	0.3722	-0.01965		-0.05895	-0.05895	-0.05895		-0.01965	-0.22378		0.00883			
Application Level		-0.05279		-0.15838	-0.15838	-0.15838		-0.05279	-0.60123		0.02373			
Ratio to IVTT ($/hr)		1		3.0002	3.0002	3.0002		1	$ 5.27		-0.44951			
Drive-Access Transit														
Top Level	0.3722	-0.01965	-0.2308	-0.05895	-0.05895	-0.05895	-0.04912	-0.01965	-0.22378	-0.22378		0.71239		
Application Level		-0.05279	-0.6201	-0.15838	-0.15838	-0.15838	-0.13198	-0.05279	-0.60123	-0.60123		1.914		
Ratio to IVTT ($/hr)		1	11.7463	3.0002	3.0002	3.0002	2.5	1	$ 5.27	$ 5.27		-36.2564		

TABLE 12
Non-Home-Based-Work Mode Choice Model Specifications

		Impedance Variable									Socioeconomic Variable		
	Nest Coefficient	IVTT	Terminal Time	Walk Time	Initial Wait	Transfer Wait	Auto Access	Boarding Time	Fare ($)	Auto Cost ($)	Work Dummy	Distance Dummy	Percent SOV
Drive-Alone													
Top Level	1	-0.03022	-0.3197							-0.1817	0.1926		0.00885
Application Level		-0.03022	-0.3197							-0.1817	0.1926		0.00885
Ratio to IVTT ($/hr)		1	10.5791							$ 9.98	-6.37326		-0.29295
HOV2+													
Top Level	1	-0.03022	-0.3197							-0.1817	-0.7627		
Application Level		-0.03022	-0.3197							-0.1817	-0.7627		
Ratio to IVTT ($/hr)		1	10.5791							$ 9.98	25.2383		
Walk													
Top Level	1			-0.07525								0.493	
Application Level				-0.07525								0.493	
Ratio to IVTT ($/hr)												-6.5515	
Walk-Access Transit													
Top Level	1	-0.03022		-0.07525	-0.08333	-0.08333		-0.03022	-0.1817				
Application Level		-0.03022		-0.07525	-0.08333	-0.08333		-0.03022	-0.1817				
Ratio to IVTT ($/hr)		1		2.49007	2.75745	2.75745		1	$ 9.98				
Drive-Access Transit													
Top Level	1	-0.03022	-0.3197	-0.07525	-0.08333	-0.08333	-0.07555	-0.03022	-0.1817	-0.1817			
Application Level		-0.03022	-0.3197	-0.07525	-0.08333	-0.08333	-0.07555	-0.03022	-0.1817	-0.1817			
Ratio to IVTT ($/hr)		1	10.5791	2.49007	2.75745	2.75745	2.5	1	$ 9.98	$ 9.98			

TABLE 13
Home-Based-School Mode Choice Model Specifications

	Nest Coefficient	Impedance Variable							Population Density
		IVTT	Terminal Time	Walk Time	Wait Time	Drive-Access Time	Fare ($)	Auto Cost ($)	
Drive-Alone									
Top Level	0.5559	-0.0305	-0.0904					-0.1803	
Application Level		-0.0548	-0.1626					-0.3244	
Ratio to IVTT ($/hr)		1.0000	2.9672					$10.14	
HOV2+									
Top Level	0.5559	-0.0305	-0.0904					-0.1803	
Application Level		-0.0548	-0.1626					-0.3244	
Ratio to IVTT ($/hr)		1.0000	2.9672					$10.14	
Walk									
Top Level	1			-0.0791					
Application Level				-0.0791					
Ratio to IVTT ($/hr)									
Walk-Access Transit									
Top Level	0.5559	-0.0305		-0.0791	-0.0791		-0.1803		0.0150
Application Level		-0.0548		-0.1423	-0.1423		-0.3244		0.0270
Ratio to IVTT ($/hr)		1.0000		2.5967	2.5967		$10.14		-0.4927
Drive-Access Transit									
Top Level	0.5559	-0.0305	-0.0904	-0.0791	-0.0791	-0.0762	-0.1803	-0.1803	0.0150
Application Level		-0.0548	-0.1626	-0.1423	-0.1423	-0.1371	-0.3244	-0.3244	0.0270
Ratio to IVTT ($/hr)		1.0000	2.9672	2.5967	2.5967	2.5018	$10.14	$10.14	-0.4927

The probability of selecting a station is determined by the combination of utilities for the auto and transit legs of the drive-access transit trip. The utility of the auto leg (U_{ik}) is a combination of the auto travel time between production TAZ i and transit station k (ATT_{ik}) and the parking capacity at transit station k (PC_k).

$$U_{ik} = -.125\ ATT_{ik} + .001\ PC_k$$

The utility of the transit leg (U_{kj}) is a function of the composite impedance used in transit path selection, which includes transit in-vehicle travel time (ITT_{kj}), boarding time (BT_{kj}), waiting time (WtT_{kj}), and walk time (WkT_{kj}) accumulated between station k and attraction TAZ j.

$$U_{kj} = -.05 * (ITT_{kj} + BT_{kj} + (2 * (WtT_{kj} + WkT_{kj})))$$

The auto leg utilities are used to identify the five most likely stations to be used for each production TAZ, the combined utilities are used to estimate the probabilities of selecting each of those stations for each pair of TAZs, and the trips are assigned to transit stations. If transit parking is constrained to capacity, some trips may not be possible since the parking demand exceeds the capacity at the station, so, for those trips, the auto leg utilities are re-estimated to identify the five most likely stations with available parking capacity, and the trips are assigned to transit stations based upon the combined utilities. Trips which are still not assignable due to inadequate parking capacity are then switched to the walk-access transit, single-occupancy vehicle, or high-occupancy vehicle mode in the same proportion of other trips of the same purpose between the same pair of TAZs.

TRIP ASSIGNMENT

Trip assignment is the fourth step in the travel demand forecasting process and in CTPS's regional travel demand model. Trip assignment is the process by which each trip in the trip tables resulting from the mode choice model is assigned to a specific submode (for example, bus or rapid transit) and a specific route. The CTPS model uses two distinct assignment procedures, one for the transit trips and one covering the highway modes.

Highway Assignment Routine

The highway assignment implemented is an equilibrium assignment. The fundamental assumption underlying such an assignment procedure is that each user of the highway network will choose the route that he or she perceives to be the best. The assignment is an aggregate assignment in that traffic volumes on any given link are an aggregate number, as opposed to being associated with a specific trip. There are several inputs used by the equilibrium assignment procedure. The key inputs are the highway demand matrices, the volume delay function, and the highway network:

Highway demand matrices

The demand matrices that the highway assignment procedure uses as an input are the demand matrices that result from the mode choice and distribution models and other sources. These are origin-destination matrices of single-occupancy vehicles, trucks, taxis, internal-external trips, through trips, and high-occupancy vehicles.

To prepare the mode choice trip tables for use in highway assignments, it is necessary to convert person trips to vehicle trips by applying vehicle occupancy factors for HOV modes. These occupancy factors, presented below, vary by trip purpose and are based upon the latest household travel survey.

Home-based work trips	HOV2: 2 persons/vehicle
	HOV3+: 3.373 persons/vehicle
Home-based other trips	HOV2+: 2.404 persons/vehicle
Home-based school trips	HOV2+: 2.788 persons/vehicle
Non-home-based trips	HOV2+: 2.385 persons/vehicle

In addition to manipulating the output matrices from mode choice, it is necessary to bring in vehicle trip tables produced outside of the mode choice process. These vehicle trip tables are:

- External Through – This matrix consists of trips that pass through the study area without stopping and hence are exogenous to the travel model. The trips were estimated from the 1991 external travel survey, 2000 Census Journey to Work data, and traffic counts.
- Taxi – The taxi vehicle trip table was originally developed from a 1993 survey and has since been revised several times based upon a factoring process.
- Logan Airport SOV and HOV – This trip table is developed from a separate Logan Airport Passenger Mode Choice Model, which was developed based on a 2007 Massachusetts Port Authority survey.
- Drive-Access-Transit Auto Access – DAT trips are determined through the station choice model, which is a part of the mode choice process. Each DAT trip requires a vehicle access trip.
- Interregional SOV and HOV – The interregional vehicle trip tables are generated through the interregional trip distribution model.
- Pick-Up/Drop-Off SOV and HOV – The pick-up/drop-off (PUDO) tables, produced by the interregional trip distribution model, cover those trips in which a person is dropped off at his or her destination (not an intermediate parking lot).
- Truck – The truck trip tables are produced from the new tour-based truck trip model.

The Boston MPO regional travel demand forecasting model previously had a truck trip table, developed from data several decades old, as a fixed input into the highway assignment model. This approach was eventually found wanting, hence, a different approach was taken to improve the estimation of the major elements that compose the commercial vehicle portion of highway traffic. An integrated behavioral tour-based model was developed from the Vehicle Inventory and Use Survey, Massachusetts Registry of Motor Vehicle files, and existing truck trip generation rates. These existing sources were supplemented by specifically-focused telephone and travel-intercept surveys and video data capture which provided information used to quantify key behavioral relationships.

The revised truck travel forecasting model incorporates new several factors into the truck trip tables used for highway assignments. With these changes, the truck model produces truck travel estimates which are sensitive to demographic changes and which are consistent with the roadway network and observed truck travel patterns and operating characteristics. These innovative features can be characterized into three major elements:

- **BEHAVIORAL.** The model is based upon functional usage categories which capture relatively homogeneous patterns of truck operation and are tied to regional socioeconomic characteristics.
- **TOUR-BASED.** The model differentiates between truck trip tour ends and their intermediate starts and stops in order to impose a tour-like form on the pairing of truck trip ends. This, as a result, distributes truck trip ends appropriately between truck garage sites and truck starts and stops along delivery routes.
- **INTEGRATED.** The model is sensitive to changes in a specific set of interacting variables that are internally consistent and externally constrained. The variables include sector employment and population, truck ownership and operational characteristics, highway network truck restrictions, link truck volume counts, time-of-day, and intra-regional and inter-regional truck travel demand. Truck travel volumes are estimated as a function of the population and employment by type of business in each TAZ.

The underlying premise of the modeling approach is that overall truck travel demand can be divided into nine relatively identifiable and homogenous functional usage categories. Each of the nine is comprised of relatively similar travel characteristics as measured in such variables as tours per day, trips per tour, and trip length.

These nine distinct categories are:

- Tankers – distinct body type, many carry hazardous materials.
- Household Goods - perform distinct service, as they move the belongings (not products) of their clients
- Less-than-truckload/Truckload – commercial carriers transporting wide varieties of goods
- Food and Warehouse Distribution – distributing goods (sometimes non-durable, so time-sensitive) to retail outlets.
- Intermodal – picking up or delivering goods also carried by rail or boat.
- Package – distinct service type, many stops per tour.
- Heavy – large vehicles, most subject to weight limitations.
- Retail – delivering goods to end users.
- Pickup/Van – small vehicles, least subject to restrictions.

Within the modeling process, a series of relationships were established among firm employment, firm truck ownership/usage, and truck type and usage category. These relationships are expressed in terms of both FHWA physical vehicle classes and usage categories. This correspondence made it possible to validate and, where necessary, to adjust our new travel demand matrices through use of trip table estimation techniques. In this way, we adjusted our initial demand levels for four time periods to observed truck volumes from counts conducted on links of the highway system.

Volume-delay function

The function used in the highway assignment procedure is a volume-delay function, which, when applied in the context of a highway assignment, changes the speeds users of the network experience based upon the volumes on the network. The volume-delay function employed in the CTPS regional model is a variation on the so-called Bureau of Public Roads (BPR) function. Developed by its now defunct namesake, the BPR function is a widely used and validated volume-delay function that is parabolic in shape and takes the form:

Congested Speed = (Free-Flow Speed)/(1 + $[\text{Volume/Capacity}]^4$)

The CTPS regional model is segmented by time periods. For each time period, the BPR function is altered to reflect the number of hours in that period.

Highway network

The highway network is an abstract digital representation of the real highway network in eastern Massachusetts. For future-year scenarios, the highway network depicts roadway links that are planned in addition to the existing highway network. The base year highway network is a depiction of the eastern

Massachusetts highway network as it existed in the year 2009. The highway network in the base and future years includes information about number of lanes, free-flow speeds, and capacity (in vehicles per lane per hour). Freeways typically have a free-flow speed of 60 miles per hour, are three lanes, and have a capacity of 1,950 vehicles per lane per hour. Smaller arterials typically have a free-flow speed of 30 to 45 miles per hour, are coded as having one or two lanes, and have a capacity of 900 to 1,000 vehicles per lane per hour. Such parameters are consistent with widely accepted traffic engineering principles and the Transportation Research Board's *Highway Capacity Manual.*

The highway assignment procedure performs a multi-class generalized cost equilibrium auto assignment. The multi-class assignment runs an assignment for the demand matrices of three modes, SOV, HOV, and trucks, from the total vehicle trip tables for each class, which are assigned by time period. Tolls affect the assignment and are stored on the network.

The highway assignment procedure is iterative in that the assignment is calculated repeatedly, in order to mathematically optimize assignment results. Three criteria are used to determine how many iterations of the assignment procedure are used:

First, the relative gap is an estimate of the difference between the current assignment and a perfect equilibrium assignment, in which all paths used for a given origin-destination pair would have exactly the same time. The default relative gap is 0.5%, but CTPS employs 0.01% so that a more accurate assignment will result.

Another criterion for when to stop the iterations is the normalized gap (or trip time differential), which is the difference between the mean trip time of the current assignment and the mean minimal trip time. The mean trip time is the average trip time on the paths used in the previous iteration; the mean minimal trip time is the average trip time computed using the shortest paths of the current iteration. Again, a minimum level is selected, 0.01 minutes, in order for the designated number of iterations to be carried out.

If neither of these criteria is met, the CTPS regional model highway assignment procedure is set to stop after running through 50 iterations.

Transit Assignment Routine

The transit assignment is a multi-path assignment based on the calculation of optimal transit strategies for system users. A transit strategy is roughly analogous to a path in highway assignment. The transit assignment allows for users of the transit system switching within the transit network between various available transit services in order to reach their destination. In basic terms, the transit assignment algorithm identifies the optimal service or services at each node in the transit network for each origin and destination node pair. This algorithm is repeated for all nodes, starting with the destination node and culminating at the origin node.

Like the highway assignment procedure, the transit assignment procedure utilizes several key inputs to estimate a transit assignment. Three of the key inputs are the transit demand matrices, the transit functions, and the transit network:

Transit demand matrices

The transit demand matrices are just that, matrices of trips that have been split into the transit mode because the utility of their trip suggests that transit is an attractive mode choice for their particular origin-destination pair. These trip tables come from three sources:

- Walk-access transit trip tables from the mode choice model
- Drive-access transit trip tables from the station choice model
- Logan transit trip tables from the Logan Airport Passenger Mode Choice Model

Functions

The function used in the transit assignment procedure depicts the relative levels of attractiveness among the numerous paths available in the eastern Massachusetts transit network for each pair of TAZs. Costs are translated to time assuming a value of time of $12 per hour (using 1991 dollars) and doubling the out-of-vehicle time (walk and wait times) before adding it to in-vehicle time.

Transit network

The transit network is an abstract digital representation of the real transit network in eastern Massachusetts. For future-year scenarios, the transit network depicts transit links that are planned in addition to the existing transit network. The base year transit network is a depiction of the eastern Massachusetts transit network as it existed in the year 2009. The transit network includes every commuter rail line, rapid transit line, bus route, and ferry route in eastern Massachusetts. The bus routes run on the highway network, and their run times are influenced by roadway traffic congestion. Among other things, the transit network in the base and future years includes estimated vehicle headways, wait times, transit run times, and fares for each line. The assignment algorithm takes into consideration all of these elements in calculating a transit assignment.

Additionally, the transit network represents and accounts for park-and-ride facilities. Park-and-ride nodes provide connections between the highway and transit networks via a walk link. As a result, drive-access transit trips use both the highway and the transit networks.

The transit network also includes an extensive set of walk-access and transfer links. All these links assume a speed of 3 miles per hour.

Walk-access links are an abstract representation of all of the walking routes transit users utilize in eastern Massachusetts to access the transit system. In other words, they are an aggregate abstraction of the sidewalks, roadways, backyards, driveways, and shortcuts people use to walk to the transit system.

The walk-access estimation process is an automated process that involves three steps. The first step builds paths and distances on a walk network roadway geographic information system (GIS) coverage that is created from the most recent statewide digital line graph (DLG) coverage of the roadway network. The roadways that are unsuitable for walking within the study area are then cut from that coverage. The path building and distance skimming between transit stops and zones is calculated on this coverage. The distances between the transit stops and stations active under the scenario under study and each TAZ are then calculated from this coverage. Up to two walk links are created between each TAZ and the stations and stops on each transit line, with no links over one mile. Transfer links are created to connect all stations and stops within a quarter-mile walk.

Fare Coding

Average transit fares based on collected empirical data are used for coding in the model network. Each transit submode (boat, bus rapid transit, rapid transit, bus, commuter rail, and shuttle) is assigned a boarding fare that is placed on the walk access links connected to the nodes that serve the stations and stops for that submode. In addition, each pair of submodes is assigned a transfer fare that is placed on the transfer links connected to the nodes that serve the stations and stops for that submode. Additional zone fares are represented as segment fares placed on the transit links crossing the fare zone boundaries. In addition, park-and-ride parking charges are coded onto the walk links that connect the park-and-ride nodes to the transit station and stop nodes.

Fares are translated into time for influencing path selection by assuming a value of time of $12 (in 1991 dollars) per hour. Although fares are expressed in minutes to allow them to be included in the impedances that influence path selection, they are kept separate from travel times for input into the mode choice model.

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Attachment F CTPS Model Base Year Representation

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CTPS CENTRAL TRANSPORTATION PLANNING STAFF

Staff to the Boston Metropolitan Planning Organization

MEMORANDUM

DATE **March 17, 2014**

TO **Kristine Wickham-Zimmerman, Joseph Wanat, Caroline Ducas - VHB**
Matthew Ciborowski - MassDOT

FROM **Bruce Kaplan, Ying Bao**
CTPS

RE **South Station Expansion: Model Year Representation**

This memorandum serves to clarify a few issues regarding the vintage of some of the input data used in the travel demand forecasting work. Some base year regional model data, such as demographic data and the transit service plans, do represent 2009/2010 conditions as opposed to the desired 2012 base year situation. Nonetheless, we are confident that the base year model does adequately represent conditions in 2012.

First, very little socio-economic and transit ridership change occurred in the Boston area between 2009 and 2011. According to the town-level estimates from US Census Bureau Population Estimates Program, the region's population grew by 0.21% and its employment grew by only 2%. Additionally, the region's commuter rail ridership remained constant during that period, only varying about 0.5%; moreover, very little service change occurred.

Second, although the base year model employed some input data from 2009 and 2010, it was calibrated to spring 2012 conditions. Transit ridership for the South Side commuter rail lines were calibrated to the spring 2012 counts. Peak hour volumes were specifically calibrated to the peak hour balanced counts that were collected in 2012. Transfer volumes at South Station were also calibrated to ensure consistency with the data collected in 2012 and 2013. Rapid transit station boardings and transfers at downtown stations (South Station, Downtown Crossing, Park Street, State, and Government Center) were calibrated to the 2012 MBTA AFC count data.

BK/bk

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Attachment G Amtrak Ridership Projections

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Date
April 30, 2014

SOUTH STATION EXPANSION PROJECT TEAM CORRESPONDENCE

To
Drew Galloway - Amtrak

From
Matt Ciborowski - MassDOT

Prepared By
Caroline Ducas, Kristine Wickham - VHB

Subject
Amtrak 2035 Horizon Year Ridership Projections

Background

In September 2013, the National Railroad Passenger Corporation (Amtrak) provided the South Station Expansion (SSX) project team with a 2040 horizon year service plan and corresponding ridership projections for SSX planning purposes.[1] In November 2013, Amtrak provided the SSX team with an updated 2020-2040 service plan for the SSX project's 2035 horizon year. Consequently, the SSX team updated the ridership projections to correspond with the most current service plan (the November 2013 Update). Amtrak approved the updated ridership forecasts in February 2014 for use in the SSX project.

This memorandum documents the methodology used to prepare the final intercity ridership forecasts for the SSX project, which correspond to Amtrak's future year 2020-2040 intercity service plan (November 2013 Update) and include estimated 2035 horizon year ridership for Amtrak intercity trains serving the Boston area stations of South Station, Back Bay, and Route 128. The results of the ridership forecasting analysis are also presented in this memorandum.

Proposed Intercity Service Plan

Table 1 below summarizes the proposed intercity service plan received from Amtrak in September 2013 as well as the November 2013 service plan update.

According to the most recent intercity service plan received from Amtrak, dated November 2013, rail service to/from Boston is anticipated to double from an existing 40 trains per weekday to a total of 80 trains per weekday in the future 2020-2040 horizon. As detailed below, the proposed service plan maintains existing Regional service operating via the Shore Line[2] and existing Long Distance service operating via the Inland Route,[3] expands Acela high speed service operating via the Shore Line, and adds new Regional service via the Inland Route.

[1] A summary of Amtrak's September 2013 ridership projections, along with supporting background materials, is included for reference in Exhibit A.
[2] The Shore Line refers to the Northeast Corridor railway line through southern Connecticut.
[3] The Inland Route refers to the Boston-Worcester-Springfield railway corridor.

Table 1 Proposed Amtrak Intercity Service Plan Summary

	2013	Future Year (2020-2040 Horizon)	
	Existing Schedule	Intercity Service Plan (Sept. 2013)	Intercity Service Plan (Nov. 2013 Update)
NextGen High Speed	-	N/A	N/A
Acela High Speed Service (Shore Line)	10 NB 10 SB **20**	15 NB 15 SB **30**	14 NB 14 SB **28**
Regional Service (Shore Line)	9 NB 9 SB **18**	9 NB 9 SB **18**	9 NB 9 SB **18**
Regional Service (Inland Route)	-	3 NB/EB 3 SB/WB **6**	4 NB/EB 4 SB/WB **8**
Long Distance Service (Inland Route)	1 NB/EB 1 SB/WB **2**	1 NB/EB 1 SB/WB **2**	1 NB/EB 1 SB/WB **2**
New England Regional (Inland Route)	-	10 NB/EB 10 SB/WB **20**	12 NB/EB 12 SB/WB **24**
TOTAL	20 NB/EB 20 SB/WB **40**	38 NB/EB 38 SB/WB **76**	40 NB/EB 40 SB/WB **80**

Note: NB = Northbound, EB = Eastbound, SB = Southbound, WB = Westbound.

Existing Intercity Service To Remain

The nine existing daily round trip Regional trains that operate between Boston, New York and points further south via Providence and the Shore Line are maintained in Amtrak's proposed intercity service plan. Also maintained is the existing Lake Shore Limited Service, which consists of one daily round trip Long Distance train that operates between Boston and Chicago via the Inland Route.

Existing Intercity Service To Be Expanded

Amtrak's proposed service plan increases Acela high speed service to/from Boston by an additional four round trips a day, for a total of 14 daily round trip Acela trains serving Boston via Providence and the Shore Line.

Proposed New Intercity Service

Amtrak's proposed service plan adds new intercity rail service operating via the Inland Route. Specifically, four new round trip Regional trains operating via the Inland Route between Boston, New York and points further south are proposed. Combined with improvements currently underway along the Springfield Line, which serves the Connecticut River Valley from New Haven to Vermont, the Springfield Line/Inland Route offers an opportunity to provide improved services between the cities along its corridor as well as additional Regional service to points west of New Haven.

In addition, 12 new round trip New England Regional trains operating between Boston and Springfield via the Inland Route are proposed. Distinct from the proposed Inland Route Regional service to New York, the New England Regional Service along the Inland Route would provide for an opportunity to provide enhanced service, appropriately sized to meet the demand of the New England region, without being required to operate the long train consists needed to meet passenger demand to/from New York Penn Station.

Next-Generation (NextGen) High Speed Rail Program

Amtrak's vision for next-generation (NextGen) high speed rail services for the Boston to Washington corridor are described in Amtrak's *A Vision for High-Speed Rail in the Northeast Corridor* (2010) and *The Amtrak Vision for the Northeast Corridor – 2012 Update Report* (2012). For the purposes of advancing the SSX project, it is assumed that the proposed NextGen service would require a new alignment with dedicated high speed tracks (likely subsurface in tunnels) due to the capacity constraints along the existing Northeast Corridor. Due to the extremely dense and therefore challenging land use patterns approaching Boston, the proposed NextGen service would also likely require a dedicated Lower Level Concourse at South Station. As such, NextGen service plans and ridership are being developed independently from the SSX project.

Intercity Ridership Projection Methodology

The following describes the methodology used to prepare the final Amtrak-approved intercity ridership projections for the SSX project's 2035 horizon year (provided in Exhibit B):

1. Baseline annual ridership by train was estimated. The Baseline ridership represents existing (2012) ridership for current services that will be maintained (Shore Line Regional and Long Distance) as well as the estimated year 2012 start-up ridership for expanded (Acela) and new proposed services (Inland Route Regional and Inland Route New England Regional).
    a. Shore Line Regional and Long Distance train Baseline ridership was estimated using FY 2012 ridership data.
    b. Inland Route train ridership (Regional and New England Regional) was estimated using a service elasticity[4] approach and previous Inland Route projections prepared by Amtrak. The methodology used for Inland Route ridership projections is detailed in a subsequent section of this memorandum, *Inland Route Ridership Methodology*.
    c. Acela ridership was estimated using a service elasticity approach and existing FY 2012 ridership data. The methodology used for Acela ridership projections is detailed in a subsequent section of this memorandum, *Acela Ridership Methodology*.
2. Total eastbound Baseline annual ridership was adjusted to equal westbound Baseline annual ridership for each Boston-area station (South Station, Back Bay, and Route 128). The overall difference in directional ridership was distributed evenly amongst all eastbound trains.
3. In order to estimate 2035 horizon year ridership, average weekday ridership by train was estimated for No Growth (equal to Baseline), Low Growth (145% of Baseline), and High Growth (175% of Baseline) scenarios. The assumptions for growth percentages and days run per year are consistent with those used in the prior (September 2013) Amtrak projections.

[4] Service elasticity refers to the degree to which ridership changes in response to changes in the frequency of service offered. Service elasticity is measured as the percentage change in ridership resulting from a one percent change in service frequency. For example, a service elasticity of 0.5 means that each one percent increase in frequency causes ridership to increase by 0.5 percent. A service elasticity of less than 1 is considered to be inelastic because a change in service frequency causes less than a proportional change in ridership. In contrast, a service elasticity of greater than 1 is considered to be elastic, corresponding to a change in service frequency causing more than a proportional change in ridership.

Inland Route Ridership Methodology

In 2012, AECOM prepared a ridership forecast for the New Haven to Boston corridor built around a service plan of five round trips a day and a horizon year of 2030. Amtrak used this AECOM forecast, (with adjustment factors to account for service frequency and horizon year changes), to prepare SSX ridership estimates based on the September 2013 service plan, which consisted of 13 combined Inland Route Regional/New England Regional round trips per day. The November 2013 service plan update increased the number of combined Inland Route Regional/New England Regional trains from 13 to 16 round trips per day. The following outlines the methodology used by the SSX team to estimate 2035 Inland Route ridership based on the November 2013 service plan update (see Exhibit C for detailed calculations):

1. A service elasticity of 0.34[5] for Amtrak Regional service, based on the Amtrak travel demand model as reported in the *New Haven-Hartford-Springfield Rail Project Service Development Plan,* was used to prepare Inland Route ridership projections (see Exhibit C, Step 1).
2. Annual start-up ridership for the November 2013 operating plan, corresponding to 16 daily round trips, was estimated using the service elasticity in Step 1 above and the SSX ridership projections previously prepared by Amtrak in September 2013, which correspond to 13 daily round trips.[6] (Refer to Exhibit C, Step 2).
3. The demand split between South Station and Back Bay was calculated using FY 2012 demand splits, consistent with Amtrak's September 2013 projection methodology (see Exhibit C, Step 3).
4. All trains from the November 2013 service plan were assigned to a demand curve time slot (see Exhibit C, Step 4).
5. The Inland Route service demand curve prepared by Amtrak in September 2013 was adjusted to assign a demand percentage to each time slot associated with a proposed train. Adjustments were approximated based on overall demand trends from Amtrak's September 2013 projections. (Refer to Exhibit C, Step 5).
6. Inland Route ridership by station and train was calculated based on the estimated demand splits (Step 3) and the adjusted demand curve (Step 5). (Refer to Exhibit C, Step 6).

Acela Ridership Methodology

Amtrak's November 2013 service plan update increased Acela service from 10 existing round trips per day to a proposed 14 round trips per day. The following methodology was used by the SSX team to estimate 2035 Acela ridership, corresponding to the November 2013 service plan update (see Exhibit D for detailed calculations):

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[5] A service elasticity of 0.34 means that each one percent increase in frequency will cause ridership to increase by 0.34 percent.

[6] Industry research shows that ridership is more sensitive to service frequency changes in cases where prior service levels are comparatively low (*TCRP Report 95*). A service elasticity of 0.34 is relatively modest (as compared to the range of train service elasticities reported in *TCRP Report 95*) and therefore would be most appropriate for calculations involving modest service changes. As such, the Inland Route projections for the November 2013 service plan (16 daily round trips) were calculated using this 0.34 service elasticity with the September 2013 Amtrak projections (13 daily round trips) as opposed to the 2013 AECOM projections (5 daily round trips).

To check the order of magnitude of the results, the service elasticity corresponding to the projected ridership increase between the 2012 AECOM projections (93,232 annual Inland Route riders for a 5 daily round trip service) and the November 2013 projections (315,361 annual Inland Route riders for a 16 daily round trip service) was calculated. The resulting service elasticity, equal to 1.04, is within a reasonable order of magnitude, particularly given the very significant increase in train service.

1. A service elasticity of 0.35[7] for Amtrak Acela service, based on the Amtrak travel demand model as reported in the *New Haven-Hartford-Springfield Rail Project Service Development Plan,* was used to prepare the Acela ridership projections (see Exhibit D, Step 1).
2. Annual start-up ridership by station for the November 2013 operating plan, corresponding to 14 daily round trips, was estimated using the service elasticity in Step 1 above and existing (FY 2012) Acela ridership data. (Refer to Exhibit D, Step 2).
3. Baseline demand distribution curves by station were approximated based on existing demand distribution trends and proposed new service slots (see Exhibit D, Step 3).
4. Acela ridership by station and train was calculated based on the estimated ridership by station (Step 2) and the estimated demand curves (Step 3). (Refer to Exhibit D, Step 4).

Intercity Ridership Projection Summary

The final Amtrak-approved intercity ridership projections for the SSX project 2035 horizon year are summarized below in Table 2. By 2035, approximately 12,690 to 15,320 combined weekday boardings and alightings are projected for South Station, Back Bay and Route 128 stations based on the Low Growth and High Growth scenarios, respectively. Please refer to Exhibit B for detailed results.

Table 2 SSX Project 2035 Horizon Year Intercity Ridership Summary

	Weekday Boardings & Alightings (Per Nov. 2013 Service Plan Update)		
	Baseline/No Growth	**Low Growth Scenario**	**High Growth Scenario**
South Station	5,290	7,680	9,270
Back Bay	2,020	2,920	3,530
Route 128	1,440	2,090	2,520
TOTAL	**8,750**	**12,690**	**15,320**

Note: Results are rounded to the nearest 10.

[7] A service elasticity of 0.35 means that each one percent increase in frequency will cause ridership to increase by 0.35 percent.

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Exhibit A Amtrak Projected 2040 Horizon Year Ridership (September 2013)

Amtrak Projected 2040 Horizon Year Ridership Summary (September 2013)

Amtrak Projected 2040 Horizon Year Ridership Supplementary Background Materials
(September 2013)

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Table A-1 Amtrak Projected 2040 Horizon Year Ridership Summary (September 2013), Westbound/Southbound Trains

PROJECTED 2040 HORIZON-YEAR INTERCITY TRAIN USAGE
Weekday Passengers Boarding Westbound / Southbound Trains from South, Back Bay and Route 128 Stations

Constructed Weekday Service					Schedule / Frequency				Constructed Baseline			No Growth =			1	Est. Low Growth =			1.45	Est. High Growth =			1.75
	FY13	New	Total	Train	Inland Route			Days	Annual Weekday Ons			Avg. Wkdy Ons			Total	Avg. Wkdy Ons			Total	Avg. Wkdy Ons			Total
Route	Trains	Trains	Trains	Starts	BOS	SPG	NHV	Run	BOS	BBY	RTE	BOS	BBY	RTE	Avg.	BOS	BBY	RTE	Avg.	BOS	BBY	RTE	Avg.
	2151		2151	HST	5:10 A			252	6,909	3,203	11,845	27	13	47	87	40	18	68	126	48	22	82	152
Inland		5501	5501	NREG	5:30 A	7:15 A		252	3,729	1,415	-	15	6	-	20	21	8	-	30	26	10	-	36
	2153		2153	HST	6:05 A			247	13,242	5,955	18,993	54	24	77	155	78	35	111	224	94	42	135	271
	95		95	REG	6:10 A			252	14,479	5,035	9,044	57	20	36	113	83	29	52	164	101	35	63	198
Inland		143	143	REG	6:30 A	8:15 A	9:40 A	252	7,991	3,031	-	32	12	-	44	46	17	-	63	55	21	-	77
	2155		2155	HST	7:15 A			252	22,141	9,877	20,540	88	39	82	209	127	57	118	302	154	69	143	365
Inland		5503	5503	NREG	7:30 A	9:15 A		252	6,926	2,627	-	27	10	-	38	40	15	-	55	48	18	-	66
Shore L.		2157	2157	HST	8:15 A			252	22,909	9,830	17,241	91	39	68	198	132	57	99	288	159	68	120	347
	171		171	REG	8:20 A			252	31,015	12,001	12,752	123	48	51	221	178	69	73	321	215	83	89	387
Inland		5505	5505	NREG	8:30 A	10:15 A		252	5,860	2,223	-	23	9	-	32	34	13	-	47	41	15	-	56
	2159		2159	HST	9:15 A			251	23,676	9,782	13,942	94	39	56	189	137	57	81	274	165	68	97	330
Inland		145	145	REG	9:30 A	11:15 A	12:40 P	252	6,926	2,627	-	27	10	-	38	40	15	-	55	48	18	-	66
	83		83	REG	9:35 A			52	6,081	2,296	2,098	117	44	40	201	170	64	59	292	205	77	71	353
	93		93		9:35 A			200	21,614	8,488	6,791	108	42	34	184	157	62	49	267	189	74	59	323
Shore L.		2161	2161	HST	10:15 A			252	22,518	9,050	11,556	89	36	46	171	130	52	66	248	156	63	80	299
Inland		5507	5507		10:30 A	12:15 P		252	4,795	1,819	-	19	7	-	26	28	10	-	38	33	13	-	46
	173		173	REG	11:05 A			252	30,040	10,190	7,075	119	40	28	188	173	59	41	272	209	71	49	329
	2163		2163	HST	11:15 A			252	21,360	8,317	9,169	85	33	36	154	123	48	53	224	148	58	64	270
Inland	449		449	LD	11:55 A	1:50 P		260	15,349	3,939		59	15	-	74	86	22	-	108	103	27	-	130
	2165		2165		12:15 P			246	17,346	6,739	6,172	71	27	25	123	102	40	36	178	123	48	44	215
	2167		2167		1:15 P			252	23,466	9,056	8,500	93	36	34	163	135	52	49	236	163	63	59	285
Inland		5513	5513		1:30 P	3:15 P		252	5,327	2,021	-	21	8	-	29	31	12	-	42	37	14	-	51
	137		137	REG	1:40 P			252	32,640	11,904	6,686	130	47	27	203	188	68	38	295	227	83	46	356
Shore L.		2169	2169		2:15 P			252	26,949	10,099	8,512	107	40	34	181	155	58	49	262	187	70	59	316
Inland		5515	5515		2:30 P	4:15 P		252	7,458	2,829	-	30	11	-	41	43	16	-	59	52	20	-	71
	2171		2171		3:15 P			252	30,432	11,141	8,523	121	44	34	199	175	64	49	288	211	77	59	348
	175		175		3:20 P			252	40,003	14,941	5,425	159	59	22	240	230	86	31	347	278	104	38	419
Inland		147	147		3:30 P	5:15 P	6:40 P	252	10,122	3,839	-	40	15	-	55	58	22	-	80	70	27	-	97
	2173		2173		4:30 P			247	29,212	11,232	6,249	118	45	25	189	171	66	37	274	207	80	44	331
Inland		5517	5517		4:30 P	6:15 P		252	12,786	4,850	-	51	19	-	70	74	28	-	101	89	34	-	122
	2175		2175		5:20 P			250	25,960	10,263	4,271	104	41	17	162	151	60	25	235	182	72	30	283
	177		177		5:35 P			252	58,054	23,046	4,368	230	91	17	339	334	133	25	492	403	160	30	594
Inland		5597	5597		5:35 P	7:20 P	8:45 P	252	14,917	5,658	-	59	22	-	82	86	33	-	118	104	39	-	143
Shore L.		2177	2177		6:30 P			252	23,364	9,237	3,844	93	37	15	145	134	53	22	210	162	64	27	253
Inland		5519	5519		6:35 P	8:20 P		252	11,188	4,244	-	44	17	-	61	64	24	-	89	78	29	-	107
	179		179		6:45 P			252	42,008	16,773	3,582	167	67	14	247	242	97	21	359	292	116	25	433
Inland		5521	5521		7:35 P	9:20 P		252	8,524	3,233	-	34	13	-	47	49	19	-	68	59	22	-	82
Shore L.		2197	2197		7:40 P			252	17,523	6,928	2,883	70	27	11	108	101	40	17	157	122	48	20	190
	67		67	REG	9:30 P			260	21,027	5,490	1,957	81	21	8	110	117	31	11	159	142	37	13	192
HST	10	5	15	7	High Speed Train				745,866	285,225	212,017	103	39	37	171	149	57	53	248	179	69	64	300
REG	9	3	12	8	Regional Service																		
LD	1	-	1	1	Long Distance Service																		
NREG	-	10	10	3	New England Regional																		
				1	Spare Layover Space																		
TOTAL	20	18	38	20	Total SSX Layovers																		

Note 1: All trains run on the Shore Line via Providence and New London unless noted in the "Route" column
Note 2: Blue shaded trains operate on Inland Route via Framingham, Worcester, Springfield, Hartford, N. Haven
Note 3: Beige shaded trains with red font indicate new services on Shore Line

Prepared by Amtrak NECIID Department: ajg - 5/21/13 (Revised 9/19/13) ----- FOR PLANNING PURPOSES ONLY ----

Note: BOS = South Station, BBY = Back Bay, RTE = Route 128, SPG = Springfield, NHV = New Haven.

Table A-2 Amtrak Projected 2040 Horizon Year Ridership Summary (September 2013), Eastbound/Northbound Trains

PROJECTED 2040 HORIZON-YEAR INTERCITY TRAIN USAGE

Weekday Passengers Arriving from Eastbound / Northbound Trains at South, Back Bay and Route 128 Stations

Adjusted Weekday Service					Schedule / Frequency				Constructed Baseline			No Growth =			1	Est. Low Growth =			1.45	Est. High Growth =			1.75
	FY13	New	Total	Train	Inland Route			Days	Annual Weekday Ons			Avg. Wkdy Ons			Total	Avg. Wkdy Ons			Total	Avg. Wkdy Ons			Total
Route	Trains	Trains	Trains	Finish	NHV	SPG	BOS	Run	BOS	BBY	RTE	BOS	BBY	RTE	Avg.	BOS	BBY	RTE	Avg.	BOS	BBY	RTE	Avg.
	178		178	REG			12:25 A	248	13,429	5,506	6,210	54	22	25	101	79	32	36	147	95	39	44	177
Inland		5500	5500			6:05 A	7:50 A	252	14,917	5,658	-	59	22	-	82	86	33	-	118	104	39	-	143
	66		66	REG			8:00 A	252	58,126	22,571	2,549	231	90	10	330	334	130	15	479	404	157	18	578
Inland		5502	5502			7:05 A	8:50 A	252	13,851	5,254	-	55	21	-	76	80	30	-	110	96	36	-	133
Shore L.		2192	2192				9:00 A	252	22,000	7,519	8,825	87	30	35	152	127	43	51	221	153	52	61	266
	2190		2190				10:10 A	251	24,149	9,294	4,123	96	37	16	150	140	54	24	217	168	65	29	262
Inland		5590	5590		6:40 A	8:05 A	9:50 A	252	10,655	4,042	-	42	16	-	58	61	23	-	85	74	28	-	102
	190		190				10:59 A	252	32,492	10,421	2,978	129	41	12	182	187	60	17	264	226	72	21	319
Inland		5504	5504			9:20 A	11:05 A	252	4,262	1,617	-	17	6	-	23	25	9	-	34	30	11	-	41
	2150		2150				11:40 A	246	26,344	10,272	6,203	107	42	25	174	155	61	37	252	187	73	44	305
Inland		140	140		8:55 A	10:20 A	12:05 P	252	7,458	2,829	-	30	11	-	41	43	16	-	59	52	20	-	71
Shore L.		2152	2152				12:40 P	252	24,992	9,892	7,197	99	39	29	167	144	57	41	242	174	69	50	292
	170		170				12:53 P	251	33,611	12,237	5,166	134	49	21	203	194	71	30	295	234	85	36	356
	2154		2154				1:40 P	252	23,639	9,411	7,540	94	37	30	161	136	54	43	234	164	65	52	282
Inland		5508	5508			12:00 P	1:45 P	252	5,327	2,021	-	21	8	-	29	31	12	-	42	37	14	-	51
	172		172				3:12 P	252	37,540	14,766	8,058	149	59	32	240	216	85	46	347	261	103	56	419
Shore L.		2156	2156				2:40 P	252	23,440	8,958	8,324	93	36	33	162	135	52	48	234	163	62	58	283
	2158		2158				3:39 P	252	23,241	8,405	8,457	92	33	34	159	134	48	49	231	161	58	59	278
Inland		5512	5512			2:00 P	3:45 P	252	8,524	3,233	-	34	13	-	47	49	19	-	68	59	22	-	82
	86		86	REG			4:36 P	252	31,298	12,519	7,420	124	50	29	203	180	72	43	295	217	87	52	356
	2160		2160				4:41 P	247	22,513	8,662	9,571	91	35	39	165	132	51	56	239	160	61	68	289
Inland		5514	5514			3:30 P	5:15 P	252	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shore L.		2162	2162	HST			5:40 P	252	23,277	9,212	13,364	92	37	53	182	134	53	77	264	162	64	93	318
Inland		5516	5516			4:30 P	6:15 P	252	8,524	3,233	-	34	13	-	47	49	19	-	68	59	22	-	82
	174		174	REG			6:30 P	252	31,370	10,366	9,689	124	41	38	204	181	60	56	296	218	72	67	357
	2164		2164	HST			6:45 P	252	24,040	9,661	16,556	95	38	66	199	138	56	95	289	167	67	115	349
Inland		144	144	REG	4:05 P	5:30 P	7:15 P	252	8,524	3,233	-	34	13	-	47	49	19	-	68	59	22	-	82
	2166		2166	HST			7:39 P	252	21,397	8,253	14,557	85	33	58	175	123	47	84	254	149	57	101	307
	176		176	REG			8:12 P	252	22,857	7,469	8,730	91	30	35	155	132	43	50	225	159	52	61	271
Inland		5518	5518			6:30 P	8:15 P	252	8,524	3,233	-	34	13	-	47	49	19	-	68	59	22	-	82
	2168		2168	HST			8:43 P	252	21,986	9,084	15,749	87	36	62	186	127	52	91	269	153	63	109	325
Inland	448		448	LD			9:10 P	260	15,349	4,339		59	17	-	76	86	24	-	110	103	29	-	133
Inland		146	146	REG	6:10 P	7:35 P	9:20 P	252	6,393	2,425	-	25	10	-	35	37	14	-	51	44	17	-	61
	2170		2170	HST			9:40 P	252	19,932	8,407	14,341	79	33	57	169	115	48	83	246	138	58	100	296
	94		94	REG			9:52 P	252	18,973	6,635	8,013	75	26	32	133	109	38	46	193	132	46	56	233
Inland		5520	5520			8:45 P	10:30 P	252	3,196	1,212	-	13	5	-	17	18	7	-	25	22	8	-	31
	2172		2172	HST			10:39 P	252	17,426	7,551	10,599	69	30	42	141	100	43	61	205	121	52	74	247
Shore L.		2174	2174	HST			11:40 P	252	11,550	6,235	7,800	46	25	31	102	66	36	45	147	80	43	54	178
HST	10	5	15	7	High Speed Train				725,127	275,636	212,017	96	37	35	161	139	53	51	233	168	64	61	281
REG	9	3	12	8	Regional Service																		
LD	1	-	1	1	Long Distance Service																		
NREG	-	10	10	3	New England Regional																		
				1	Spare Layover Space																		
TOTAL	20	18	38	20	Total SSX Layovers																		

Note 1: All trains run on the Shore Line via Providence and New London unless noted in the "Route" column

Note 2: Blue shaded trains operate on Inland Route via Framingham, Worcester, Springfield, Hartford, N. Haven

Note 3: Beige shaded trains with red font indicate new services on Shore Line

Note 4: Eastbound total riders adjusted to equal westbound total riders

Prepared by Amtrak NECIID Department: ajg - 5/21/13 (Revised 9/19/13) -----FOR PLANNING PURPOSES ONLY -----

Note: BOS = South Station, BBY = Back Bay, RTE = Route 128, SPG = Springfield, NHV = New Haven.

Amtrak Projected 2040 Horizon Year Ridership Supplementary Background Materials (September 2013)

Table A-3 South Station and Back Bay Origin/Destination Ridership Forecasts for Inland Route Start-Up Service

		Baseline			Alternative C1 Base Fares *(Assumes 5 Regional Inland RTs/Day)*			South Station Expansion Project *(Baseline for Sept 2013 Op Plan Assumes 13 Regional Inland RTs/Day)*		
Station Pair (total)		Direct	Connect via NHV	Total	Direct	Connect via NHV	Total	From Alt C1	Headway Factor	Total
BOS	FRA	0	0	0	290	0	290	290	7.00	2,032
BOS	WOR	81	0	81	460	0	460	460	7.00	3,221
BOS	SPG	3,188	0	3,188	15,048	0	15,048	15,048	7.00	105,334
BOS	ENF	0	0	0	254	0	254	254	2.00	507
BOS	WNL	0	0	0	1,786	0	1,786	1,786	2.00	3,572
BOS	WND	0	0	0	117	0	117	117	2.00	235
BOS	HFD	0	0	0	19,158	0	19,158	19,158	2.00	38,316
BOS	BER	0	0	0	329	0	329	329	2.00	658
BOS	MDN	0	0	0	6,701	0	6,701	6,701	2.00	13,402
BOS	WFD	0	0	0	266	0	266	266	2.00	533
BBY	FRA	14	0	14	528	0	528	528	7.00	3,696
BBY	WOR	54	0	54	308	0	308	308	7.00	2,154
BBY	SPG	1,027	0	1,027	4,860	0	4,860	4,860	7.00	34,019
BBY	ENF	0	0	0	386	0	386	386	2.00	772
BBY	WNL	0	0	0	2,701	0	2,701	2,701	2.00	5,402
BBY	WND	0	0	0	178	0	178	178	2.00	357
BBY	HFD	0	0	0	28,893	0	28,893	28,893	2.00	57,786
BBY	BER	0	0	0	499	0	499	499	2.00	998
BBY	MDN	0	0	0	10,067	0	10,067	10,067	2.00	20,134
BBY	WFD	0	0	0	403	0	403	403	2.00	805
				4,364			**93,232**			**293,931**

Source: In 2012, AECOM Inc. provided horizon-year 2030 forecasts for ALT C-1. Amtrak provided train schedule Alternative C1.
Note: BOS and BBY volumes combined as intercity model does not discriminate between the two.

Table A-4 Assignment of Inland Route Ridership to South Station and Back Bay Stations – Using Current BOS/BBY Demand Split

FY'12 Actuals		
BOS	526,054	72.5%
BBY	199,668	27.5%
Shore Line	**725,722**	
Future Allocation		
BOS	213,100	72.5%
BBY	80,831	27.5%
Inland Rte	**293,931**	

Note: BOS = South Station, BBY = Back Bay

Amtrak Projected 2040 Horizon Year Ridership Supplementary Background Materials Con't.

Table A-5 Distribution of Westbound Inland Route Riders by Time of Day (September 2013)

Using Current NEC Ridership Demand Curve

FY'12	Time Slot	BOS	Percent
Actuals	4a -6a	6909	1.4%
Boarding	6a -8a	49862	9.8%
Trains	8a -10a	82386	16.1%
(WB)	10a -12p	51400	10.1%
	12p -2p	73452	14.4%
	2p -4p	70435	13.8%
	4p -6p	113226	22.2%
	6p -8p	42008	8.2%
	8p -10p	21027	4.1%
	Shore Line	510705	

Time periods with no value in them do not contain train departures for the respective period.

Using High Frequency Inland Rt Service Demand Curve

Future	Time Slot	Percent	BOS	BBY	Train No.
Allocation	4a - 5a	0.0%	-	-	
Boarding	5a - 6a	3.5%	3,729	1,415	5501
Trains	6a - 7a	7.5%	7,991	3,031	143
(WB)	7a - 8a	6.5%	6,926	2,627	5503
	8a - 9a	5.5%	5,860	2,223	5505
	9a -10a	6.5%	6,926	2,627	145
	10a -11a	4.5%	4,795	1,819	5507
	11a -12p	0.0%	-	-	
	12p - 1p	0.0%	-	-	
	1p - 2p	5.0%	5,327	2,021	5513
	2p - 3p	7.0%	7,458	2,829	5515
	3p - 4p	9.5%	10,122	3,839	147
	4p - 5p	12.0%	12,786	4,850	5517
	5p - 6p	14.0%	14,917	5,658	5597
	6p - 7p	10.5%	11,188	4,244	5519
	7p - 8p	8.0%	8,524	3,233	5521
	8p - 9p	0.0%	-	-	
	9p-10p	0.0%	-	-	
	10p -11p	0.0%	-	-	
	11p-12a	0.0%	-	-	
Inland Rte (One half of trips)		100.0%	106,550	40,416	

Note: BOS = South Station, BBY = Back Bay.

Table A-6 Distribution of Eastbound Inland Route Riders by Time of Day (September 2013)

Using Current NEC Ridership Demand Curve

FY'12	Time Slot	BOS	Percent
Actuals	7a -9a	58126	11.4%
Arriving	9a -11a	56641	11.1%
Trains	11a -1p	59955	11.7%
(EB)	1p -3p	61179	12.0%
	3p -5p	77052	15.1%
	5p -7p	55410	10.8%
	7p -9p	57277	11.2%
	9p -11p	56331	11.0%
	11p -1a	13429	2.6%
	Shore Line	495400	

Time periods with no value in them do not contain train arrivals for the respective period.

Using High Frequency Inland Rt Service Demand Curve

Future	Time Slot	Percent	BOS	BBY	Train No.
Allocation	4a - 5a	0.0%	-	-	
Arriving	5a - 6a	0.0%	-	-	
Trains	6a - 7a	0.0%	-	-	
(EB)	7a - 8a	14.0%	14,917	5,658	5500
	8a - 9a	13.0%	13,851	5,254	5502
	9a -10a	10.0%	10,655	4,042	5590
	10a -11a	4.0%	4,262	1,617	5504
	11a -12p	7.0%	7,458	2,829	140
	12p - 1p	0.0%	-	-	
	1p - 2p	5.0%	5,327	2,021	5508
	2p - 3p	0.0%	-	-	
	3p - 4p	8.0%	8,524	3,233	5512
	4p - 5p	0.0%	-	-	
	5p - 6p	8.0%	8,524	3,233	5514
	6p - 7p	9.0%	9,589	3,637	5516
	7p - 8p	8.0%	8,524	3,233	144
	8p - 9p	5.0%	5,327	2,021	5518
	9p-10p	6.0%	6,393	2,425	146
	10p-11p	3.0%	3,196	1,212	5520
	11p-12a	0.0%	-	-	
Inland Rte (One half of trips)		100.0%	106,550	40,416	

Note: BOS = South Station, BBY = Back Bay.

Exhibit B Amtrak-Approved SSX Project 2035 Horizon Year Ridership Summary (November 2013 Update)

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Table B-1 Amtrak-Approved SSX Project 2035 Horizon Year Ridership Summary (November 2013 Update), Westbound/Southbound Trains

PROJECTED 2035 HORIZON-YEAR INTERCITY TRAIN USAGE
Weekday Passengers Boarding Westbound / Southbound Trains from South, Back Bay and Route 128 Stations

Adjusted Weekday Service					Schedule / Frequency		FY '12 Constructed Baseline			2035 Low Growth = 1.45			2035 High Growth = 1.75			Baseline/No Growth = 1				2035 Est. Low Growth = 1.45				2035 Est. High Growth = 1.75			
	FY13	New	11/13 Op Plan	Train	Depart	Days	Annual Weekday Ons			Annual Weekday Ons			Annual Weekday Ons			Avg. Wkdy Ons			Total	Avg. Wkdy Ons			Total	Avg. Wkdy Ons			Total
Route	Trains	Trains	Train #		BOS	Run	BOS	BBY	RTE	BOS	BBY	RTE	BOS	BBY	RTE	BOS	BBY	RTE	Avg.	BOS	BBY	RTE	Avg.	BOS	BBY	RTE	Avg.
	2151		3151	HST	5:10 A	252	7,207	3,366	13,377	10,450	4,880	19,397	12,612	5,890	23,410	29	13	53	95	41	19	77	138	50	23	93	166
Inland		5501	5501	NREG	5:30 A	252	4,001	1,518	-	5,802	2,201	-	7,002	2,656	-	16	6	-	22	23	9	-	32	28	11	-	38
	95		95	REG	6:05 A	252	14,479	5,035	9,044	20,995	7,301	13,114	25,338	8,811	15,827	57	20	36	113	83	29	52	164	101	35	63	198
	2153		3153	HST	6:10 A	247	10,810	6,251	16,417	15,675	9,064	23,805	18,918	10,939	28,730	44	25	66	136	63	37	96	197	77	44	116	237
Inland		143	143	REG	6:10 A	252	8,574	3,252	-	12,432	4,716	-	15,004	5,691	-	34	13	-	47	49	19	-	68	60	23	-	82
	2155		3155	HST	7:10 A	252	14,414	7,693	17,633	20,900	11,155	25,569	25,224	13,463	30,859	57	31	70	158	83	44	101	229	100	53	122	276
Inland		5503	5503	NREG	7:10 A	252	7,431	2,819	-	10,775	4,087	-	13,004	4,932	-	29	11	-	41	43	16	-	59	52	20	-	71
Shore L.		3157	3157	HST	8:10 A	252	16,816	8,174	14,593	24,383	11,852	21,160	29,428	14,305	25,538	67	32	58	157	97	47	84	228	117	57	101	275
	171		171	REG	8:10 A	252	31,015	12,001	12,752	44,972	17,401	18,490	54,276	21,002	22,316	123	48	51	221	178	69	73	321	215	83	89	387
Inland		5505	5505	NREG	8:10 A	252	6,288	2,385	-	9,117	3,458	-	11,003	4,174	-	25	9	-	34	36	14	-	50	44	17	-	60
	2159		3159	HST	9:10 A	251	18,017	7,693	11,553	26,125	11,155	16,752	31,530	13,463	20,218	72	31	46	148	104	44	67	215	126	54	81	260
Inland		5507	5507	NREG	9:10 A	252	5,144	1,951	-	7,459	2,829	-	9,003	3,415	-	20	8	-	28	30	11	-	41	36	14	-	49
	83		83	REG	9:30 A	52	6,081	2,296	2,098	8,817	3,329	3,042	10,642	4,018	3,672	117	44	40	201	170	64	59	292	205	77	71	353
	93		93		9:30 A	200	21,614	8,488	6,791	31,340	12,308	9,847	37,825	14,854	11,884	108	42	34	184	157	62	49	267	189	74	59	323
Inland		145	145	REG	10:10 A	252	4,001	1,518	-	5,802	2,201	-	7,002	2,656	-	16	6	-	22	23	9	-	32	28	11	-	38
Shore L.		3161	3161	HST	10:10 A	252	16,816	6,732	8,513	24,383	9,761	12,343	29,428	11,780	14,897	67	27	34	127	97	39	49	184	117	47	59	223
	2163		3163	HST	11:10 A	252	14,414	5,289	6,081	20,900	7,669	8,817	25,224	9,256	10,641	57	21	24	102	83	30	35	148	100	37	42	179
Inland		5513	5513	NREG	11:10 A	252	3,430	1,301	-	4,973	1,886	-	6,002	2,277	-	14	5	-	19	20	7	-	27	24	9	-	33
Inland	449		449	LD	11:55 A	260	15,349	3,939	-	22,256	5,712	-	26,861	6,893	-	59	15	-	74	86	22	-	108	103	27	-	130
	173		173	REG	12:00 P	252	30,040	10,190	7,075	43,558	14,776	10,259	52,570	17,833	12,381	119	40	28	188	173	59	41	272	209	71	49	329
	2165		3165	HST	12:10 P	246	12,011	3,847	3,648	17,416	5,578	5,290	21,020	6,732	6,385	49	16	15	79	71	23	22	115	85	27	26	139
Inland		5517	5517	NREG	1:10 P	252	5,716	2,168	-	8,288	3,144	-	10,003	3,794	-	23	9	-	31	33	12	-	45	40	15	-	55
	2167		3167	HST	1:10 P	252	16,816	6,251	6,081	24,383	9,064	8,817	29,428	10,939	10,641	67	25	24	116	97	36	35	168	117	43	42	202
	137		137	REG	1:30 P	252	32,640	11,904	6,686	47,328	17,261	9,695	57,120	20,832	11,701	130	47	27	203	188	68	38	295	227	83	46	356
Shore L.		3169	3169	HST	2:10 P	252	21,620	7,693	6,689	31,349	11,155	9,698	37,836	13,463	11,705	86	31	27	143	124	44	38	207	150	53	46	250
Inland		5519	5519	NREG	2:10 P	252	8,002	3,035	-	11,603	4,401	-	14,004	5,312	-	32	12	-	44	46	17	-	64	56	21	-	77
	2171		3171	HST	3:10 P	252	26,425	8,655	6,081	38,316	12,550	8,817	46,244	15,146	10,641	105	34	24	163	152	50	35	237	184	60	42	286
Inland		5521	5521	NREG	3:10 P	252	10,860	4,119	-	15,747	5,973	-	19,005	7,209	-	43	16	-	59	62	24	-	86	75	29	-	104
	175		175	REG	3:35 P	252	40,003	14,941	5,425	58,004	21,664	7,866	70,005	26,147	9,494	159	59	22	240	230	86	31	347	278	104	38	419
Inland		147	147	REG	3:55 P	252	13,147	4,987	-	19,063	7,231	-	23,007	8,727	-	52	20	-	72	76	29	-	104	91	35	-	126
	2173		3173	HST	4:10 P	247	25,224	9,136	4,864	36,574	13,247	7,053	44,142	15,988	8,513	102	37	20	159	148	54	29	230	179	65	34	278
Inland		5525	5525	NREG	5:10 P	252	14,861	5,637	-	21,549	8,174	-	26,007	9,865	-	59	22	-	81	86	32	-	118	103	39	-	142
	2193		3175	HST	5:20 P	250	21,620	8,655	3,648	31,349	12,550	5,290	37,836	15,146	6,385	86	35	15	136	125	50	21	197	151	61	26	237
	177		177	REG	5:40 P	252	58,054	23,046	4,368	84,178	33,417	6,334	101,595	40,331	7,644	230	91	17	339	334	133	25	492	403	160	30	594
Inland		5527	5527	NREG	6:10 P	252	9,717	3,686	-	14,090	5,344	-	17,005	6,450	-	39	15	-	53	56	21	-	77	67	26	-	93
Shore L.		3197	3197	HST	6:20 P	252	18,017	6,732	2,432	26,125	9,761	3,527	31,530	11,780	4,256	71	27	10	108	104	39	14	156	125	47	17	189
Inland		149	149	REG	7:10 P	252	5,716	2,168	-	8,288	3,144	-	10,003	3,794	-	23	9	-	31	33	12	-	45	40	15	-	55
	179		179	REG	7:15 P	252	42,008	16,773	3,582	60,912	24,321	5,194	73,514	29,353	6,269	167	67	14	247	242	97	21	359	292	116	25	433
Inland		5531	5531	NREG	8:10 P	252	4,001	1,518	-	5,802	2,201	-	7,002	2,656	-	16	6	-	22	23	9	-	32	28	11	-	38
Inland		5533	5533	NREG	9:10 P	252	3,430	1,301	-	4,973	1,886	-	6,002	2,277	-	14	5	-	19	20	7	-	27	24	9	-	33
	67		67	REG	9:30 P	260	21,027	5,490	1,957	30,489	7,961	2,838	36,797	9,608	3,425	81	21	8	110	117	31	11	159	142	37	13	192
HST	10	4	14		High Speed Train		666,854	253,631	181,388	966,939	367,765	263,013	1,166,995	443,854	317,429	2,645	1,007	721	4,373	3,835	1,460	1,045	6,340	4,629	1,762	1,261	7,652
REG	9	4	13		Regional Service																						
LD	1	-	1		Long Distance Service																						
NREG	-	12	12		New England Regional																						
TOTAL	20	20	40																								

Note 1: All trains run on the Shore Line via Providence and New London unless noted in the "Route" column
Note 2: Blue shaded trains operate on Inland Route via Framingham, Worcester, Springfield, Hartford, N. Haven
Note 3: Beige shaded trains with red font indicate new services on Shore Line

Prepared by SSX Team: cd - 2/4/14 ----- FOR PLANNING PURPOSES ONLY ----

Note: BOS = South Station, BBY = Back Bay, RTE = Route 128.

Table B-2 Amtrak-Approved SSX Project 2035 Horizon Year Ridership Summary (November 2013 Update), Eastbound/Northbound Trains

PROJECTED 2035 HORIZON-YEAR INTERCITY TRAIN USAGE

Weekday Passengers Arriving from Eastbound / Northbound Trains at South, Back Bay and Route 128 Stations

Adjusted Weekday Service					Schedule / Frequency		FY '12 Constructed Baseline Annual Weekday Offs			2035 Low Growth = 1.45 Annual Weekday Offs			2035 High Growth = 1.75 Annual Weekday Offs			Baseline/No Growth = 1 Avg. Wkdy Offs				2035 Est. Low Growth = 1.45 Avg. Wkdy Offs				2035 Est. High Growth = 1.75 Avg. Wkdy Offs			
Route	FY13 Trains	New Trains	11/13 Op Plan Train #	Train	Arrive BOS	Days Run	BOS	BBY	RTE	BOS	BBY	RTE	BOS	BBY	RTE	BOS	BBY	RTE	Total Avg.	BOS	BBY	RTE	Total Avg.	BOS	BBY	RTE	Total Avg.
	178		178	REG	12:03 A	248	13,630	5,404	6,268	19,764	7,836	9,089	23,853	9,458	10,970	55	22	25	102	80	32	37	148	96	38	44	179
Inland		5500	5500	NREG	7:53 A	252	16,206	6,509	-	23,499	9,438	-	28,360	11,391	-	64	26	-	90	93	37	-	131	113	45	-	158
	66		66	REG	8:00 A	252	58,327	21,609	2,607	84,575	31,333	3,781	102,073	37,816	4,563	231	86	10	328	336	124	15	475	405	150	18	573
Inland		5502	5502	NREG	8:53 A	252	15,063	6,075	-	21,841	8,809	-	26,360	10,632	-	60	24	-	84	87	35	-	122	105	42	-	147
	2190		3190	HST	9:51 A	251	16,566	6,518	3,298	24,020	9,451	4,782	28,990	11,407	5,771	66	26	13	105	96	38	19	152	115	45	23	184
Inland		5504	5504	NREG	9:53 A	252	11,633	4,775	-	16,868	6,923	-	20,358	8,355	-	46	19	-	65	67	27	-	94	81	33	-	114
Shore L.		3192	3192	HST	10:35 A	252	17,825	6,986	3,881	25,846	10,130	5,627	31,193	12,225	6,791	71	28	15	114	103	40	22	165	124	49	27	199
Inland		140	140	REG	10:58 A	252	7,061	3,040	-	10,238	4,408	-	12,356	5,320	-	28	12	-	40	41	17	-	58	49	21	-	70
	190		190	REG	11:16 A	252	32,693	10,359	3,036	47,405	15,021	4,403	57,213	18,129	5,314	130	41	12	183	188	60	17	265	227	72	21	320
	2150		3150	HST	11:35 A	246	19,083	7,454	4,464	27,671	10,808	6,472	33,396	13,044	7,812	78	30	18	126	112	44	26	183	136	53	32	221
Inland		5506	5506	NREG	12:03 P	252	5,917	2,606	-	8,580	3,779	-	10,355	4,561	-	23	10	-	34	34	15	-	49	41	18	-	59
Shore L.		3152	3152	HST	12:35 P	252	17,825	6,986	5,047	25,846	10,130	7,318	31,193	12,225	8,832	71	28	20	118	103	40	29	172	124	49	35	207
	170		170	REG	12:51 P	251	33,812	12,175	5,224	49,028	17,654	7,575	59,172	21,307	9,143	135	49	21	204	195	70	30	296	236	85	36	357
Inland		5508	5508	NREG	1:03 P	252	4,203	1,956	-	6,094	2,836	-	7,354	3,423	-	17	8	-	24	24	11	-	35	29	14	-	43
	2154		3154	HST	1:35 P	252	16,566	6,518	5,630	24,020	9,451	8,163	28,990	11,407	9,852	66	26	22	114	95	38	32	165	115	45	39	199
Inland		142	142	REG	2:23 P	252	5,917	2,606	-	8,580	3,779	-	10,355	4,561	-	23	10	-	34	34	15	-	49	41	18	-	59
Shore L.		3156	3156	HST	2:35 P	252	16,566	6,051	6,213	24,020	8,773	9,008	28,990	10,589	10,872	66	24	25	114	95	35	36	166	115	42	43	200
	172		172	REG	2:51 P	252	37,741	14,704	8,116	54,725	21,321	11,769	66,047	25,733	14,204	150	58	32	240	217	85	47	348	262	102	56	421
	2158		3158	HST	3:35 P	252	16,566	6,051	6,795	24,020	8,773	9,853	28,990	10,589	11,892	66	24	27	117	95	35	39	169	115	42	47	204
Inland		5512	5512	NREG	4:03 P	252	7,061	3,040	-	10,238	4,408	-	12,356	5,320	-	28	12	-	40	41	17	-	58	49	21	-	70
	2160		3160	HST	4:35 P	247	16,566	6,051	7,961	24,020	8,773	11,544	28,990	10,589	13,932	67	24	32	124	97	36	47	180	117	43	56	217
	86		86	REG	4:41 P	252	31,499	12,457	7,503	45,674	18,063	10,880	55,124	21,800	13,131	125	49	30	204	181	72	43	296	219	87	52	357
Inland		5514	5514	NREG	5:23 P	252	8,204	3,474	-	11,895	5,037	-	14,356	6,079	-	33	14	-	46	47	20	-	67	57	24	-	81
Shore L.		3162	3162	HST	5:35 P	252	17,825	6,518	9,127	25,846	9,451	13,234	31,193	11,407	15,972	71	26	36	133	103	38	53	193	124	45	63	232
	174		174	REG	5:51 P	252	31,571	10,304	9,772	45,779	14,941	14,170	55,250	18,033	17,102	125	41	39	205	182	59	56	297	219	72	68	359
Inland		5516	5516	NREG	6:23 P	252	9,918	4,124	-	14,382	5,980	-	17,357	7,217	-	39	16	-	56	57	24	-	81	69	29	-	98
	2164		3164	HST	6:35 P	252	19,083	7,454	12,042	27,671	10,808	17,460	33,396	13,044	21,073	76	30	48	153	110	43	69	222	133	52	84	268
Inland		5518	5518	NREG	7:03 P	252	4,774	2,173	-	6,923	3,151	-	8,355	3,802	-	19	9	-	28	27	13	-	40	33	15	-	48
Inland		144	144	REG	7:27 P	252	4,774	2,173	-	6,923	3,151	-	8,355	3,802	-	19	9	-	28	27	13	-	40	33	15	-	48
	2166		3166	HST	7:35 P	252	20,342	7,921	14,956	29,496	11,486	21,687	35,599	13,862	26,173	81	31	59	172	117	46	86	249	141	55	104	300
	176		176	REG	7:49 P	252	23,058	7,407	8,813	33,435	10,741	12,779	40,352	12,963	15,423	92	29	35	156	133	43	51	226	160	51	61	273
Inland		5520	5520	NREG	8:03 P	252	5,917	2,606	-	8,580	3,779	-	10,355	4,561	-	23	10	-	34	34	15	-	49	41	18	-	59
	2168		3168	HST	8:35 P	252	20,342	8,389	15,539	29,496	12,164	22,532	35,599	14,681	27,193	81	33	62	176	117	48	89	255	141	58	108	307
Inland	448		448	LD	9:10 P	260	13,224	2,587	-	19,175	3,752	-	23,143	4,528	-	51	10	-	61	74	14	-	88	89	17	-	106
Inland		5522	5522	NREG	9:18 P	252	3,631	1,739	-	5,265	2,522	-	6,354	3,044	-	14	7	-	21	21	10	-	31	25	12	-	37
	2170		3170	HST	9:35 P	252	20,342	8,389	15,539	29,496	12,164	22,532	35,599	14,681	27,193	81	33	62	176	117	48	89	255	141	58	108	307
	94		94	REG	9:43 P	252	19,174	6,573	8,096	27,803	9,531	11,740	33,555	11,503	14,169	76	26	32	134	110	38	47	195	133	46	56	235
Inland		146	146	REG	9:46 P	252	3,631	1,739	-	5,265	2,522	-	6,354	3,044	-	14	7	-	21	21	10	-	31	25	12	-	37
	2172		3172	HST	10:35 P	252	19,083	8,389	11,459	27,671	12,164	16,615	33,396	14,681	20,053	76	33	45	154	110	48	66	224	133	58	80	270
Inland		5524	5524	NREG	10:53 P	252	3,631	1,739	-	5,265	2,522	-	6,354	3,044	-	14	7	-	21	21	10	-	31	25	12	-	37
HST	10	4	14		High Speed Train		666,854	253,631	181,388	966,938	367,765	263,013	1,166,994	443,854	317,429	2,649	1,008	721	4,379	3,842	1,462	1,046	6,349	4,637	1,764	1,262	7,663
REG	9	4	13		Regional Service																						
LD	1	-	1		Long Distance Service																						
NREG	-	12	12		New England Regional																						
TOTAL	20	20	40																								

Note 1: All trains run on the Shore Line via Providence and New London unless noted in the "Route" column

Note 2: Blue shaded trains operate on Inland Route via Framingham, Worcester, Springfield, Hartford, N. Haven

Note 3: Beige shaded trains with red font indicate new services on Shore Line

Note 4: Eastbound constructed baseline total riders adjusted to equal westbound total riders

BOS= 201 BBY= 438 RTE= 383

Prepared by SSX Team: cd - 2/4/14 ----- FOR PLANNING PURPOSES ONLY ----

Note: BOS = South Station, BBY = Back Bay, RTE = Route 128.

Exhibit C — Inland Route Ridership Calculations (November 2013 Update)

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Inland Route Ridership Calculations (November 2013 Update)

1. Assume Inland Regional service elasticity equals 0.34, based on the Amtrak travel demand model as reported in the *New Haven-Hartford-Springfield Rail Project Service Development Plan* for Amtrak Regional service (March 2011).

2. Calculate estimated start-up ridership for the proposed operating plan (November 2013 Update) with increased Inland Regional service from 13 to 16 round trips a day, based on the elasticity in Step 1 and previously prepared Amtrak ridership projection for SSX (September 2013). Midpoint Arc Elasticity (h) = (Q2-Q1)(F1+F2) / (F2-F1)(Q1+Q2)

Ridership 1	Ridership 2	Frequency 1 (RTs)	Frequency 2 (RTs)	Service Elasticity
293,931	315,361	13	16	0.34

3. Calculate the South Station/Back Bay (BOS/BBY) demand split using FY 2012 actual percentage splits. (Amtrak's September 2013 ridership projections were also based on FY 2012 actual splits.)

Assignment of Inland Route Ridership to BOS and BBY stations

	Using Current BOS / BBY Demand Split	
BOS	72.5%	228,637
BBY	27.5%	86,724
Inland Rte		**315,361**

4. Assign trains from the operating plan (November 2013 Update) to time slots. Please refer to the "Time Slot" and "Train No." columns in Tables C-1 and C-2.

5. Adjust the previously prepared Inland Route service demand curves (September 2013, see Tables A-5 and A-6 in Exhibit A) as necessary to assign demand percentages to all time periods associated with train departures/arrivals. Demand percentage adjustments are indicated in **bold** in the "Percent" column of Tables C-1 and C-2.

6. Calculate ridership by train based on the demand splits (Step 3) and the adjusted demand curves (Step 5). Westbound and eastbound ridership results by train are calculated below in Tables C-1 and C-2.

Inland Route Ridership Calculations (November 2013 Update) Con't.

Table C-1 Distribution of Westbound Inland Route Riders by Time of Day (November 2013 Update)

Future	Time Slot	Percent	BOS	BBY	Train No.
Allocation	4a - 5a	0.0%			
Boarding	5a - 6a	3.5%	4,001	1,518	5501
Trains	6a - 7a	7.5%	8,574	3,252	143
(WB)	7a - 8a	6.5%	7,431	2,819	5503
	8a - 9a	5.5%	6,288	2,385	5505
	9a -10a	**4.5%**	5,144	1,951	5507
	10a -11a	**3.5%**	4,001	1,518	145
	11a -12p	**3.0%**	3,430	1,301	5513
	12p - 1p	0.0%			
	1p - 2p	5.0%	5,716	2,168	5517
	2p - 3p	7.0%	8,002	3,035	5519
	3p - 4p	9.5%	10,860	4,119	5521
	4p - 5p	**11.5%**	13,147	4,987	147
	5p - 6p	**13.0%**	14,861	5,637	5525
	6p - 7p	**8.5%**	9,717	3,686	5527
	7p - 8p	**5.0%**	5,716	2,168	149
	8p - 9p	**3.5%**	4,001	1,518	5531
	9p-10p	**3.0%**	3,430	1,301	5533
	10p -11p	0.0%			
	11p-12a	0.0%			
	Inland Rte (One half of trips)	100.0%	114,318	43,362	

Note: BOS = South Station, BBY = Back Bay. Demand percentage adjustments are indicated in **bold** in the "Percent" column.

Table C-2 Distribution of Eastbound Inland Route Riders by Time of Day (November 2013 Update)

Future	Time Slot	Percent	BOS	BBY	Train No.
Allocation	4a - 5a	0.0%			
Arriving	5a - 6a	0.0%			
Trains	6a - 7a	0.0%			
(EB)	7a - 8a	14.0%	16,005	6,071	5500
	8a - 9a	13.0%	14,861	5,637	5502
	9a -10a	10.0%	11,432	4,336	5504
	10a -11a	**6.0%**	6,859	2,602	140
	11a -12p	**0.0%**			
	12p - 1p	**5.0%**	5,716	2,168	5506
	1p - 2p	**3.5%**	4,001	1,518	5508
	2p - 3p	**5.0%**	5,716	2,168	142
	3p - 4p	**0.0%**			
	4p - 5p	**6.0%**	6,859	2,602	5512
	5p - 6p	**7.0%**	8,002	3,035	5514
	6p - 7p	**8.5%**	9,717	3,686	5516
	7p - 7:30p	**4.0%**	4,573	1,734	5518
	7:30p - 8p	**4.0%**	4,573	1,734	144
	8p - 9p	5.0%	5,716	2,168	5520
	9p - 9:30p	**3.0%**	3,430	1,301	5522
	9:30p - 10p	**3.0%**	3,430	1,301	146
	10p-11p	3.0%	3,430	1,301	5524
	11p-12a	0.0%			
	Inland Rte (One half of trips)	100.0%	114,318	43,362	

Note: BOS = South Station, BBY = Back Bay. Demand percentage adjustments are indicated in **bold** in the "Percent" column.

Exhibit D Acela Ridership Calculations (November 2013 Update)

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Acela Ridership Calculations (November 2013 Update)

1. Assume Acela service elasticity equals 0.35, based on the Amtrak travel demand model as reported in the *New Haven-Hartford-Springfield Rail Project Service Development Plan* for Amtrak Acela service (March 2011).

2. Calculate total Baseline Acela ridership by station for the proposed operating plan (November 2013 Update) with increased Acela service from 10 to 14 roundtrips a day, based on the elasticity in Step 1 and FY 2012 Acela ridership. Midpoint Arc Elasticity (h) = (Q2-Q1)(F1+F2) / (F2-F1)(Q1+Q2)

Baseline Acela Ridership at South Station (Westbound)

Ridership 1	Ridership 2	Frequency 1	Frequency 2	Service Elasticity
213,744	240,226	10	14	0.35

Baseline Acela Ridership at South Station (Eastbound)

Ridership 1	Ridership 2	Frequency 1	Frequency 2	Service Elasticity
224,007	251,760	10	14	0.35

Baseline Acela Ridership at Back Bay (Westbound)

Ridership 1	Ridership 2	Frequency 1	Frequency 2	Service Elasticity
85,565	96,166	10	14	0.35

Baseline Acela Ridership at Back Bay (Eastbound)

Ridership 1	Ridership 2	Frequency 1	Frequency 2	Service Elasticity
83,227	93,538	10	14	0.35

Baseline Acela Ridership at Route 128 (Westbound)

Ridership 1	Ridership 2	Frequency 1	Frequency 2	Service Elasticity
108,204	121,610	10	14	0.35

Baseline Acela Ridership at Route 128 (Eastbound)

Ridership 1	Ridership 2	Frequency 1	Frequency 2	Service Elasticity
103,731	116,583	10	14	0.35

3. Estimate the proposed Baseline demand distribution by station based on existing demand distribution trends and proposed new service slots. Refer to the "Existing Demand Distribution" and "Proposed Baseline Demand Distribution" columns in Tables D-1 and D-2.

4. Calculate projected ridership by train based on the total ridership by station (Step 2) and the estimated demand distributions (Step 3). Westbound and eastbound ridership results by train are calculated in the "Estimated Baseline Ridership - All Trains" columns in Tables D-1 and D-2.

Table D-1 Ridership and Demand Distribution for Westbound Acela Riders by Train (November 2013 Update)

11/13 Op Plan Train #	Existing (FY 2012) Ridership			Existing (FY 2012) Demand Distribution			Proposed Baseline Demand Distribution			Estimated Baseline Ridership All Trains		
	BOS	BBY	RTE	BOS	BBY	RTE	BOS	BBY	RTE	BOS	BBY	RTE
3151	6,909	3,203	11,845	3.2%	3.7%	10.9%	3.0%	3.5%	11.0%	7,207	3,366	13,377
3153	13,242	5,955	18,993	6.2%	7.0%	17.6%	4.5%	6.5%	13.5%	10,810	6,251	16,417
3155	22,141	9,877	20,540	10.4%	11.5%	19.0%	6.0%	8.0%	14.5%	14,414	7,693	17,633
3157	-	-	-	-	-	-	7.0%	8.5%	12.0%	16,816	8,174	14,593
3159	23,676	9,782	13,942	11.1%	11.4%	12.9%	7.5%	8.0%	9.5%	18,017	7,693	11,553
3161	-	-	-	-	-	-	7.0%	7.0%	7.0%	16,816	6,732	8,513
3163	21,360	8,317	9,169	10.0%	9.7%	8.5%	6.0%	5.5%	5.0%	14,414	5,289	6,081
3165	17,346	6,739	6,172	8.1%	7.9%	5.7%	5.0%	4.0%	3.0%	12,011	3,847	3,648
3167	23,466	9,056	8,500	11.0%	10.6%	7.9%	7.0%	6.5%	5.0%	16,816	6,251	6,081
3169	-	-	-	-	-	-	9.0%	8.0%	5.5%	21,620	7,693	6,689
3171	30,432	11,141	8,523	14.2%	13.0%	7.9%	11.0%	9.0%	5.0%	26,425	8,655	6,081
3173	29,212	11,232	6,249	13.7%	13.1%	5.8%	10.5%	9.5%	4.0%	25,224	9,136	4,864
3175	25,960	10,263	4,271	12.1%	12.0%	3.9%	9.0%	9.0%	3.0%	21,620	8,655	3,648
3197	-	-	-	-	-	-	7.5%	7.0%	2.0%	18,017	6,732	2,432
SUM	**213,744**	**85,565**	**108,204**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**240,226**	**96,166**	**121,610**

Note: BOS = South Station, BBY = Back Bay, RTE = Route 128.

Table D-2 Ridership and Demand Distribution for Eastbound Acela Riders by Train (November 2013 Update)

11/13 Op Plan Train #	Existing (FY 2012) Ridership			Existing (FY 2012) Demand Distribution			Proposed Baseline Demand Distribution			Estimated Baseline Ridership All Trains		
	BOS	BBY	RTE	BOS	BBY	RTE	BOS	BBY	RTE	BOS	BBY	RTE
3190	24,149	8,794	3,798	10.8%	10.6%	3.7%	6.5%	6.5%	2.5%	16,364	6,080	2,915
3192	-	-	-	-	-	-	7.0%	7.0%	3.0%	17,623	6,548	3,497
3150	26,344	9,772	5,878	11.8%	11.7%	5.7%	7.5%	7.5%	3.5%	18,882	7,015	4,080
3152	-	-	-	-	-	-	7.0%	7.0%	4.0%	17,623	6,548	4,663
3154	23,639	8,911	7,215	10.6%	10.7%	7.0%	6.5%	6.5%	4.5%	16,364	6,080	5,246
3156	-	-	-	-	-	-	6.5%	6.0%	5.0%	16,364	5,612	5,829
3158	23,241	7,905	8,147	10.4%	9.5%	7.9%	6.5%	6.0%	5.5%	16,364	5,612	6,412
3160	22,513	8,162	9,271	10.1%	9.8%	8.9%	6.5%	6.0%	6.5%	16,364	5,612	7,578
3162	-	-	-	-	-	-	7.0%	6.5%	7.5%	17,623	6,080	8,744
3164	24,040	9,161	16,256	10.7%	11.0%	15.7%	7.5%	7.5%	10.0%	18,882	7,015	11,658
3166	21,397	7,753	14,257	9.6%	9.3%	13.7%	8.0%	8.0%	12.5%	20,141	7,483	14,573
3168	21,326	7,811	14,569	9.5%	9.4%	14.0%	8.0%	8.5%	13.0%	20,141	7,951	15,156
3170	19,932	7,907	14,041	8.9%	9.5%	13.5%	8.0%	8.5%	13.0%	20,141	7,951	15,156
3172	17,426	7,051	10,299	7.8%	8.5%	9.9%	7.5%	8.5%	9.5%	18,882	7,951	11,075
SUM	**224,007**	**83,227**	**103,731**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**251,760**	**93,538**	**116,583**

Note: BOS = South Station, BBY = Back Bay, RTE = Route 128.

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Attachment H Transportation Analysis Zone (TAZ) Subareas Surrounding South Station

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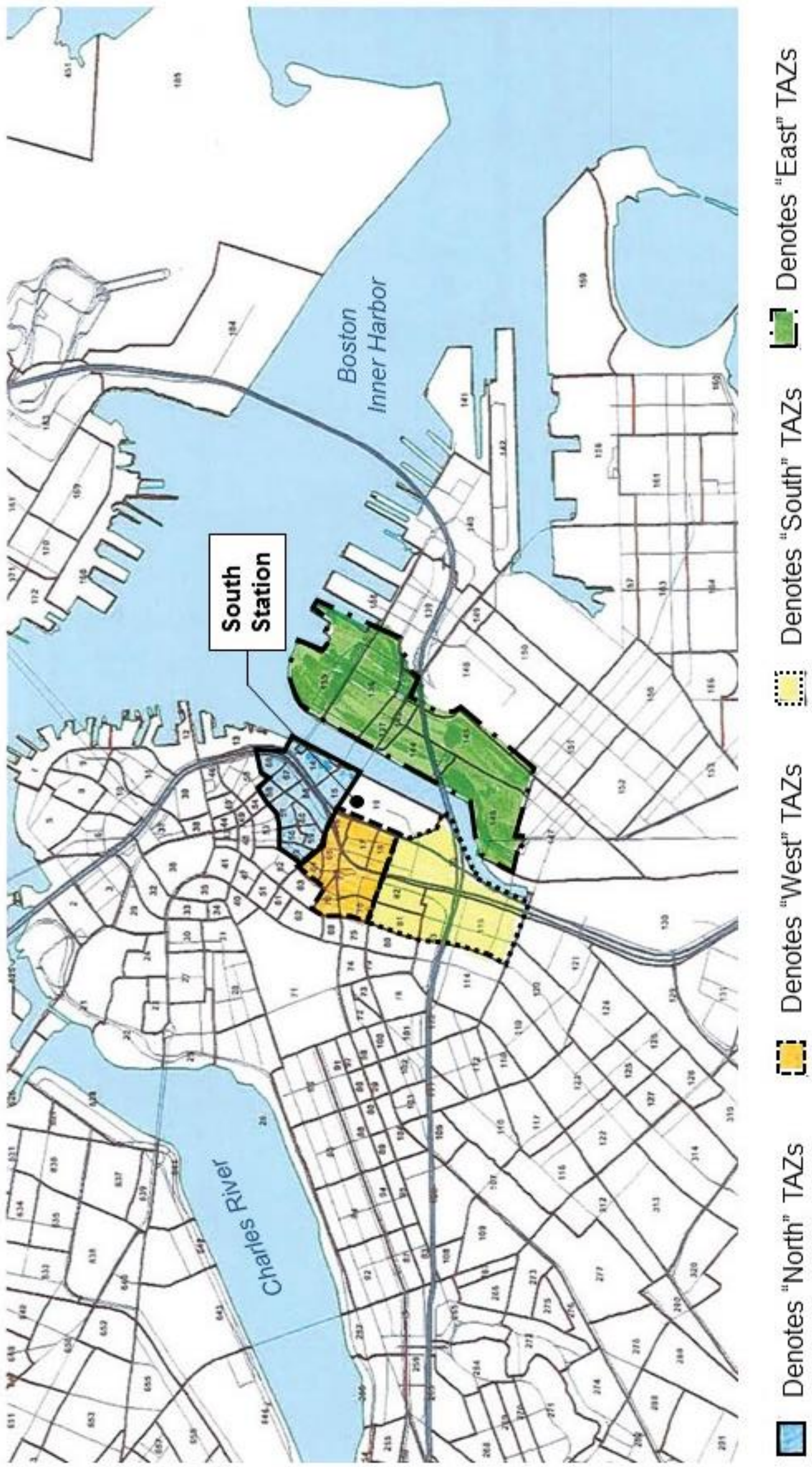
Transportation Analysis Zone (TAZ) Subareas Surrounding South Station



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Attachment I 2025 Opening Year Ridership Interpolation Methodology

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CTPS CENTRAL TRANSPORTATION PLANNING STAFF
Staff to the Boston Region Metropolitan Planning Organization

MEMORANDUM

DATE **December 3, 2013**

TO **Matt Ciborowski, MassDOT**
Kristine Wickham-Zimmerman, Joseph Wanat, and Caroline Ducas, VHB

FROM **Bruce Kaplan and Ying Bao**
CTPS Staff

RE **Methodology for Interpolating Modeling Results for Year 2025**

In lieu of performing model runs for the year 2025 for the South Station Expansion project, CTPS was requested to suggest a methodology for using the existing model outputs from the base year (2009/2010) model run and 2035 model runs to derive forecasts for 2025.

The future year 2025 roadway and transit networks are relatively similar to those in the 2035 horizon year, thus no major discrepancies between the 2035 results and any 2025 results are anticipated as a result of network changes. All of the MPO's programmed transit projects (including South Coast Rail) and the majority of programmed roadway projects are scheduled to be completed by 2025. Only four programmed highway projects (listed below) are scheduled to be completed between 2025 and 2035. However, none of them are located in the immediate South Station study area.

- Route 126/Route 135 Grade Separation – Framingham
- I-93/Route 3 (Braintree Split) – Braintree
- I-93/I-95 Interchange – Reading, Woburn
- Route 1 Improvements – Malden, Revere, Saugus

One way of accounting for the growth in transit boardings, alightings, and transfers, as well as roadway volumes for 2025 is to use the associated growth rates in employment and households as a proxy. Table 1 on the next page shows the total household, population, and employment by year within 101 communities of MAPC region.

State Transportation Building • Ten Park Plaza, Suite 2150 • Boston, MA 02116-3968 • (617) 973-7100 • Fax (617) 973-8855 • TTY (617) 973-7089 • ctps@ctps.org

TABLE 1
Household, Population and Employment in MAPC Region

Year	Household	Population	Employment
2009	1,282,858	3,139,718	1,810,686
2020	1,359,446	3,294,000	1,921,000
2025	1,398,359	3,353,500	1,926,500
2030	1,437,272	3,413,000	1,932,000
2035	1,464,349	3,475,000	1,937,000

As Table 1 shows, approximately 93% of the employment growth and approximately 63% of the household growth, in the 101 MAPC communities, from 2009 to 2035, occurs by 2025. Both of these growth percentages are higher than the growth percentage derived by a direct linear interpolation. Therefore, CTPS recommends applying a factor of 78% (the average between the two aforementioned growth percentages) to the projected growth between the 2009 and 2035 results to estimate forecasts for 2025 transit boardings, alightings, transfers, and roadway volumes.

BK/YB/BK/bk

Attachment J Final SSX Ridership Results

- Final Amtrak Projections
- Final Pedestrian Transfer Matrices
- Final Geographic Distribution of Ridership To/From Surrounding Neighborhoods
- Final Ridership Summaries

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PROJECTED 2035 HORIZON-YEAR INTERCITY TRAIN USAGE

Weekday Passengers Boarding Westbound / Southbound Trains from South, Back Bay and Route 128 Stations

Adjusted Weekday Service					Schedule / Frequency		FY '12 Constructed Baseline			2035 Low Growth = 1.45			2035 High Growth = 1.75			Baseline/No Growth = 1				2035 Est. Low Growth = 1.45				2035 Est. High Growth = 1.75			
	FY13	New	11/13 Op Plan	Train	Depart	Days	Annual Weekday Ons			Annual Weekday Ons			Annual Weekday Ons			Avg. Wkdy Ons			Total	Avg. Wkdy Ons			Total	Avg. Wkdy Ons			Total
Route	Trains	Trains	Train #		BOS	Run	BOS	BBY	RTE	BOS	BBY	RTE	BOS	BBY	RTE	BOS	BBY	RTE	Avg.	BOS	BBY	RTE	Avg.	BOS	BBY	RTE	Avg.
	2151		3151	HST	5:10 A	252	7,207	3,366	13,377	10,450	4,880	19,397	12,612	5,890	23,410	29	13	53	95	41	19	77	138	50	23	93	166
Inland		5501	5501	NREG	5:30 A	252	4,001	1,518	-	5,802	2,201	-	7,002	2,656	-	16	6	-	22	23	9	-	32	28	11	-	38
	95		95	REG	6:05 A	252	14,479	5,035	9,044	20,995	7,301	13,114	25,338	8,811	15,827	57	20	36	113	83	29	52	164	101	35	63	198
	2153		3153	HST	6:10 A	247	10,810	6,251	16,417	15,675	9,064	23,805	18,918	10,939	28,730	44	25	66	136	63	37	96	197	77	44	116	237
Inland		143	143	REG	6:10 A	252	8,574	3,252	-	12,432	4,716	-	15,004	5,691	-	34	13	-	47	49	19	-	68	60	23	-	82
	2155		3155	HST	7:10 A	252	14,414	7,693	17,633	20,900	11,155	25,569	25,224	13,463	30,859	57	31	70	158	83	44	101	229	100	53	122	276
Inland		5503	5503	NREG	7:10 A	252	7,431	2,819	-	10,775	4,087	-	13,004	4,932	-	29	11	-	41	43	16	-	59	52	20	-	71
Shore L.		3157	3157	HST	8:10 A	252	16,816	8,174	14,593	24,383	11,852	21,160	29,428	14,305	25,538	67	32	58	157	97	47	84	228	117	57	101	275
	171		171	REG	8:10 A	252	31,015	12,001	12,752	44,972	17,401	18,490	54,276	21,002	22,316	123	48	51	221	178	69	73	321	215	83	89	387
Inland		5505	5505	NREG	8:10 A	252	6,288	2,385	-	9,117	3,458	-	11,003	4,174	-	25	9	-	34	36	14	-	50	44	17	-	60
	2159		3159	HST	9:10 A	251	18,017	7,693	11,553	26,125	11,155	16,752	31,530	13,463	20,218	72	31	46	148	104	44	67	215	126	54	81	260
Inland		5507	5507	NREG	9:10 A	252	5,144	1,951	-	7,459	2,829	-	9,003	3,415	-	20	8	-	28	30	11	-	41	36	14	-	49
	83		83	REG	9:30 A	52	6,081	2,296	2,098	8,817	3,329	3,042	10,642	4,018	3,672	117	44	40	201	170	64	59	292	205	77	71	353
	93		93		9:30 A	200	21,614	8,488	6,791	31,340	12,308	9,847	37,825	14,854	11,884	108	42	34	184	157	62	49	267	189	74	59	323
Inland		145	145	REG	10:10 A	252	4,001	1,518	-	5,802	2,201	-	7,002	2,656	-	16	6	-	22	23	9	-	32	28	11	-	38
Shore L.		3161	3161	HST	10:10 A	252	16,816	6,732	8,513	24,383	9,761	12,343	29,428	11,780	14,897	67	27	34	127	97	39	49	184	117	47	59	223
	2163		3163	HST	11:10 A	252	14,414	5,289	6,081	20,900	7,669	8,817	25,224	9,256	10,641	57	21	24	102	83	30	35	148	100	37	42	179
Inland		5513	5513	NREG	11:10 A	252	3,430	1,301	-	4,973	1,886	-	6,002	2,277	-	14	5	-	19	20	7	-	27	24	9	-	33
Inland	449		449	LD	11:55 A	260	15,349	3,939	-	22,256	5,712	-	26,861	6,893	-	59	15	-	74	86	22	-	108	103	27	-	130
	173		173	REG	12:00 P	252	30,040	10,190	7,075	43,558	14,776	10,259	52,570	17,833	12,381	119	40	28	188	173	59	41	272	209	71	49	329
	2165		3165	HST	12:10 P	246	12,011	3,847	3,648	17,416	5,578	5,290	21,020	6,732	6,385	49	16	15	79	71	23	22	115	85	27	26	139
Inland		5517	5517	NREG	1:10 P	252	5,716	2,168	-	8,288	3,144	-	10,003	3,794	-	23	9	-	31	33	12	-	45	40	15	-	55
	2167		3167	HST	1:10 P	252	16,816	6,251	6,081	24,383	9,064	8,817	29,428	10,939	10,641	67	25	24	116	97	36	35	168	117	43	42	202
	137		137	REG	1:30 P	252	32,640	11,904	6,686	47,328	17,261	9,695	57,120	20,832	11,701	130	47	27	203	188	68	38	295	227	83	46	356
Shore L.		3169	3169	HST	2:10 P	252	21,620	7,693	6,689	31,349	11,155	9,698	37,836	13,463	11,705	86	31	27	143	124	44	38	207	150	53	46	250
Inland		5519	5519	NREG	2:10 P	252	8,002	3,035	-	11,603	4,401	-	14,004	5,312	-	32	12	-	44	46	17	-	64	56	21	-	77
	2171		3171	HST	3:10 P	252	26,425	8,655	6,081	38,316	12,550	8,817	46,244	15,146	10,641	105	34	24	163	152	50	35	237	184	60	42	286
Inland		5521	5521	NREG	3:10 P	252	10,860	4,119	-	15,747	5,973	-	19,005	7,209	-	43	16	-	59	62	24	-	86	75	29	-	104
	175		175	REG	3:35 P	252	40,003	14,941	5,425	58,004	21,664	7,866	70,005	26,147	9,494	159	59	22	240	230	86	31	347	278	104	38	419
Inland		147	147	REG	3:55 P	252	13,147	4,987	-	19,063	7,231	-	23,007	8,727	-	52	20	-	72	76	29	-	104	91	35	-	126
	2173		3173	HST	4:10 P	247	25,224	9,136	4,864	36,574	13,247	7,053	44,142	15,988	8,513	102	37	20	159	148	54	29	230	179	65	34	278
Inland		5525	5525	NREG	5:10 P	252	14,861	5,637	-	21,549	8,174	-	26,007	9,865	-	59	22	-	81	86	32	-	118	103	39	-	142
	2193		3175	HST	5:20 P	250	21,620	8,655	3,648	31,349	12,550	5,290	37,836	15,146	6,385	86	35	15	136	125	50	21	197	151	61	26	237
	177		177	REG	5:40 P	252	58,054	23,046	4,368	84,178	33,417	6,334	101,595	40,331	7,644	230	91	17	339	334	133	25	492	403	160	30	594
Inland		5527	5527	NREG	6:10 P	252	9,717	3,686	-	14,090	5,344	-	17,005	6,450	-	39	15	-	53	56	21	-	77	67	26	-	93
Shore L.		3197	3197	HST	6:20 P	252	18,017	6,732	2,432	26,125	9,761	3,527	31,530	11,780	4,256	71	27	10	108	104	39	14	156	125	47	17	189
Inland		149	149	REG	7:10 P	252	5,716	2,168	-	8,288	3,144	-	10,003	3,794	-	23	9	-	31	33	12	-	45	40	15	-	55
	179		179	REG	7:15 P	252	42,008	16,773	3,582	60,912	24,321	5,194	73,514	29,353	6,269	167	67	14	247	242	97	21	359	292	116	25	433
Inland		5531	5531	NREG	8:10 P	252	4,001	1,518	-	5,802	2,201	-	7,002	2,656	-	16	6	-	22	23	9	-	32	28	11	-	38
Inland		5533	5533	NREG	9:10 P	252	3,430	1,301	-	4,973	1,886	-	6,002	2,277	-	14	5	-	19	20	7	-	27	24	9	-	33
	67		67	REG	9:30 P	260	21,027	5,490	1,957	30,489	7,961	2,838	36,797	9,608	3,425	81	21	8	110	117	31	11	159	142	37	13	192
HST	10	4	14		High Speed Train		666,854	253,631	181,388	966,939	367,765	263,013	1,166,995	443,854	317,429	2,645	1,007	721	4,373	3,835	1,460	1,045	6,340	4,629	1,762	1,261	7,652
REG	9	4	13		Regional Service																						
LD	1	-	1		Long Distance Service																						
NREG	-	12	12		New England Regional																						
TOTAL	20	20	40																								

Note 1: All trains run on the Shore Line via Providence and New London unless noted in the "Route" column

Note 2: Blue shaded trains operate on Inland Route via Framingham, Worcester, Springfield, Hartford, N. Haven

Note 3: Beige shaded trains with red font indicate new services on Shore Line

Prepared by SSX Team: cd - 2/4/14 ----- FOR PLANNING PURPOSES ONLY ----

PROJECTED 2035 HORIZON-YEAR INTERCITY TRAIN USAGE
Weekday Passengers Arriving from Eastbound / Northbound Trains at South, Back Bay and Route 128 Stations

Adjusted Weekday Service					Schedule / Frequency		FY '12 Constructed Baseline			2035 Low Growth = 1.45			2035 High Growth = 1.75			Baseline/No Growth = 1				2035 Est. Low Growth = 1.45				2035 Est. High Growth = 1.75			
	FY13	New	11/13 Op Plan	Train	Arrive	Days	Annual Weekday Offs			Annual Weekday Offs			Annual Weekday Offs			Avg. Wkdy Offs			Total	Avg. Wkdy Offs			Total	Avg. Wkdy Offs			Total
Route	Trains	Trains	Train #		BOS	Run	BOS	BBY	RTE	BOS	BBY	RTE	BOS	BBY	RTE	BOS	BBY	RTE	Avg.	BOS	BBY	RTE	Avg.	BOS	BBY	RTE	Avg.
	178		178	REG	12:03 A	248	13,630	5,404	6,268	19,764	7,836	9,089	23,853	9,458	10,970	55	22	25	102	80	32	37	148	96	38	44	179
Inland		5500	5500	NREG	7:53 A	252	16,206	6,509	-	23,499	9,438	-	28,360	11,391	-	64	26	-	90	93	37	-	131	113	45	-	158
	66		66	REG	8:00 A	252	58,327	21,609	2,607	84,575	31,333	3,781	102,073	37,816	4,563	231	86	10	328	336	124	15	475	405	150	18	573
Inland		5502	5502	NREG	8:53 A	252	15,063	6,075	-	21,841	8,809	-	26,360	10,632	-	60	24	-	84	87	35	-	122	105	42	-	147
	2190		3190	HST	9:51 A	251	16,566	6,518	3,298	24,020	9,451	4,782	28,990	11,407	5,771	66	26	13	105	96	38	19	152	115	45	23	184
Inland		5504	5504	NREG	9:53 A	252	11,633	4,775	-	16,868	6,923	-	20,358	8,355	-	46	19	-	65	67	27	-	94	81	33	-	114
Shore L.		3192	3192	HST	10:35 A	252	17,825	6,986	3,881	25,846	10,130	5,627	31,193	12,225	6,791	71	28	15	114	103	40	22	165	124	49	27	199
Inland		140	140	REG	10:58 A	252	7,061	3,040	-	10,238	4,408	-	12,356	5,320	-	28	12	-	40	41	17	-	58	49	21	-	70
	190		190	REG	11:16 A	252	32,693	10,359	3,036	47,405	15,021	4,403	57,213	18,129	5,314	130	41	12	183	188	60	17	265	227	72	21	320
	2150		3150	HST	11:35 A	246	19,083	7,454	4,464	27,671	10,808	6,472	33,396	13,044	7,812	78	30	18	126	112	44	26	183	136	53	32	221
Inland		5506	5506	NREG	12:03 P	252	5,917	2,606	-	8,580	3,779	-	10,355	4,561	-	23	10	-	34	34	15	-	49	41	18	-	59
Shore L.		3152	3152	HST	12:35 P	252	17,825	6,986	5,047	25,846	10,130	7,318	31,193	12,225	8,832	71	28	20	118	103	40	29	172	124	49	35	207
	170		170	REG	12:51 P	251	33,812	12,175	5,224	49,028	17,654	7,575	59,172	21,307	9,143	135	49	21	204	195	70	30	296	236	85	36	357
Inland		5508	5508	NREG	1:03 P	252	4,203	1,956	-	6,094	2,836	-	7,354	3,423	-	17	8	-	24	24	11	-	35	29	14	-	43
	2154		3154	HST	1:35 P	252	16,566	6,518	5,630	24,020	9,451	8,163	28,990	11,407	9,852	66	26	22	114	95	38	32	165	115	45	39	199
Inland		142	142	REG	2:23 P	252	5,917	2,606	-	8,580	3,779	-	10,355	4,561	-	23	10	-	34	34	15	-	49	41	18	-	59
Shore L.		3156	3156	HST	2:35 P	252	16,566	6,051	6,213	24,020	8,773	9,008	28,990	10,589	10,872	66	24	25	114	95	35	36	166	115	42	43	200
	172		172	REG	2:51 P	252	37,741	14,704	8,116	54,725	21,321	11,769	66,047	25,733	14,204	150	58	32	240	217	85	47	348	262	102	56	421
	2158		3158	HST	3:35 P	252	16,566	6,051	6,795	24,020	8,773	9,853	28,990	10,589	11,892	66	24	27	117	95	35	39	169	115	42	47	204
Inland		5512	5512	NREG	4:03 P	252	7,061	3,040	-	10,238	4,408	-	12,356	5,320	-	28	12	-	40	41	17	-	58	49	21	-	70
	2160		3160	HST	4:35 P	247	16,566	6,051	7,961	24,020	8,773	11,544	28,990	10,589	13,932	67	24	32	124	97	36	47	180	117	43	56	217
	86		86	REG	4:41 P	252	31,499	12,457	7,503	45,674	18,063	10,880	55,124	21,800	13,131	125	49	30	204	181	72	43	296	219	87	52	357
Inland		5514	5514	NREG	5:23 P	252	8,204	3,474	-	11,895	5,037	-	14,356	6,079	-	33	14	-	46	47	20	-	67	57	24	-	81
Shore L.		3162	3162	HST	5:35 P	252	17,825	6,518	9,127	25,846	9,451	13,234	31,193	11,407	15,972	71	26	36	133	103	38	53	193	124	45	63	232
	174		174	REG	5:51 P	252	31,571	10,304	9,772	45,779	14,941	14,170	55,250	18,033	17,102	125	41	39	205	182	59	56	297	219	72	68	359
Inland		5516	5516	NREG	6:23 P	252	9,918	4,124	-	14,382	5,980	-	17,357	7,217	-	39	16	-	56	57	24	-	81	69	29	-	98
	2164		3164	HST	6:35 P	252	19,083	7,454	12,042	27,671	10,808	17,460	33,396	13,044	21,073	76	30	48	153	110	43	69	222	133	52	84	268
Inland		5518	5518	NREG	7:03 P	252	4,774	2,173	-	6,923	3,151	-	8,355	3,802	-	19	9	-	28	27	13	-	40	33	15	-	48
Inland		144	144	REG	7:27 P	252	4,774	2,173	-	6,923	3,151	-	8,355	3,802	-	19	9	-	28	27	13	-	40	33	15	-	48
	2166		3166	HST	7:35 P	252	20,342	7,921	14,956	29,496	11,486	21,687	35,599	13,862	26,173	81	31	59	172	117	46	86	249	141	55	104	300
	176		176	REG	7:49 P	252	23,058	7,407	8,813	33,435	10,741	12,779	40,352	12,963	15,423	92	29	35	156	133	43	51	226	160	51	61	273
Inland		5520	5520	NREG	8:03 P	252	5,917	2,606	-	8,580	3,779	-	10,355	4,561	-	23	10	-	34	34	15	-	49	41	18	-	59
	2168		3168	HST	8:35 P	252	20,342	8,389	15,539	29,496	12,164	22,532	35,599	14,681	27,193	81	33	62	176	117	48	89	255	141	58	108	307
Inland	448		448	LD	9:10 P	260	13,224	2,587	-	19,175	3,752	-	23,143	4,528	-	51	10	-	61	74	14	-	88	89	17	-	106
Inland		5522	5522	NREG	9:18 P	252	3,631	1,739	-	5,265	2,522	-	6,354	3,044	-	14	7	-	21	21	10	-	31	25	12	-	37
	2170		3170	HST	9:35 P	252	20,342	8,389	15,539	29,496	12,164	22,532	35,599	14,681	27,193	81	33	62	176	117	48	89	255	141	58	108	307
	94		94	REG	9:43 P	252	19,174	6,573	8,096	27,803	9,531	11,740	33,555	11,503	14,169	76	26	32	134	110	38	47	195	133	46	56	235
Inland		146	146	REG	9:46 P	252	3,631	1,739	-	5,265	2,522	-	6,354	3,044	-	14	7	-	21	21	10	-	31	25	12	-	37
	2172		3172	HST	10:35 P	252	19,083	8,389	11,459	27,671	12,164	16,615	33,396	14,681	20,053	76	33	45	154	110	48	66	224	133	58	80	270
Inland		5524	5524	NREG	10:53 P	252	3,631	1,739	-	5,265	2,522	-	6,354	3,044	-	14	7	-	21	21	10	-	31	25	12	-	37
HST	10	4	14		High Speed Train		666,854	253,631	181,388	966,938	367,765	263,013	1,166,994	443,854	317,429	2,649	1,008	721	4,379	3,842	1,462	1,046	6,349	4,637	1,764	1,262	7,663
REG	9	4	13		Regional Service																						
LD	1	-	1		Long Distance Service																						
NREG	-	12	12		New England Regional																						
TOTAL	20	20	40																								

Note 1: All trains run on the Shore Line via Providence and New London unless noted in the "Route" column
Note 2: Blue shaded trains operate on Inland Route via Framingham, Worcester, Springfield, Hartford, N. Haven
Note 3: Beige shaded trains with red font indicate new services on Shore Line
Note 4: Eastbound constructed baseline total riders adjusted to equal westbound total riders

BOS= 201 BBY= 438 RTE= 383

Prepared by SSX Team: cd - 2/4/14 ----- FOR PLANNING PURPOSES ONLY ----

Base Year (2009-2010) Transfer Activities in South Station

AM Peak (6 am - 9 am)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	66	3,216	586	14	129	73	33	3	2	19	11,316	15,457
Red Line	380	0	2,221	4	173	440	130	1	4	6	7,070	10,429
Silver Line	12	213	0	0	5	4	3	0	1	0	160	398
Taxi	0	4	1	0	0	23	46	0	0	0	16	90
MBTA Bus	8	80	15	0	12	27	0	0	0	0	206	348
Commuter/Intercity Bus	10	439	23	27	57	19	7	5	0	3	790	1,380
AMTRAK	2	38	5	12	0	2	0	0	0	0	165	224
Auto Pick Up/Drop Off (Kiss and Ride)	4	9	10	0	0	49	8	0	0	0	53	133
Parking	2	24	0	0	0	2	8	0	0	0	137	173
Private Shuttle	1	6	0	0	0	2	1	0	0	0	0	10
Walk Access	253	713	219	12	25	138	86	1	3	0	0	1,450
To Mode Total	738	4,742	3,080	69	401	779	322	10	10	28	19,913	30,092

Midday (9 am - 3 pm)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	25	1,041	132	11	34	42	15	8	3	5	1,892	3,208
Red Line	531	0	1,670	11	167	938	224	17	19	6	4,845	8,428
Silver Line	46	694	0	0	13	20	13	0	9	0	318	1,113
Taxi	1	8	2	0	0	104	162	0	0	0	22	299
MBTA Bus	10	81	11	0	11	52	0	0	0	0	124	289
Commuter/Intercity Bus	20	689	28	112	79	58	16	78	2	4	741	1,827
AMTRAK	5	119	12	91	0	12	0	11	5	2	302	559
Auto Pick Up/Drop Off (Kiss and Ride)	11	20	16	0	0	205	29	0	0	0	69	350
Parking	1	12	0	0	0	2	7	0	0	0	41	63
Private Shuttle	2	7	0	0	0	5	4	0	0	0	0	18
Walk Access	704	2,242	459	72	49	585	289	19	24	0	0	4,443
To Mode Total	1,356	4,913	2,330	297	353	2,023	759	133	62	17	8,354	20,597

Base Year (2009-2010) Transfer Activities in South Station

PM Peak (3 pm - 6 pm)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	48	309	20	2	9	11	3	2	2	0	184	590
Red Line	3,191	0	671	7	124	545	134	9	29	2	999	5,711
Silver Line	493	1,749	0	0	19	31	16	0	26	0	130	2,464
Taxi	3	5	0	0	0	49	61	0	0	0	3	121
MBTA Bus	185	253	20	0	34	166	0	0	0	0	280	938
Commuter/Intercity Bus	80	539	9	54	45	33	8	33	2	1	139	943
AMTRAK	42	180	8	84	0	13	0	9	11	0	109	457
Auto Pick Up/Drop Off (Kiss and Ride)	24	8	3	0	0	64	8	0	0	0	7	114
Parking	2	4	0	0	0	0	2	0	0	0	3	11
Private Shuttle	18	11	0	0	0	6	3	0	0	0	0	38
Walk Access	10,292	6,786	382	129	104	1,395	497	30	103	0	0	19,718
To Mode Total	14,378	9,844	1,113	276	335	2,313	732	83	173	3	1,854	31,105

Night (6 pm - 6 am)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	10	131	10	2	4	4	0	3	0	2	535	701
Red Line	524	0	358	3	28	146	16	9	1	3	1,397	2,485
Silver Line	162	1,432	0	0	12	18	5	0	1	0	48	1,678
Taxi	1	4	0	0	0	36	25	0	0	0	18	84
MBTA Bus	8	23	2	0	2	10	0	0	0	0	58	103
Commuter/Intercity Bus	35	460	9	82	38	26	2	119	0	5	809	1,585
AMTRAK	15	126	7	104	0	9	0	27	0	4	520	813
Auto Pick Up/Drop Off (Kiss and Ride)	16	11	4	0	0	76	5	0	0	0	62	174
Parking	0	1	0	0	0	0	0	0	0	0	8	9
Private Shuttle	1	2	0	0	0	1	0	0	0	0	0	4
Walk Access	4,544	5,509	129	200	89	1,005	223	110	7	0	0	11,816
To Mode Total	5,316	7,699	519	391	173	1,331	275	268	9	14	3,455	19,451

Base Year (2009-2010) Transfer Activities in South Station

Daily

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	149	4,697	748	29	176	130	51	16	7	26	13,927	19,956
Red Line	4,626	0	4,920	25	492	2,069	503	36	53	17	14,311	27,052
Silver Line	713	4,088	0	0	49	73	37	0	37	0	656	5,653
Taxi	5	21	3	0	0	212	294	0	0	0	59	594
MBTA Bus	211	437	48	0	59	255	0	0	0	0	668	1,678
Commuter/Intercity Bus	145	2,127	69	275	219	136	33	235	4	13	2,479	5,735
AMTRAK	63	464	33	292	0	36	0	48	16	5	1,097	2,052
Auto Pick Up/Drop Off (Kiss and Ride)	55	48	33	0	0	394	50	0	0	0	191	771
Parking	5	41	0	0	0	4	17	0	0	0	189	256
Private Shuttle	22	26	0	0	0	14	9	0	0	0	0	71
Walk Access	15,793	15,250	1,189	413	267	3,123	1,094	160	137	0	0	37,426
To Mode Total	21,787	27,199	7,043	1,034	1,262	6,446	2,088	495	254	61	33,577	101,244

2025 True No-Build Transfer Activities in South Station

AM Peak (6 am - 9 am)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	121	3,962	821	16	171	75	38	4	2	22	13,040	18,272
Red Line	648	0	2,756	4	217	440	156	1	4	7	7,597	11,828
Silver Line	82	946	0	0	25	15	13	0	3	0	661	1,744
Taxi	0	4	1	0	0	23	52	0	0	0	16	96
MBTA Bus	17	114	24	0	19	32	0	0	0	0	276	483
Commuter/Intercity Bus	10	451	27	28	65	19	8	5	0	3	793	1,409
AMTRAK	3	54	7	14	0	2	0	0	0	0	199	279
Auto Pick Up/Drop Off (Kiss and Ride)	7	11	13	0	0	49	11	0	0	0	58	148
Parking	4	28	0	0	0	2	10	0	0	0	149	192
Private Shuttle	2	6	0	0	0	2	2	0	0	0	0	12
Walk Access	468	897	297	14	34	147	113	1	3	0	0	1,975
To Mode Total	1,360	6,473	3,946	75	531	807	402	11	12	32	22,788	36,438

Midday (9 am - 3 pm)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	41	1,530	254	12	36	42	12	10	3	6	2,092	4,037
Red Line	938	0	2,884	13	167	984	302	21	21	7	5,363	10,699
Silver Line	122	1,546	0	0	16	31	28	0	15	0	535	2,293
Taxi	2	10	3	0	0	106	181	0	0	0	22	323
MBTA Bus	16	114	19	0	11	54	0	0	0	0	134	348
Commuter/Intercity Bus	26	747	39	112	74	58	18	79	2	4	749	1,908
AMTRAK	16	205	21	101	0	12	0	13	5	2	322	697
Auto Pick Up/Drop Off (Kiss and Ride)	17	28	26	0	0	207	38	0	0	0	74	390
Parking	2	16	0	0	0	2	8	0	0	0	41	69
Private Shuttle	3	8	0	0	0	5	4	0	0	0	0	20
Walk Access	1,121	2,969	746	75	49	587	356	21	24	0	0	5,949
To Mode Total	2,304	7,172	3,992	312	353	2,089	946	143	70	19	9,331	26,731

2025 True No-Build Transfer Activities in South Station

PM Peak (3 pm - 6 pm)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	107	524	147	5	31	25	18	5	4	0	826	1,692
Red Line	3,689	0	1,237	8	180	554	164	10	30	2	1,442	7,315
Silver Line	1,122	2,721	0	0	49	55	35	0	47	0	415	4,443
Taxi	3	5	0	0	0	51	65	0	0	0	4	128
MBTA Bus	201	253	35	0	46	166	0	0	0	0	353	1,054
Commuter/Intercity Bus	80	539	15	56	60	33	9	33	2	1	183	1,011
AMTRAK	45	174	17	109	0	14	0	12	13	0	186	570
Auto Pick Up/Drop Off (Kiss and Ride)	27	8	6	0	0	66	10	0	0	0	10	126
Parking	2	4	0	0	0	0	2	0	0	0	4	12
Private Shuttle	20	11	0	0	0	6	4	0	0	0	0	42
Walk Access	11,521	6,882	649	143	150	1,405	606	32	105	0	0	21,493
To Mode Total	16,816	11,121	2,104	321	516	2,375	913	92	201	3	3,423	37,886

Night (6 pm - 6 am)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	35	360	66	4	9	8	0	6	0	4	1,047	1,538
Red Line	967	0	1,186	5	42	191	30	14	2	4	1,807	4,246
Silver Line	288	2,263	0	0	17	24	8	0	1	0	59	2,660
Taxi	1	5	0	0	0	36	32	0	0	0	20	94
MBTA Bus	10	30	4	0	3	12	0	0	0	0	60	120
Commuter/Intercity Bus	40	526	20	91	40	26	3	127	0	4	826	1,703
AMTRAK	22	183	22	145	0	11	0	37	0	4	589	1,014
Auto Pick Up/Drop Off (Kiss and Ride)	21	14	10	0	0	83	6	0	0	0	62	196
Parking	0	1	0	0	0	0	0	0	0	0	9	10
Private Shuttle	1	2	0	0	0	1	0	0	0	0	0	4
Walk Access	5,124	6,015	270	211	89	1,005	265	112	7	0	0	13,099
To Mode Total	6,510	9,399	1,578	456	199	1,397	343	296	10	16	4,479	24,683

2025 True No-Build Transfer Activities in South Station

Daily

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	304	6,376	1,288	37	246	150	68	25	9	31	17,005	25,539
Red Line	6,241	0	8,063	29	606	2,169	651	45	56	19	16,208	34,088
Silver Line	1,614	7,476	0	0	107	125	83	0	66	0	1,669	11,140
Taxi	6	23	4	0	0	217	329	0	0	0	62	641
MBTA Bus	244	511	82	0	79	264	0	0	0	0	824	2,004
Commuter/Intercity Bus	157	2,264	100	286	239	136	38	244	4	12	2,552	6,030
AMTRAK	86	616	66	369	0	41	0	62	18	6	1,296	2,560
Auto Pick Up/Drop Off (Kiss and Ride)	72	60	55	0	0	405	64	0	0	0	204	861
Parking	7	49	0	0	0	4	20	0	0	0	202	283
Private Shuttle	26	27	0	0	0	14	10	0	0	0	0	77
Walk Access	18,234	16,763	1,963	443	322	3,144	1,339	167	139	0	0	42,516
To Mode Total	26,991	34,165	11,620	1,164	1,599	6,668	2,604	543	293	69	40,022	125,738

2025 Transportation Improvement Only Alternative Transfer Activities in South Station

AM Peak (6 am - 9 am)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	159	4,563	1,022	19	180	75	85	5	2	24	17,165	23,299
Red Line	693	0	2,748	4	217	432	249	1	4	7	7,514	11,869
Silver Line	83	941	0	0	25	15	13	0	3	0	652	1,732
Taxi	0	4	1	0	0	23	85	0	0	0	18	131
MBTA Bus	18	114	24	0	19	32	0	0	0	0	272	479
Commuter/Intercity Bus	16	442	27	25	62	17	11	5	0	2	791	1,398
AMTRAK	6	106	14	24	0	2	0	0	0	0	382	534
Auto Pick Up/Drop Off (Kiss and Ride)	7	11	13	0	0	49	17	0	0	0	58	155
Parking	4	28	0	0	0	2	16	0	0	0	149	198
Private Shuttle	2	6	0	0	0	2	3	0	0	0	0	13
Walk Access	554	813	206	14	34	140	186	1	3	0	0	1,951
To Mode Total	1,542	7,027	4,055	87	537	789	667	12	12	33	26,999	41,759

Midday (9 am - 3 pm)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	61	1,728	309	15	37	42	36	12	4	7	2,780	5,029
Red Line	1,006	0	2,884	13	167	956	442	21	21	7	5,298	10,815
Silver Line	138	1,538	0	0	16	31	43	0	15	0	506	2,287
Taxi	2	10	3	0	0	103	268	0	0	0	22	407
MBTA Bus	19	114	19	0	11	54	0	0	0	0	130	346
Commuter/Intercity Bus	30	739	39	108	71	54	26	78	2	3	738	1,889
AMTRAK	35	441	45	200	0	25	0	27	10	4	659	1,445
Auto Pick Up/Drop Off (Kiss and Ride)	20	28	26	0	0	205	55	0	0	0	74	407
Parking	2	16	0	0	0	2	11	0	0	0	41	72
Private Shuttle	3	8	0	0	0	4	6	0	0	0	0	21
Walk Access	1,371	2,841	691	79	46	583	532	21	24	0	0	6,188
To Mode Total	2,685	7,462	4,016	414	348	2,059	1,419	159	76	21	10,247	28,906

2025 Transportation Improvement Only Alternative Transfer Activities in South Station

PM Peak (3 pm - 6 pm)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	172	670	152	5	33	25	27	5	5	0	802	1,896
Red Line	4,327	0	1,237	8	180	553	234	10	30	2	1,171	7,751
Silver Line	1,384	2,706	0	0	49	54	51	0	46	0	392	4,683
Taxi	4	5	0	0	0	49	92	0	0	0	5	154
MBTA Bus	216	253	35	0	46	163	0	0	0	0	351	1,065
Commuter/Intercity Bus	80	518	15	56	60	30	13	33	2	1	182	989
AMTRAK	84	227	23	152	0	20	0	16	18	0	263	803
Auto Pick Up/Drop Off (Kiss and Ride)	33	7	6	0	0	65	14	0	0	0	10	135
Parking	2	4	0	0	0	0	3	0	0	0	4	13
Private Shuttle	23	11	0	0	0	6	6	0	0	0	0	47
Walk Access	14,827	6,717	644	149	150	1,403	864	32	105	0	0	24,891
To Mode Total	21,153	11,118	2,111	369	519	2,368	1,303	97	207	3	3,179	42,426

Night (6 pm - 6 am)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	37	388	82	5	9	8	0	7	0	4	1,240	1,779
Red Line	1,104	0	1,182	5	42	191	54	14	2	4	1,741	4,338
Silver Line	354	2,251	0	0	17	24	15	0	1	0	40	2,703
Taxi	2	5	0	0	0	36	62	0	0	0	20	124
MBTA Bus	12	30	4	0	3	10	0	0	0	0	53	112
Commuter/Intercity Bus	40	499	19	91	40	26	6	126	0	5	802	1,654
AMTRAK	33	220	28	187	0	15	0	48	0	5	751	1,286
Auto Pick Up/Drop Off (Kiss and Ride)	25	14	10	0	0	80	12	0	0	0	62	203
Parking	0	1	0	0	0	0	0	0	0	0	9	10
Private Shuttle	1	2	0	0	0	1	0	0	0	0	0	4
Walk Access	6,375	5,984	267	211	88	1,000	531	112	7	0	0	14,575
To Mode Total	7,982	9,394	1,592	498	199	1,390	681	307	10	17	4,718	26,788

2025 Transportation Improvement Only Alternative Transfer Activities in South Station

Daily

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	428	7,349	1,564	44	260	150	148	28	11	34	21,987	32,003
Red Line	7,131	0	8,051	29	606	2,132	980	45	56	19	15,724	34,773
Silver Line	1,960	7,436	0	0	106	124	122	0	66	0	1,590	11,404
Taxi	7	23	4	0	0	211	506	0	0	0	64	816
MBTA Bus	265	511	82	0	79	258	0	0	0	0	806	2,002
Commuter/Intercity Bus	167	2,198	100	280	232	127	56	242	4	11	2,513	5,930
AMTRAK	157	993	111	562	0	62	0	91	28	9	2,054	4,068
Auto Pick Up/Drop Off (Kiss and Ride)	85	60	55	0	0	399	99	0	0	0	204	901
Parking	7	49	0	0	0	4	31	0	0	0	202	293
Private Shuttle	29	27	0	0	0	13	15	0	0	0	0	84
Walk Access	23,127	16,354	1,808	454	318	3,125	2,113	167	139	0	0	47,605
To Mode Total	33,363	35,001	11,775	1,368	1,602	6,605	4,070	574	305	74	45,144	139,880

2025 Minimum Land Use Alternative Transfer Activities in South Station

AM Peak (6 am - 9 am)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	160	4,560	1,020	19	190	78	82	5	2	24	17,213	23,351
Red Line	694	0	2,741	4	213	432	248	1	4	7	7,583	11,927
Silver Line	85	930	0	0	24	15	16	0	3	0	669	1,743
Taxi	0	4	1	0	0	23	84	0	0	0	18	129
MBTA Bus	18	110	24	0	18	32	0	0	0	0	277	479
Commuter/Intercity Bus	16	443	27	26	62	17	11	5	0	2	802	1,412
AMTRAK	6	99	14	24	0	2	0	0	0	0	388	534
Auto Pick Up/Drop Off (Kiss and Ride)	7	10	13	0	0	49	16	0	0	0	61	155
Parking	4	28	0	0	0	2	16	0	0	0	152	201
Private Shuttle	2	6	0	0	0	2	3	0	0	0	0	13
Walk Access	559	860	223	14	37	150	191	1	3	0	0	2,038
To Mode Total	1,551	7,050	4,063	88	544	801	667	12	12	33	27,163	41,982

Midday (9 am - 3 pm)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	61	1,718	313	15	38	47	36	12	4	7	2,796	5,046
Red Line	996	0	2,865	13	165	965	446	21	21	7	5,361	10,859
Silver Line	138	1,531	0	0	18	32	42	0	15	0	517	2,293
Taxi	2	10	3	0	0	105	268	0	0	0	26	413
MBTA Bus	19	112	19	0	11	54	0	0	0	0	133	348
Commuter/Intercity Bus	31	757	40	108	70	56	26	78	2	3	751	1,921
AMTRAK	34	434	44	198	0	21	0	26	10	4	673	1,445
Auto Pick Up/Drop Off (Kiss and Ride)	20	27	26	0	0	207	57	0	0	0	76	414
Parking	2	15	0	0	0	2	11	0	0	0	43	73
Private Shuttle	3	8	0	0	0	4	6	0	0	0	0	21
Walk Access	1,402	2,888	722	78	47	588	527	22	26	0	0	6,299
To Mode Total	2,708	7,500	4,031	412	348	2,082	1,419	159	77	21	10,376	29,132

2025 Minimum Land Use Alternative Transfer Activities in South Station

PM Peak (3 pm - 6 pm)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	172	672	153	5	35	25	26	5	5	0	812	1,911
Red Line	4,320	0	1,220	8	187	550	228	9	29	2	1,236	7,789
Silver Line	1,357	2,707	0	0	55	54	50	0	46	0	421	4,689
Taxi	4	5	0	0	0	49	90	0	0	0	5	152
MBTA Bus	218	249	33	0	47	156	0	0	0	0	361	1,064
Commuter/Intercity Bus	80	525	15	55	65	30	13	33	2	1	193	1,011
AMTRAK	75	233	22	144	0	19	0	17	17	0	276	803
Auto Pick Up/Drop Off (Kiss and Ride)	33	7	6	0	0	65	14	0	0	0	12	136
Parking	2	5	0	0	0	0	3	0	0	0	5	14
Private Shuttle	23	13	0	0	0	6	6	0	0	0	0	48
Walk Access	14,874	6,736	663	148	179	1,438	873	34	108	0	0	25,053
To Mode Total	21,156	11,152	2,112	359	568	2,392	1,303	98	208	3	3,319	42,672

Night (6 pm - 6 am)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	38	388	71	5	9	9	0	7	0	4	1,258	1,790
Red Line	1,104	0	1,183	5	42	195	53	13	2	3	1,761	4,361
Silver Line	365	2,230	0	0	17	25	15	0	1	0	53	2,706
Taxi	2	5	0	0	0	36	60	0	0	0	20	123
MBTA Bus	12	29	4	0	2	10	0	0	0	0	55	112
Commuter/Intercity Bus	41	508	21	88	40	26	6	128	0	4	811	1,673
AMTRAK	33	218	27	183	0	14	0	48	0	5	757	1,286
Auto Pick Up/Drop Off (Kiss and Ride)	25	13	10	0	0	80	12	0	0	0	63	204
Parking	0	1	0	0	0	0	0	0	0	0	9	10
Private Shuttle	2	2	0	0	0	1	0	0	0	0	0	5
Walk Access	6,386	6,044	275	211	90	1,007	535	115	7	0	0	14,669
To Mode Total	8,008	9,438	1,592	492	199	1,404	681	310	10	16	4,788	26,938

2025 Minimum Land Use Alternative Transfer Activities in South Station

Daily

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	431	7,339	1,557	44	272	159	145	28	11	34	22,079	32,098
Red Line	7,114	0	8,009	29	607	2,143	975	44	55	19	15,942	34,937
Silver Line	1,945	7,398	0	0	113	126	123	0	66	0	1,660	11,431
Taxi	7	23	4	0	0	213	502	0	0	0	68	818
MBTA Bus	267	500	80	0	79	252	0	0	0	0	826	2,004
Commuter/Intercity Bus	168	2,232	102	277	237	128	55	244	4	11	2,558	6,017
AMTRAK	148	984	108	549	0	57	0	91	28	9	2,094	4,068
Auto Pick Up/Drop Off (Kiss and Ride)	85	57	55	0	0	401	98	0	0	0	211	908
Parking	7	49	0	0	0	4	30	0	0	0	208	298
Private Shuttle	30	28	0	0	0	13	15	0	0	0	0	86
Walk Access	23,220	16,528	1,883	451	352	3,183	2,126	172	144	0	0	48,059
To Mode Total	33,423	35,139	11,798	1,351	1,660	6,679	4,070	579	308	72	45,646	140,724

2025 Maximum Land Use Alternative Transfer Activities in South Station

AM Peak (6 am - 9 am)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	161	4,554	1,018	18	210	78	61	5	2	24	17,567	23,698
Red Line	697	0	2,726	4	207	432	247	1	3	6	7,907	12,229
Silver Line	95	911	0	0	24	15	23	0	3	0	696	1,766
Taxi	0	4	1	0	0	23	81	0	0	0	17	126
MBTA Bus	19	108	24	0	18	33	0	0	0	0	296	498
Commuter/Intercity Bus	17	444	27	28	65	17	12	5	0	3	845	1,462
AMTRAK	8	93	14	26	0	4	0	0	0	0	389	534
Auto Pick Up/Drop Off (Kiss and Ride)	8	10	12	0	0	50	17	0	0	0	62	159
Parking	4	28	0	0	0	2	17	0	0	0	157	207
Private Shuttle	2	6	0	0	0	2	3	0	0	0	0	13
Walk Access	575	1,038	304	14	37	164	208	1	3	0	0	2,344
To Mode Total	1,585	7,197	4,125	90	561	821	667	12	11	33	27,935	43,036

Midday (9 am - 3 pm)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	62	1,659	317	14	41	54	38	12	4	7	2,901	5,107
Red Line	988	0	2,825	13	164	979	449	21	21	7	5,621	11,087
Silver Line	138	1,509	0	0	21	33	45	0	15	0	574	2,334
Taxi	2	9	2	0	0	106	271	0	0	0	29	420
MBTA Bus	19	111	19	0	11	56	0	0	0	0	147	363
Commuter/Intercity Bus	32	788	41	110	68	58	27	80	2	4	774	1,984
AMTRAK	33	423	47	199	0	13	0	27	10	4	687	1,445
Auto Pick Up/Drop Off (Kiss and Ride)	20	26	27	0	0	212	59	0	0	0	78	423
Parking	2	14	0	0	0	2	12	0	0	0	44	74
Private Shuttle	3	8	0	0	0	4	7	0	0	0	0	22
Walk Access	1,479	3,120	824	76	49	599	511	23	26	0	0	6,706
To Mode Total	2,777	7,667	4,102	411	354	2,117	1,419	163	77	21	10,855	29,964

2025 Maximum Land Use Alternative Transfer Activities in South Station

PM Peak (3 pm - 6 pm)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	173	676	156	5	37	27	24	5	5	0	841	1,949
Red Line	4,315	0	1,183	8	190	547	211	9	28	2	1,458	7,949
Silver Line	1,339	2,698	0	0	57	56	49	0	46	0	502	4,748
Taxi	4	4	0	0	0	50	86	0	0	0	5	148
MBTA Bus	223	244	33	0	49	151	0	0	0	0	385	1,086
Commuter/Intercity Bus	80	540	16	52	67	31	12	33	2	1	212	1,046
AMTRAK	56	252	22	135	0	19	0	16	16	0	285	803
Auto Pick Up/Drop Off (Kiss and Ride)	32	11	6	0	0	64	13	0	0	0	12	137
Parking	2	7	0	0	0	0	3	0	0	0	5	17
Private Shuttle	23	14	0	0	0	6	6	0	0	0	0	49
Walk Access	15,156	6,952	725	147	182	1,528	900	35	112	0	0	25,738
To Mode Total	21,404	11,400	2,140	347	581	2,479	1,303	99	210	3	3,704	43,670

Night (6 pm - 6 am)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	38	388	67	5	10	9	0	8	0	4	1,328	1,858
Red Line	1,110	0	1,172	5	42	204	55	14	2	3	1,861	4,467
Silver Line	403	2,214	0	0	17	25	17	0	1	0	74	2,751
Taxi	2	5	0	0	0	35	59	0	0	0	20	122
MBTA Bus	13	28	4	0	2	11	0	0	0	0	61	119
Commuter/Intercity Bus	43	528	21	88	41	26	6	129	0	4	836	1,722
AMTRAK	33	224	27	171	0	14	0	46	0	5	765	1,286
Auto Pick Up/Drop Off (Kiss and Ride)	25	13	10	0	0	83	11	0	0	0	65	208
Parking	0	1	0	0	0	0	0	0	0	0	9	10
Private Shuttle	2	2	0	0	0	1	0	0	0	0	0	5
Walk Access	6,485	6,267	312	211	94	1,016	532	117	8	0	0	15,042
To Mode Total	8,153	9,670	1,614	480	207	1,424	681	313	11	15	5,020	27,590

2025 Maximum Land Use Alternative Transfer Activities in South Station

Daily

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	434	7,278	1,558	42	298	169	123	29	11	34	22,636	32,612
Red Line	7,110	0	7,906	29	602	2,161	962	45	54	18	16,847	35,732
Silver Line	1,975	7,333	0	0	118	129	134	0	65	0	1,845	11,599
Taxi	7	22	4	0	0	214	497	0	0	0	71	815
MBTA Bus	274	492	80	0	80	251	0	0	0	0	890	2,066
Commuter/Intercity Bus	172	2,299	104	278	241	133	57	247	4	12	2,667	6,214
AMTRAK	131	992	111	532	0	51	0	89	26	8	2,126	4,068
Auto Pick Up/Drop Off (Kiss and Ride)	85	60	55	0	0	409	99	0	0	0	218	927
Parking	7	50	0	0	0	4	32	0	0	0	214	307
Private Shuttle	30	30	0	0	0	13	15	0	0	0	0	88
Walk Access	23,694	17,377	2,165	448	363	3,306	2,151	176	149	0	0	49,829
To Mode Total	33,919	35,934	11,982	1,329	1,703	6,841	4,070	587	309	72	47,514	144,259

2035 True No-Build Transfer Activities in South Station

AM Peak (6 am - 9 am)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	136	4,172	888	16	183	76	40	4	2	23	13,526	19,065
Red Line	723	0	2,907	4	229	440	163	1	4	7	7,745	12,222
Silver Line	101	1,153	0	0	31	18	16	0	4	0	802	2,124
Taxi	0	4	1	0	0	23	54	0	0	0	16	98
MBTA Bus	19	124	27	0	21	34	0	0	0	0	296	521
Commuter/Intercity Bus	10	455	28	28	67	19	8	5	0	3	794	1,417
AMTRAK	4	59	8	14	0	2	0	0	0	0	208	295
Auto Pick Up/Drop Off (Kiss and Ride)	8	11	13	0	0	49	11	0	0	0	60	152
Parking	4	29	0	0	0	2	10	0	0	0	152	197
Private Shuttle	2	6	0	0	0	2	2	0	0	0	0	12
Walk Access	529	949	320	15	37	150	120	1	3	0	0	2,124
To Mode Total	1,536	6,961	4,190	77	568	815	424	11	13	33	23,599	38,228

Midday (9 am - 3 pm)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	46	1,668	289	12	36	42	11	10	3	6	2,148	4,271
Red Line	1,053	0	3,227	13	167	997	324	22	21	7	5,509	11,340
Silver Line	143	1,787	0	0	17	35	32	0	17	0	596	2,626
Taxi	2	10	3	0	0	107	186	0	0	0	22	330
MBTA Bus	18	123	21	0	11	54	0	0	0	0	137	364
Commuter/Intercity Bus	28	763	42	112	73	58	18	79	2	4	751	1,930
AMTRAK	19	230	23	103	0	12	0	13	5	2	328	736
Auto Pick Up/Drop Off (Kiss and Ride)	19	30	29	0	0	208	40	0	0	0	75	401
Parking	2	17	0	0	0	2	9	0	0	0	41	71
Private Shuttle	3	8	0	0	0	5	4	0	0	0	0	20
Walk Access	1,239	3,174	827	76	49	587	375	22	24	0	0	6,373
To Mode Total	2,572	7,809	4,461	316	353	2,107	999	146	72	19	9,607	28,462

2035 True No-Build Transfer Activities in South Station

PM Peak (3 pm - 6 pm)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	124	585	182	6	37	29	22	6	5	0	1,007	2,003
Red Line	3,829	0	1,396	8	196	556	173	10	30	2	1,567	7,767
Silver Line	1,299	2,995	0	0	58	61	40	0	53	0	496	5,001
Taxi	3	5	0	0	0	52	66	0	0	0	4	130
MBTA Bus	205	253	39	0	50	166	0	0	0	0	374	1,087
Commuter/Intercity Bus	80	539	16	56	64	33	9	33	2	1	196	1,030
AMTRAK	46	172	19	116	0	15	0	12	14	0	207	602
Auto Pick Up/Drop Off (Kiss and Ride)	28	8	6	0	0	66	10	0	0	0	11	130
Parking	2	4	0	0	0	0	2	0	0	0	4	12
Private Shuttle	21	11	0	0	0	6	5	0	0	0	0	43
Walk Access	11,867	6,909	724	147	163	1,408	636	33	106	0	0	21,993
To Mode Total	17,504	11,481	2,384	333	568	2,392	964	94	209	3	3,866	39,798

Night (6 pm - 6 am)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	42	424	81	5	10	9	0	7	0	4	1,192	1,774
Red Line	1,092	0	1,420	5	46	204	33	15	2	4	1,922	4,743
Silver Line	324	2,498	0	0	18	26	9	0	1	0	61	2,937
Taxi	1	5	0	0	0	36	33	0	0	0	21	96
MBTA Bus	11	32	5	0	3	12	0	0	0	0	61	124
Commuter/Intercity Bus	42	545	23	93	40	26	3	129	0	4	831	1,736
AMTRAK	24	199	26	157	0	12	0	40	0	4	609	1,071
Auto Pick Up/Drop Off (Kiss and Ride)	22	15	12	0	0	85	7	0	0	0	62	203
Parking	0	1	0	0	0	0	0	0	0	0	9	10
Private Shuttle	1	2	0	0	0	1	0	0	0	0	0	4
Walk Access	5,288	6,158	310	214	89	1,005	277	113	7	0	0	13,461
To Mode Total	6,847	9,878	1,877	474	206	1,416	362	304	10	16	4,768	26,159

2035 True No-Build Transfer Activities in South Station

Daily

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	348	6,849	1,440	39	266	156	73	27	10	33	17,873	27,114
Red Line	6,697	0	8,949	30	638	2,197	693	48	57	20	16,743	36,072
Silver Line	1,868	8,432	0	0	123	140	96	0	74	0	1,955	12,687
Taxi	6	24	4	0	0	218	339	0	0	0	63	654
MBTA Bus	253	532	92	0	85	266	0	0	0	0	868	2,096
Commuter/Intercity Bus	160	2,302	109	289	244	136	39	246	4	12	2,572	6,113
AMTRAK	93	659	76	391	0	42	0	66	19	6	1,352	2,703
Auto Pick Up/Drop Off (Kiss and Ride)	77	64	61	0	0	408	68	0	0	0	208	886
Parking	8	51	0	0	0	4	22	0	0	0	206	291
Private Shuttle	27	27	0	0	0	14	11	0	0	0	0	79
Walk Access	18,923	17,190	2,181	452	338	3,150	1,408	169	140	0	0	43,951
To Mode Total	28,459	36,130	12,911	1,201	1,694	6,730	2,749	556	304	71	41,840	132,646

2035 Transportation Improvement Only Alternative Transfer Activities in South Station

AM Peak (6 am - 9 am)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	185	4,943	1,145	20	195	76	100	5	2	25	18,815	25,511
Red Line	781	0	2,897	4	229	430	283	1	4	7	7,639	12,275
Silver Line	103	1,146	0	0	31	18	16	0	4	0	791	2,108
Taxi	0	4	1	0	0	23	96	0	0	0	18	142
MBTA Bus	21	124	26	0	21	33	0	0	0	0	290	515
Commuter/Intercity Bus	18	443	28	25	63	16	13	5	0	2	791	1,403
AMTRAK	8	125	17	28	0	3	0	0	0	0	443	622
Auto Pick Up/Drop Off (Kiss and Ride)	8	11	13	0	0	49	20	0	0	0	60	161
Parking	4	29	0	0	0	2	18	0	0	0	152	205
Private Shuttle	2	6	0	0	0	2	4	0	0	0	0	14
Walk Access	639	841	203	15	37	140	214	1	3	0	0	2,093
To Mode Total	1,769	7,671	4,330	92	576	791	764	12	13	34	28,998	45,050

Midday (9 am - 3 pm)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	71	1,922	359	16	38	42	42	13	4	7	3,030	5,543
Red Line	1,140	0	3,227	13	167	961	504	22	21	7	5,426	11,488
Silver Line	164	1,776	0	0	17	34	51	0	17	0	559	2,617
Taxi	2	10	3	0	0	103	298	0	0	0	22	437
MBTA Bus	21	123	21	0	11	54	0	0	0	0	132	362
Commuter/Intercity Bus	33	753	42	107	69	53	29	78	2	3	737	1,906
AMTRAK	43	532	54	230	0	29	0	31	12	5	759	1,695
Auto Pick Up/Drop Off (Kiss and Ride)	22	30	29	0	0	205	62	0	0	0	75	424
Parking	2	17	0	0	0	2	13	0	0	0	41	75
Private Shuttle	3	8	0	0	0	4	6	0	0	0	0	21
Walk Access	1,559	3,010	757	81	45	582	600	22	24	0	0	6,680
To Mode Total	3,060	8,181	4,491	447	347	2,069	1,605	166	80	22	10,781	31,249

2035 Transportation Improvement Only Alternative Transfer Activities in South Station

PM Peak (3 pm - 6 pm)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	207	772	189	6	40	29	33	6	6	0	976	2,264
Red Line	4,648	0	1,396	8	196	555	262	10	30	2	1,219	8,327
Silver Line	1,636	2,976	0	0	57	61	61	0	52	0	466	5,309
Taxi	4	5	0	0	0	49	100	0	0	0	5	163
MBTA Bus	225	253	39	0	50	162	0	0	0	0	371	1,100
Commuter/Intercity Bus	80	512	16	56	64	29	14	33	2	1	194	1,002
AMTRAK	95	240	28	170	0	22	0	18	20	0	306	900
Auto Pick Up/Drop Off (Kiss and Ride)	36	7	6	0	0	65	16	0	0	0	11	141
Parking	2	4	0	0	0	0	4	0	0	0	4	14
Private Shuttle	25	11	0	0	0	6	7	0	0	0	0	49
Walk Access	16,106	6,697	718	155	163	1,405	967	33	106	0	0	26,350
To Mode Total	23,064	11,477	2,393	395	570	2,383	1,464	100	216	3	3,552	45,619

Night (6 pm - 6 am)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	44	460	102	6	11	9	0	8	0	4	1,439	2,083
Red Line	1,268	0	1,414	5	46	204	65	15	2	4	1,838	4,861
Silver Line	409	2,482	0	0	18	25	18	0	1	0	38	2,992
Taxi	2	5	0	0	0	36	72	0	0	0	21	136
MBTA Bus	13	32	5	0	3	10	0	0	0	0	52	115
Commuter/Intercity Bus	42	510	22	93	40	26	7	128	0	5	800	1,674
AMTRAK	38	246	34	210	0	16	0	54	0	5	816	1,419
Auto Pick Up/Drop Off (Kiss and Ride)	27	15	12	0	0	81	14	0	0	0	62	211
Parking	0	1	0	0	0	0	0	0	0	0	9	10
Private Shuttle	1	2	0	0	0	1	0	0	0	0	0	4
Walk Access	6,891	6,118	305	214	88	998	618	113	7	0	0	15,353
To Mode Total	8,734	9,872	1,895	528	206	1,407	795	318	10	18	5,075	28,858

2035 Transportation Improvement Only Alternative Transfer Activities in South Station

Daily

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	507	8,097	1,794	48	284	156	175	32	12	36	24,260	35,401
Red Line	7,837	0	8,934	30	638	2,150	1,115	48	57	20	16,122	36,951
Silver Line	2,312	8,381	0	0	122	139	146	0	74	0	1,854	13,027
Taxi	8	24	4	0	0	211	566	0	0	0	66	879
MBTA Bus	280	532	92	0	85	259	0	0	0	0	845	2,093
Commuter/Intercity Bus	173	2,218	109	281	236	124	63	244	4	11	2,522	5,985
AMTRAK	184	1,143	133	639	0	69	0	103	32	10	2,324	4,637
Auto Pick Up/Drop Off (Kiss and Ride)	93	63	61	0	0	400	113	0	0	0	208	937
Parking	8	51	0	0	0	4	34	0	0	0	206	303
Private Shuttle	31	27	0	0	0	13	17	0	0	0	0	88
Walk Access	25,195	16,666	1,983	465	333	3,125	2,400	169	140	0	0	50,476
To Mode Total	36,628	37,201	13,109	1,463	1,698	6,650	4,629	596	319	77	48,406	150,777

2035 Minimum Land Use Alternative Transfer Activities in South Station

AM Peak (6 am - 9 am)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	186	4,939	1,143	20	207	79	96	5	2	25	18,876	25,578
Red Line	783	0	2,888	4	224	430	281	1	4	7	7,728	12,350
Silver Line	106	1,132	0	0	29	18	20	0	4	0	813	2,122
Taxi	0	4	1	0	0	23	94	0	0	0	18	140
MBTA Bus	21	118	26	0	20	33	0	0	0	0	297	515
Commuter/Intercity Bus	18	444	28	26	64	16	12	5	0	2	806	1,421
AMTRAK	8	117	17	28	0	3	0	0	0	0	451	622
Auto Pick Up/Drop Off (Kiss and Ride)	8	10	13	0	0	49	18	0	0	0	63	161
Parking	4	29	0	0	0	2	18	0	0	0	156	209
Private Shuttle	2	6	0	0	0	2	4	0	0	0	0	14
Walk Access	645	902	225	15	40	153	221	1	3	0	0	2,204
To Mode Total	1,780	7,701	4,340	93	584	807	764	12	13	34	29,208	45,336

Midday (9 am - 3 pm)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	71	1,909	363	16	39	48	43	13	4	7	3,051	5,564
Red Line	1,127	0	3,202	13	165	973	508	22	21	7	5,507	11,545
Silver Line	164	1,767	0	0	19	36	50	0	17	0	574	2,626
Taxi	2	10	3	0	0	105	298	0	0	0	27	445
MBTA Bus	22	121	21	0	11	55	0	0	0	0	135	365
Commuter/Intercity Bus	34	776	44	107	67	55	28	78	2	3	754	1,948
AMTRAK	42	523	53	229	0	24	0	31	12	5	777	1,695
Auto Pick Up/Drop Off (Kiss and Ride)	23	29	29	0	0	208	65	0	0	0	78	432
Parking	2	16	0	0	0	2	13	0	0	0	43	76
Private Shuttle	3	8	0	0	0	4	6	0	0	0	0	21
Walk Access	1,599	3,070	796	80	46	589	594	23	26	0	0	6,822
To Mode Total	3,090	8,229	4,510	445	347	2,098	1,605	167	81	22	10,946	31,540

2035 Minimum Land Use Alternative Transfer Activities in South Station

PM Peak (3 pm - 6 pm)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	207	775	191	6	42	29	33	6	6	0	989	2,284
Red Line	4,638	0	1,374	8	205	552	255	9	29	2	1,303	8,376
Silver Line	1,600	2,977	0	0	65	61	59	0	52	0	502	5,317
Taxi	4	5	0	0	0	49	98	0	0	0	5	161
MBTA Bus	227	248	37	0	51	153	0	0	0	0	384	1,100
Commuter/Intercity Bus	80	521	16	55	71	29	14	33	2	1	208	1,030
AMTRAK	84	248	26	160	0	21	0	19	19	0	323	900
Auto Pick Up/Drop Off (Kiss and Ride)	35	7	6	0	0	65	16	0	0	0	13	142
Parking	2	5	0	0	0	0	3	0	0	0	5	15
Private Shuttle	25	13	0	0	0	6	7	0	0	0	0	51
Walk Access	16,166	6,722	743	153	200	1,450	979	35	110	0	0	26,558
To Mode Total	23,068	11,520	2,394	382	634	2,415	1,464	102	218	3	3,732	45,934

Night (6 pm - 6 am)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	46	461	88	6	11	11	0	8	0	4	1,462	2,097
Red Line	1,268	0	1,416	5	46	209	63	14	2	3	1,864	4,890
Silver Line	422	2,455	0	0	18	27	18	0	1	0	55	2,996
Taxi	2	5	0	0	0	36	70	0	0	0	21	134
MBTA Bus	13	31	5	0	2	10	0	0	0	0	54	115
Commuter/Intercity Bus	43	521	24	90	40	26	7	130	0	4	812	1,697
AMTRAK	38	244	33	205	0	16	0	54	0	5	824	1,419
Auto Pick Up/Drop Off (Kiss and Ride)	28	14	12	0	0	81	14	0	0	0	63	212
Parking	0	1	0	0	0	0	0	0	0	0	9	10
Private Shuttle	2	2	0	0	0	1	0	0	0	0	0	5
Walk Access	6,905	6,195	316	214	90	1,008	623	116	7	0	0	15,474
To Mode Total	8,768	9,929	1,894	520	207	1,424	795	322	10	16	5,164	29,049

2035 Minimum Land Use Alternative Transfer Activities in South Station

Daily

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	510	8,084	1,785	48	299	167	171	32	12	36	24,378	35,523
Red Line	7,816	0	8,880	30	640	2,164	1,108	46	56	19	16,402	37,161
Silver Line	2,292	8,331	0	0	131	141	148	0	74	0	1,944	13,061
Taxi	8	24	4	0	0	213	561	0	0	0	71	881
MBTA Bus	283	518	89	0	84	251	0	0	0	0	870	2,095
Commuter/Intercity Bus	175	2,262	112	278	242	126	62	246	4	10	2,580	6,096
AMTRAK	172	1,131	129	622	0	63	0	104	31	10	2,375	4,637
Auto Pick Up/Drop Off (Kiss and Ride)	94	60	61	0	0	403	112	0	0	0	217	947
Parking	8	51	0	0	0	4	34	0	0	0	213	310
Private Shuttle	32	29	0	0	0	13	17	0	0	0	0	91
Walk Access	25,315	16,889	2,079	462	376	3,200	2,417	175	146	0	0	51,059
To Mode Total	36,705	37,379	13,139	1,440	1,772	6,745	4,629	603	323	75	49,050	151,859

2035 Maximum Land Use Alternative Transfer Activities in South Station

AM Peak (6 am - 9 am)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	188	4,932	1,139	19	233	80	69	5	2	25	19,330	26,022
Red Line	786	0	2,868	4	216	430	280	1	3	6	8,143	12,737
Silver Line	118	1,108	0	0	29	18	28	0	4	0	847	2,152
Taxi	0	4	1	0	0	23	91	0	0	0	17	136
MBTA Bus	22	116	26	0	20	35	0	0	0	0	321	540
Commuter/Intercity Bus	19	445	27	28	67	17	14	5	0	3	860	1,485
AMTRAK	10	108	17	30	0	5	0	0	0	0	452	622
Auto Pick Up/Drop Off (Kiss and Ride)	9	10	13	0	0	50	19	0	0	0	65	166
Parking	4	29	0	0	0	2	19	0	0	0	162	216
Private Shuttle	2	6	0	0	0	2	3	0	0	0	0	13
Walk Access	666	1,130	328	15	41	171	242	1	3	0	0	2,597
To Mode Total	1,824	7,889	4,420	96	606	833	764	12	12	34	30,197	46,687

Midday (9 am - 3 pm)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	72	1,833	369	15	43	58	44	13	4	7	3,185	5,643
Red Line	1,117	0	3,150	13	163	990	513	22	21	7	5,840	11,836
Silver Line	163	1,739	0	0	23	37	54	0	16	0	646	2,678
Taxi	2	9	3	0	0	107	302	0	0	0	31	454
MBTA Bus	22	119	21	0	11	57	0	0	0	0	154	384
Commuter/Intercity Bus	35	816	45	109	65	58	30	81	2	4	783	2,028
AMTRAK	41	509	57	229	0	14	0	32	11	5	796	1,695
Auto Pick Up/Drop Off (Kiss and Ride)	23	28	30	0	0	214	67	0	0	0	81	443
Parking	2	15	0	0	0	2	14	0	0	0	45	78
Private Shuttle	3	8	0	0	0	4	8	0	0	0	0	23
Walk Access	1,697	3,367	927	77	49	603	574	24	26	0	0	7,344
To Mode Total	3,178	8,443	4,602	443	354	2,143	1,605	172	81	23	11,561	32,605

2035 Maximum Land Use Alternative Transfer Activities in South Station

PM Peak (3 pm - 6 pm)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	208	780	194	6	45	31	30	6	6	0	1,026	2,332
Red Line	4,632	0	1,327	8	208	547	233	9	28	2	1,587	8,581
Silver Line	1,578	2,966	0	0	67	63	59	0	52	0	607	5,392
Taxi	4	4	0	0	0	50	92	0	0	0	5	155
MBTA Bus	234	242	37	0	53	147	0	0	0	0	415	1,128
Commuter/Intercity Bus	80	540	18	52	73	31	13	33	2	1	233	1,075
AMTRAK	60	273	27	149	0	21	0	18	18	0	334	900
Auto Pick Up/Drop Off (Kiss and Ride)	34	12	6	0	0	64	14	0	0	0	13	144
Parking	2	8	0	0	0	0	3	0	0	0	5	18
Private Shuttle	25	15	0	0	0	6	6	0	0	0	0	52
Walk Access	16,528	6,999	822	152	204	1,565	1,014	37	115	0	0	27,436
To Mode Total	23,385	11,839	2,430	367	650	2,525	1,464	103	221	3	4,225	47,214

Night (6 pm - 6 am)

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	46	461	84	6	12	11	0	9	0	4	1,552	2,185
Red Line	1,275	0	1,402	5	46	220	66	15	2	3	1,992	5,026
Silver Line	471	2,434	0	0	19	27	21	0	1	0	81	3,054
Taxi	2	5	0	0	0	35	69	0	0	0	21	132
MBTA Bus	14	30	5	0	2	11	0	0	0	0	62	124
Commuter/Intercity Bus	45	547	24	90	42	26	7	132	0	4	844	1,760
AMTRAK	38	251	33	190	0	16	0	51	0	5	835	1,419
Auto Pick Up/Drop Off (Kiss and Ride)	28	14	12	0	0	85	13	0	0	0	66	218
Parking	0	1	0	0	0	0	0	0	0	0	9	10
Private Shuttle	2	2	0	0	0	1	0	0	0	0	0	5
Walk Access	7,032	6,481	363	214	96	1,019	619	119	8	0	0	15,952
To Mode Total	8,954	10,226	1,922	505	217	1,451	795	326	11	16	5,462	29,885

2035 Maximum Land Use Alternative Transfer Activities in South Station

Daily

From/to	Commuter Rail	Red Line	Silver Line	Taxi	MBTA Bus	Commuter / Intercity Bus	AMTRAK	Auto Pick Up/Drop Off (Kiss and Ride)	Parking	Private Shuttle	Walk Egress	From Mode Total
Commuter Rail	514	8,006	1,786	46	333	180	143	33	12	36	25,093	36,182
Red Line	7,810	0	8,748	30	633	2,187	1,091	47	54	18	17,562	38,180
Silver Line	2,330	8,248	0	0	138	144	161	0	73	0	2,181	13,276
Taxi	8	22	4	0	0	215	555	0	0	0	74	877
MBTA Bus	292	507	89	0	86	250	0	0	0	0	952	2,176
Commuter/Intercity Bus	179	2,348	114	279	247	132	63	251	4	12	2,720	6,349
AMTRAK	150	1,142	133	599	0	56	0	101	29	9	2,417	4,637
Auto Pick Up/Drop Off (Kiss and Ride)	94	64	62	0	0	413	113	0	0	0	225	971
Parking	8	53	0	0	0	4	36	0	0	0	221	322
Private Shuttle	32	31	0	0	0	13	17	0	0	0	0	93
Walk Access	25,923	17,977	2,440	458	390	3,358	2,449	181	152	0	0	53,328
To Mode Total	37,340	38,397	13,375	1,412	1,827	6,952	4,629	613	325	75	51,445	156,391

Summary of Boardings/Alightings from Nearby TAZ

1. Base Year (2009)

Average of Daily Boardings & Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	210	4,700	3,920	8,830
South	90	890	400	1,380
East	0	5,460	1,110	6,570
West	200	2,250	2,440	4,890
Totals	**500**	**13,300**	**7,870**	**21,670**

Average of AM Boardings & PM Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	0	160	40	200
South	50	40	0	90
East	0	340	60	400
West	70	100	40	210
Totals	**120**	**640**	**140**	**900**

Average of PM Boardings & AM Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	60	3,080	3,060	6,200
South	30	240	310	580
East	0	1,850	800	2,650
West	60	1,220	1,880	3,160
Totals	**150**	**6,390**	**6,050**	**12,590**

2. 2025 True No Build

Average of Daily Boardings & Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	360	5,390	4,590	10,340
South	350	1,020	710	2,080
East	0	6,260	2,720	8,980
West	530	2,570	2,880	5,980
Totals	**1,240**	**15,240**	**10,900**	**27,380**

Average of AM Boardings & PM Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	10	150	50	210
South	110	60	20	190
East	0	570	290	860
West	120	110	60	290
Totals	**240**	**890**	**420**	**1,550**

Average of PM Boardings & AM Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	110	3,250	3,420	6,780
South	100	250	510	860
East	0	1,940	1,630	3,570
West	190	1,290	2,100	3,580
Totals	**400**	**6,730**	**7,660**	**14,790**

3. 2025 Transit Improvements Only

Average of Daily Boardings & Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	400	5,140	5,890	11,430
South	390	1,010	900	2,300
East	0	6,220	3,590	9,810
West	610	2,450	3,690	6,750
Totals	**1,400**	**14,820**	**14,070**	**30,290**

Average of AM Boardings & PM Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	10	140	60	210
South	100	60	20	180
East	0	540	330	870
West	100	100	70	270
Totals	**210**	**840**	**480**	**1,530**

Average of PM Boardings & AM Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	110	3,060	4,470	7,640
South	100	260	650	1,010
East	0	2,080	2,200	4,280
West	190	1,200	2,720	4,110
Totals	**400**	**6,600**	**10,040**	**17,040**

4. 2025 Maximum Land Use

Average of Daily Boardings & Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	410	5,430	6,040	11,880
South	400	1,050	920	2,370
East	0	6,610	3,720	10,330
West	630	2,590	3,780	7,000
Totals	**1,440**	**15,680**	**14,460**	**31,580**

Average of AM Boardings & PM Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	10	150	60	220
South	120	60	30	210
East	0	610	330	940
West	120	120	70	310
Totals	**250**	**940**	**490**	**1,680**

Average of PM Boardings & AM Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	110	3,160	4,570	7,840
South	110	260	670	1,040
East	0	2,170	2,250	4,420
West	210	1,240	2,780	4,230
Totals	**430**	**6,830**	**10,270**	**17,530**

5. 2025 Minimum Land Use

Average of Daily Boardings & Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	410	5,400	5,990	11,800
South	390	1,040	910	2,340
East	0	6,500	3,680	10,180
West	620	2,550	3,750	6,920
Totals	**1,420**	**15,490**	**14,330**	**31,240**

Average of AM Boardings & PM Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	10	140	50	200
South	120	60	30	210
East	0	610	330	940
West	120	100	70	290
Totals	**250**	**910**	**480**	**1,640**

Average of PM Boardings & AM Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	110	3,120	4,530	7,760
South	110	260	660	1,030
East	0	2,150	2,230	4,380
West	220	1,240	2,760	4,220
Totals	**440**	**6,770**	**10,180**	**17,390**

Notes:

1. TAZ Group: North: 14,15,55-60,66-8
South: 20,81-3,115
East: 135-7, 143-6
West: 16-8, 64-5,70,76,77
2. Boardings and alightings include Silver Line Gateway in all 2025 alternatives.
3. The boardings and alightings include South Coast Rail in the 2025 Build alternatives.
4. AMTRAK and Intercity Buses are not included in this ridership summary.
5. Average Boardings & Alightings tables should be doubled to calculate total boardings plus alightings.
6. Results are rounded to the nearest ten. As an artifact of rounding, column and row totals are +/- 10 the sum of individual column and row elements.

Summary of Boardings/Alightings from Nearby TAZ

1. Base Year (2009)

Average of Daily Boardings & Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	210	4,700	3,920	8,830
South	90	890	400	1,380
East	0	5,460	1,110	6,570
West	200	2,250	2,440	4,890
Totals	**500**	**13,300**	**7,870**	**21,670**

Average of AM Boardings & PM Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	0	160	40	200
South	50	40	0	90
East	0	340	60	400
West	70	100	40	210
Totals	**120**	**640**	**140**	**900**

Average of PM Boardings & AM Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	60	3,080	3,060	6,200
South	30	240	310	580
East	0	1,850	800	2,650
West	60	1,220	1,880	3,160
Totals	**150**	**6,390**	**6,050**	**12,590**

2. 2035 True No Build

Average of Daily Boardings & Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	400	5,580	4,780	10,760
South	420	1,060	800	2,280
East	0	6,480	3,180	9,660
West	620	2,660	3,010	6,290
Totals	**1,440**	**15,780**	**11,770**	**28,990**

Average of AM Boardings & PM Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	10	150	50	210
South	130	70	30	230
East	0	630	350	980
West	130	110	70	310
Totals	**280**	**960**	**500**	**1,740**

Average of PM Boardings & AM Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	120	3,300	3,520	6,940
South	120	250	570	940
East	0	1,960	1,870	3,830
West	230	1,310	2,160	3,700
Totals	**460**	**6,820**	**8,120**	**15,400**

3. 2035 Transit Improvements Only

Average of Daily Boardings & Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	450	5,260	6,450	12,160
South	480	1,040	1,040	2,560
East	0	6,440	4,290	10,730
West	730	2,510	4,040	7,280
Totals	**1,650**	**15,250**	**15,820**	**32,720**

Average of AM Boardings & PM Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	10	130	60	200
South	110	60	30	200
East	0	590	400	990
West	110	100	80	290
Totals	**230**	**880**	**570**	**1,680**

Average of PM Boardings & AM Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	120	3,060	4,870	8,050
South	120	260	750	1,130
East	0	2,150	2,590	4,740
West	230	1,200	2,960	4,390
Totals	**460**	**6,670**	**11,170**	**18,300**

4. 2035 Maximum Land Use

Average of Daily Boardings & Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	470	5,640	6,640	12,750
South	490	1,100	1,070	2,660
East	0	6,930	4,450	11,380
West	750	2,680	4,160	7,590
Totals	**1,710**	**16,350**	**16,320**	**34,380**

Average of AM Boardings & PM Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	10	150	60	220
South	140	70	40	250
East	0	680	410	1,090
West	140	120	80	340
Totals	**300**	**1,020**	**590**	**1,910**

Average of PM Boardings & AM Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	130	3,180	5,000	8,310
South	130	270	770	1,170
East	0	2,260	2,660	4,920
West	250	1,250	3,040	4,540
Totals	**500**	**6,960**	**11,470**	**18,930**

5. 2035 Minimum Land Use

Average of Daily Boardings & Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	460	5,600	6,580	12,640
South	480	1,080	1,060	2,620
East	0	6,790	4,410	11,200
West	740	2,630	4,120	7,490
Totals	**1,680**	**16,100**	**16,170**	**33,950**

Average of AM Boardings & PM Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	10	140	50	200
South	140	70	40	250
East	0	680	410	1,090
West	140	100	80	320
Totals	**300**	**990**	**580**	**1,860**

Average of PM Boardings & AM Alightings at South Station

TAZ Group	Silver Line	Red Line	CRR	Totals
North	130	3,130	4,950	8,210
South	130	270	760	1,160
East	0	2,230	2,630	4,860
West	260	1,240	3,010	4,510
Totals	**510**	**6,870**	**11,350**	**18,740**

Notes:

1. TAZ Group: North: 14,15,55-60,66-8
South: 20,81-3,115
East: 135-7, 143-6
West: 16-8, 64-5,70,76,77
2. Boardings and alightings include Silver Line Gateway in all 2035 alternatives.
3. The boardings and alightings include South Coast Rail in the 2035 Build alternatives.
4. AMTRAK and Intercity Buses are not included in this ridership summary.
5. Average Boardings & Alightings tables should be doubled to calculate total boardings plus alightings.
6. Results are rounded to the nearest ten. As an artifact of rounding, column and row totals are +/- 10 the sum of individual column and row elements.

South Station Expansion

Summary of Transit Ridership - Part 1

1. South Side Commuter Rail Ridership - all South Side Commuter Rail Stations

Scenario	AM	MD	PM	NT	Daily
Base Year (2009)	28,720	5,710	26,200	5,200	65,830
2025 True No-Build	33,780	9,160	32,550	8,190	83,680
2025 Transportation Improvement Only [1]	36,360	9,680	34,910	8,900	89,850
2025 Maximum Land Use [1]	37,420	9,930	35,960	9,190	92,500
2025 Minimum Land Use [1]	36,920	9,790	35,490	9,010	91,210

Notes:

1. The ridership summary includes South Coast Rail in the Transportation Improvement Only alternative, the Minimum Land Use alternative and the Maximum Land Use alternative.

South Station Expansion

E. Summary of Transit Ridership - Part 2

2. Boardings at South Station

Base Year (2009)

Transit Mode	AM	MD	PM	NT	Daily
Commuter Rail	738	1,356	14,378	5,316	**21,788**
Red Line	4,742	4,913	9,844	7,699	**27,198**
Silver Line	3,080	2,330	1,113	519	**7,042**
Bus	401	353	335	173	**1,262**
Total	**8,961**	**8,952**	**25,670**	**13,707**	**57,290**

2025 True No-Build

Transit Mode	AM	MD	PM	NT	Daily
Commuter Rail	1,360	2,304	16,816	6,510	**26,990**
Red Line	6,473	7,172	11,121	9,399	**34,165**
Silver Line	3,946	3,992	2,104	1,578	**11,620**
Bus	531	353	516	199	**1,599**
Total	**12,310**	**13,821**	**30,557**	**17,686**	**74,374**

2025 Transportation Improvement Only [1]

Transit Mode	AM	MD	PM	NT	Daily
Commuter Rail	1,542	2,685	21,153	7,982	**33,362**
Red Line	7,027	7,462	11,118	9,394	**35,001**
Silver Line	4,055	4,016	2,111	1,592	**11,774**
Bus	537	348	519	199	**1,603**
Total	**13,161**	**14,511**	**34,901**	**19,167**	**81,740**

2025 Maximum Land Use [1]

Transit Mode	AM	MD	PM	NT	Daily
Commuter Rail	1,585	2,777	21,404	8,153	**33,919**
Red Line	7,197	7,667	11,400	9,670	**35,934**
Silver Line	4,125	4,102	2,140	1,614	**11,981**
Bus	561	354	581	207	**1,703**
Total	**13,468**	**14,900**	**35,525**	**19,644**	**83,537**
Diff. (Max LU - TIO)	**307**	**389**	**624**	**477**	**1,797**

2025 Minimum Land Use [1]

Transit Mode	AM	MD	PM	NT	Daily
Commuter Rail	1,551	2,708	21,156	8,008	**33,423**
Red Line	7,050	7,500	11,152	9,438	**35,140**
Silver Line	4,063	4,031	2,112	1,592	**11,798**
Bus	544	348	568	199	**1,659**
Total	**13,208**	**14,587**	**34,988**	**19,237**	**82,020**
Diff. (Min LU - TIO)	**47**	**76**	**87**	**70**	**280**

Notes:

1. The boardings and alightings includes SCR in the Transportation Improvement Only alternative, the Maximum Land Use alternative, and the Minimum Land Use alternative.
2. AMTRAK and Intercity Buses are not included in this ridership summary.
3. All future year scenarios include the Fairmount Service improvements.
4. Due to rounding, the daily totals in the summary tables above are +/- 1 the values in the Daily Pedestrian Transfer Matrices.

South Station Expansion

E. Summary of Transit Ridership - Part 2 Continued

3. Alightings at South Station

Base Year (2009)

Transit Mode	AM	MD	PM	NT	Daily
Commuter Rail	15,457	3,208	590	701	**19,956**
Red Line	10,429	8,428	5,711	2,485	**27,053**
Silver Line	398	1,113	2,464	1,678	**5,653**
Bus	348	289	938	103	**1,678**
Total	**26,632**	**13,038**	**9,703**	**4,967**	**54,340**

2025 True No-Build

Transit Mode	AM	MD	PM	NT	Daily
Commuter Rail	18,272	4,037	1,692	1,538	**25,539**
Red Line	11,828	10,699	7,315	4,246	**34,088**
Silver Line	1,744	2,293	4,443	2,660	**11,140**
Bus	483	348	1,054	120	**2,005**
Total	**32,327**	**17,377**	**14,504**	**8,564**	**72,772**

2025 Transportation Improvement Only [1]

Transit Mode	AM	MD	PM	NT	Daily
Commuter Rail	23,299	5,029	1,896	1,779	**32,003**
Red Line	11,869	10,815	7,751	4,338	**34,773**
Silver Line	1,732	2,287	4,683	2,703	**11,405**
Bus	479	346	1,065	112	**2,002**
Total	**37,379**	**18,477**	**15,395**	**8,932**	**80,183**

2025 Maximum Land Use [1]

Transit Mode	AM	MD	PM	NT	Daily
Commuter Rail	23,698	5,107	1,949	1,858	**32,612**
Red Line	12,229	11,087	7,949	4,467	**35,732**
Silver Line	1,766	2,334	4,748	2,751	**11,599**
Bus	498	363	1,086	119	**2,066**
Total	**38,191**	**18,891**	**15,732**	**9,195**	**82,009**
Diff. (Max LU - TIO)	**812**	**414**	**337**	**263**	**1,826**

2025 Minimum Land Use [1]

Transit Mode	AM	MD	PM	NT	Daily
Commuter Rail	23,351	5,046	1,911	1,790	**32,098**
Red Line	11,927	10,859	7,789	4,361	**34,936**
Silver Line	1,743	2,293	4,689	2,706	**11,431**
Bus	479	348	1,064	112	**2,003**
Total	**37,500**	**18,546**	**15,453**	**8,969**	**80,468**
Diff. (Min LU - TIO)	**121**	**69**	**58**	**37**	**285**

Notes:

1. The boardings and alightings includes SCR in the Transportation Improvement Only alternative, the Maximum Land Use alternative, and the Minimum Land Use alternative.
2. AMTRAK and Intercity Buses are not included in this ridership summary.
3. All future year scenarios include the Fairmount Service improvements.
4. Due to rounding, the daily totals in the summary tables above are +/- 1 the values in the Daily Pedestrian Transfer Matrices.

South Station Expansion

Summary of Transit Ridership - Part 1

1. South Side Commuter Rail Ridership - all South Side Commuter Rail Stations

Scenario	AM	MD	PM	NT	Daily
Base Year (2009)	28,720	5,710	26,200	5,200	65,830
2035 True No-Build	35,210	10,130	34,340	9,030	88,710
2035 Transportation Improvement Only [1]	38,510	10,800	37,370	9,940	96,620
2035 Maximum Land Use [1]	39,880	11,120	38,710	10,320	100,030
2035 Minimum Land Use [1]	39,230	10,940	38,110	10,090	98,370

Notes:

1. The ridership summary includes South Coast Rail in the Transportation Improvement Only alternative, the Minimum Land Use alternative and the Maximum Land Use alternative.

South Station Expansion

E. Summary of Transit Ridership - Part 2

2. Boardings at South Station

Base Year (2009)

Transit Mode	AM	MD	PM	NT	Daily
Commuter Rail	738	1,356	14,378	5,316	**21,788**
Red Line	4,742	4,913	9,844	7,699	**27,198**
Silver Line	3,080	2,330	1,113	519	**7,042**
Bus	401	353	335	173	**1,262**
Total	**8,961**	**8,952**	**25,670**	**13,707**	**57,290**

2035 True No-Build

Transit Mode	AM	MD	PM	NT	Daily
Commuter Rail	1,536	2,572	17,504	6,847	**28,459**
Red Line	6,961	7,809	11,481	9,878	**36,129**
Silver Line	4,190	4,461	2,384	1,877	**12,912**
Bus	568	353	568	206	**1,695**
Total	**13,255**	**15,195**	**31,937**	**18,808**	**79,195**

2035 Transportation Improvement Only [1]

Transit Mode	AM	MD	PM	NT	Daily
Commuter Rail	1,769	3,060	23,064	8,734	**36,627**
Red Line	7,671	8,181	11,477	9,872	**37,201**
Silver Line	4,330	4,491	2,393	1,895	**13,109**
Bus	576	347	570	206	**1,699**
Total	**14,346**	**16,079**	**37,504**	**20,707**	**88,636**

2035 Maximum Land Use [1]

Transit Mode	AM	MD	PM	NT	Daily
Commuter Rail	1,824	3,178	23,385	8,954	**37,341**
Red Line	7,889	8,443	11,839	10,226	**38,397**
Silver Line	4,420	4,602	2,430	1,922	**13,374**
Bus	606	354	650	217	**1,827**
Total	**14,739**	**16,577**	**38,304**	**21,319**	**90,939**
Diff. (Max LU - TIO)	**393**	**498**	**800**	**612**	**2,303**

2035 Minimum Land Use [1]

Transit Mode	**AM**	**MD**	**PM**	**NT**	**Daily**
Commuter Rail	1,780	3,090	23,068	8,768	**36,706**
Red Line	7,701	8,229	11,520	9,929	**37,379**
Silver Line	4,340	4,510	2,394	1,894	**13,138**
Bus	584	347	634	207	**1,772**
Total	**14,405**	**16,176**	**37,616**	**20,798**	**88,995**
Diff. (Min LU - TIO)	**59**	**97**	**112**	**91**	**359**

Notes:

1. The boardings and alightings includes SCR in the Transportation Improvement Only alternative, the Maximum Land Use alternative, and the Minimum Land Use alternative.
2. AMTRAK and Intercity Buses are not included in this ridership summary.
3. All future year scenarios include the Fairmount Service improvements.
4. Due to rounding, the daily totals in the summary tables above are +/- 1 the values in the Daily Pedestrian Transfer Matrices.

South Station Expansion

E. Summary of Transit Ridership - Part 2 Continued

3. Alightings at South Station

Base Year (2009)

Transit Mode	AM	MD	PM	NT	Daily
Commuter Rail	15,457	3,208	590	701	**19,956**
Red Line	10,429	8,428	5,711	2,485	**27,053**
Silver Line	398	1,113	2,464	1,678	**5,653**
Bus	348	289	938	103	**1,678**
Total	**26,632**	**13,038**	**9,703**	**4,967**	**54,340**

2035 True No-Build

Transit Mode	AM	MD	PM	NT	Daily
Commuter Rail	19,065	4,271	2,003	1,774	**27,113**
Red Line	12,222	11,340	7,767	4,743	**36,072**
Silver Line	2,124	2,626	5,001	2,937	**12,688**
Bus	521	364	1,087	124	**2,096**
Total	**33,932**	**18,601**	**15,858**	**9,578**	**77,969**

2035 Transportation Improvement Only [1]

Transit Mode	AM	MD	PM	NT	Daily
Commuter Rail	25,511	5,543	2,264	2,083	**35,401**
Red Line	12,275	11,488	8,327	4,861	**36,951**
Silver Line	2,108	2,617	5,309	2,992	**13,026**
Bus	515	362	1,100	115	**2,092**
Total	**40,409**	**20,010**	**17,000**	**10,051**	**87,470**

2035 Maximum Land Use [1]

Transit Mode	AM	MD	PM	NT	Daily
Commuter Rail	26,022	5,643	2,332	2,185	**36,182**
Red Line	12,737	11,836	8,581	5,026	**38,180**
Silver Line	2,152	2,678	5,392	3,054	**13,276**
Bus	540	384	1,128	124	**2,176**
Total	**41,451**	**20,541**	**17,433**	**10,389**	**89,814**
Diff. (Max LU - TIO)	**1,042**	**531**	**433**	**338**	**2,344**

2035 Minimum Land Use [1]

Transit Mode	AM	MD	PM	NT	Daily
Commuter Rail	25,578	5,564	2,284	2,097	**35,523**
Red Line	12,350	11,545	8,376	4,890	**37,161**
Silver Line	2,122	2,626	5,317	2,996	**13,061**
Bus	515	365	1,100	115	**2,095**
Total	**40,565**	**20,100**	**17,077**	**10,098**	**87,840**
Diff. (Min LU - TIO)	**156**	**90**	**77**	**47**	**370**

Notes:

1. The boardings and alightings includes SCR in the Transportation Improvement Only alternative, the Maximum Land Use alternative, and the Minimum Land Use alternative.

2. AMTRAK and Intercity Buses are not included in this ridership summary.

3. All future year scenarios include the Fairmount Service improvements.

4. Due to rounding, the daily totals in the summary tables above are +/- 1 the values in the Daily Pedestrian Transfer Matrices.

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Attachment K CTPS Transit Vehicle Crowding Analysis

2035 Build Year Analysis Tables:

- Commuter Rail
- Rapid Transit: Red Line, Blue Line, Orange Line, and Silver Line
- Rapid Transit: Green Line
- Local Bus

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South Station Expansion Project

Results for Transit Crowding Analysis

South Side Commuter Rail - AM Peak Period (6am - 9am)

2035 True No-Build

		AM Peak Train Set Info						AM Peak 1 Hour Service Info 3-hour Data							
Commuter Rail Line Service	Peak Load Point (From CTPS Travel Demand Model)	Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume- Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	Modeled Volume - Peak Point	Peak Hour / Peak Period
Needham Line IB	Forest Hills - Ruggles	45	8	185	204	1,480	1,628	2	2,960	3,256	578	0.20	0.18	850	0.68
Needham Line OB	South Station - Back Bay	60	8	185	204	1,480	1,628	1	1,480	1,628	286	0.19	0.18	530	0.54
Worcester/Framingham Line IB	Newtonville - Yawkey	26	8	185	204	1,480	1,628	3	4,440	4,884	1,918	0.43	0.39	2,950	0.65
Worcester/Framingham Line OB	South Station - Back Bay	60	8	185	204	1,480	1,628	1	1,480	1,628	442	0.30	0.27	660	0.67
Franklin Line IB	Hyde Park - Ruggles	26	8	185	204	1,480	1,628	3	4,440	4,884	1,566	0.35	0.32	2,700	0.58
Franklin Line OB	South Station - Back Bay	60	8	185	204	1,480	1,628	1	1,480	1,628	199	0.13	0.12	280	0.71
Providence/Attleboro Line IB	Hyde Park - Ruggles	26	8	185	204	1,480	1,628	3	4,440	4,884	1,534	0.35	0.31	2,840	0.54
Providence/Attleboro Line OB	South Station - Back Bay	45	8	185	204	1,480	1,628	2	2,960	3,256	491	0.17	0.15	630	0.78
Canton/Stoughton Line IB	Hyde Park - Ruggles	60	8	185	204	1,480	1,628	1	1,480	1,628	1,165	0.79	0.72	1,820	0.64
Canton/Stoughton Line OB	South Station - Back Bay	60	8	185	204	1,480	1,628	1	1,480	1,628	203	0.14	0.12	390	0.52
Fairmount Line IB	Uphams Corner - Newmarket	15	8	185	204	1,480	1,628	4	5,920	6,512	1,128	0.19	0.17	1,820	0.62
Fairmount Line OB	Talbot Ave - Morton St	15	8	185	204	1,480	1,628	4	5,920	6,512	166	0.03	0.03	200	0.83
Middleborough Line IB	JFK/Umass - South Station	45	8	185	204	1,480	1,628	2	2,960	3,256	2,761	0.93	0.85	4,930	0.56
Middleborough Line OB	Montello - Brockton	90	8	185	204	1,480	1,628	1	1,480	1,628	68	0.05	0.04	120	0.57
Plymouth/Kingston Line IB	S Weymouth - Braintree	45	8	185	204	1,480	1,628	2	2,960	3,256	2,355	0.80	0.72	3,680	0.64
Plymouth/Kingston Line OB	South Station - JFK/Umass	90	8	185	204	1,480	1,628	1	1,480	1,628	12	0.01	0.01	20	0.58
Greenbush Line IB	JFK/Umass - South Station	45	8	185	204	1,480	1,628	2	2,960	3,256	1,110	0.38	0.34	1,850	0.60
Greenbush Line OB	South Station - JFK/Umass	180	8	185	204	1,480	1,628	1	1,480	1,628	30	0.02	0.02	30	1.00

2035 Transit Improvement Only

		AM Peak Train Set Info						AM Peak 1 Hour Service Info 3-hour Data							
Commuter Rail Line Service	Peak Load Point (From CTPS Travel Demand Model)	Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume- Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	Modeled Volume - Peak Point	Peak Hour / Peak Period
Needham Line IB	Forest Hills - Ruggles	36	8	185	204	1,480	1,628	2	2,960	3,256	639	0.22	0.20	940	0.68
Needham Line OB	South Station - Back Bay	60	8	185	204	1,480	1,628	1	1,480	1,628	286	0.19	0.18	530	0.54
Worcester/Framingham Line IB	Newtonville - Yawkey	23	8	185	204	1,480	1,628	3	4,440	4,884	2,015	0.45	0.41	3,100	0.65
Worcester/Framingham Line OB	South Station - Back Bay	60	8	185	204	1,480	1,628	1	1,480	1,628	442	0.30	0.27	660	0.67
Franklin Line IB	Hyde Park - Ruggles	23	8	185	204	1,480	1,628	3	4,440	4,884	1,618	0.36	0.33	2,790	0.58
Franklin Line OB	South Station - Back Bay	60	8	185	204	1,480	1,628	1	1,480	1,628	199	0.13	0.12	280	0.71
Providence/Attleboro Line IB	Hyde Park - Ruggles	23	8	185	204	1,480	1,628	3	4,440	4,884	1,620	0.36	0.33	3,000	0.54
Providence/Attleboro Line OB	South Station - Back Bay	45	8	185	204	1,480	1,628	2	2,960	3,256	491	0.17	0.15	630	0.78
Canton/Stoughton/South Coast Rail Line IB	Ruggles - Back Bay	23	8	185	204	1,480	1,628	3	4,440	4,884	3,558	0.80	0.73	5,560	0.64
Canton/Stoughton/South Coast Rail Line OB	South Station - Back Bay	60	8	185	204	1,480	1,628	1	1,480	1,628	203	0.14	0.12	390	0.52
Fairmount Line IB	Uphams Corner - Newmarket	15	8	185	204	1,480	1,628	4	5,920	6,512	1,128	0.19	0.17	1,820	0.62
Fairmount Line OB	Talbot Ave - Morton St	15	8	185	204	1,480	1,628	4	5,920	6,512	166	0.03	0.03	200	0.83
Middleborough Line IB	JFK/Umass - South Station	45	8	185	204	1,480	1,628	2	2,960	3,256	2,778	0.94	0.85	4,960	0.56
Middleborough Line OB	Montello - Brockton	90	8	185	204	1,480	1,628	1	1,480	1,628	68	0.05	0.04	120	0.57
Plymouth/Kingston Line IB	S Weymouth - Braintree	45	8	185	204	1,480	1,628	2	2,960	3,256	2,355	0.80	0.72	3,680	0.64
Plymouth/Kingston Line OB	South Station - JFK/Umass	90	8	185	204	1,480	1,628	1	1,480	1,628	12	0.01	0.01	20	0.58
Greenbush Line IB	JFK/Umass - South Station	45	8	185	204	1,480	1,628	2	2,960	3,256	1,110	0.38	0.34	1,850	0.60
Greenbush Line OB	South Station - JFK/Umass	180	8	185	204	1,480	1,628	1	1,480	1,628	40	0.03	0.02	40	1.00

South Station Expansion Project

Results for Transit Crowding Analysis

South Side Commuter Rail - AM Peak Period (6am - 9am)

2035 Maximum Land Use

		AM Peak Train Set Info						AM Peak 1 Hour Service Info						3-hour Data	
Commuter Rail Line Service	Peak Load Point (From CTPS Travel Demand Model)	Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume- Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	Modeled Volume - Peak Point	Peak Hour / Peak Period
Needham Line IB	Forest Hills - Ruggles	36	8	185	204	1,480	1,628	2	2,960	3,256	653	0.22	0.20	960	0.68
Needham Line OB	South Station - Back Bay	60	8	185	204	1,480	1,628	1	1,480	1,628	292	0.20	0.18	540	0.54
Worcester/Framingham Line IB	Newtonville - Yawkey	23	8	185	204	1,480	1,628	3	4,440	4,884	2,054	0.46	0.42	3,160	0.65
Worcester/Framingham Line OB	South Station - Back Bay	60	8	185	204	1,480	1,628	1	1,480	1,628	449	0.30	0.28	670	0.67
Franklin Line IB	Hyde Park - Ruggles	23	8	185	204	1,480	1,628	3	4,440	4,884	1,647	0.37	0.34	2,840	0.58
Franklin Line OB	South Station - Back Bay	60	8	185	204	1,480	1,628	1	1,480	1,628	199	0.13	0.12	280	0.71
Providence/Attleboro Line IB	Hyde Park - Ruggles	23	8	185	204	1,480	1,628	3	4,440	4,884	1,690	0.38	0.35	3,130	0.54
Providence/Attleboro Line OB	South Station - Back Bay	45	8	185	204	1,480	1,628	2	2,960	3,256	499	0.17	0.15	640	0.78
Canton/Stoughton/South Coast Rail Line IB	Ruggles - Back Bay	23	8	185	204	1,480	1,628	3	4,440	4,884	3,558	0.80	0.73	5,560	0.64
Canton/Stoughton/South Coast Rail Line OB	South Station - Back Bay	60	8	185	204	1,480	1,628	1	1,480	1,628	203	0.14	0.12	390	0.52
Fairmount Line IB	Uphams Corner - Newmarket	15	8	185	204	1,480	1,628	4	5,920	6,512	1,135	0.19	0.17	1,830	0.62
Fairmount Line OB	Talbot Ave - Morton St	15	8	185	204	1,480	1,628	4	5,920	6,512	166	0.03	0.03	200	0.83
Middleborough Line IB	JFK/Umass - South Station	45	8	185	204	1,480	1,628	2	2,960	3,256	2,778	0.94	0.85	4,960	0.56
Middleborough Line OB	Montello - Brockton	90	8	185	204	1,480	1,628	1	1,480	1,628	68	0.05	0.04	120	0.57
Plymouth/Kingston Line IB	S Weymouth - Braintree	45	8	185	204	1,480	1,628	2	2,960	3,256	2,355	0.80	0.72	3,680	0.64
Plymouth/Kingston Line OB	South Station - JFK/Umass	90	8	185	204	1,480	1,628	1	1,480	1,628	12	0.01	0.01	20	0.58
Greenbush Line IB	JFK/Umass - South Station	45	8	185	204	1,480	1,628	2	2,960	3,256	1,110	0.38	0.34	1,850	0.60
Greenbush Line OB	South Station - JFK/Umass	180	8	185	204	1,480	1,628	1	1,480	1,628	40	0.03	0.02	40	1.00

2035 Minimum Land Use

		AM Peak Train Set Info						AM Peak 1 Hour Service Info						3-hour Data	
Commuter Rail Line Service	Peak Load Point (From CTPS Travel Demand Model)	Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume- Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	Modeled Volume - Peak Point	Peak Hour / Peak Period
Needham Line IB	Forest Hills - Ruggles	36	8	185	204	1,480	1,628	2	2,960	3,256	646	0.22	0.20	950	0.68
Needham Line OB	South Station - Back Bay	60	8	185	204	1,480	1,628	1	1,480	1,628	286	0.19	0.18	530	0.54
Worcester/Framingham Line IB	Newtonville - Yawkey	23	8	185	204	1,480	1,628	3	4,440	4,884	2,028	0.46	0.42	3,120	0.65
Worcester/Framingham Line OB	South Station - Back Bay	60	8	185	204	1,480	1,628	1	1,480	1,628	442	0.30	0.27	660	0.67
Franklin Line IB	Hyde Park - Ruggles	23	8	185	204	1,480	1,628	3	4,440	4,884	1,624	0.37	0.33	2,800	0.58
Franklin Line OB	South Station - Back Bay	60	8	185	204	1,480	1,628	1	1,480	1,628	199	0.13	0.12	280	0.71
Providence/Attleboro Line IB	Hyde Park - Ruggles	23	8	185	204	1,480	1,628	3	4,440	4,884	1,669	0.38	0.34	3,090	0.54
Providence/Attleboro Line OB	South Station - Back Bay	45	8	185	204	1,480	1,628	2	2,960	3,256	491	0.17	0.15	630	0.78
Canton/Stoughton/South Coast Rail Line IB	Ruggles-Back Bay	23	8	185	204	1,480	1,628	3	4,440	4,884	3,558	0.80	0.73	5,560	0.64
Canton/Stoughton/South Coast Rail Line OB	South Station - Back Bay	60	8	185	204	1,480	1,628	1	1,480	1,628	203	0.14	0.12	390	0.52
Fairmount Line IB	Uphams Corner - Newmarket	15	8	185	204	1,480	1,628	4	5,920	6,512	1,128	0.19	0.17	1,820	0.62
Fairmount Line OB	Talbot Ave - Morton St	15	8	185	204	1,480	1,628	4	5,920	6,512	166	0.03	0.03	200	0.83
Middleborough Line IB	JFK/Umass - South Station	45	8	185	204	1,480	1,628	2	2,960	3,256	2,778	0.94	0.85	4,960	0.56
Middleborough Line OB	Montello - Brockton	90	8	185	204	1,480	1,628	1	1,480	1,628	68	0.05	0.04	120	0.57
Plymouth/Kingston Line IB	S Weymouth - Braintree	45	8	185	204	1,480	1,628	2	2,960	3,256	2,355	0.80	0.72	3,680	0.64
Plymouth/Kingston Line OB	South Station - JFK/Umass	90	8	185	204	1,480	1,628	1	1,480	1,628	12	0.01	0.01	20	0.58
Greenbush Line IB	JFK/Umass - South Station	45	8	185	204	1,480	1,628	2	2,960	3,256	1,110	0.38	0.34	1,850	0.60
Greenbush Line OB	South Station - JFK/Umass	180	8	185	204	1,480	1,628	1	1,480	1,628	40	0.03	0.02	40	1.00

Note: Fractional train sets are rounded up for the peak hour to reflect the peak number of trains in a 60 minute period during the peak 180 minute period

South Station Expansion Project

Results for Transit Crowding Analysis

South Side Commuter Rail - PM Peak Period (3pm - 6pm)

2035 True No-Build

		PM Peak Train Set Info						PM Peak 1 Hour Service Info						3-hour Data	
Commuter Rail Line Service	Peak Load Point (From CTPS Travel Demand Model)	Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume- Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	Modeled Volume - Peak Point	Peak Hour / Peak Period
Needham Line IB	Back Bay - South Station	60	8	185	204	1,480	1,628	1	1,480	1,628	342	0.23	0.21	510	0.67
Needham Line OB	Ruggles - Forest Hills	36	8	185	204	1,480	1,628	2	2,960	3,256	678	0.23	0.21	1,130	0.60
Worcester/Framingham Line IB	Wellesley Hills - Wellesley Farms	90	8	185	204	1,480	1,628	1	1,480	1,628	281	0.19	0.17	550	0.51
Worcester/Framingham Line OB	Yawkey - Newtonville	26	8	185	204	1,480	1,628	3	4,440	4,884	1,446	0.33	0.30	2,450	0.59
Franklin Line IB	Uphams Corner - Newmarket	90	8	185	204	1,480	1,628	1	1,480	1,628	204	0.14	0.13	300	0.68
Franklin Line OB	Ruggles - Hyde Park	36	8	185	204	1,480	1,628	2	2,960	3,256	1,227	0.41	0.38	2,080	0.59
Providence/Attleboro Line IB	Back Bay - South Station	180	8	185	204	1,480	1,628	1	1,480	1,628	290	0.20	0.18	290	1.00
Providence/Attleboro Line OB	Ruggles - Hyde Park	36	8	185	204	1,480	1,628	2	2,960	3,256	514	0.17	0.16	1,070	0.48
Canton/Stoughton Line IB	Back Bay - South Station	90	8	185	204	1,480	1,628	1	1,480	1,628	382	0.26	0.23	670	0.57
Canton/Stoughton Line OB	Ruggles - Hyde Park	45	8	185	204	1,480	1,628	2	2,960	3,256	1,665	0.56	0.51	2,220	0.75
Fairmount Line IB	Uphams Corner - Newmarket	15	8	185	204	1,480	1,628	4	5,920	6,512	227	0.04	0.03	420	0.54
Fairmount Line OB	Newmarket - Uphams Corner	15	8	185	204	1,480	1,628	4	5,920	6,512	1,190	0.20	0.18	1,750	0.68
Middleborough Line IB	JFK/Umass - South Station	180	8	185	204	1,480	1,628	1	1,480	1,628	430	0.29	0.26	430	1.00
Middleborough Line OB	South Station - JFK/Umass	45	8	185	204	1,480	1,628	2	2,960	3,256	2,632	0.89	0.81	4,700	0.56
Plymouth/Kingston Line IB	JFK/Umass - South Station	90	8	185	204	1,480	1,628	1	1,480	1,628	45	0.03	0.03	90	0.50
Plymouth/Kingston Line OB	Braintree - South Weymouth	60	8	185	204	1,480	1,628	1	1,480	1,628	1,537	1.04	0.94	2,520	0.61
Greenbush Line IB	JFK/Umass - South Station	90	8	185	204	1,480	1,628	1	1,480	1,628	102	0.07	0.06	150	0.68
Greenbush Line OB	South Station - JFK/Umass	45	8	185	204	1,480	1,628	2	2,960	3,256	1,272	0.43	0.39	1,570	0.81

2035 Transit Improvement Only

		PM Peak Train Set Info						PM Peak 1 Hour Service Info						3-hour Data	
Commuter Rail Line Service	Peak Load Point (From CTPS Travel Demand Model)	Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume- Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	Modeled Volume - Peak Point	Peak Hour / Peak Period
Needham Line IB	Back Bay - South Station	60	8	185	204	1,480	1,628	1	1,480	1,628	342	0.23	0.21	510	0.67
Needham Line OB	Ruggles - Forest Hills	30	8	185	204	1,480	1,628	2	2,960	3,256	744	0.25	0.23	1,240	0.60
Worcester/Framingham Line IB	Wellesley Hills - Wellesley Farms	90	8	185	204	1,480	1,628	1	1,480	1,628	286	0.19	0.18	560	0.51
Worcester/Framingham Line OB	Yawkey - Newtonville	26	8	185	204	1,480	1,628	3	4,440	4,884	1,499	0.34	0.31	2,540	0.59
Franklin Line IB	Uphams Corner - Newmarket	90	8	185	204	1,480	1,628	1	1,480	1,628	204	0.14	0.13	300	0.68
Franklin Line OB	Ruggles - Hyde Park	30	8	185	204	1,480	1,628	2	2,960	3,256	1,304	0.44	0.40	2,210	0.59
Providence/Attleboro Line IB	Back Bay - South Station	180	8	185	204	1,480	1,628	1	1,480	1,628	290	0.20	0.18	290	1.00
Providence/Attleboro Line OB	Ruggles - Hyde Park	30	8	185	204	1,480	1,628	2	2,960	3,256	571	0.19	0.18	1,190	0.48
Canton/Stoughton/South Coast Rail Line IB	Back Bay - South Station	90	8	185	204	1,480	1,628	1	1,480	1,628	382	0.26	0.23	670	0.57
Canton/Stoughton/South Coast Rail Line OB	Back Bay - Ruggles	30	8	185	204	1,480	1,628	2	2,960	3,256	4,470	1.51	1.37	5,960	0.75
Fairmount Line IB	Uphams Corner - Newmarket	15	8	185	204	1,480	1,628	4	5,920	6,512	227	0.04	0.03	420	0.54
Fairmount Line OB	Newmarket - Uphams Corner	15	8	185	204	1,480	1,628	4	5,920	6,512	1,224	0.21	0.19	1,800	0.68
Middleborough Line IB	JFK/Umass - South Station	180	8	185	204	1,480	1,628	1	1,480	1,628	440	0.30	0.27	440	1.00
Middleborough Line OB	South Station - JFK/Umass	45	8	185	204	1,480	1,628	2	2,960	3,256	2,632	0.89	0.81	4,700	0.56
Plymouth/Kingston Line IB	JFK/Umass - South Station	90	8	185	204	1,480	1,628	1	1,480	1,628	45	0.03	0.03	90	0.50
Plymouth/Kingston Line OB	Braintree - South Weymouth	60	8	185	204	1,480	1,628	1	1,480	1,628	1,537	1.04	0.94	2,520	0.61
Greenbush Line IB	JFK/Umass - South Station	90	8	185	204	1,480	1,628	1	1,480	1,628	102	0.07	0.06	150	0.68
Greenbush Line OB	South Station - JFK/Umass	45	8	185	204	1,480	1,628	2	2,960	3,256	1,272	0.43	0.39	1,570	0.81

South Station Expansion Project

Results for Transit Crowding Analysis

South Side Commuter Rail - PM Peak Period (3pm - 6pm)

2035 Maximum Land Use

		PM Peak Train Set Info						PM Peak 1 Hour Service Info						3-hour Data	
Commuter Rail Line Service	Peak Load Point (From CTPS Travel Demand Model)	Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume- Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	Modeled Volume - Peak Point	Peak Hour / Peak Period
Needham Line IB	Back Bay - South Station	60	8	185	204	1,480	1,628	1	1,480	1,628	348	0.24	0.21	520	0.67
Needham Line OB	Ruggles - Forest Hills	30	8	185	204	1,480	1,628	2	2,960	3,256	756	0.26	0.23	1,260	0.60
Worcester/Framingham Line IB	Wellesley Hills - Wellesley Farms	90	8	185	204	1,480	1,628	1	1,480	1,628	286	0.19	0.18	560	0.51
Worcester/Framingham Line OB	Yawkey - Newtonville	26	8	185	204	1,480	1,628	3	4,440	4,884	1,516	0.34	0.31	2,570	0.59
Franklin Line IB	Uphams Corner - Newmarket	90	8	185	204	1,480	1,628	1	1,480	1,628	211	0.14	0.13	310	0.68
Franklin Line OB	Ruggles - Hyde Park	30	8	185	204	1,480	1,628	2	2,960	3,256	1,328	0.45	0.41	2,250	0.59
Providence/Attleboro Line IB	Back Bay - South Station	180	8	185	204	1,480	1,628	1	1,480	1,628	290	0.20	0.18	290	1.00
Providence/Attleboro Line OB	Ruggles - Hyde Park	30	8	185	204	1,480	1,628	2	2,960	3,256	590	0.20	0.18	1,230	0.48
Canton/Stoughton/South Coast Rail Line IB	Back Bay - South Station	90	8	185	204	1,480	1,628	1	1,480	1,628	393	0.27	0.24	690	0.57
Canton/Stoughton/South Coast Rail Line OB	Back Bay - Ruggles	30	8	185	204	1,480	1,628	2	2,960	3,256	4,470	1.51	1.37	5,960	0.75
Fairmount Line IB	Uphams Corner - Newmarket	15	8	185	204	1,480	1,628	4	5,920	6,512	238	0.04	0.04	440	0.54
Fairmount Line OB	Newmarket - Uphams Corner	15	8	185	204	1,480	1,628	4	5,920	6,512	1,224	0.21	0.19	1,800	0.68
Middleborough Line IB	JFK/Umass - South Station	180	8	185	204	1,480	1,628	1	1,480	1,628	440	0.30	0.27	440	1.00
Middleborough Line OB	South Station - JFK/Umass	45	8	185	204	1,480	1,628	2	2,960	3,256	2,632	0.89	0.81	4,700	0.56
Plymouth/Kingston Line IB	JFK/Umass - South Station	90	8	185	204	1,480	1,628	1	1,480	1,628	45	0.03	0.03	90	0.50
Plymouth/Kingston Line OB	Braintree - South Weymouth	60	8	185	204	1,480	1,628	1	1,480	1,628	1,537	1.04	0.94	2,520	0.61
Greenbush Line IB	JFK/Umass - South Station	90	8	185	204	1,480	1,628	1	1,480	1,628	109	0.07	0.07	160	0.68
Greenbush Line OB	South Station - JFK/Umass	45	8	185	204	1,480	1,628	2	2,960	3,256	1,272	0.43	0.39	1,570	0.81

2035 Minimum Land Use

		PM Peak Train Set Info						PM Peak 1 Hour Service Info						3-hour Data	
Commuter Rail Line Service	Peak Load Point (From CTPS Travel Demand Model)	Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume- Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	Modeled Volume - Peak Point	Peak Hour / Peak Period
Needham Line IB	Back Bay - South Station	60	8	185	204	1,480	1,628	1	1,480	1,628	342	0.23	0.21	510	0.67
Needham Line OB	Ruggles - Forest Hills	30	8	185	204	1,480	1,628	2	2,960	3,256	744	0.25	0.23	1,240	0.60
Worcester/Framingham Line IB	Wellesley Hills - Wellesley Farms	90	8	185	204	1,480	1,628	1	1,480	1,628	286	0.19	0.18	560	0.51
Worcester/Framingham Line OB	Yawkey - Newtonville	26	8	185	204	1,480	1,628	3	4,440	4,884	1,499	0.34	0.31	2,540	0.59
Franklin Line IB	Uphams Corner - Newmarket	90	8	185	204	1,480	1,628	1	1,480	1,628	211	0.14	0.13	310	0.68
Franklin Line OB	Ruggles - Hyde Park	30	8	185	204	1,480	1,628	2	2,960	3,256	1,310	0.44	0.40	2,220	0.59
Providence/Attleboro Line IB	Back Bay - South Station	180	8	185	204	1,480	1,628	1	1,480	1,628	290	0.20	0.18	290	1.00
Providence/Attleboro Line OB	Ruggles - Hyde Park	30	8	185	204	1,480	1,628	2	2,960	3,256	581	0.20	0.18	1,210	0.48
Canton/Stoughton/South Coast Rail Line IB	Back Bay - South Station	90	8	185	204	1,480	1,628	1	1,480	1,628	388	0.26	0.24	680	0.57
Canton/Stoughton/South Coast Rail Line OB	Back Bay - Ruggles	30	8	185	204	1,480	1,628	2	2,960	3,256	4,470	1.51	1.37	5,960	0.75
Fairmount Line IB	Uphams Corner - Newmarket	15	8	185	204	1,480	1,628	4	5,920	6,512	232	0.04	0.04	430	0.54
Fairmount Line OB	Newmarket - Uphams Corner	15	8	185	204	1,480	1,628	4	5,920	6,512	1,224	0.21	0.19	1,800	0.68
Middleborough Line IB	JFK/Umass - South Station	180	8	185	204	1,480	1,628	1	1,480	1,628	440	0.30	0.27	440	1.00
Middleborough Line OB	South Station - JFK/Umass	45	8	185	204	1,480	1,628	2	2,960	3,256	2,632	0.89	0.81	4,700	0.56
Plymouth/Kingston Line IB	JFK/Umass - South Station	90	8	185	204	1,480	1,628	1	1,480	1,628	45	0.03	0.03	90	0.50
Plymouth/Kingston Line OB	Braintree - South Weymouth	60	8	185	204	1,480	1,628	1	1,480	1,628	1,537	1.04	0.94	2,520	0.61
Greenbush Line IB	JFK/Umass - South Station	90	8	185	204	1,480	1,628	1	1,480	1,628	109	0.07	0.07	160	0.68
Greenbush Line OB	South Station - JFK/Umass	45	8	185	204	1,480	1,628	2	2,960	3,256	1,272	0.43	0.39	1,570	0.81

Note: Fractional train sets are rounded up for the peak hour to reflect the peak number of trains in a 60 minute period during the peak 180 minute period

South Station Expansion Project

Results for Transit Crowding Analysis

Rapid Transit - AM Peak Period (6am - 9am)

2035 True No-Build

		AM Peak Train Set Info						AM Peak 1 Hour Service Info						3-hour Data	
Rapid Transit Service	Peak Load Point (From CTPS Travel Demand Model)	Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume-Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	Modeled Volume - Peak Point	Peak Hour / Peak Period
Red Line NB	Broadway - South Station	4.3	6	62	167	372	1,002	15	5,580	15,030	8,880	1.59	0.59	22,200	0.40
Red Line SB	Kendall Square - MGH	4.3	6	62	167	372	1,002	15	5,580	15,030	4,800	0.86	0.32	12,000	0.40
Silver Line WFL/Gateway EB	South Station - Courthouse	1.7	1	45	65	45	65	36	1,620	2,340	1,676	1.03	0.72	4,190	0.40
Silver Line WFL/Gateway WB	Courthouse - South Station	1.7	1	45	65	45	65	36	1,620	2,340	848	0.52	0.36	2,120	0.40
Silver Line 4 NB	Herald-NEMC	10.0	1	57	79	57	79	6	342	474	508	1.49	1.07	1,270	0.40
Silver Line 4 SB	Herald-E Berkley	10.0	1	57	79	57	79	6	342	474	856	2.50	1.81	2,140	0.40
Silver Line 5 NB	Herald-NEMC	10.0	1	57	79	57	79	6	342	474	508	1.49	1.07	1,270	0.40
Silver Line 5 SB	Herald-E Berkley	10.0	1	57	79	57	79	6	342	474	856	2.50	1.81	2,140	0.40
Orange NB	NEMC - Chinatown	4.5	6	58	131	348	786	14	4,872	11,004	4,960	1.02	0.45	12,400	0.40
Orange SB	Community College - North Station	4.5	6	58	131	348	786	14	4,872	11,004	5,280	1.08	0.48	13,200	0.40
Blue NB	State - Aquarium	4.5	6	35	95	210	570	14	2,940	7,980	1,040	0.35	0.13	2,600	0.40
Blue SB	Maverick - Aquarium	4.5	6	35	95	210	570	14	2,940	7,980	6,960	2.37	0.87	17,400	0.40

2035 Transit Improvement Only

		AM Peak Train Set Info						AM Peak 1 Hour Service Info						3-hour Data	
Rapid Transit Service	Peak Load Point (From CTPS Travel Demand Model)	Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume-Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	Modeled Volume - Peak Point	Peak Hour / Peak Period
Red Line NB	Broadway - South Station	4.3	6	62	167	372	1,002	15	5,580	15,030	8,920	1.60	0.59	22,300	0.40
Red Line SB	Kendall Square - MGH	4.3	6	62	167	372	1,002	15	5,580	15,030	4,800	0.86	0.32	12,000	0.40
Silver Line WFL/Gateway EB	South Station - Courthouse	1.7	1	45	65	45	65	36	1,620	2,340	1,732	1.07	0.74	4,330	0.40
Silver Line WFL/Gateway WB	Courthouse - South Station	1.7	1	45	65	45	65	36	1,620	2,340	848	0.52	0.36	2,120	0.40
Silver Line 4 NB	Herald-NEMC	10.0	1	57	79	57	79	6	342	474	508	1.49	1.07	1,270	0.40
Silver Line 4 SB	Herald-E Berkley	10.0	1	57	79	57	79	6	342	474	856	2.50	1.81	2,140	0.40
Silver Line 5 NB	Herald-NEMC	10.0	1	57	79	57	79	6	342	474	508	1.49	1.07	1,270	0.40
Silver Line 5 SB	Herald-E Berkley	10.0	1	57	79	57	79	6	342	474	856	2.50	1.81	2,140	0.40
Orange NB	NEMC - Chinatown	4.5	6	58	131	348	786	14	4,872	11,004	5,000	1.03	0.45	12,500	0.40
Orange SB	Community College - North Station	4.5	6	58	131	348	786	14	4,872	11,004	5,280	1.08	0.48	13,200	0.40
Blue NB	State - Aquarium	4.5	6	35	95	210	570	14	2,940	7,980	1,040	0.35	0.13	2,600	0.40
Blue SB	Maverick - Aquarium	4.5	6	35	95	210	570	14	2,940	7,980	6,960	2.37	0.87	17,400	0.40

South Station Expansion Project

Results for Transit Crowding Analysis

Rapid Transit - AM Peak Period (6am - 9am)

2035 Maximum Land Use

		AM Peak Train Set Info						AM Peak 1 Hour Service Info						3-hour Data	
Rapid Transit Service	Peak Load Point (From CTPS Travel Demand Model)	Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume- Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	Modeled Volume - Peak Point	Peak Hour / Peak Period
Red Line NB	Broadway - South Station	4.3	6	62	167	372	1,002	15	5,580	15,030	8,920	1.60	0.59	22,300	0.40
Red Line SB	Kendall Square - MGH	4.3	6	62	167	372	1,002	15	5,580	15,030	4,840	0.87	0.32	12,100	0.40
Silver Line WFL/Gateway EB	South Station - Courthouse	1.7	1	45	65	45	65	36	1,620	2,340	1,768	1.09	0.76	4,420	0.40
Silver Line WFL/Gateway WB	Courthouse - South Station	1.7	1	45	65	45	65	36	1,620	2,340	860	0.53	0.37	2,150	0.40
Silver Line 4 NB	Herald-NEMC	10.0	1	57	79	57	79	6	342	474	508	1.49	1.07	1,270	0.40
Silver Line 4 SB	Herald-E Berkley	10.0	1	57	79	57	79	6	342	474	852	2.49	1.80	2,130	0.40
Silver Line 5 NB	Herald-NEMC	10.0	1	57	79	57	79	6	342	474	508	1.49	1.07	1,270	0.40
Silver Line 5 SB	Herald-E Berkley	10.0	1	57	79	57	79	6	342	474	852	2.49	1.80	2,130	0.40
Orange NB	NEMC - Chinatown	4.5	6	58	131	348	786	14	4,872	11,004	5,000	1.03	0.45	12,500	0.40
Orange SB	Community College - North Station	4.5	6	58	131	348	786	14	4,872	11,004	5,280	1.08	0.48	13,200	0.40
Blue NB	State - Aquarium	4.5	6	35	95	210	570	14	2,940	7,980	1,040	0.35	0.13	2,600	0.40
Blue SB	Maverick - Aquarium	4.5	6	35	95	210	570	14	2,940	7,980	6,960	2.37	0.87	17,400	0.40

2035 Minimum Land Use

		AM Peak Train Set Info						AM Peak 1 Hour Service Info						3-hour Data	
Rapid Transit Service	Peak Load Point (From CTPS Travel Demand Model)	Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume- Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	Modeled Volume - Peak Point	Peak Hour / Peak Period
Red Line NB	Broadway - South Station	4.3	6	62	167	372	1,002	15	5,580	15,030	8,920	1.60	0.59	22,300	0.40
Red Line SB	Kendall Square - MGH	4.3	6	62	167	372	1,002	15	5,580	15,030	4,800	0.86	0.32	12,000	0.40
Silver Line WFL/Gateway EB	South Station - Courthouse	1.7	1	45	65	45	65	36	1,620	2,340	1,736	1.07	0.74	4,340	0.40
Silver Line WFL/Gateway WB	Courthouse - South Station	1.7	1	45	65	45	65	36	1,620	2,340	848	0.52	0.36	2,120	0.40
Silver Line 4 NB	Herald-NEMC	10.0	1	57	79	57	79	6	342	474	508	1.49	1.07	1,270	0.40
Silver Line 4 SB	Herald-E Berkley	10.0	1	57	79	57	79	6	342	474	852	2.49	1.80	2,130	0.40
Silver Line 5 NB	Herald-NEMC	10.0	1	57	79	57	79	6	342	474	508	1.49	1.07	1,270	0.40
Silver Line 5 SB	Herald-E Berkley	10.0	1	57	79	57	79	6	342	474	852	2.49	1.80	2,130	0.40
Orange NB	NEMC - Chinatown	4.5	6	58	131	348	786	14	4,872	11,004	5,000	1.03	0.45	12,500	0.40
Orange SB	Community College - North Station	4.5	6	58	131	348	786	14	4,872	11,004	5,280	1.08	0.48	13,200	0.40
Blue NB	State - Aquarium	4.5	6	35	95	210	570	14	2,940	7,980	1,040	0.35	0.13	2,600	0.40
Blue SB	Maverick - Aquarium	4.5	6	35	95	210	570	14	2,940	7,980	6,960	2.37	0.87	17,400	0.40

Note: Silver Line WFL service includes Silver Line Gateway service to Chelsea

Note: Seated capacities for vehicles were calculated from a weighted average of the current vehicle fleet (2014 Bluebook)

Note: Fractional train sets are rounded up for the peak hour to reflect the peak number of trains in a 60 minute period during the peak 180 minute period

South Station Expansion Project

Results for Transit Crowding Analysis

Rapid Transit - PM Peak Period (3pm - 6pm)

2035 True No-Build

		PM Peak Train Set Info						PM Peak 1 Hour Service Info						3-hour Data	
Rapid Transit Service	Peak Load Point (From CTPS Travel Demand Model)	Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume- Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	Modeled Volume - Peak Point	Peak Hour / Peak Period
Red Line NB	South Station - DTX	4.0	6	62	167	372	1,002	15	5,580	15,030	4,520	0.81	0.30	11,300	0.40
Red Line SB	South Station - Broadway	4.0	6	62	167	372	1,002	15	5,580	15,030	8,040	1.44	0.53	20,100	0.40
Silver Line WFL/Gateway EB	South Station - Courthouse	1.7	1	45	65	45	65	36	1,620	2,340	952	0.59	0.41	2,380	0.40
Silver Line WFL/Gateway WB	Courthouse - South Station	1.7	1	45	65	45	65	36	1,620	2,340	2,000	1.23	0.85	5,000	0.40
Silver Line 4 NB	Herald-NEMC	10.0	1	57	79	57	79	6	342	474	612	1.79	1.29	1,530	0.40
Silver Line 4 SB	Herald-E Berkley	10.0	1	57	79	57	79	6	342	474	628	1.84	1.32	1,570	0.40
Silver Line 5 NB	Herald-NEMC	10.0	1	57	79	57	79	6	342	474	612	1.79	1.29	1,530	0.40
Silver Line 5 SB	Herald-E Berkley	10.0	1	57	79	57	79	6	342	474	628	1.84	1.32	1,570	0.40
Orange NB	State - Haymarket	4.5	6	58	131	348	786	14	4,872	11,004	4,360	0.89	0.40	10,900	0.40
Orange SB	Chinatown - NEMC	4.5	6	58	131	348	786	14	4,872	11,004	3,880	0.80	0.35	9,700	0.40
Blue NB	Aquarium - Maverick	4.5	6	35	95	210	570	14	2,940	7,980	4,440	1.51	0.56	11,100	0.40
Blue SB	Maverick - Aquarium	4.5	6	35	95	210	570	14	2,940	7,980	2,000	0.68	0.25	5,000	0.40

2035 Transit Improvement Only

		PM Peak Train Set Info						PM Peak 1 Hour Service Info						3-hour Data	
Rapid Transit Service	Peak Load Point (From CTPS Travel Demand Model)	Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume- Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	Modeled Volume - Peak Point	Peak Hour / Peak Period
Red Line NB	South Station - DTX	4.0	6	62	167	372	1,002	15	5,580	15,030	4,520	0.81	0.30	11,300	0.40
Red Line SB	South Station - Broadway	4.0	6	62	167	372	1,002	15	5,580	15,030	8,040	1.44	0.53	20,100	0.40
Silver Line WFL/Gateway EB	South Station - Courthouse	1.7	1	45	65	45	65	36	1,620	2,340	956	0.59	0.41	2,390	0.40
Silver Line WFL/Gateway WB	Courthouse - South Station	1.7	1	45	65	45	65	36	1,620	2,340	2,124	1.31	0.91	5,310	0.40
Silver Line 4 NB	Herald-NEMC	10.0	1	57	79	57	79	6	342	474	612	1.79	1.29	1,530	0.40
Silver Line 4 SB	Herald-E Berkley	10.0	1	57	79	57	79	6	342	474	628	1.84	1.32	1,570	0.40
Silver Line 5 NB	Herald-NEMC	10.0	1	57	79	57	79	6	342	474	612	1.79	1.29	1,530	0.40
Silver Line 5 SB	Herald-E Berkley	10.0	1	57	79	57	79	6	342	474	628	1.84	1.32	1,570	0.40
Orange NB	State - Haymarket	4.5	6	58	131	348	786	14	4,872	11,004	4,360	0.89	0.40	10,900	0.40
Orange SB	Chinatown - NEMC	4.5	6	58	131	348	786	14	4,872	11,004	3,920	0.80	0.36	9,800	0.40
Blue NB	Aquarium - Maverick	4.5	6	35	95	210	570	14	2,940	7,980	4,440	1.51	0.56	11,100	0.40
Blue SB	Maverick - Aquarium	4.5	6	35	95	210	570	14	2,940	7,980	2,000	0.68	0.25	5,000	0.40

South Station Expansion Project

Results for Transit Crowding Analysis

Rapid Transit - PM Peak Period (3pm - 6pm)

2035 Maximum Land Use

		PM Peak Train Set Info						PM Peak 1 Hour Service Info						3-hour Data	
Rapid Transit Service	Peak Load Point (From CTPS Travel Demand Model)	Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume- Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	Modeled Volume - Peak Point	Peak Hour / Peak Period
Red Line NB	South Station - DTX	4.0	6	62	167	372	1,002	15	5,580	15,030	4,640	0.83	0.31	11,600	0.40
Red Line SB	South Station - Broadway	4.0	6	62	167	372	1,002	15	5,580	15,030	8,080	1.45	0.54	20,200	0.40
Silver Line WFL/Gateway EB	South Station - Courthouse	1.7	1	45	65	45	65	36	1,620	2,340	972	0.60	0.42	2,430	0.40
Silver Line WFL/Gateway WB	Courthouse - South Station	1.7	1	45	65	45	65	36	1,620	2,340	2,156	1.33	0.92	5,390	0.40
Silver Line 4 NB	Herald-NEMC	10.0	1	57	79	57	79	6	342	474	616	1.80	1.30	1,540	0.40
Silver Line 4 SB	Herald-E Berkley	10.0	1	57	79	57	79	6	342	474	628	1.84	1.32	1,570	0.40
Silver Line 5 NB	Herald-NEMC	10.0	1	57	79	57	79	6	342	474	616	1.80	1.30	1,540	0.40
Silver Line 5 SB	Herald-E Berkley	10.0	1	57	79	57	79	6	342	474	628	1.84	1.32	1,570	0.40
Orange NB	State - Haymarket	4.5	6	58	131	348	786	14	4,872	11,004	4,400	0.90	0.40	11,000	0.40
Orange SB	Chinatown - NEMC	4.5	6	58	131	348	786	14	4,872	11,004	3,920	0.80	0.36	9,800	0.40
Blue NB	Aquarium - Maverick	4.5	6	35	95	210	570	14	2,940	7,980	4,440	1.51	0.56	11,100	0.40
Blue SB	Maverick - Aquarium	4.5	6	35	95	210	570	14	2,940	7,980	2,040	0.69	0.26	5,100	0.40

2035 Minimum Land Use

		PM Peak Train Set Info						PM Peak 1 Hour Service Info						3-hour Data	
Rapid Transit Service	Peak Load Point (From CTPS Travel Demand Model)	Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume- Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	Modeled Volume - Peak Point	Peak Hour / Peak Period
Red Line NB	South Station - DTX	4.0	6	62	167	372	1,002	15	5,580	15,030	4,600	0.82	0.31	11,500	0.40
Red Line SB	South Station - Broadway	4.0	6	62	167	372	1,002	15	5,580	15,030	8,080	1.45	0.54	20,200	0.40
Silver Line WFL/Gateway EB	South Station - Courthouse	1.7	1	45	65	45	65	36	1,620	2,340	956	0.59	0.41	2,390	0.40
Silver Line WFL/Gateway WB	Courthouse - South Station	1.7	1	45	65	45	65	36	1,620	2,340	2,128	1.31	0.91	5,320	0.40
Silver Line 4 NB	Herald-NEMC	10.0	1	57	79	57	79	6	342	474	616	1.80	1.30	1,540	0.40
Silver Line 4 SB	Herald-E Berkley	10.0	1	57	79	57	79	6	342	474	628	1.84	1.32	1,570	0.40
Silver Line 5 NB	Herald-NEMC	10.0	1	57	79	57	79	6	342	474	616	1.80	1.30	1,540	0.40
Silver Line 5 SB	Herald-E Berkley	10.0	1	57	79	57	79	6	342	474	628	1.84	1.32	1,570	0.40
Orange NB	State - Haymarket	4.5	6	58	131	348	786	14	4,872	11,004	4,400	0.90	0.40	11,000	0.40
Orange SB	Chinatown - NEMC	4.5	6	58	131	348	786	14	4,872	11,004	3,920	0.80	0.36	9,800	0.40
Blue NB	Aquarium - Maverick	4.5	6	35	95	210	570	14	2,940	7,980	4,440	1.51	0.56	11,100	0.40
Blue SB	Maverick - Aquarium	4.5	6	35	95	210	570	14	2,940	7,980	2,040	0.69	0.26	5,100	0.40

Note: Silver Line WFL service includes Silver Line Gateway service to Chelsea

Note: Seated capacities for vehicles were calculated from a weighted average of the current vehicle fleet (2014 Bluebook)

Note: Fractional train sets are rounded up for the peak hour to reflect the peak number of trains in a 60 minute period during the peak 180 minute period

South Station Expansion Project

Results for Transit Crowding Analysis

Green Line - AM Peak Period (6am - 9am)

2035 True No-Build

		AM Peak Train Set Info						AM Peak 1 Hour Service Info						3-hour Data	
Rapid Transit Service	Peak Load Point (From CTPS Travel Demand Model)	Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume- Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	Modeled Volume - Peak Point	Peak Hour / Peak Period
Central Subway EB	Copley-Arlington	1.3	3	46	104	138	312	46	6,348	14,352	7,160	1.13	0.50	17,900	0.40
Central Subway WB	Park St - Boylston	1.3	3	46	104	138	312	46	6,348	14,352	11,200	1.76	0.78	28,000	0.40
North NB	North Station - Science Park	2.7	3	46	104	138	312	23	3,174	7,176	2,480	0.78	0.35	6,200	0.40
North SB	Science Park - North Station	2.7	3	46	104	138	312	23	3,174	7,176	3,800	1.20	0.53	9,500	0.40
B EB	BU West - BU Central	5.0	3	46	104	138	312	12	1,656	3,744	2,680	1.62	0.72	6,700	0.40
B WB	Kenmore - Blanford	5.0	3	46	104	138	312	12	1,656	3,744	1,360	0.82	0.36	3,400	0.40
C EB	Hawes-St Marys	6.5	3	46	104	138	312	10	1,380	3,120	800	0.58	0.26	2,000	0.40
C WB	St Marys-Hawes	6.5	3	46	104	138	312	10	1,380	3,120	480	0.35	0.15	1,200	0.40
D EB	Fenway - Kenmore	5.7	3	46	104	138	312	11	1,518	3,432	2,080	1.37	0.61	5,200	0.40
D WB	Kenmore - Fenway	5.7	3	46	104	138	312	11	1,518	3,432	2,200	1.45	0.64	5,500	0.40
E EB	Prudential - Copley	5.0	3	46	104	138	312	12	1,656	3,744	1,520	0.92	0.41	3,800	0.40
E WB	Prudential - Symphony	5.0	3	46	104	138	312	12	1,656	3,744	2,480	1.50	0.66	6,200	0.40

2035 Transit Improvement Only

		AM Peak Train Set Info						AM Peak 1 Hour Service Info						3-hour Data	
Rapid Transit Service	Peak Load Point (From CTPS Travel Demand Model)	Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume- Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	Modeled Volume - Peak Point	Peak Hour / Peak Period
Central Subway EB	Copley-Arlington	1.3	3	46	104	138	312	46	6,348	14,352	7,160	1.13	0.50	17,900	0.40
Central Subway WB	Park St - Boylston	1.3	3	46	104	138	312	46	6,348	14,352	11,200	1.76	0.78	28,000	0.40
North NB	North Station - Science Park	2.7	3	46	104	138	312	23	3,174	7,176	2,480	0.78	0.35	6,200	0.40
North SB	Science Park - North Station	2.7	3	46	104	138	312	23	3,174	7,176	3,800	1.20	0.53	9,500	0.40
B EB	BU West - BU Central	5.0	3	46	104	138	312	12	1,656	3,744	2,680	1.62	0.72	6,700	0.40
B WB	Kenmore - Blanford	5.0	3	46	104	138	312	12	1,656	3,744	1,360	0.82	0.36	3,400	0.40
C EB	Hawes-St Marys	6.5	3	46	104	138	312	10	1,380	3,120	800	0.58	0.26	2,000	0.40
C WB	Kenmore - St Marys	6.5	3	46	104	138	312	10	1,380	3,120	480	0.35	0.15	1,200	0.40
D EB	Fenway - Kenmore	5.7	3	46	104	138	312	11	1,518	3,432	2,080	1.37	0.61	5,200	0.40
D WB	Kenmore - Fenway	5.7	3	46	104	138	312	11	1,518	3,432	2,200	1.45	0.64	5,500	0.40
E EB	Prudential - Copley	5.0	3	46	104	138	312	12	1,656	3,744	1,520	0.92	0.41	3,800	0.40
E WB	Copley - Prudential	5.0	3	46	104	138	312	12	1,656	3,744	2,480	1.50	0.66	6,200	0.40

South Station Expansion Project

Results for Transit Crowding Analysis

Green Line - AM Peak Period (6am - 9am)

2035 Maximum Land Use

Rapid Transit Service	Peak Load Point (From CTPS Travel Demand Model)	AM Peak Train Set Info: Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	AM Peak 1 Hour Service Info: Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume- Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	3-hour Data: Modeled Volume - Peak Point	Peak Hour / Peak Period
Central Subway EB	Copley-Arlington	1.3	3	46	104	138	312	46	6,348	14,352	7,160	1.13	0.50	17,900	0.40
Central Subway WB	Park St - Boylston	1.3	3	46	104	138	312	46	6,348	14,352	11,200	1.76	0.78	28,000	0.40
North NB	North Station - Science Park	2.7	3	46	104	138	312	23	3,174	7,176	2,520	0.79	0.35	6,300	0.40
North SB	Science Park - North Station	2.7	3	46	104	138	312	23	3,174	7,176	3,840	1.21	0.54	9,600	0.40
B EB	BU West - BU Central	5.0	3	46	104	138	312	12	1,656	3,744	2,680	1.62	0.72	6,700	0.40
B WB	Kenmore - Blanford	5.0	3	46	104	138	312	12	1,656	3,744	1,360	0.82	0.36	3,400	0.40
C EB	Hawes-St Marys	6.5	3	46	104	138	312	10	1,380	3,120	800	0.58	0.26	2,000	0.40
C WB	Kenmore - St Marys	6.5	3	46	104	138	312	10	1,380	3,120	480	0.35	0.15	1,200	0.40
D EB	Fenway - Kenmore	5.7	3	46	104	138	312	11	1,518	3,432	2,080	1.37	0.61	5,200	0.40
D WB	Kenmore - Fenway	5.7	3	46	104	138	312	11	1,518	3,432	2,240	1.48	0.65	5,600	0.40
E EB	Prudential - Copley	5.0	3	46	104	138	312	12	1,656	3,744	1,520	0.92	0.41	3,800	0.40
E WB	Copley - Prudential	5.0	3	46	104	138	312	12	1,656	3,744	2,480	1.50	0.66	6,200	0.40

2035 Minimum Land Use

Rapid Transit Service	Peak Load Point (From CTPS Travel Demand Model)	AM Peak Train Set Info: Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	AM Peak 1 Hour Service Info: Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume- Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	3-hour Data: Modeled Volume - Peak Point	Peak Hour / Peak Period
Central Subway EB	Copley-Arlington	1.3	3	46	104	138	312	46	6,348	14,352	7,160	1.13	0.50	17,900	0.40
Central Subway WB	Park St - Boylston	1.3	3	46	104	138	312	46	6,348	14,352	11,200	1.76	0.78	28,000	0.40
North NB	North Station - Science Park	2.7	3	46	104	138	312	23	3,174	7,176	2,520	0.79	0.35	6,300	0.40
North SB	Science Park - North Station	2.7	3	46	104	138	312	23	3,174	7,176	3,840	1.21	0.54	9,600	0.40
B EB	BU West - BU Central	5.0	3	46	104	138	312	12	1,656	3,744	2,680	1.62	0.72	6,700	0.40
B WB	Kenmore - Blanford	5.0	3	46	104	138	312	12	1,656	3,744	1,360	0.82	0.36	3,400	0.40
C EB	Hawes-St Marys	6.5	3	46	104	138	312	10	1,380	3,120	800	0.58	0.26	2,000	0.40
C WB	Kenmore - St Marys	6.5	3	46	104	138	312	10	1,380	3,120	480	0.35	0.15	1,200	0.40
D EB	Fenway - Kenmore	5.7	3	46	104	138	312	11	1,518	3,432	2,080	1.37	0.61	5,200	0.40
D WB	Kenmore - Fenway	5.7	3	46	104	138	312	11	1,518	3,432	2,240	1.48	0.65	5,600	0.40
E EB	Prudential - Copley	5.0	3	46	104	138	312	12	1,656	3,744	1,520	0.92	0.41	3,800	0.40
E WB	Copley - Prudential	5.0	3	46	104	138	312	12	1,656	3,744	2,480	1.50	0.66	6,200	0.40

Note: Fractional train sets are rounded up for the peak hour to reflect the peak number of trains in a 60 minute period during the peak 180 minute period

South Station Expansion Project

Results for Transit Crowding Analysis

Green Line - PM Peak Period (3pm - 6pm)

2035 True No-Build

		PM Peak Train Set Info						PM Peak 1 Hour Service Info						3-hour Data	
Rapid Transit Service	Peak Load Point (From CTPS Travel Demand Model)	Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume- Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	Modeled Volume - Peak Point	Peak Hour / Peak Period
Central Subway EB	Boylston - Park St	1.3	3	46	104	138	312	46	6,348	14,352	7,920	1.25	0.55	19,800	0.40
Central Subway WB	Arlington - Copley	1.3	3	46	104	138	312	46	6,348	14,352	7,600	1.20	0.53	19,000	0.40
North NB	North Station - Science Park	2.7	3	46	104	138	312	23	3,174	7,176	3,080	0.97	0.43	7,700	0.40
North SB	Science Park - North Station	2.7	3	46	104	138	312	23	3,174	7,176	2,760	0.87	0.38	6,900	0.40
B EB	BU Central - BU East	5.0	3	46	104	138	312	12	1,656	3,744	1,680	1.01	0.45	4,200	0.40
B WB	Kenmore - Blanford	5.0	3	46	104	138	312	12	1,656	3,744	2,000	1.21	0.53	5,000	0.40
C EB	Hawes - St Marys	6.5	3	46	104	138	312	10	1,380	3,120	360	0.26	0.12	900	0.40
C WB	Kenmore - St Marys	6.5	3	46	104	138	312	10	1,380	3,120	1,160	0.84	0.37	2,900	0.40
D EB	Fenway - Kenmore	5.7	3	46	104	138	312	11	1,518	3,432	1,960	1.29	0.57	4,900	0.40
D WB	Kenmore - Fenway	5.7	3	46	104	138	312	11	1,518	3,432	2,080	1.37	0.61	5,200	0.40
E EB	Prudential - Copley	5.0	3	46	104	138	312	12	1,656	3,744	2,000	1.21	0.53	5,000	0.40
E WB	Prudential - Symphony	5.0	3	46	104	138	312	12	1,656	3,744	1,640	0.99	0.44	4,100	0.40

2035 Transit Improvement Only

		PM Peak Train Set Info						PM Peak 1 Hour Service Info						3-hour Data	
Rapid Transit Service	Peak Load Point (From CTPS Travel Demand Model)	Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume- Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	Modeled Volume - Peak Point	Peak Hour / Peak Period
Central Subway EB	Boylston - Park St	1.3	3	46	104	138	312	46	6,348	14,352	7,920	1.25	0.55	19,800	0.40
Central Subway WB	Arlington - Copley	1.3	3	46	104	138	312	46	6,348	14,352	7,600	1.20	0.53	19,000	0.40
North NB	North Station - Science Park	2.7	3	46	104	138	312	23	3,174	7,176	3,080	0.97	0.43	7,700	0.40
North SB	Science Park - North Station	2.7	3	46	104	138	312	23	3,174	7,176	2,760	0.87	0.38	6,900	0.40
B EB	BU Central - BU East	5.0	3	46	104	138	312	12	1,656	3,744	1,680	1.01	0.45	4,200	0.40
B WB	Kenmore - Blanford	5.0	3	46	104	138	312	12	1,656	3,744	2,000	1.21	0.53	5,000	0.40
C EB	Hawes - St Marys	6.5	3	46	104	138	312	10	1,380	3,120	360	0.26	0.12	900	0.40
C WB	Kenmore - St Marys	6.5	3	46	104	138	312	10	1,380	3,120	1,160	0.84	0.37	2,900	0.40
D EB	Fenway - Kenmore	5.7	3	46	104	138	312	11	1,518	3,432	1,960	1.29	0.57	4,900	0.40
D WB	Kenmore - Fenway	5.7	3	46	104	138	312	11	1,518	3,432	2,080	1.37	0.61	5,200	0.40
E EB	Prudential - Copley	5.0	3	46	104	138	312	12	1,656	3,744	2,000	1.21	0.53	5,000	0.40
E WB	Prudential - Symphony	5.0	3	46	104	138	312	12	1,656	3,744	1,640	0.99	0.44	4,100	0.40

South Station Expansion Project

Results for Transit Crowding Analysis

Green Line - PM Peak Period (3pm - 6pm)

2035 Maximum Land Use

		PM Peak Train Set Info						PM Peak 1 Hour Service Info						3-hour Data	
Rapid Transit Service	Peak Load Point (From CTPS Travel Demand Model)	Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume- Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	Modeled Volume - Peak Point	Peak Hour / Peak Period
Central Subway EB	Boylston - Park St	1.3	3	46	104	138	312	46	6,348	14,352	7,920	1.25	0.55	19,800	0.40
Central Subway WB	Arlington - Copley	1.3	3	46	104	138	312	46	6,348	14,352	7,600	1.20	0.53	19,000	0.40
North NB	North Station - Science Park	2.7	3	46	104	138	312	23	3,174	7,176	3,120	0.98	0.43	7,800	0.40
North SB	Science Park - North Station	2.7	3	46	104	138	312	23	3,174	7,176	2,800	0.88	0.39	7,000	0.40
B EB	BU Central - BU East	5.0	3	46	104	138	312	12	1,656	3,744	1,680	1.01	0.45	4,200	0.40
B WB	Kenmore - Blanford	5.0	3	46	104	138	312	12	1,656	3,744	2,000	1.21	0.53	5,000	0.40
C EB	Hawes - St Marys	6.5	3	46	104	138	312	10	1,380	3,120	360	0.26	0.12	900	0.40
C WB	Kenmore - St Marys	6.5	3	46	104	138	312	10	1,380	3,120	1,160	0.84	0.37	2,900	0.40
D EB	Fenway - Kenmore	5.7	3	46	104	138	312	11	1,518	3,432	1,960	1.29	0.57	4,900	0.40
D WB	Kenmore - Fenway	5.7	3	46	104	138	312	11	1,518	3,432	2,080	1.37	0.61	5,200	0.40
E EB	Prudential - Copley	5.0	3	46	104	138	312	12	1,656	3,744	2,000	1.21	0.53	5,000	0.40
E WB	Prudential - Symphony	5.0	3	46	104	138	312	12	1,656	3,744	1,640	0.99	0.44	4,100	0.40

2035 Minimum Land Use

		PM Peak Train Set Info						PM Peak 1 Hour Service Info						3-hour Data	
Rapid Transit Service	Peak Load Point (From CTPS Travel Demand Model)	Headway (min.)	Cars / Train Set	Car Seated Capacity	Car Policy Max Load	Train Set Seated Capacity	Train Set Policy Max Load	Train Sets	Seated Capacity	Service Policy Max Load	Modeled Volume- Peak Point	Volume / Seated Capacity	Volume / Policy Max Load	Modeled Volume - Peak Point	Peak Hour / Peak Period
Central Subway EB	Boylston - Park St	1.3	3	46	104	138	312	46	6,348	14,352	7,920	1.25	0.55	19,800	0.40
Central Subway WB	Arlington - Copley	1.3	3	46	104	138	312	46	6,348	14,352	7,600	1.20	0.53	19,000	0.40
North NB	North Station - Science Park	2.7	3	46	104	138	312	23	3,174	7,176	3,120	0.98	0.43	7,800	0.40
North SB	Science Park - North Station	2.7	3	46	104	138	312	23	3,174	7,176	2,800	0.88	0.39	7,000	0.40
B EB	BU Central - BU East	5.0	3	46	104	138	312	12	1,656	3,744	1,680	1.01	0.45	4,200	0.40
B WB	Kenmore - Blanford	5.0	3	46	104	138	312	12	1,656	3,744	2,000	1.21	0.53	5,000	0.40
C EB	Hawes - St Marys	6.5	3	46	104	138	312	10	1,380	3,120	360	0.26	0.12	900	0.40
C WB	Kenmore - St Marys	6.5	3	46	104	138	312	10	1,380	3,120	1,160	0.84	0.37	2,900	0.40
D EB	Fenway - Kenmore	5.7	3	46	104	138	312	11	1,518	3,432	1,960	1.29	0.57	4,900	0.40
D WB	Kenmore - Fenway	5.7	3	46	104	138	312	11	1,518	3,432	2,080	1.37	0.61	5,200	0.40
E EB	Prudential - Copley	5.0	3	46	104	138	312	12	1,656	3,744	2,000	1.21	0.53	5,000	0.40
E WB	Prudential - Symphony	5.0	3	46	104	138	312	12	1,656	3,744	1,640	0.99	0.44	4,100	0.40

Note: Fractional train sets are rounded up for the peak hour to reflect the peak number of trains in a 60 minute period during the peak 180 minute period

South Station Expansion Project

Transit Vehicle Crowding Analysis

South Station area (Summer Street) MBTA buses - AM Peak Period (6am - 9am)

2035 True No-Build

	AM Peak Bus Info			AM Peak 1 Hour Service Info						3-hour Data	
Bus Service	Headway (min.)	Bus Seated Capacity	Bus Policy Max Load	Buses	Seated Capacity	Service Policy Max Load	South Station Modeled Volume	Volume / Seated Capacity	Volume / Policy Max Load	South Station Modeled Volume	Peak Hour / Peak Period
11 EB	16.0	39	54	4	156	216	1	0.01	0.01	3	0.40
448 SB	90.0	39	54	1	39	54	14	0.35	0.25	34	0.40
448 NB	180.0	39	54	1	39	54	1	0.03	0.02	3	0.40
449 SB	60.0	39	54	1	39	54	13	0.33	0.24	32	0.40
449 NB	180.0	39	54	1	39	54	1	0.03	0.02	3	0.40
459 SB	60.0	39	54	1	39	54	32	0.83	0.60	81	0.40
459 NB	36.0	39	54	2	78	108	6	0.08	0.06	15	0.40
7 WB	5.0	39	54	12	468	648	383	0.82	0.59	957	0.40
7 EB	6.4	39	54	10	390	540	70	0.18	0.13	174	0.40
SL4 NB	10.0	57	79	6	342	474	199	0.58	0.42	498	0.40
SL4 SB	10.0	57	79	6	342	474	281	0.82	0.59	702	0.40
South Station Summer St WB Bus Stop	4.1	39	54	15	571	790	442	0.77	0.56	1,104	0.40
South Station Summer St EB Bus Stop	5.1	39	54	12	459	635	79	0.17	0.12	198	0.40

2035 Transit Improvement Only

	AM Peak Bus Info			AM Peak 1 Hour Service Info						3-hour Data	
Bus Service	Headway (min.)	Bus Seated Capacity	Bus Policy Max Load	Buses	Seated Capacity	Service Policy Max Load	South Station Modeled Volume	Volume / Seated Capacity	Volume / Policy Max Load	South Station Modeled Volume	Peak Hour / Peak Period
11 EB	16.0	39	54	4	156	216	1	0.01	0.01	3	0.40
448 SB	90.0	39	54	1	39	54	14	0.35	0.25	34	0.40
448 NB	180.0	39	54	1	39	54	1	0.03	0.02	3	0.40
449 SB	60.0	39	54	1	39	54	13	0.33	0.24	32	0.40
449 NB	180.0	39	54	1	39	54	1	0.03	0.02	3	0.40
459 SB	60.0	39	54	1	39	54	32	0.83	0.60	81	0.40
459 NB	36.0	39	54	2	78	108	6	0.08	0.06	15	0.40
7 WB	5.0	39	54	12	468	648	383	0.82	0.59	957	0.40
7 EB	6.4	39	54	10	390	540	70	0.18	0.13	176	0.40
SL4 NB	10.0	57	79	6	342	474	199	0.58	0.42	497	0.40
SL4 SB	10.0	57	79	6	342	474	281	0.82	0.59	702	0.40
South Station Summer St WB Bus Stop	4.1	39	54	15	571	790	442	0.77	0.56	1,104	0.40
South Station Summer St EB Bus Stop	5.1	39	54	12	459	635	80	0.17	0.13	200	0.40

2035 Maximum Land Use

	AM Peak Bus Info			AM Peak 1 Hour Service Info						3-hour Data	
Bus Service	Headway (min.)	Bus Seated Capacity	Bus Policy Max Load	Buses	Seated Capacity	Service Policy Max Load	South Station Modeled Volume	Volume / Seated Capacity	Volume / Policy Max Load	South Station Modeled Volume	Peak Hour / Peak Period
11 EB	16.0	39	54	4	156	216	1	0.01	0.01	3	0.40
448 SB	90.0	39	54	1	39	54	14	0.35	0.25	34	0.40
448 NB	180.0	39	54	1	39	54	1	0.03	0.02	3	0.40
449 SB	60.0	39	54	1	39	54	13	0.33	0.24	32	0.40
449 NB	180.0	39	54	1	39	54	1	0.03	0.02	3	0.40
459 SB	60.0	39	54	1	39	54	34	0.86	0.62	84	0.40
459 NB	36.0	39	54	2	78	108	6	0.08	0.06	16	0.40
7 WB	5.0	39	54	12	468	648	388	0.83	0.60	971	0.40
7 EB	6.4	39	54	10	390	540	83	0.21	0.15	208	0.40
SL4 NB	10.0	57	79	6	342	474	199	0.58	0.42	498	0.40
SL4 SB	10.0	57	79	6	342	474	280	0.82	0.59	700	0.40
South Station Summer St WB Bus Stop	4.1	39	54	15	571	790	448	0.79	0.57	1,121	0.40
South Station Summer St EB Bus Stop	5.1	39	54	12	459	635	93	0.20	0.15	233	0.40

2035 Minimum Land Use

	AM Peak Bus Info			AM Peak 1 Hour Service Info						3-hour Data	
Bus Service	Headway (min.)	Bus Seated Capacity	Bus Policy Max Load	Buses	Seated Capacity	Service Policy Max Load	South Station Modeled Volume	Volume / Seated Capacity	Volume / Policy Max Load	South Station Modeled Volume	Peak Hour / Peak Period
11 EB	16.0	39	54	4	156	216	1	0.01	0.01	3	0.40
448 SB	90.0	39	54	1	39	54	14	0.35	0.25	34	0.40
448 NB	180.0	39	54	1	39	54	1	0.03	0.02	3	0.40
449 SB	60.0	39	54	1	39	54	13	0.33	0.24	32	0.40
449 NB	180.0	39	54	1	39	54	1	0.03	0.02	3	0.40
459 SB	60.0	39	54	1	39	54	33	0.85	0.61	83	0.40
459 NB	36.0	39	54	2	78	108	6	0.08	0.06	16	0.40
7 WB	5.0	39	54	12	468	648	387	0.83	0.60	968	0.40
7 EB	6.4	39	54	10	390	540	94	0.24	0.17	235	0.40
SL4 NB	10.0	57	79	6	342	474	199	0.58	0.42	498	0.40
SL4 SB	10.0	57	79	6	342	474	278	0.81	0.59	696	0.40
South Station Summer St WB Bus Stop	4.1	39	54	15	571	790	447	0.78	0.57	1,117	0.40
South Station Summer St EB Bus Stop	5.1	39	54	12	459	635	104	0.23	0.16	260	0.40

Note: South Station Modeled Volumes are the greater of the arriving or departing loads at the MBTA bus stops located proximate to South Station along Summer Street at Dorchester Avenue and adjacent to the existing station headhouse.

South Station Expansion Project

Transit Vehicle Crowding Analysis

South Station area (Summer Street) MBTA buses - PM Peak Period (3pm - 6pm)

2035 True No-Build

	PM Peak Bus Info			PM Peak 1 Hour Service Info						3-hour Data	
Bus Service	Headway (min.)	Bus Seated Capacity	Bus Policy Max Load	Buses	Seated Capacity	Service Policy Max Load	South Station Modeled Volume	Volume / Seated Capacity	Volume / Policy Max Load	South Station Modeled Volume	Peak Hour / Peak Period
11 EB	12.0	39	54	5	195	270	9	0.05	0.03	22	0.40
4 EB	26.0	39	54	3	117	162	1	0.01	0.00	2	0.40
448 NB	90.0	39	54	1	39	54	14	0.37	0.27	36	0.40
449 NB	90.0	39	54	1	39	54	14	0.37	0.27	36	0.40
459 SB	25.7	39	54	3	117	162	34	0.29	0.21	86	0.40
459 NB	60.0	39	54	1	39	54	3	0.08	0.06	8	0.40
7 WB	12.0	39	54	5	195	270	105	0.54	0.39	262	0.40
7 EB	8.0	39	54	8	312	432	155	0.50	0.36	388	0.40
SL4 NB	10.0	57	79	6	342	474	150	0.44	0.32	374	0.40
SL4 SB	10.0	57	79	6	342	474	270	0.79	0.57	676	0.40
South Station Summer St WB Bus Stop	3.5	39	54	17	663	918	139	0.21	0.15	348	0.40
South Station Summer St EB Bus Stop	8.2	39	54	7	285	395	197	0.69	0.50	492	0.40

2035 Transit Improvement Only

	PM Peak Bus Info			PM Peak 1 Hour Service Info						3-hour Data	
Bus Service	Headway (min.)	Bus Seated Capacity	Bus Policy Max Load	Buses	Seated Capacity	Service Policy Max Load	South Station Modeled Volume	Volume / Seated Capacity	Volume / Policy Max Load	South Station Modeled Volume	Peak Hour / Peak Period
11 EB	12.0	39	54	5	195	270	9	0.05	0.03	22	0.40
4 EB	26.0	39	54	3	117	162	1	0.01	0.00	2	0.40
448 NB	90.0	39	54	1	39	54	14	0.37	0.27	36	0.40
449 NB	90.0	39	54	1	39	54	14	0.37	0.27	36	0.40
459 SB	25.7	39	54	3	117	162	34	0.29	0.21	86	0.40
459 NB	60.0	39	54	1	39	54	3	0.08	0.06	8	0.40
7 WB	12.0	39	54	5	195	270	105	0.54	0.39	262	0.40
7 EB	8.0	39	54	8	312	432	155	0.50	0.36	388	0.40
SL4 NB	10.0	57	79	6	342	474	150	0.44	0.32	374	0.40
SL4 SB	10.0	57	79	6	342	474	270	0.79	0.57	676	0.40
South Station Summer St WB Bus Stop	3.5	39	54	17	663	918	139	0.21	0.15	348	0.40
South Station Summer St EB Bus Stop	8.2	39	54	7	285	395	197	0.69	0.50	492	0.40

2035 Maximum Land Use

	PM Peak Bus Info			PM Peak 1 Hour Service Info						3-hour Data	
Bus Service	Headway (min.)	Bus Seated Capacity	Bus Policy Max Load	Buses	Seated Capacity	Service Policy Max Load	South Station Modeled Volume	Volume / Seated Capacity	Volume / Policy Max Load	South Station Modeled Volume	Peak Hour / Peak Period
11 EB	12.0	39	54	5	195	270	9	0.05	0.03	23	0.40
4 EB	26.0	39	54	3	117	162	1	0.01	0.00	2	0.40
448 NB	90.0	39	54	1	39	54	15	0.38	0.27	37	0.40
449 NB	90.0	39	54	1	39	54	15	0.38	0.27	37	0.40
459 SB	25.7	39	54	3	117	162	36	0.31	0.22	90	0.40
459 NB	60.0	39	54	1	39	54	3	0.08	0.06	8	0.40
7 WB	12.0	39	54	5	195	270	113	0.58	0.42	282	0.40
7 EB	8.0	39	54	8	312	432	162	0.52	0.37	404	0.40
SL4 NB	10.0	57	79	6	342	474	150	0.44	0.32	374	0.40
SL4 SB	10.0	57	79	6	342	474	272	0.80	0.57	680	0.40
South Station Summer St WB Bus Stop	3.5	39	54	17	663	918	149	0.22	0.16	372	0.40
South Station Summer St EB Bus Stop	8.2	39	54	7	285	395	204	0.72	0.52	511	0.40

2035 Minimum Land Use

	PM Peak Bus Info			PM Peak 1 Hour Service Info						3-hour Data	
Bus Service	Headway (min.)	Bus Seated Capacity	Bus Policy Max Load	Buses	Seated Capacity	Service Policy Max Load	South Station Modeled Volume	Volume / Seated Capacity	Volume / Policy Max Load	South Station Modeled Volume	Peak Hour / Peak Period
11 EB	12.0	39	54	5	195	270	9	0.05	0.03	23	0.40
4 EB	26.0	39	54	3	117	162	1	0.01	0.00	2	0.40
448 NB	90.0	39	54	1	39	54	15	0.38	0.27	37	0.40
449 NB	90.0	39	54	1	39	54	15	0.38	0.27	37	0.40
459 SB	25.7	39	54	3	117	162	35	0.30	0.22	88	0.40
459 NB	60.0	39	54	1	39	54	3	0.08	0.06	8	0.40
7 WB	12.0	39	54	5	195	270	112	0.57	0.41	280	0.40
7 EB	8.0	39	54	8	312	432	160	0.51	0.37	400	0.40
SL4 NB	10.0	57	79	6	342	474	150	0.44	0.32	374	0.40
SL4 SB	10.0	57	79	6	342	474	271	0.79	0.57	678	0.40
South Station Summer St WB Bus Stop	3.5	39	54	17	663	918	147	0.22	0.16	368	0.40
South Station Summer St EB Bus Stop	8.2	39	54	7	285	395	203	0.71	0.51	507	0.40

Note: South Station Modeled Volumes are the greater of the arriving or departing loads at the MBTA bus stops located proximate to South Station along Summer Street at Dorchester Avenue and adjacent to the existing station headhouse.

Attachment L Station Crowding Analysis Summary Tables

2035 Build Year Platform Activity Summary:

- South Station Red Line Platforms
- South Station Silver Line Platforms
- Park Street Red Line Platforms
- Park Street Green Line Platforms
- Downtown Crossing Red Line Platforms
- Downtown Crossing Orange Line Platforms
- Government Center Blue Line Platforms
- Government Center Green Line Platforms
- State Street Blue Line Platforms
- State Street Orange Line Platforms

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Table 44—2035 Build Year South Station Red Line Platform Activity Summary

Alternative	AM Peak Period		PM Peak Period		Daily	
	Boardings and Alightings	% Increase from No Build Alternative	Boardings and Alightings	% Increase from No Build Alternative	Boardings and Alightings	% Increase from No Build Alternative
No Build Alternative	19,180	-	19,250	-	72,200	-
Alternative 1 – Transportation Improvements Only	19,950	4.0%	19,800	2.9%	74,150	2.7%
Alternative 2 – Joint/Private Development Minimum Build	20,050	4.5%	19,900	3.4%	74,540	3.2%
Alternative 3 – Joint/Private Development Maximum Build	20,630	7.6%	20,420	6.1%	76,580	6.1%

Source: *Final SSX Ridership Results* provided in Appendix 9 - *Ridership Forecasting Technical Report.*
Note: Boardings and alightings results rounded to the nearest ten.

Table 45—2035 Build Year South Station Silver Line Platform Activity Summary

Alternative	AM Peak Period		PM Peak Period		Daily	
	Boardings and Alightings	% Increase from No Build Alternative	Boardings and Alightings	% Increase from No Build Alternative	Boardings and Alightings	% Increase from No Build Alternative
No Build Alternative	6,310	-	7,390	-	25,600	-
Alternative 1 – Transportation Improvements Only	6,440	2.1%	7,700	4.2%	26,140	2.1%
Alternative 2 – Joint/Private Development Minimum Build	6,460	2.4%	7,710	4.3%	26,200	2.3%
Alternative 3 – Joint/Private Development Maximum Build	6,570	4.1%	7,820	5.8%	26,650	4.1%

Source: *Final SSX Ridership Results* provided in Appendix 9 - *Ridership Forecasting Technical Report.*
Note: Boardings and alightings results rounded to the nearest ten.

Table 46—2035 Build Year Park Street Red Line Platform Activity Summary

Alternative	AM Peak Period		PM Peak Period		Daily	
	Boardings and Alightings	% Increase from No Build Alternative	Boardings and Alightings	% Increase from No Build Alternative	Boardings and Alightings	% Increase from No Build Alternative
No Build Alternative	19,460	-	22,810	-	90,930	-
Alternative 1 – Transportation Improvements Only	19,520	0.3%	22,870	0.3%	91,080	0.2%
Alternative 2 – Joint/Private Development Minimum Build	19,570	0.6%	22,950	0.6%	91,270	0.4%
Alternative 3 – Joint/Private Development Maximum Build	19,690	1.2%	23,080	1.2%	91,650	0.8%

Source: Ridership data from CTPS, *Results of Station Activities at Downtown Stations*.
Note: Boardings and alightings results rounded to the nearest ten.

Table 47—2035 Build Year Park Street Green Line Platform Activity Summary

Alternative	AM Peak Period		PM Peak Period		Daily	
	Boardings and Alightings	% Increase from No Build Alternative	Boardings and Alightings	% Increase from No Build Alternative	Boardings and Alightings	% Increase from No Build Alternative
No Build Alternative	19,310	-	22,030	-	92,820	-
Alternative 1 – Transportation Improvements Only	19,350	0.2%	22,060	0.1%	92,900	0.1%
Alternative 2 – Joint/Private Development Minimum Build	19,430	0.6%	22,130	0.5%	93,120	0.3%
Alternative 3 – Joint/Private Development Maximum Build	19,560	1.3%	22,230	0.9%	93,460	0.7%

Source: Ridership data from CTPS, *Results of Station Activities at Downtown Stations*.
Note: Boardings and alightings results rounded to the nearest ten.

Table 48—2035 Build Year Downtown Crossing Red Line Platform Activity Summary

Alternative	AM Peak Period		PM Peak Period		Daily	
	Boardings and Alightings	% Increase from No Build Alternative	Boardings and Alightings	% Increase from No Build Alternative	Boardings and Alightings	% Increase from No Build Alternative
No Build Alternative	18,530	-	20,470	-	78,750	-
Alternative 1 – Transportation Improvements Only	18,580	0.3%	20,510	0.2%	78,890	0.2%
Alternative 2 – Joint/Private Development Minimum Build	18,600	0.4%	20,530	0.3%	78,930	0.2%
Alternative 3 – Joint/Private Development Maximum Build	18,650	0.6%	20,550	0.4%	79,000	0.3%

Source: Ridership data from CTPS, *Results of Station Activities at Downtown Stations*.
Note: Boardings and alightings results rounded to the nearest ten.

Table 49—2035 Build Year Downtown Crossing Orange Line Platform Activity Summary

Alternative	AM Peak Period		PM Peak Period		Daily	
	Boardings and Alightings	% Increase from No Build Alternative	Boardings and Alightings	% Increase from No Build Alternative	Boardings and Alightings	% Increase from No Build Alternative
No Build Alternative	18,550	-	21,440	-	81,150	-
Alternative 1 – Transportation Improvements Only	18,600	0.3%	21,500	0.3%	81,310	0.2%
Alternative 2 – Joint/Private Development Minimum Build	18,630	0.4%	21,570	0.6%	81,520	0.5%
Alternative 3 – Joint/Private Development Maximum Build	18,690	0.8%	21,660	1.0%	81,810	0.8%

Source: Ridership data from CTPS, *Results of Station Activities at Downtown Stations*.
Note: Boardings and alightings results rounded to the nearest ten.

Table 50—2035 Build Year Government Center Blue Line Platform Activity Summary

Alternative	AM Peak Period		PM Peak Period		Daily	
	Boardings and Alightings	% Increase from No Build Alternative	Boardings and Alightings	% Increase from No Build Alternative	Boardings and Alightings	% Increase from No Build Alternative
No Build Alternative	6,720	-	9,150	-	34,020	-
Alternative 1 – Transportation Improvements Only	6,730	0.1%	9,150	0.0%	34,040	0.1%
Alternative 2 – Joint/Private Development Minimum Build	6,730	0.1%	9,160	0.1%	34,080	0.2%
Alternative 3 – Joint/Private Development Maximum Build	6,730	0.1%	9,170	0.2%	34,110	0.3%

Source: Ridership data from CTPS, *Results of Station Activities at Downtown Stations*.
Note: Boardings and alightings results rounded to the nearest ten.

Table 51—2035 Build Year Government Center Green Line Platform Activity Summary

Alternative	AM Peak Period		PM Peak Period		Daily	
	Boardings and Alightings	% Increase from No Build Alternative	Boardings and Alightings	% Increase from No Build Alternative	Boardings and Alightings	% Increase from No Build Alternative
No Build Alternative	10,120	-	12,480	-	51,320	-
Alternative 1 – Transportation Improvements Only	10,130	0.1%	12,480	0.0%	51,330	0.0%
Alternative 2 – Joint/Private Development Minimum Build	10,130	0.1%	12,490	0.1%	51,460	0.3%
Alternative 3 – Joint/Private Development Maximum Build	10,130	0.1%	12,490	0.1%	51,570	0.5%

Source: Ridership data from CTPS, *Results of Station Activities at Downtown Stations*.
Note: Boardings and alightings results rounded to the nearest ten.

Table 52—2035 Build Year State Street Blue Line Platform Activity Summary

Alternative	AM Peak Period		PM Peak Period		Daily	
	Boardings and Alightings	% Increase from No Build Alternative	Boardings and Alightings	% Increase from No Build Alternative	Boardings and Alightings	% Increase from No Build Alternative
No Build Alternative	7,630	-	8,420	-	34,410	-
Alternative 1 – Transportation Improvements Only	7,630	0.0%	8,420	0.0%	34,420	0.0%
Alternative 2 – Joint/Private Development Minimum Build	7,630	0.0%	8,440	0.2%	34,460	0.1%
Alternative 3 – Joint/Private Development Maximum Build	7,630	0.0%	8,460	0.5%	34,500	0.3%

Source: Ridership data from CTPS, *Results of Station Activities at Downtown Stations*.
Note: Boardings and alightings results rounded to the nearest ten.

Table 53—2035 Build Year State Street Orange Line Platform Activity Summary

Alternative	AM Peak Period		PM Peak Period		Daily	
	Boardings and Alightings	% Increase from No Build Alternative	Boardings and Alightings	% Increase from No Build Alternative	Boardings and Alightings	% Increase from No Build Alternative
No Build Alternative	10,350	-	10,820	-	40,730	-
Alternative 1 – Transportation Improvements Only	10,380	0.3%	10,870	0.5%	40,810	0.2%
Alternative 2 – Joint/Private Development Minimum Build	10,380	0.3%	10,880	0.6%	40,880	0.4%
Alternative 3 – Joint/Private Development Maximum Build	10,380	0.3%	10,890	0.6%	40,940	0.5%

Source: Ridership data from CTPS, *Results of Station Activities at Downtown Stations*.
Note: Boardings and alightings results rounded to the nearest ten.

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Attachment M SSX Project Air Quality Analysis Protocol

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SOUTH STATION EXPANSION

SSX Project Air Quality Analysis Protocol

5/16/14

1. Introduction

The Massachusetts Department of Transportation (MassDOT), with funding support from the Federal Railroad Administration (FRA), is preparing an Environmental Impact Report and Environmental Assessment (EIR and EA) for the proposed expansion of South Station in Boston, Massachusetts. South Station is one of the busiest transportation hubs in New England and is the largest train station and bus terminal in Boston. South Station is located at the northern terminus of the Northeast Corridor (NEC) and is the city terminus of the Massachusetts Bay Transportation Authority (MBTA) commuter rail western and southern routes. Red Line subway, Silver Line buses, and other privately operated buses also service the Station. This major intermodal terminal is a gateway to Boston's Financial District, situated at the intersection of Atlantic Avenue and Summer Street in Dewey Square.

The South Station Expansion (SSX) project is being undertaken to improve intercity passenger rail service on the NEC and support high-speed rail initiatives. It will expand South Station to meet planned 2035 capacity requirements for Amtrak High Speed Intercity Passenger Rail Program (HSIPR), as well as MBTA commuter rail service. The project will include the following elements:

- Expanding the South Station terminal facilities, including the addition of tracks and platforms, extension of some existing platforms, reconstruction of approach interlockings, and construction of a new passenger concourse onto the site of the USPS General Mail Facility.
- Acquiring and demolishing the existing USPS General Mail Facility located on Dorchester Avenue adjacent to South Station, which will provide an approximate 16-acre site onto which to expand South Station. The USPS facility will be relocated by the USPS. The relocation of the USPS facility is undergoing a separate environmental review process by others.[1]
- Restoring Dorchester Avenue for public and station access along the harborside edge of the expanded terminal, including constructing an extension of the Harborwalk.
- Providing for the possibility of future joint/private development at an expanded South Station.
- Constructing mid-day layover facilities to accommodate existing needs and to facilitate future Amtrak and MBTA service expansions and other planned improvements.

Figure 1 shows the SSX Project Area Map. The SSX project includes South Station and three layover facility sites: Widett Circle in the South Boston neighborhood of Boston, Beacon Park Yard in the Allston neighborhood of Boston, and Readville – Yard 2 in the Readville section of Hyde Park in Boston. Figure 2 shows an aerial view of the South Station site.

MassDOT is conducting the following alternatives analyses for the SSX project elements: terminal expansion alternatives at the South Station site, including rail configuration alternatives; layover facility site alternatives, consisting of three potential layover sites; and joint/private development alternatives at the South Station site. The joint/private development alternatives are distinguished by the degree to which private development would or would not be accommodated at South Station. Alternative 1 would include transportation improvements only, but would not provide for potential private development at South Station. Alternatives 2 and 3 represent the lower and upper bounds, respectively, of potential private development at South Station.

[1] As directed by FRA for the EA, the demolition of the USPS facility will be addressed as a direct impact of the SSX project, and the relocation of the USPS facility will be addressed as an indirect impact of the SSX project.

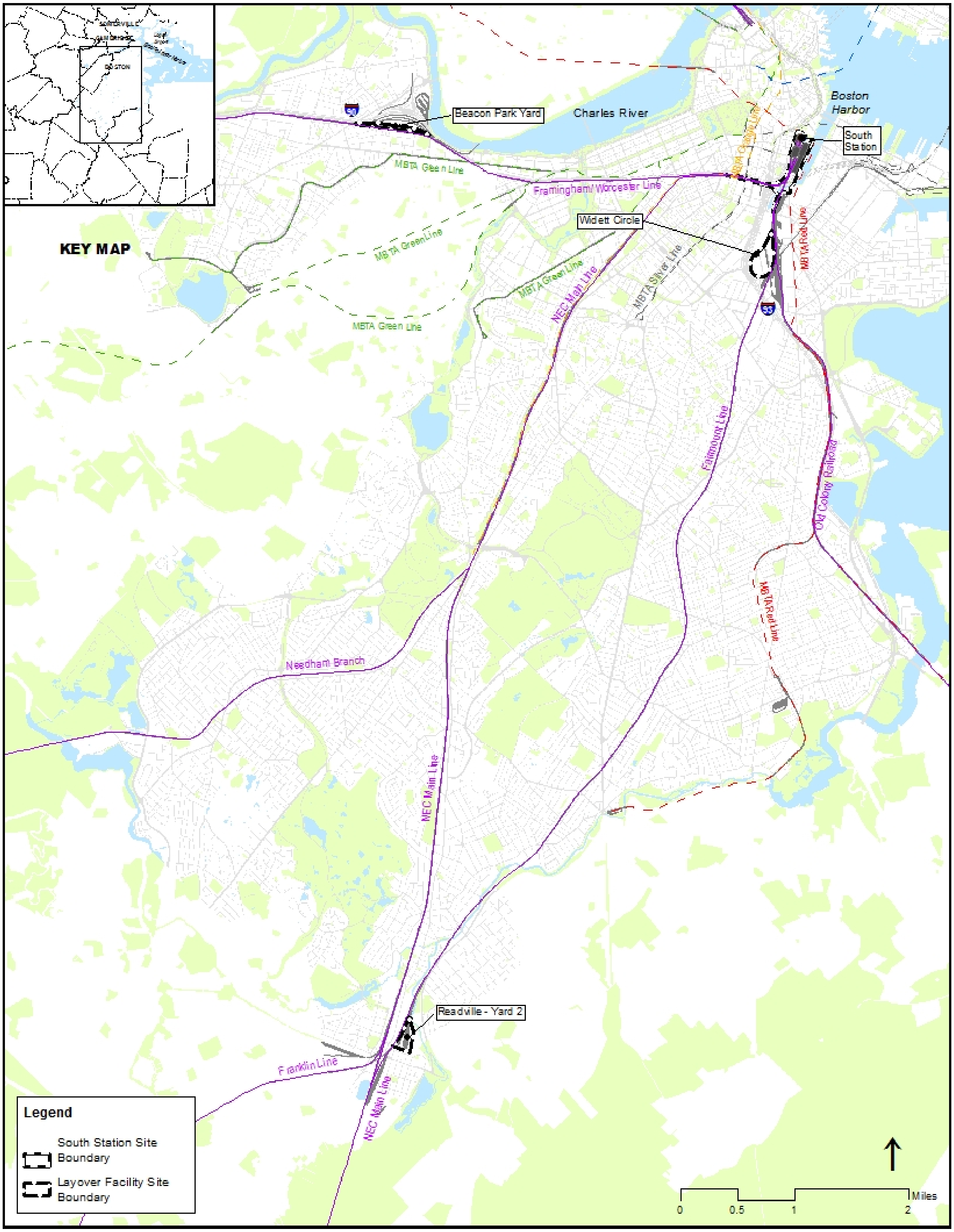

Figure 1 – Map of SSX Project Area

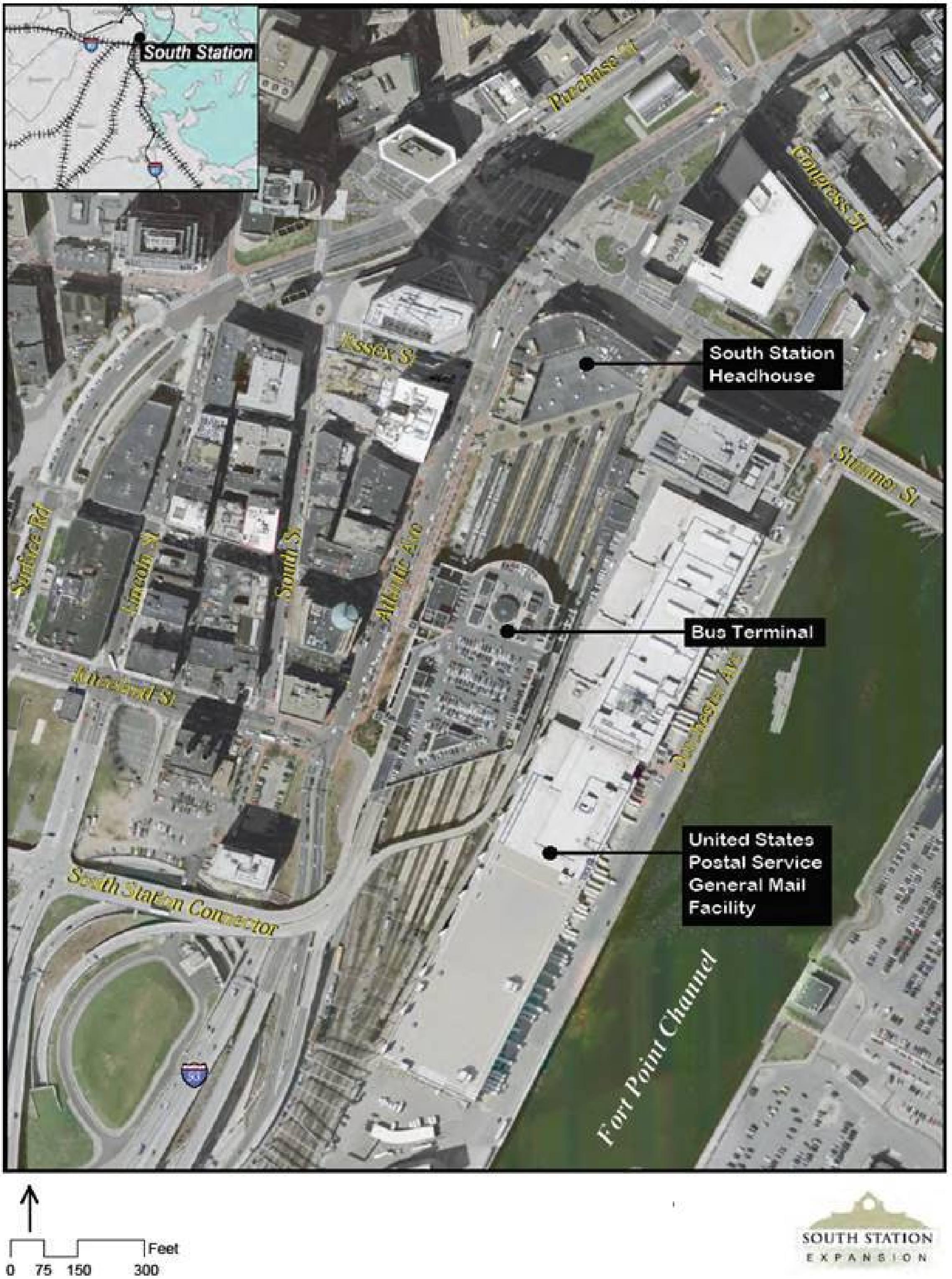
South Station
Purchase St
Congress St
Essex St
South Station Headhouse
Summer St
Surface Rd
Lincoln St
South St
Atlantic Ave
Bus Terminal
Kneeland St
Dorchester Ave
United States Postal Service General Mail Facility
South Station Connector
Fort Point Channel
Feet
0 75 150 300
SOUTH STATION
EXPANSION

Figure 2 - Aerial View of the South Station Site.

At the South Station site, the air quality analysis will address air quality impacts resulting from traffic associated with the joint/private development alternatives. There will be essentially no difference between the rail configuration alternatives at the South Station site with respect to air quality impacts.

The EIR and EA will be developed in accordance with the National Environmental Policy Act of 1969 (NEPA) and its implementing regulations (40 Code of Federal Regulations (CFR) Parts 1500-1508); FRA's *Procedures for Considering Environmental Impacts*, 64 Federal Register (FR) 28545, and 23 CFR Part 7710; the Massachusetts Environmental Policy Act (MEPA) and its implementing regulations (301 Code of Massachusetts Regulations (CMR) 11.00), U.S. Environmental Protection Agency (U.S. EPA) technical guidance documents, and technical guidance from the Massachusetts Department of Environmental Protection (MassDEP) and MassDOT. Additionally, the EIR and EA will be prepared in accordance with the Certificate of the Secretary of the Office of Energy and Environmental Affairs (EEA) on the Environmental Notification Form (ENF) for the SSX project (April 19, 2013).

2. Scope of the Air Quality Analysis

The air quality study will consist of the following components: a regional emissions inventory (mesoscale) analysis to estimate project-related emission burdens for the study area; an ambient concentrations (microscale) analysis to estimate ambient carbon monoxide (CO) concentrations at selected roadway intersections; a qualitative Mobile Source Air Toxics (MSATs) assessment; a quantitative particulate matter (PM) with an aerodynamic diameter of 2.5 micrometers and less ($PM_{2.5}$) hotspot analysis; and a dispersion modeling analysis for nitrogen dioxide (NO_2) concentrations.

For the South Station site, the air quality analysis will assess three joint/private development alternatives for the opening year of 2025 and the design year of 2035. These alternatives include the No Build Alternative; Alternative 1, Transportation Improvements Only; and Alternative 3, Joint/Private Development Maximum Build. Alternative 1 would include transportation improvements only, but would not provide for potential private development at South Station. Alternative 3 represents the upper bounds of potential private development at South Station, and would be the worst case scenario with respect to air quality.

For the layover facility sites, the air quality analysis will evaluate the No Build and Build alternatives for the opening year of 2025 and the design year of 2035.

Under authority of the Clean Air Act, U.S. EPA has established National Ambient Air Quality Standards (NAAQS) for criteria pollutants to protect the public health and welfare. The criteria pollutants which are of significance to the transportation sector include CO, NO_2, ozone (O_3), PM_{10} and $PM_{2.5}$. The criteria pollutants which are not of significance to the transportation sector include sulfur dioxide (SO_2) and lead (Pb). The ambient air quality standards for Massachusetts are identical to the NAAQS.

Since the implementation of the U.S. EPA's Ultra-Low Sulfur Diesel Fuel Requirements that were promulgated in 2006, SO_2 emissions from transportation projects have been greatly reduced. For MEPA and NEPA compliance purposes, SO_2 will be addressed in the SSX project EIR and EA. Lead is no longer considered to be a pollutant of concern for transportation projects. The major source of Pb emissions to the atmosphere had been from motor vehicles burning gasoline with Pb-containing additives. Lead emissions from motor vehicle sources have been nearly eliminated, however, as unleaded gasoline has replaced leaded gasoline nationwide. Further, there is almost no Pb in diesel engine emissions. Therefore, Pb emissions are no longer required to be assessed.

EPA promulgated final General Conformity regulations at 40 CFR Part 93 Subpart B for all federal activities except those covered under Transportation Conformity. FRA activities are not covered under Transportation Conformity; therefore General Conformity regulations apply to the SSX project.

South Station is located in Suffolk County, MA, which has been designated by U.S. EPA as a moderate nonattainment area with respect to the 8-hour O_3 NAAQS. Massachusetts, through its State Implementation Plan (SIP), specifies target dates for achieving compliance with the NAAQS, and identifies specific emission reduction goals for nonattainment or maintenance areas. It has been determined that the SSX project is not explicitly included in a conforming Regional Transportation Plan (RTP) or a Transportation Improvement Program (TIP). Therefore, a regional analysis of project emissions will be conducted for purposes of demonstrating compliance with the General Conformity rules. Emissions inventories also will be prepared for the purpose of NEPA disclosure of impacts from project alternatives.

The Boston area is also designated as a Maintenance Area for CO, having achieved attainment in 1995 after being designated as a Moderate Nonattainment area. Therefore, a CO Hot Spot (Intersection) modeling analysis will be performed for the purpose of demonstrating compliance with the National and Massachusetts CO air quality standards.

3. Emissions Inventory Analysis

Mesoscale air quality impacts are defined as the incremental change in regional emissions of criteria pollutants due to the proposed project alternatives relative to the No Build Alternative, for a given year. The emissions inventory will be developed for motor vehicles and buses on affected roadways within the project study area, and railroad locomotives entering, idling, and leaving the station. Differences in vehicular emissions are a direct function of the changes in daily vehicle-miles traveled (VMT) and their associated pollutant emission rates. Differences in train locomotive emissions are a direct function in the number of locomotives idling in the station and the emissions from locomotives entering and leaving the station, and their associated pollutant emission rates. The motor vehicle emissions inventory will be developed using the roadway network and traffic data defined in the project traffic studies, along with appropriate year-dependent and speed-dependent emission factors. A preliminary list of the roadway links to be used in the analysis is presented for MassDEP's concurrence in Table 1. The train emissions will be developed based on the current and future train schedules and the appropriate U.S. EPA year-specific (i.e., Tier) emission factors for locomotives. The emission inventories will be prepared in accordance with EPA guidelines.[2] Emissions will be calculated for volatile organic compounds (VOC), nitrogen oxides (NOx), CO, $PM_{10,}$ $PM_{2.5}$, and SO_2.

3.1. Motor Vehicle and Bus Emission Factors

The motor vehicle emission factors (expressed as grams of pollutant per vehicle mile) that will be used to estimate the motor vehicle emissions will be calculated using the most recently approved version of the U.S. EPA MOVES program (currently MOVES2010b). Emission factors will be provided for all vehicle categories combined (the composite emission factor) and for heavy duty diesel vehicles (buses) separately.

[2] *Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources*. U.S. Environmental Protection Agency, Office of Mobile Sources (now Office of Transportation and Air Quality). Report number EPA-450/4-81-026d (Revised). Ann Arbor, MI. 1992.

3.2. Locomotive Emission Factors

U.S. EPA's Locomotives Exhaust Emission Standards will be used to calculate locomotive emissions and emission rates. The standards, which are codified at 40 CFR Part 1033.101, include several sets of emission standards based on the date a locomotive is first manufactured or remanufactured. The standards used for this analysis are presented in Table 2. The duty cycle for all locomotives at South Station is assumed to be "Line-haul" only, no "switch" engine activities occur at South Station.

Table 1
Preliminary List of Roadway Links to be Used in the Emissions Inventory Analysis

Link ID No.	Link Description
1	Atlantic Avenue - Kneeland Street to Essex Street
2	Atlantic Avenue - Essex Street to Summer Street
3	Atlantic Avenue - Summer Street to Congress Street
4	Atlantic Avenue - Congress Street to Northern Avenue/Seaport Blvd
5	Summer Street - Atlantic Avenue to Purchase Street
6	Summer Street - Atlantic Avenue to Dorchester Avenue
7	Summer Street - Dorchester Avenue to Haul Road
8	Essex Street - Chauncy Street to Lincoln Street
9	Essex Street - Lincoln Street to Atlantic Avenue
10	A Street - Congress Street to Dorchester Avenue
11	Dorchester Avenue - West 4th St to Old Colony Avenue
12	Dorchester Avenue - West 4th Street to West Broadway
13	Dorchester Avenue - West Broadway to West 2nd Street
14	Dorchester Avenue - Summer Street to West 2nd Street
15	Congress Street - Atlantic Avenue to Purchase Street
16	Congress Street - Atlantic Avenue to Dorchester Avenue
17	Congress Street - A Street to Dorchester Avenue
18	Purchase Street - Seaport Blvd/Northern Avenue to Congress Street
19	Purchase Street - Congress Street to Summer Street
20	Surface Road - Summer Street to Lincoln Street/Essex Street
21	Surface Road - Lincoln Street/Essex Street to Kneeland Street
22	Surface Road - Kneeland Street to I-90 Ramp
23	Lincoln Street - Essex Street to Kneeland Street
24	Lincoln Street - Kneeland Street to Hwy Ramps
25	South Station Connector - Surface Road to Lincoln Street
26	South Station Connector - Lincoln Street to Bus Terminal Entrance/HOV Parking Ramp
27	Kneeland Street - Washington Street to Surface Road
28	Kneeland Street - Surface Road to Lincoln Street
29	Kneeland Street - Lincoln Street to Atlantic Avenue
30	Beach Street - Atlantic Avenue to Surface Road

Source: KM Chng Environmental Inc. January 2014.

All existing MBTA locomotives will be assumed to comply with the U.S. EPA's Tier-1 emission standards, based on the date of sale or remanufacture of the engines. The more stringent Tier-4 emission standards will be used for MBTA locomotives in the future 2025 and 2035 scenarios. The F40PH-2C locomotive with a 3,000 horsepower (hp) EMD 16-645E3B engine was chosen as the representative engine for all existing MBTA locomotives. Throttle notch and fuel consumption rates taken from Appendix B of the *Locomotive Emission Standards, EPA-420-R-98-101, April, 1998*, as shown in Table 3, will be used for the MBTA locomotives.

Table 2
U.S. EPA Line Haul Locomotives Exhaust Emission Standards

Tier	Year	HC (g/hp-hr)	NOx (g/bhp-hr)	PM (g/bhp-hr)	CO (g/bhp-hr)
Tier 0	1973-1992	1.00	9.5	0.22	5.0
Tier 1	1993-2004	0.55	7.4	0.22	2.2
Tier 2	2005-2011	0.30	5.5	0.10	1.5
Tier 3	2012-2014	0.30	5.5	0.10	1.5
Tier 4	2015+	0.14	1.3	0.03	1.5

Source: http://www.epa.gov/otaq/standards/nonroad/locomotives.htm

The P42-DC locomotive with a 3,200 hp GE 7FDL engine was chosen to be the representative locomotive for the Amtrak diesel locomotives and the engine throttle data was taken from *Appendix A-2 of Emissions Summary for Other Diesel Emission Sources in and Adjacent to the West Oakland Community*, as shown in Table 3. Because there were no fuel consumption data available for the 7FDL engine, the fuel consumption rate for the GE16 engine (an engine with operational characteristics similar to the 7FDL) will be used for Amtrak engines. All existing Amtrak locomotives are assumed to be compliant with the U.S. EPA's Tier-0 emission standards, based on the date of sale or remanufacture of the engines. The more stringent Tier-4 emission standards will be used for Amtrak locomotives in the future 2025 and 2035 scenarios.

The existing and future daily South Station train schedules will be used to calculate locomotive idling and traveling times in the study area.

Table 3
Throttle Notch Data and Fuel Consumption Rate

Throttle Notch Setting	Power in Notch (bhp)	Fuel Rate (lb/hr)	Power in Notch (bhp)	Fuel Rate* (lb/hr)
	EMD 16-645E3B Engine (Rated Power = 3,000 bhp)		GE 7FDL Engine (Rated Power = 3,200 bhp)	
Dynamic Brake	138	126	109	-
Idling	17	279	11	17
1	105	296	179	50
2	363	361	388	86
3	721	432	787	273
4	1030	528	919	368
5	1438	657	1413	532
6	1821	827	2014	680
7	2492	1066	2699	858
8	3070	1186	3200	1082

Source of EMD Data: Appendix B, Locomotive Emission Standards. U.S. EPA, Office of Transportation and Air Quality, EPA-420-R-98-101, April 1998. http://www.epa.gov/otaq/documents/420r98101.pdf
Source of 7FDL Data: Table 1 of the *Brunswick Rail Maintenance Facility, Potential Air Quality Impacts of Proposed Facility on Nearby Sensitive Land Uses*, Parsons Brinckerhoff, August 2011. http://www.amtrakdowneaster.com/sites/default/files/Potential%20Air%20Quality%20Impacts.pdf
* Fuel Rate for GE12 Engine from *Appendix B, Locomotive Emission Standards.* EPA-420-R-98-101, April 1998.

Hydrocarbons (HC), PM, NOx and CO emissions will be calculated by the following equation:

Emissions (g) = Emission Factor (g/bhp-hr) * brake horsepower at a particular notch setting * time (hr)

SO_2 and CO_2 emissions are dependent on fuel consumption rates and the following assumptions taken from *Emission Factors for Locomotives*, U.S. EPA, Office of Transportation and Air Quality, EPA-420-F-09-025, April 2009 will be used in these calculations:

- Diesel fuel density of 3,200 grams per gallon (g/gal)
- Fraction of fuel sulfur converted to SO_2 of 98 percent
- Diesel fuel sulfur content of 15 parts per million (ppm)
- Carbon content of fuel of 87 percent by mass

SO_2 and CO_2 emissions will be estimated by the methodology outlined on Page 5 of *U.S. EPA's Emission Factors for Locomotives*, EPA-420-F-09-025, April 2009. Emission factors for the existing and future years are presented in Table 4 in units of grams per hour (g/hr).

Table 4
Locomotive Emission Rates

	MBTA Locomotives				AMTRAK Locomotives			
	Existing 2012		Future Years		Existing 2012		Future Years	
	(Tier-1 Standards)		(Tier-4 Standards)		(Tier-3 Standards)		(Tier-4 Standards)	
	Emission Rate		Emission Rate		Emission Rate		Emission Rate	
Pollutant	(g/hr)		(g/hr)		(g/hr)		(g/hr)	
	Idling	Notch 1	Idling	Notch 1	Idling	Notch 1	Idling	Notch 1
HC	9.4	57.8	2.4	14.7	11.0	179.0	1.5	25.1
NOx	125.8	777.0	22.1	136.5	104.5	1700.5	14.3	232.7
PM_{10}	3.7	23.1	0.5	3.2	2.4	39.4	0.3	5.4
$PM_{2.5}$	2.8	17.3	0.4	2.4	1.8	29.5	0.2	4.0
CO	37.4	231.0	25.5	157.5	55.0	895.0	16.5	268.5
	Emission Rate		Emission Rate		Emission Rate		Emission Rate	
	(g/gal of fuel)		(g/gal of fuel)		(g/gal of fuel)		(g/gal of fuel)	
SO_2	0.094		0.094		0.094		0.094	
CO_2	10,217.0		10,217.0		10,217.0		10,217.0	

Source: KM Chng Environmental Inc. January 2014.

The South Station average weekday train schedules will be used to calculate the annual PM_{10}, $PM_{2.5}$, HC, NOx, CO, SO_2, and CO_2 emissions. VOC emissions will be assumed to be equal to 1.053 times the HC emissions. PM emissions will be expressed as PM_{10}. $PM_{2.5}$ emissions will be estimated as 0.97 times the PM_{10} emissions.[3]

Emissions from the Amtrak Acela trains will not be assessed as the electric locomotives do not have direct air emissions.

All locomotives in the study area are assumed to be either in Idling Mode or Notch-1 setting.

[3] *Emission Factors for Locomotives*, U.S. Environmental Protection Agency, Office of Transportation and Air Quality. EPA-420-F-09-025. April 2009.

3.3. Calculation of Annual Emissions

Emissions from each identified roadway segment (i.e., each link included in the SSX project's traffic study) will be calculated by multiplying the average daily traffic (ADT) volume on the link by the roadway link length to calculate VMT. The VMT will then be multiplied by the MOVES pollutant-specific emission factor for the parameter values (e.g., average vehicle speed, vehicle types, other operating conditions, and roadway functional class) applicable to that roadway segment. The emissions from each roadway segment will be summed to provide the average 24-hour emissions on each link. The average daily emissions will be multiplied by 365 to calculate annual emissions from motor vehicles and buses in tons per year.

Emissions from each train (including up to two locomotives each) for the typical daily schedule will be calculated by multiplying the number of operating hours each locomotive is at idle in the station by the appropriate idling emission factor and adding to it the emissions from each locomotive entering and leaving the station using the appropriate emission factors. The emissions from each train will be summed to provide the average 24-hour emissions. The average daily emissions will be multiplied by 365 to calculate annual emissions from trains in tons per year.

The results from the emission inventory analysis will consist of the total emissions in tons per year of VOC, NOx, CO, PM_{10}, $PM_{2.5}$, and SO_2 for the study area, presented in tabular form.

4. Greenhouse Gas Analysis

CO_2 emissions will be estimated from transportation sources for the 2012 existing condition and the two SSX project No Build and Build alternatives in the opening year of 2025 and the design year of 2035. The U.S. EPA's MOVES program will be used to determine CO_2 emission factors from motor vehicles (all vehicles combined and buses separately). Emission factors will be combined with motor vehicle generated VMTs to estimate GHG emissions.

GHG emissions from each train (locomotive) will be calculated by multiplying the number of operating hours the locomotive is at idle in the station by the appropriate idling emission factor and adding to it the emissions from each locomotive entering and leaving the station using the appropriate emission factor.

5. CO Hot-Spot Analysis

The dispersion modeling analysis will estimate ambient CO concentrations and demonstrate the air quality impacts of the SSX project at four selected signalized roadway intersections in the vicinity of South Station and one intersection in the vicinity of each of the three layover sites for the same years and project alternatives as described for the Emission Inventory Analysis.

5.1. Intersection Analysis

The roadway intersections that will be included in the air quality analysis will be selected based on criteria given in U.S. EPA guidelines.[4] In order to determine which candidate intersections should be analyzed for air quality impacts, each intersection will be screened based on the Level of Service (LOS) and approach volume and delay data from the SSX project traffic studies. The traffic study has identified 21 intersections in the vicinity of the South Station site study area to be evaluated and these intersections are listed in Table 5.

[4] *Guideline for Modeling Carbon Monoxide From Roadway Intersections*. Report number EPA-454/R-92-005. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. November 1992.

The traffic study also identified two intersections in the vicinity of the Widett Circle layover site, one intersection in the vicinity of the Beacon Park layover site, and two intersections in the vicinity of the Readville - Yard 2 layover site to be evaluated and these intersections are listed in Table 6.

Table 5
List of Intersections Analyzed in the South Station Site Traffic Study Area

Intersection ID No.	Description
1	Congress Street at Dorchester Avenue
2	Summer Street at Dorchester Avenue
3	Atlantic Avenue at Seaport Boulevard
4	Atlantic Avenue at Congress Street
5	Purchase Street at Congress Street
6	Atlantic Avenue at Summer Street
7	Purchase Street at Summer Street
8	Atlantic Avenue at Essex Street
9	Surface Road at Essex Street & Lincoln Street
10	Atlantic Avenue at East Street
11	Atlantic Avenue at Beach Street
12	Atlantic Avenue at Kneeland Street
13	Kneeland Street at Lincoln Street
14	Surface Road at Kneeland Street
15	Lincoln Street at South Station Connector
16	Surface Road at South Station Connector
17	Dorchester Avenue at West 2nd Street
18	Dorchester Avenue at West Broadway / Traveler Street
19	Dorchester Ave at West 4th Street
20	Purchase Street at I-93 Off-Ramp, & Seaport Boulevard
21	Congress Street at A Street / Thompson Place

Source: KM Chng Environmental Inc. January 2014.

Table 6
List of Intersections Analyzed in the Layover Sites' Vicinities

Traffic Study ID No.	Intersection Name
Beacon Park Yard	
1	Cambridge Street / Lincoln Street
Widett Circle	
2	Frontage Road / Widett Circle Access Road
3	Widett Circle / Widett Circle Access Road
Readville – Yard 2	
4	Hyde Park Avenue/Neponset Valley Pkwy/Wolcott Ct/Wolcott Square
5	Wolcott Ct / Layover Driveway

Source: KM Chng Environmental Inc. January 2014.

Based on the preliminary LOS, delay, and total volume data, the four intersections in the vicinity of the South Station site that were selected to be assessed in the detailed air quality analysis for all calendar years and alternatives are listed in Table 7. Table 7 also lists the intersections in the vicinity of each Layover site selected to be assessed in the detailed air quality analysis for all calendar years.

Table 7
Traffic Intersections Selected for the SSX Detailed Air Quality Analysis

ID	Intersection Name
South Station Site Vicinity	
3	Atlantic Avenue at Seaport Boulevard
6	Atlantic Avenue at Summer Street
14	Surface Road at Kneeland Street
18	Dorchester Avenue at West Broadway / Traveler Street
Widett Circle Layover Site Vicinity	
3	Widett Circle / Widett Circle Access Road
Beacon Park Yard Layover Site Vicinity	
1	Cambridge Street / Lincoln Street
Readville - Yard 2 Layover Vicinity Site	
4	Hyde Park Avenue/Neponset Valley Pkwy/Wolcott Ct/Wolcott Square

Source: KM Chng Environmental Inc. January 2014.

5.2. Receptor Locations

At each of the intersections selected for the detailed dispersion modeling analysis, maximum 1-hour and 8-hour CO concentrations will be estimated at a number of receptor locations. In accordance with U.S. EPA guidelines,[5] "sidewalk" receptors will be placed on both sides of each approach of each intersection, outside of the mixing zones of the free-flow links being modeled. These receptors will be located on the sidewalk, at least 3 meters from the edge of the nearest travel lane, at distances of 3 meters, 25 meters, and 50 meters from the cross street. These sidewalk receptors will be supplemented with other receptors, to the extent applicable, and will be placed at sensitive locations such as residences, schools, health care facilities, businesses, and other areas where the public has access.

5.3. Emission Factor Development

Emission factors for CO will be developed using MOVES in the same way as proposed for the Emission Inventory Analysis. The winter emission factors for CO will be used in the CO hot-spot analysis, based on the same MassDEP guidance as proposed for the Emission Inventory Analysis. Idle CO emission factors for the dispersion modeling analysis will be developed using U.S. EPA's recommended procedure.[6]

5.4. Background CO Concentrations

Total CO concentrations will be determined by adding the appropriate 1-hour and 8-hour background levels to the predicted CO concentrations. The background values represent worst-case ambient CO

[5] *Guideline for Modeling Carbon Monoxide From Roadway Intersections*. Report number EPA-454/R-92-005. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. November 1992.

[6] *Technical Guidance on the Use of MOBILE6.2 for Emission Inventory Preparation, Section 4.4.4,* Transportation and Regional Programs Division, Office of Transportation and Air Quality, U.S. Environmental Protection Agency. EPA420-R-04-013. August 2004.

levels that are assumed to occur independently of the project-related emissions being analyzed. Background CO concentrations will either be provided by MassDEP or will be based on MassDEP's recommended procedure [7] of using the highest second-highest measured 1-hour or 8-hour CO concentrations from the nearest representative CO monitoring location for the most recent three full years of monitoring data (2010 – 2012).[8,9,10] These background levels are intended to represent worst-case urban conditions and will be conservatively held constant for all analysis years and project alternatives.

The nearest representative MassDEP monitoring site to South Station that measures CO is the Kenmore Square Site (ID 25-025-0002). Carbon monoxide data for the most recent three years of data available are presented in Table 8 below. Based on this data, we will use 1.8 ppm for the 1-hour background concentration and 1.2 ppm for the 8-hour background concentration.

Table 8
Highest and Second-Highest 1-hour and 8-Hour CO Concentrations for Most Recent Three Years of Data from at the Kenmore Square Site

Monitoring Year	Max 1-hr (ppm)	2nd Max 1-hr (ppm)	Max 8-hr (ppm)	2nd Max 8-hr (ppm)
2010	1.9	1.8	1.5	0.9
2011	1.5	1.5	1.3	1.2
2012	1.4	1.3	1.1	0.9
Background	--	1.8	--	1.2

Source: KM Chng Environmental Inc. January 2014.

5.5. Dispersion Modeling Analysis for CO

Maximum 1-hour CO concentrations will be estimated with U.S. EPA's CAL3QHC Version 2.0 model.[11] The 1-hour modeled CO concentrations (without a background CO concentration) will be multiplied by a scale (persistence) factor to determine the estimated 8-hour CO concentrations. Based on EPA[5] and MDEP guidelines[7], the proposed value of the scale factor is 0.70.

The results from the dispersion modeling analysis will consist of maximum 1-hour and 8-hour CO concentrations (including an appropriate background CO concentration) at each receptor location at each intersection analyzed, presented in tabular form. The results will be compared to the Massachusetts and National Ambient Air Quality Standards for CO.

When executing the CAL3QHC model, the site and traffic input assumptions given in Table 9 will be used. These values are consistent with U.S. EPA guidance.[7]

Table 10 provides the CAL3QHC meteorological parameters that will be used in the dispersion modeling analysis.

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7 *Recommended Compliance Demonstrations for Sources of Air Pollution in Massachusetts*, Massachusetts Department of Environmental Protection, Division of Air Quality Control, January 2012.

8 *Commonwealth of Massachusetts 2010 Air Quality Report*, Department of Environmental Protection, Bureau of Waste Prevention, Division of Planning and Evaluation, Air Assessment Branch, Wall Experiment Station, June 2011

9 *Commonwealth of Massachusetts 2011 Air Quality Report*, Department of Environmental Protection, Bureau of Waste Prevention, Division of Planning and Evaluation, Air Assessment Branch, Wall Experiment Station, August 2012

10 *Commonwealth of Massachusetts 2012 Air Quality Report*, Department of Environmental Protection, Bureau of Waste Prevention, Division of Planning and Evaluation, Air Assessment Branch, Wall Experiment Station, July 2013

11 *User's Guide to CAL3QHC Version 2.0: A Modeling Methodology for Predicting Pollutant Concentrations Near Roadway Intersections*. U.S. Environmental Protection Agency. Report number EPA-454/R-92-006. Research Triangle Park, NC. 1992. Revised June 1993.

Table 9
CAL3QHC Site and Traffic Input Assumptions

Parameter	Assumed Value
Surface roughness coefficient (Z_0)	321 cm (central business district/high-rise buildings)
Design saturation flow rate (SFR)	1600 vehicles/hour (urban default value)
Arrival rate (AT)	3 (random arrivals)
Signal type (ST)	1 (pre-timed; worst-case assumption)
Averaging Time	60 minutes
Link Height	0.0 meters (at-grade)
Receptor Height	1.8 meters

Source: KM Chng Environmental Inc. January 2014.

Table 10
CAL3QHC Meteorological Input Assumptions

Parameter	Assumed Value
Wind speed	1 meter/second
Pasquill-Gifford stability class	D (Neutral; urban land use)
Mixing height	1000 meters
Wind directions	10º - 360º scanned at 10º increments

Source: KM Chng Environmental Inc. January 2014

6. Mobile Source Air Toxics Assessment

The qualitative MSATs assessment will follow FHWA's "Interim Guidance on Air Toxic Analysis in NEPA Documents," dated February 3, 2006 (and updated September 30, 2009). A description of MSATs, the U.S. EPA-defined priority MSATs, and their effects on health will be included. The discussion will also include measures undertaken by U.S. EPA to reduce MSAT emissions and will present national trend data from Appendix C of the FHWA guidance document.

The MSATs assessment will qualitatively compare the differences in MSAT emissions between the No Build and the two Build Alternatives in the opening year of 2025 and the design year of 2035. The description of the differences will be based on changes in VMT, vehicle mix, and speeds. In compliance with CEQ regulations, a discussion regarding incomplete and unavailable data that would be required for an accurate assessment of human health impacts will be included.

7. $PM_{2.5}$ Hot Spot Analysis

Massachusetts has been designated as being unclassifiable/attainment for $PM_{2.5}$. For NEPA disclosure purposes and to make the localized impact assessment more comprehensive, a $PM_{2.5}$ Hot Spot dispersion modeling analysis will be performed using U.S. EPA's November 2013 guidance.[12] The analysis will be conducted for the existing condition and the No Build and two Build Alternatives at the South Station site in project opening year of 2025 and in the project's design year of 2035.

7.1. Model Selection

The AERMOD model (version 12345) will be used to determine predicted impacts from the SSX project at the South Station site. AERMOD is identified by U.S. EPA in the "Guideline on Air Quality Models" (40 CFR 51, Appendix W) as a recommended refined model for a wide range of regulatory applications in

12 *Transportation Conformity Guidance for Quantitative Hot-spot Analyses in PM2.5 and PM10 Nonattainment and Maintenance Areas*, Transportation and Climate Division, Office of Transportation and Air Quality, U.S. Environmental Protection Agency. EPA-420-B-13-053. November 2013.

all types of terrain and in cases where aerodynamic downwash is important. AERMOD includes the PRIME downwash algorithm which accounts for potential building wake and cavity effects on stack emissions. While the terrain in the vicinity of the South Station is relatively flat, AERMOD also includes a refined complex terrain algorithm and can provide predicted impacts in all terrain regimes. However, the flat terrain option in AERMOD will be used.

The locomotive stack heights are likely to be below the maximum GEP formula height calculated based on the proposed station improvements and nearby structures, so building downwash may affect stack emissions. In addition, locomotive stack heights are short enough relative to nearby structures that building cavity effects on stack emissions may be important. As previously noted, AERMOD can account for building wake and cavity effects on stack emissions. For these reasons, AERMOD is an appropriate and recommended model to use for estimating impacts from the SSX project emissions. Therefore, AERMOD with regulatory default model options is proposed for use for this modeling analysis.

7.2. Meteorological Data

AERMOD will be executed using five years of preprocessed meteorological data provided by the MassDEP. Surface data will be from Boston Logan Airport for calendar years 2007 through 2011 (the latest years of processed data available); upper air data will be from Gray, ME for the same years.

7.3. Motor Vehicle Roadway Network

A preliminary network of 30 roadway links will be used in the $PM_{2.5}$ modeling analysis. The network links are the same links used in the Emissions Inventory Analysis and are described in Table 1. The $PM_{2.5}$ speed-dependent emission factors for the motor vehicles and buses will be the same as used in the Emissions Inventory Analysis. The roadway links will be treated as narrow area sources with a release height of 0.0 meters.

7.4. Locomotive Source Inputs

Locomotive stack parameters to be used in the modeling analyses were taken from a 2007 Sierra Research, Inc. Report[13] and are presented in Table 11.

Table 11
Locomotive Modeling Input Parameters

Parameter	Assumed Value
Stack Height (m)	4.76
Stack Diameter (m)	0.625
Exit Velocity – Idle (m/s)	3.1
Exit Velocity – Moving (m/s)	8.0
Exit Temperature - Idle (º K)	364
Exit Temperature - Moving (º K)	420
Locomotive Length (m)	17.1
Locomotive Width (m)	3.2
Locomotive Height (m)	4.6

Source: KM Chng Environmental Inc. January 2014.

13 *Toxic Air Contaminant Emissions Inventory and Air Dispersion Modeling Report for the Stockton Rail Yard, Stockton, California*, Final Report-2/23/07, Sierra Research, Inc. January 2007.

Stationary, idling trains will be treated as point sources, and moving trains will be treated as volume sources with the sources stretching along the tracks from the parking locations at South Station until they reach the Tower 1 interlocking. The $PM_{2.5}$ emission factors for the locomotives will be the same as were used in the Emissions Inventory Analysis as presented previously in Table 4.

7.5. Receptor Network

A preliminary network of discrete receptors using simple terrain is provided in Table 12 for concurrence by MassDEP. The preliminary network of discrete receptors includes fence line receptors surrounding South Station, as well as sensitive locations such as residences, office buildings, schools, parks, playgrounds, businesses, and other areas where the public has access.

Table 12
Preliminary list of Discrete Receptors for PM2.5 Modeling Analysis

Receptor No.	Receptor Description	Receptor No.	Receptor Description
R1	South Station Parking Center	R24	Federal Reserve Building
R2	South Station Parking South	R25	Federal Reserve Building - sitting area
R3	South Station Parking West	R26	280 Congress Street
R4	South Station Parking North	R27	Park near Harbor Walk
R5	Kneeland Street & Atlantic Avenue	R28	Restaurant at Pearl Street Extension
R6	183 Beach Street	R29	John Joseph Moakley Federal Courthouse
R7	Dunkin Donuts on Atlantic Avenue	R30	Fan Pier Public Green
R8	200 Essex Street	R31	MetroLacrosse, 25 Thomson Place, Boston
R9	Financial Center, Boston	R32	Factory 63, 63 Melcher Street, South Boston
R10	Dewey Square Plaza (at the Farmer's Market)	R33	Wormwood Park, South Boston
R11	201 South St #614, Boston	R34	Binford Street Park, South Boston
R12	143 South St #6, Boston	R35	Gillette Park, South Boston
R13	89 South St, Boston	R36	Restaurant at 98 A Street, South Boston
R14	Leather District Park, Essex St	R37	Diner at 75 W Broadway, South Boston
R15	Boston-Fiduciary Trust Building	R38	Flaherty Park, W 3rd and B Streets, South Boston
R16	Rose Fitzgerald Kennedy Greenway Conservancy	R39	Tai Tung Park, Tai-Tung Street
R17	Reggie Wong Memorial Park, Lincoln Street	R40	Eliot Norton Park, Tremont Street
R18	150 Lincoln Street (office building)	R41	Millicent Way Park, Millicent Way
R19	1 Lincoln Street (office building)	R42	Peters Park, 230 Shawmut Avenue
R20	100 Summer St, Boston	R43	Dorchester Ave, 150 feet south of Summer Street
R21	Dewey Square Park	R44	Dorchester Ave, 800 feet south of Summer Street
R22	Park St at Congress Street and Atlantic Avenue	R45	Dorchester Ave, 1500 feet south of Summer Street
R23	Fort Point Center Park, Pearl Street & Atlantic Avenue	R46	Dorchester Ave, 2100 feet south of Summer Street

Source: KM Chng Environmental Inc. January 2014.

7.6. Background $PM_{2.5}$ Concentrations

Total $PM_{2.5}$ concentrations will be determined by adding the appropriate 24-hour and annual background levels to the predicted $PM_{2.5}$ concentrations. The background values represent worst-case ambient $PM_{2.5}$ levels that are assumed to occur independently of the project emissions being analyzed. Background $PM_{2.5}$ concentrations will either be provided by MassDEP or will be based on MassDEP's recommended procedure[11]. For the 24-hour background $PM_{2.5}$ concentration, the three-year average of the 98th percentile 24-hour values recorded at the nearest representative $PM_{2.5}$ monitoring location for the most recent three full years of monitoring data available (2010 – 2012) will be used. For the annual $PM_{2.5}$ background concentration, the three year average of the annual average values recorded at the nearest representative $PM_{2.5}$ monitoring location for the most recent three full years of monitoring data available (2010 – 2012)[12, 13, 14] will be used. These background levels are intended to represent worst-case urban conditions and will be conservatively held constant for all analysis years and project alternatives.

The nearest representative MassDEP monitoring site to South Station that measures $PM_{2.5}$ is the Kenmore Square Site (ID 25-025-0002). Annual and 24-hour data for the most recent three years (2010 – 2012) are presented in Table 13. Based on this data, we will use 21.7 µg/m³ for the 24-hour $PM_{2.5}$ background concentration and 9.2 µg/m³ for the annual $PM_{2.5}$ background concentration.

Table 13
98th Percentile 24-hour and Annual $PM_{2.5}$ Concentrations
For Most Recent Three Years of Data from at the Kenmore Square Site

Monitoring Year	98th Percentile 24-hr Conc. (µg/m³)	Annual Mean Conc. (µg/m³)
2010	22	9.3
2011	21	9.4
2012	22	9.0
Background	21.7	9.2

Source: KM Chng Environmental Inc. January 2014.

8. NO_2 Dispersion Modeling Analysis

Massachusetts has been in compliance with the annual NO_2 standard of 53 ppb for at least the past two decades. In 2010, U.S. EPA promulgated a new one-hour NO_2 standard of 100 parts per billion (ppb). For NEPA disclosure and to make the localized impact assessment more comprehensive, a dispersion modeling analysis of NO_2 concentrations will be performed for one worst case Build Alternative in the SSX project's design year of 2035.

The same dispersion model (AERMOD), locomotive source inputs, motor vehicle inputs, and receptor network as described for the $PM_{2.5}$ Hot Spot analysis in Section 7 will be used in this analysis.

8.1. Background NO_2 Concentrations

As in the CO intersection and $PM_{2.5}$ Hot Spot modeling, total concentrations will be determined by adding the appropriate 1-hour and annual background levels to the predicted NO_2 concentrations. The background values represent worst-case ambient NO_2 levels that are assumed to occur independently of the project emissions being analyzed. Background NO_2 concentrations will either be provided by MassDEP or will be based on MassDEP's recommended procedure.[11] For the 1-hour background NO_2 concentration, the three year average of the 98th percentile 1-hour values recorded at the nearest representative NO_2 monitoring location for the most recent three full years of monitoring data available (2010 – 2012) will be used and are presented in Table 14.

Table 14
98th Percentile 1-hour and Annual NO_2 Concentrations
For Most Recent Three Years of Data from at the Kenmore Square Site

Monitoring Year	98th Percentile 1-hr Conc. (ppb)	Annual Mean Conc. (ppb)
2010	51.5	19.1
2011	52.9	20.4
2012	49.0	19.1
Background	51.1	19.5

Source: KM Chng Environmental Inc. January 2014.

For the annual NO_2 background concentration, the highest annual average value recorded at the nearest representative NO_2 monitoring location for the most recent three full years of monitoring data available (2010 – 2012)[12,13,14] will be used. These background levels are intended to represent worst-case urban conditions and will be conservatively held constant for all analysis years and project alternatives.

Based on this data, the SSX team will use 51.1 ppb for the 24-hour NO_2 background concentration and 19.5 ppb for the annual NO_2 background concentration.

9. Assessment and Mitigation

9.1. Assessments

Annual emissions of each pollutant for the No Build Alternative will be compared to the corresponding emissions for each of the three Build Alternatives in the opening year of 2025 and the design year of 2035. The results of these assessments will be presented in the EIR and EA in tabular form. The emission inventory results will be discussed for purposes of disclosure and public information under NEPA.

The modeled 1-hour and 8-hour CO concentrations for each of the three Build Alternatives in the opening year of 2025 and the design year of 2035 will be compared to their respective Massachusetts and National Ambient Air Quality Standards. In order to demonstrate compliance with the ambient CO standards, predicted CO concentrations (including an appropriate background concentration) must not equal or exceed the NAAQS.

The modeled 24-hour and annual $PM_{2.5}$ concentrations for the No Build and each of the three Build Alternatives in the project's opening year of 2025 and the project's design year of 2035 will be compared to their respective Massachusetts and National Ambient Air Quality Standards. To demonstrate compliance with the ambient $PM_{2.5}$ standards, predicted $PM_{2.5}$ concentrations (including an appropriate background concentration) must not equal or exceed the NAAQS.

The modeled 1-hour and annual NO_2 concentrations for the worst-case Build Alternative in the SSX project's design year of 2035 will be compared to their respective Massachusetts and National Ambient Air Quality Standards. In order to demonstrate compliance with the ambient NO_2 standards, predicted

NO_2 concentrations (including an appropriate background concentration) must not equal or exceed the NAAQS.

The project's transportation-related GHG emissions for each of the Build alternatives will be included in the overall GHG analysis. Potential GHG mitigation measures will be discussed in the overall GHG analysis.

A General Conformity evaluation is required for the project with respect to emissions of VOC and NOx, and concentrations of CO. Direct project-related emission plus indirect emissions will be compared to the pollutant specific emission rates for maintenance areas. The results of the air quality analysis are expected to provide the information necessary to support any necessary project-level conformity determination for the project. If conformity cannot be demonstrated for any project alternative, then candidate mitigation measures will be identified for further evaluation. The effects of selected candidate mitigation measures will be described qualitatively.

9.2. Mitigation

If adverse air quality impacts during routine SSX project operations are anticipated, mitigation measures will be identified and their potential benefits will be described qualitatively. The focus of this assessment will be on mitigation measures that can be implemented to prevent potential adverse impacts.

Control measures that have direct impacts on GHG emissions from transportation sources will be identified, and their benefits will be described qualitatively.

10. Construction Impacts

Air quality impacts anticipated during SSX project construction will be described in a qualitative manner. If adverse air quality impacts during construction are anticipated, mitigation measures will be identified and their potential benefits will be described qualitatively. The focus of this assessment will be on mitigation measures that can be implemented to prevent potential adverse impacts, such as dust emissions and elevated CO and $PM_{10}/PM_{2.5}$ concentrations, at sensitive receptor locations within the project area. Administrative Consent Order (ACO-BO-00-7001), and its amendments, agreed to by MassDEP and the Massachusetts Executive Office of Transportation on January 26, 2005, requires Massachusetts Executive Office of Transportation to implement a construction equipment retrofit program and retrofit equipment with emission control technologies such as oxidation catalysts and particulate filters for large projects. Accordingly, it is assumed that contractors will be required to have retrofitted their diesel-powered equipment with emission controls, and that low sulfur fuel will be used.

Attachment N Mass DEP Protocol Approval Email

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Date: Wed, 4 Jun 2014 13:35:51 -0400
From: "Grafe, Jerome (DEP)" <jerome.grafe@state.ma.us>
To: Alan Goldman <alangoldman@kmchng.com>
CC: "epetrie@hntb.com" <epetrie@hntb.com>, "snwalker@hntb.com" <s .....
Subject: SSX Project AQ Analysis

Hi Alan,

I am writing to confirm we met today to discuss the attached Air Quality Analysis Protocol submitted by Km Chng Environmental on the May 7, 2014. Mr. Blanchet and I reviewed the Protocol and concur in principle with the methodology as described for use in the upcoming environmental review.

Thank you,

Jerome

Attachment 2: AQAnalysis Protocol for DEIR5-16-14.pdf (2.7MB)	Delete
Type: application/pdf Encoding: base64 Description: AQAnalysis Protocol for DEIR5-16-14.pdf	Download

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Attachment O Discussion of Project-Related Diesel Particulates

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Discussion of Project-related Diesel Particulates

MEPA requested that diesel particulates be analyzed in the DEIR. Diesel particulate matter (DPM) is part of a complex mixture that makes up diesel exhaust. Diesel exhaust is composed of two phases, the gas phase and the particle phase, and both phases can contribute to the potential health risk. The gas phase is composed of many of the urban hazardous air pollutants, such as acetaldehyde, acrolein, benzene, 1,3-butadiene, formaldehyde and polycyclic aromatic hydrocarbons. The particle phase also has many different types of particles that can be classified by size or composition. The size of diesel particulates that are of greatest health concern are those that are in the categories of fine, and ultrafine particles. The composition of these fine and ultrafine particles may be composed of elemental carbon with adsorbed compounds such as organic compounds, sulfate, nitrate, metals and other trace elements. Diesel exhaust is emitted from a broad range of diesel engines; the on road diesel engines of trucks, buses and cars and the off-road diesel engines that include railroad locomotives.

1. Health Effects of Diesel Particulates

Short-term exposure to high concentrations of DPM can cause headache, dizziness, and irritation of the eye, nose and throat. Prolonged DPM exposure can increase the risk of cardiovascular, cardiopulmonary and respiratory disease and lung cancer. In June, 2012, the International Agency for Cancer Research classified DPM as a known human carcinogen. As described in Section 2.3.2 of the *Air Quality Technical Report* (Appendix 10 of the DEIR), emissions of toxic pollutants would increase by from 2 to 4 percent. Thus, impacts due to the SSX project are expected to be minimal and no impacts to health are anticipated.

2. Existing Regulations of Diesel Particulates

At present, there are no regulations at the federal or state levels to which contain air quality standards for diesel particulates. EPA's National Scale Assessment uses several types of health hazard information to provide a quantitative "threshold of concern" or a health benchmark concentration at which it is expected that no adverse health effects occur at exposures to that level. Health effects information on carcinogenic, short and long-term noncarcinogenic end points are used to establish selective protective health levels to compare to the modeled exposures levels. Unfortunately the exposure response data in human studies are considered too uncertain to develop a carcinogenic unit risk for EPA's use. There is a Reference Concentration (RFC) that is used as a health benchmark protective of chronic noncarcinogenic health effects, but it is for diesel exhaust and not specifically set for diesel particulate matter.

3. Diesel Particulate Emission Factors for Transportation Sources

The state of understanding of the formation and fate of diesel particles in the atmosphere is still too elementary to develop quantitative emission factors for various types of transportation sources. At present, there are no emission factors for diesel particulates from transportation sources.

4. Available Controls and Mitigation Measures

Over the past 15 years, considerable research has taken place to develop suitable control technologies, especially for vehicles operating in confined areas (e.g., underground mining). Proven control technologies include: low emission engines, low emission fuels, ventilation of enclosed areas, engine maintenance, exhaust filtration systems, driver and workforce education, and personal protective equipment. Experience has shown that no one single simple solution exists and that individual activities need to explore which of the previously discussed control technologies best fit their circumstances.

5. Potential Impacts of Diesel Particulate Emissions from the SSX Project

At the present time, sufficient data are not available to accurately achieve a quantitative assessment of diesel particulate emissions from various project alternatives. However, a general qualitative assessment can be made by assuming that the emissions of diesel particulate in the vicinity of South Station will follow the emissions trends of $PM_{2.5}$ emissions from diesel fueled sources. The diesel fueled sources include locomotives and intercity buses (which are all assumed to be diesel fueled).

Using $PM_{2.5}$ emissions from diesel fueled sources as a surrogate, diesel particulate emissions are expected to increase with the growth in diesel powered vehicles. For the same calendar year, Alternative 1 would produce more diesel particulate emissions than the No Build Alternative, and Alternative 3 would produce more Diesel Particulate emissions than either Alternative 1 or the No Build Alternatives.

Attachment P Discussion of Ultrafine Particulates

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Ultrafine Particles

MEPA requested that ultrafine particulates be analyzed in the DEIR. Ultrafine particulates (UFPs) refer to particulate matter that is generally less than 100 nanometers in size. Compared with $PM_{2.5}$, the ultrafine particles would be 0.1 microns and smaller or roughly 25 times smaller than the regulated $PM_{2.5}$.

1. Sources of Ultrafine Particles

Ultrafine particles can come from natural sources, or be artificially created by humans. The natural sources include volcanic eruptions, sprays from ocean waves, and smoke from wildfires. Man-made sources include combustion of all petroleum products, which include all non-electrical transportation sources, home heating, and power generation. Man-made sources also include cooking, tobacco smoke, and the use of office machines such as laser printers and copiers. With rapidly growing applications of nano structures in both the medical and technology fields, emissions of ultrafine particulates are expected to increase.

2. Health Effects of Ultrafine Particles

Compared with bigger particles of the same mass concentration, ultrafine particles will have much higher numbers and surface areas to carry other toxic agents and penetrate deeper into the lungs. Once inside the lungs, the ultrafine particles could penetrate the tissues, and be absorbed into the blood stream. The medical and pharmaceutical professions recognize this and use this process as another mechanism to deliver drugs to their patients. In theory, therefore, ultrafines have the capacity to cause respiratory and cardiovascular effects.

Although there have been many studies focusing on the ultrafine particles and their health effects, there is still insufficient evidence to isolate the effects of ultrafine particles from the other co-pollutants that are either adsorbed on the ultrafine particle surfaces or inhaled into the lungs at the same time. Also, there is no current agreement on the metric to measure ultrafine particles for the purpose of assessing health effects. There is postulation that a number count may be a better measure than a mass count. But there is no generally agreed upon protocol on how to measure the count of ultrafine particles.

3. Existing Regulations of Ultrafine Particles

At present, there is no progress at the federal or state levels to regulate air quality standards for ultrafine particles. As the nanotechnology sector grows, the need to regulate exposure to ultrafine particles in the work place will also increase. But the research that must precede the proposed regulation for outdoor exposure has not been completed.

4. Ultrafine Particle Emission Factors for Transportation Sources

The state of understanding of the formation and fate of ultrafine particles in the atmosphere is still too elementary to develop quantitative emission factors for various types of transportation sources. Because ultrafine particles do not have a lot of mass, it is generally agreed that the better metric might be a count of the number of particles in a unit volume. Ultrafine particles are formed during combustion inside the engine. But even outside of the exhaust pipe, ultrafine particles are lost through coalescence, while new particles are formed by nucleation of the exhaust products. A generally agreed upon measuring protocol needs to be in place before a data base of emission factors of ultrafine particles for transportation sources can be developed.

5. Potential Impacts of Ultrafine Particles from the South Station Expansion Project

At the present time, sufficient data are not available to achieve a quantitative assessment of various project alternatives on ultrafine particles in the atmosphere. However, a general qualitative assessment can be made as follows. UFP emissions in the vicinity of South Station are similar to UFP emissions from highways because they both include diesel and gasoline burning transportation sources.

The half-life of primary UFPs is short, and a sharp drop-off UFPs near a highway has been shown to occur from 2.5 to 4 times the width of the highway. Translating these results loosely, a similar drop of UFPs could be expected between 1,100 and 1,800 feet (or about 0.34 miles) from the center track of South Station.

Using fuel consumption as a surrogate, UFPs are expected to increase with time, with any alternative. For the same calendar year, Alternative 1 would produce more UFPs than the No Build Alternative, and Alternative 3 would produce more UFPs than either Alternative 1 or the No Build Alternatives.

Control technologies to reduce UFPs without increasing $PM_{2.5}$ or other size fractions of particulate matter are still in developmental stages. A combination of particulate filtration and specially formulated oxidation catalyst technology appear to show promise in reducing the number count of UFPs and limiting the mass emissions of some particulate matter at the same time.

Attachment Q Discussion of Control Technologies for Locomotive Emissions

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Control Technologies for Locomotive Emissions

MEPA requested that new locomotive technologies be discussed in the DEIR. Control technologies for locomotive emissions are presented below with respect to compliance with federal standards, alternative power sources, retrofit devices, alternative fuels, and operational strategies.

1. Compliance with Locomotive Emission Standards

U.S. EPA's Locomotives Exhaust Emission Standards which are codified at 40 CFR Part 1033.101, include several sets of emission standards based on the date a locomotive is first manufactured or remanufactured. These standards for locomotives set upper limits for pollutant emissions per unit fuel burned or per unit of work expended. These limits are organized into tiers (Tier 0 through Tier 4), based on the years of implementation. For example, Tier 0 standards apply to locomotive engines manufactured or remanufactured between 1973 and 1992; Tier 1 standards are for engines manufactured or remanufactured between 1993 and 2004; and Tier 4 standards are for engines manufactured or remanufactured in 2015 or later.

The air quality analysis for the South Station Expansion project assumed that, for the 2012 Existing Conditions, the typical MBTA locomotive (represented by the F40PH-2C locomotive) would be in compliance with the Tier 1 standards because it would have been manufactured or remanufacture between 1993 and 2004. The analysis also assumed that the typical Amtrak locomotive would be in compliance with the Tier 0 standards because it would have been manufactured or remanufactured prior to 1992. For the No Build and all Build Conditions in both 2025 and 2035, it was assumed that all locomotives would be in compliance with the Tier 4 standards. Between Tier 1 and Tier 4, there is a very large reduction in emission limits: 82% for NOx, 86% for PM, and 75% for HC.

2. Alternative Power Sources

Emissions from locomotives using South Station could be eliminated if all of the trains were electrified. Full electrification would mean new equipment and new infrastructure.

A Diesel Multiple Unit or DMU is a diesel-powered, self-propelled passenger railcar that can respond to local or remote throttle and brake commands. MassDOT and the MBTA are contemplating the use of Diesel Multiple Units (DMUs) on the MBTA's commuter rail system. Initial plans are under development for acquisition of a DMU fleet and implementation of service on the Fairmount Line. Therefore, there would potentially be no decrease in emissions. Further study of DMU impacts on emissions has not been evaluated as part of this project.

The use of battery storage technology to power the trains has not been fully developed for such heavy-duty applications. The needs and costs of the associated infrastructures to support such technologies are also not developed at the present time.

3. Retrofit Devices

All new or re-manufactured engines will have to comply with emission limits described previously. Retrofit devices are products that may be added to locomotive engines to further reduce emissions from engines that have already been certified to meet the mandated limits. Table E.1 shows typical emission reductions for PM, NOx, and HC for various types of retrofit devices.

Oxidation catalysts work better with fuel with low sulfur content. They are intended to lower both PM and HC emissions. However, their effectiveness on ultrafines is still not well defined.

Diesel particulates filter (DPF) can reduce baseline PM emissions by as much as 95%. But size fraction data are currently unavailable. DPFs can have passive or active regeneration systems to oxidize the PM that may have accumulated in the filter.

Table 1 - Typical Emissions Reductions (in Percent)[a] for PM, NOx, and HC for Various Types of Retrofit Devices

Retrofit Device	PM	NOx	HC
Diesel Oxidation Catalyst	20 - 40	ND[b]	40 - 70
Diesel Particulate Filter	85 - 95	ND	85 - 95
Selective Catalytic Reduction	ND	≤75	ND
Exhaust Gas Recirculation	ND	25 - 40	ND
Lean NOx Catalyst	ND	5 - 40	ND

a Reduction is expressed in percent (versus the un-retrofitted baseline).
b ND means no data or not applicable.

Selective catalytic reduction (SCR) systems use a reducing agent (often referred to as a diesel exhaust fluid or DEF) to convert NOx in the exhaust to N_2 (nitrogen gas). Reduction of NOx with this system can be as high as 75%.

Exhaust gas recirculation (EGR) redirects some of the exhaust gas back into the engine to cool the peak combustion temperature, thereby reducing the production of NOx. With proper engine integration, EGR systems could potentially reduce NOx between 25 and 40%.

Lean NOx Catalyst (LNC) injects diesel fuel into the exhaust stream to achieve a catalytic reaction and reduce NOx formation. LNC is not as popular as EGR because it is not as effective and there is an increased fuel penalty as well.

4. Alternative Fuels

A number of other fossil fuels could be substituted for diesel fuel to achieve a cleaner exhaust from the locomotive.

Use of ultra-low sulfur diesel (ULSD) can generally lead to lower PM emissions. The amount of emission reduction will vary with sulfur content and other fuel properties such as the number and concentration of specific aromatics. ULSD is required for all locomotives in use as of 2012.

Biodiesel fuel is manufactured from new or used vegetable oil and animal fats can be used instead of diesel fuel. Typically, blends of 20% biodiesel and 80% petroleum diesel can be used without engine modification. This so called B20 fuel could reduce PM and HC emissions, but could actually lead to increased NOx emissions.

Natural gas, in its compressed form (CNG) or liquefied form (LNG), can also be used as an alternative fuel for diesel locomotives. Emissions from natural gas combustion should generally be cleaner than baseline diesel engines before being retrofitted with exhaust cleaning devices. However, fueling infrastructure is currently not as well developed as for diesel.

5. Operational Strategies

Operational strategies refer to ways of reducing fuel consumption and associated emissions by reducing engine idling times or engine running times to accomplish the same function.

There are currently limits in place to limit train idling at the platforms at South Station and these will be continued in the expanded South Station. Bus idling at South Station is already limited by regulations to no more than 5 minutes at a time.

Shore power exists today at South Station and is proposed at the expanded South Station and at the layover facilities, as part of the SSX project.

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Attachment R PM2.5 Hot Spot Analysis

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1. Introduction

A quantitative $PM_{2.5}$ Hot Spot Analysis is only required for those projects which are located in a $PM_{2.5}$ Nonattainment area. This area of Boston, and the entire state of Massachusetts, is in attainment of the $PM_{2.5}$ standards; and therefore a $PM_{2.5}$ Hot Spot analysis is not required for this Project. However, this analysis was prepared as requested by the Secretary's Certificate. This analysis was conducted to provide disclosure of potential harmful health effects of "diesel particulate" (a known carcinogen) emitted by the increase in rail operations due to the increase in the number of railroad tracks at South Station. Even though this analysis is not required by any regulations, this quantitative $PM_{2.5}$ Hot Spot analysis was conducted following U.S. EPA's November 2013 guidance[1]. The $PM_{2.5}$ Hot Spot analysis was prepared in accordance with the methodology as described in the SSX Air Quality Analysis Protocol approved by Massachusetts Department of Environmental Protection (MassDEP) on June 4, 2014.

The analysis focused only on the emissions from the diesel trains operating at South Station, the motor vehicles on roadways in the vicinity of South Station, and intercity buses operating at the South Station Bus Terminal. The U.S. EPA's Locomotives Exhaust Emission Standards were used to determine the emission rates for the MBTA and Amtrak locomotives in 2012, 2025, and 2035. The U.S. EPA's MOVES emission factors program was used to determine emission rates from motor vehicles and intercity buses for the same calendar years. Background $PM_{2.5}$ concentration levels (approved by MassDEP) were used to estimate 24-hour and annual $PM_{2.5}$ impacts and were assumed to remain constant for all years analyzed. Individual modeling analyses were prepared for the 2012 Existing Conditions, 2025 No Build Alternative, 2025 Alternative 1, 2025 Alternative 3, 2035 No Build Alternative, 2035 Alternative 1, and the 2035 Alternative 3. The results of the analyses were compared to the National and Massachusetts 24-hour and annual $PM_{2.5}$ standards.

2. $PM_{2.5}$ Modeling Results for the 2012 Existing Conditions

The eighth highest modeled 24-hour $PM_{2.5}$ concentrations at each of the receptors analyzed for the 2012 Existing Conditions are presented in Table 1. The maximum modeled $PM_{2.5}$ 24-hour concentration was estimated to be 25.7 $\mu g/m^3$ and included a background concentration of 21.7 $\mu g/m^3$. This maximum 24-hour $PM_{2.5}$ concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled 24-hour $PM_{2.5}$ concentrations at all of the receptors modeled for the 2012 Existing Conditions were well below the 24-hour $PM_{2.5}$ National and Massachusetts standard of 35 $\mu g/m^3$.

The maximum modeled Annual $PM_{2.5}$ concentrations at each of the receptors analyzed for the 2012 Existing Conditions are also presented in Table 1. The maximum modeled $PM_{2.5}$ Annual concentration was estimated to be 10.2 $\mu g/m^3$ and included a background concentration of 9.2 $\mu g/m^3$. This maximum annual concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled Annual $PM_{2.5}$ concentrations at all of the receptors modeled for the 2012 Existing Conditions were well below the Annual $PM_{2.5}$ National and Massachusetts standard of 12 $\mu g/m^3$.

Table 1 - Maximum Modeled 24-Hour and Annual $PM_{2.5}$ Concentrations for the 2012 Existing Conditions

Receptor ID No.	Receptor Description	24-Hour $PM_{2.5}$ Concentration[a] ($\mu g/m^3$)	Annual $PM_{2.5}$ Concentration[b] ($\mu g/m^3$)

[1] *Transportation Conformity Guidance for Quantitative Hot-Spot Analyses in PM2.5 and PM10 Nonattainment and Maintenance Areas*, Transportation and Climate Division, Office of Transportation and Air Quality, U.S. Environmental Protection Agency. EPA-420-B-13-053. November 2013.

Receptor ID No.	Receptor Description	24-Hour $PM_{2.5}$ Concentration[a] ($\mu g/m^3$)	Annual $PM_{2.5}$ Concentration[b] ($\mu g/m^3$)
R1	800 Atlantic Avenue	25.7	10.2
R2	800 Atlantic Avenue-ROOF	21.8	9.2
R3	183 Beach Street	23.6	9.9
R4	183 Beach Street-ROOF	21.8	9.2
R5	711 Atlantic Ave	23.0	9.7
R6	711 Atlantic Ave-ROOF	22.0	9.3
R7	200 Essex Street	22.9	9.7
R8	200 Essex Street-ROOF	21.8	9.2
R9	1 Financial Center, Boston	22.7	9.7
R10	1 Financial Center, Boston-ROOF	21.7	9.2
R11	Dewey Square Plaza Farmer's Market	22.6	9.6
R12	201 South Street, Boston	23.8	9.8
R13	143 South Street, Boston	22.8	9.6
R14	89 South Street, Boston	22.4	9.5
R15	Leather District Park, Essex Street, Boston.	22.4	9.6
R16	Boston Fiduciary Trust Bldg. at 175 Federal St, Boston	22.4	9.5
R17	Rose Fitzgerald Kennedy Greenway Conservancy Bldg. at 185 Kneeland Street	25.0	10.1
R18	Reggie Wong Memorial Park, Kneeland Street, Boston	23.1	9.8
R19	150 Lincoln Street (office Bldg.)	23.0	9.9
R20	1 Lincoln Street (office Bldg.)	22.6	9.6
R21	100 Summer St, Boston,	22.1	9.3
R22	Dewey Square Park	22.5	9.6
R23	Park at Congress Street and Atlantic Avenue	22.5	9.6
R24	Fort Point Channel Parks	22.4	9.5
R25	Federal Reserve Bldg. at 600 Atlantic Avenue	22.5	9.6
R26	Federal Reserve Bldg.-ROOF	21.7	9.2
R27	Federal Reserve Bldg. (sitting area)	22.4	9.5
R28	280 Congress Street	22.4	9.6
R29	Park near Harbor Walk near Pearl Street Extension	22.2	9.4
R30	Restaurant at Pearl Street Extension	22.2	9.4
R31	Moakley Federal Courthouse, 1 Courthouse Way	21.9	9.3
R32	Fan Pier Public Green	21.8	9.2
R33	Business at 25 Thomson Place, Boston	22.0	9.3
R34	Restaurant at 63 Melcher Street	22.1	9.4
R35	Wormwood Park, A Street, Boston	22.3	9.5
R36	Binford Street Park	22.4	9.4
R37	Gillette Park, Boston	22.1	9.3
R38	Restaurant at 98 A Street, Boston	22.2	9.4
R39	Diner at 75 W Broadway, Boston	22.1	9.4
R40	Flaherty Park, W. 3rd Street	22.0	9.3
R41	Tai Tung Park, Tyler Street	22.5	9.4
R42	Eliot Norton Park, Tremont Street	21.9	9.2
R43	Millicent Way Park	21.9	9.2
R44	Peters Park	21.9	9.2
R45	Dorchester Ave, 150 feet south of Summer Street	22.5	9.5

Receptor ID No.	Receptor Description	24-Hour $PM_{2.5}$ Concentration[a] ($\mu g/m^3$)	Annual $PM_{2.5}$ Concentration[b] ($\mu g/m^3$)
R46	Dorchester Ave, 800 feet south of Summer Street	23.0	9.6
R47	Dorchester Ave, 1500 feet south of Summer Street	23.1	9.6
R48	Dorchester Ave, 2100 feet south of Summer Street	22.6	9.4
R49	Fidelity Building at 245 Summer Street	22.5	9.6
R50	Fidelity Building at 245 Summer Street-ROOF	21.8	9.2

[a] - Concentrations include a 24-hour $PM_{2.5}$ background concentration of 21.7 $\mu g/m^3$.

[b] - Concentrations include an Annual $PM_{2.5}$ background concentration of 9.2 $\mu g/m^3$.

The National Ambient Air Quality Standards for $PM_{2.5}$ are: 24-hour = 35 $\mu g/m^3$ and Annual = 12 $\mu g/m^3$.

3. $PM_{2.5}$ Modeling Results for the 2025 No Build Alternative

The eighth highest modeled 24-hour $PM_{2.5}$ concentrations at each of the receptors analyzed for the 2025 No Build Alternative are presented in Table 2. The maximum modeled $PM_{2.5}$ 24-hour concentration was estimated to be 22.6 $\mu g/m^3$ and included a background concentration of 21.7 $\mu g/m^3$. This maximum 24-hour $PM_{2.5}$ concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled 24-hour $PM_{2.5}$ concentrations at all of the receptors modeled for the 2025 No Build Alternative were well below the 24-hour $PM_{2.5}$ National and Massachusetts standard of 35 $\mu g/m^3$.

The maximum modeled Annual $PM_{2.5}$ concentrations at each of the receptors analyzed for the 2025 No Build Alternative are also presented in Table 2. The maximum modeled $PM_{2.5}$ Annual concentration was estimated to be 9.5 $\mu g/m^3$ and included a background concentration of 9.2 $\mu g/m^3$. This maximum annual concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled Annual $PM_{2.5}$ concentrations at all of the receptors modeled for the 2025 No Build Alternative were well below the Annual $PM_{2.5}$ National and Massachusetts standard of 12 $\mu g/m^3$.

Table 2 - Maximum Modeled 24-Hour and Annual $PM_{2.5}$ Concentrations for the 2025 No Build Alternative

Receptor ID No.	Receptor Description	24-Hour $PM_{2.5}$ Concentration[a] ($\mu g/m^3$)	Annual $PM_{2.5}$ Concentration[b] ($\mu g/m^3$)
R1	800 Atlantic Avenue	22.6	9.5
R2	800 Atlantic Avenue-ROOF	21.7	9.2
R3	183 Beach Street	22.2	9.4
R4	183 Beach Street-ROOF	21.7	9.2
R5	711 Atlantic Ave	22.1	9.4
R6	711 Atlantic Ave-ROOF	21.8	9.2
R7	200 Essex Street	22.1	9.4
R8	200 Essex Street-ROOF	21.7	9.2
R9	1 Financial Center, Boston	22.1	9.4
R10	1 Financial Center, Boston-ROOF	21.7	9.2
R11	Dewey Square Plaza Farmer's Market	22.1	9.4
R12	201 South Street, Boston	22.2	9.4
R13	143 South Street, Boston	22.0	9.3
R14	89 South Street, Boston	21.9	9.3
R15	Leather District Park, Essex Street, Boston.	22.0	9.4
R16	Boston Fiduciary Trust Bldg. at 175 Federal St, Boston	22.0	9.3
R17	Rose Fitzgerald Kennedy Greenway Conservancy Bldg. at 185 Kneeland Street	22.4	9.4

Receptor ID No.	Receptor Description	24-Hour $PM_{2.5}$ Concentration[a] ($\mu g/m^3$)	Annual $PM_{2.5}$ Concentration[b] ($\mu g/m^3$)
R18	Reggie Wong Memorial Park, Kneeland Street, Boston	22.1	9.4
R19	150 Lincoln Street (office Bldg.)	22.0	9.4
R20	1 Lincoln Street (office Bldg.)	22.1	9.4
R21	100 Summer St, Boston,	21.9	9.3
R22	Dewey Square Park	22.1	9.4
R23	Park at Congress Street and Atlantic Avenue	22.1	9.4
R24	Fort Point Channel Parks	22.1	9.4
R25	Federal Reserve Bldg. at 600 Atlantic Avenue	22.0	9.4
R26	Federal Reserve Bldg.-ROOF	21.7	9.2
R27	Federal Reserve Bldg. (sitting area)	22.0	9.3
R28	280 Congress Street	22.1	9.4
R29	Park near Harbor Walk near Pearl Street Extension	21.9	9.3
R30	Restaurant at Pearl Street Extension	21.9	9.3
R31	Moakley Federal Courthouse, 1 Courthouse Way	21.8	9.2
R32	Fan Pier Public Green	21.8	9.2
R33	Business at 25 Thomson Place, Boston	21.8	9.2
R34	Restaurant at 63 Melcher Street	21.9	9.3
R35	Wormwood Park, A Street, Boston	22.0	9.4
R36	Binford Street Park	21.9	9.3
R37	Gillette Park, Boston	21.8	9.2
R38	Restaurant at 98 A Street, Boston	22.0	9.3
R39	Diner at 75 W Broadway, Boston	22.0	9.3
R40	Flaherty Park, W. 3rd Street	21.8	9.2
R41	Tai Tung Park, Tyler Street	22.0	9.3
R42	Eliot Norton Park, Tremont Street	21.8	9.2
R43	Millicent Way Park	21.8	9.2
R44	Peters Park	21.8	9.2
R45	Dorchester Ave, 150 feet south of Summer Street	21.9	9.3
R46	Dorchester Ave, 800 feet south of Summer Street	22.0	9.3
R47	Dorchester Ave, 1500 feet south of Summer Street	22.0	9.3
R48	Dorchester Ave, 2100 feet south of Summer Street	21.9	9.3
R49	Fidelity Building at 245 Summer Street	22.0	9.3
R50	Fidelity Building at 245 Summer Street-ROOF	21.7	9.2

[a] - Concentrations include a 24-hour $PM_{2.5}$ background concentration of 21.7 $\mu g/m^3$.
[b] - Concentrations include an Annual $PM_{2.5}$ background concentration of 9.2 $\mu g/m^3$.
The National Ambient Air Quality Standards for $PM_{2.5}$ are: 24-hour = 35 $\mu g/m^3$ and Annual = 12 $\mu g/m^3$.

4. $PM_{2.5}$ Modeling Results for Alternative 1 in 2025

The eighth highest modeled 24-hour $PM_{2.5}$ concentrations at each of the receptors analyzed for Alternative 1 in 2025 are presented in Table 3. The maximum modeled $PM_{2.5}$ 24-hour concentration was estimated to be 22.7 $\mu g/m^3$ and included a background concentration of 21.7 $\mu g/m^3$. This maximum 24-hour $PM_{2.5}$ concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled 24-hour $PM_{2.5}$ concentrations at all of the receptors modeled for Alternative 1 in 2025 were well below the 24-hour $PM_{2.5}$ National and Massachusetts standard of 35 $\mu g/m^3$. The 24-hour $PM_{2.5}$ concentrations due to the 2025 Alternative 1 are slightly higher than the 2025 No Build Alternative concentrations. This is due to the very slight increase in traffic volumes and rail operations occurring in the 2025 Alternative 1 compared to the 2025 No Build Alternative.

The maximum modeled Annual $PM_{2.5}$ concentrations at each of the receptors analyzed for Alternative 1 in 2025 are also presented in Table 3. The maximum modeled $PM_{2.5}$ Annual concentration was estimated to be 9.5 $\mu g/m^3$ and included a background concentration of 9.2 $\mu g/m^3$. This maximum annual concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled Annual $PM_{2.5}$ concentrations at all of the receptors modeled for Alternative 1 in 2025 were well below the Annual $PM_{2.5}$ National and Massachusetts standard of 12 $\mu g/m^3$. The annual $PM_{2.5}$ concentrations due to the 2025 Alternative 1 are nearly identical to the 2025 No Build Alternative concentrations. This is due to the very slight increase in traffic volumes and rail operations occurring in the 2025 Alternative 1 having almost no impact on local $PM_{2.5}$ concentrations compared to the 2025 No Build Alternative.

Table 3 - Maximum Modeled 24-Hour and Annual $PM_{2.5}$ Concentrations for Alternative 1 in 2025

Receptor ID No.	Receptor Description	24-Hour $PM_{2.5}$ Concentration[a] ($\mu g/m^3$)	Annual $PM_{2.5}$ Concentration[b] ($\mu g/m^3$)
R1	800 Atlantic Avenue	22.7	9.5
R2	800 Atlantic Avenue-ROOF	21.7	9.2
R3	183 Beach Street	22.2	9.4
R4	183 Beach Street-ROOF	21.7	9.2
R5	711 Atlantic Ave	22.1	9.3
R6	711 Atlantic Ave-ROOF	21.8	9.2
R7	200 Essex Street	22.1	9.4
R8	200 Essex Street-ROOF	21.7	9.2
R9	1 Financial Center, Boston	22.1	9.4
R10	1 Financial Center, Boston-ROOF	21.7	9.2
R11	Dewey Square Plaza Farmer's Market	22.1	9.4
R12	201 South Street, Boston	22.2	9.4
R13	143 South Street, Boston	22.0	9.3
R14	89 South Street, Boston	21.9	9.3
R15	Leather District Park, Essex Street, Boston.	22.0	9.4
R16	Boston Fiduciary Trust Bldg. at 175 Federal St, Boston	22.0	9.3
R17	Rose Fitzgerald Kennedy Greenway Conservancy Bldg. at 185 Kneeland Street	22.5	9.4
R18	Reggie Wong Memorial Park, Kneeland Street, Boston	22.1	9.4
R19	150 Lincoln Street (office Bldg.)	22.1	9.4
R20	1 Lincoln Street (office Bldg.)	22.1	9.4
R21	100 Summer St, Boston,	21.9	9.3
R22	Dewey Square Park	22.1	9.4
R23	Park at Congress Street and Atlantic Avenue	22.1	9.4
R24	Fort Point Channel Parks	22.1	9.4
R25	Federal Reserve Bldg. at 600 Atlantic Avenue	22.0	9.4
R26	Federal Reserve Bldg.-ROOF	21.7	9.2
R27	Federal Reserve Bldg. (sitting area)	22.0	9.3
R28	280 Congress Street	22.1	9.4
R29	Park near Harbor Walk near Pearl Street Extension	21.9	9.3
R30	Restaurant at Pearl Street Extension	21.9	9.3
R31	Moakley Federal Courthouse, 1 Courthouse Way	21.8	9.2
R32	Fan Pier Public Green	21.8	9.2

Receptor ID No.	Receptor Description	24-Hour $PM_{2.5}$ Concentration[a] ($\mu g/m^3$)	Annual $PM_{2.5}$ Concentration[b] ($\mu g/m^3$)
R33	Business at 25 Thomson Place, Boston	21.8	9.2
R34	Restaurant at 63 Melcher Street	21.9	9.3
R35	Wormwood Park, A Street, Boston	22.0	9.3
R36	Binford Street Park	21.9	9.3
R37	Gillette Park, Boston	21.8	9.3
R38	Restaurant at 98 A Street, Boston	22.0	9.3
R39	Diner at 75 W Broadway, Boston	21.9	9.3
R40	Flaherty Park, W. 3rd Street	21.8	9.2
R41	Tai Tung Park, Tyler Street	22.0	9.3
R42	Eliot Norton Park, Tremont Street	21.8	9.2
R43	Millicent Way Park	21.8	9.2
R44	Peters Park	21.8	9.2
R45	Dorchester Ave, 150 feet south of Summer Street	22.0	9.4
R46	Dorchester Ave, 800 feet south of Summer Street	22.1	9.4
R47	Dorchester Ave, 1500 feet south of Summer Street	22.1	9.4
R48	Dorchester Ave, 2100 feet south of Summer Street	22.0	9.3
R49	Fidelity Building at 245 Summer Street	22.0	9.3
R50	Fidelity Building at 245 Summer Street-ROOF	21.7	9.2

[a]- Concentrations include a 24-hour $PM_{2.5}$ background concentration of 21.7 $\mu g/m^3$.
[b] - Concentrations include an Annual $PM_{2.5}$ background concentration of 9.2 $\mu g/m^3$.
The National Ambient Air Quality Standards for $PM_{2.5}$ are: 24-hour = 35 $\mu g/m^3$ and Annual = 12 $\mu g/m^3$.

5. $PM_{2.5}$ Modeling Results for Alternative 3 in 2025

The eighth highest modeled 24-hour $PM_{2.5}$ concentrations at each of the receptors analyzed for Alternative 3 in 2025 are presented in Table 4. The maximum modeled $PM_{2.5}$ 24-hour concentration was estimated to be 22.7 $\mu g/m^3$ and included a background concentration of 21.7 $\mu g/m^3$. This maximum 24-hour $PM_{2.5}$ concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled 24-hour $PM_{2.5}$ concentrations at all of the receptors modeled for Alternative 3 in 2025 were well below the 24-hour $PM_{2.5}$ National and Massachusetts standard of 35 $\mu g/m^3$. The 24-hour $PM_{2.5}$ concentrations due to the 2025 Alternative 3 are slightly higher than the 2025 No Build Alternative concentrations and nearly identical to the 2025 Alternative 1 concentrations. This is due to the very slight increase in traffic volumes and rail operations occurring in the 2025 Alternative 3 compared to the 2025 No Build Alternative and the 2025 Alternative 1.

The maximum modeled Annual $PM_{2.5}$ concentrations at each of the receptors analyzed for Alternative 3 in 2025 are also presented in Table 4. The maximum modeled $PM_{2.5}$ Annual concentration was estimated to be 9.5 $\mu g/m^3$ and included a background concentration of 9.2 $\mu g/m^3$. This maximum annual concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled Annual $PM_{2.5}$ concentrations at all of the receptors modeled for Alternative 3 in 2025 were well below the Annual $PM_{2.5}$ National and Massachusetts standard of 12 $\mu g/m^3$. The annual $PM_{2.5}$ concentrations due to the 2025 Alternative 3 are nearly identical to the 2025 No Build Alternative and to the 2025 Alternative 1 concentrations. This is due to the very slight increase in traffic volumes and rail operations occurring in the 2025 Alternative 3 having almost no impact on local $PM_{2.5}$ concentrations compared to the 2025 No Build Alternative or the 2025 Alternative 1.

Table 4 - Maximum Modeled 24-Hour and Annual $PM_{2.5}$ Concentrations for Alternative 3 in 2025

Receptor ID No.	Receptor Description	24-Hour $PM_{2.5}$ Concentration[a] ($\mu g/m^3$)	Annual $PM_{2.5}$ Concentration[b] ($\mu g/m^3$)
R1	800 Atlantic Avenue	22.7	9.5
R2	800 Atlantic Avenue-ROOF	21.7	9.2
R3	183 Beach Street	22.2	9.4
R4	183 Beach Street-ROOF	21.7	9.2
R5	711 Atlantic Ave	22.1	9.4
R6	711 Atlantic Ave-ROOF	21.8	9.2
R7	200 Essex Street	22.1	9.4
R8	200 Essex Street-ROOF	21.7	9.2
R9	1 Financial Center, Boston	22.1	9.4
R10	1 Financial Center, Boston-ROOF	21.7	9.2
R11	Dewey Square Plaza Farmer's Market	22.1	9.4
R12	201 South Street, Boston	22.3	9.4
R13	143 South Street, Boston	22.0	9.3
R14	89 South Street, Boston	21.9	9.3
R15	Leather District Park, Essex Street, Boston.	22.0	9.4
R16	Boston Fiduciary Trust Bldg. at 175 Federal St, Boston	22.0	9.3
R17	Rose Fitzgerald Kennedy Greenway Conservancy Bldg. at 185 Kneeland Street	22.6	9.5
R18	Reggie Wong Memorial Park, Kneeland Street, Boston	22.1	9.4
R19	150 Lincoln Street (office Bldg.)	22.1	9.4
R20	1 Lincoln Street (office Bldg.)	22.1	9.4
R21	100 Summer St, Boston,	21.9	9.3
R22	Dewey Square Park	22.1	9.4
R23	Park at Congress Street and Atlantic Avenue	22.1	9.4
R24	Fort Point Channel Parks	22.1	9.4
R25	Federal Reserve Bldg. at 600 Atlantic Avenue	22.0	9.4
R26	Federal Reserve Bldg.-ROOF	21.7	9.2
R27	Federal Reserve Bldg. (sitting area)	22.0	9.3
R28	280 Congress Street	22.1	9.4
R29	Park near Harbor Walk near Pearl Street Extension	21.9	9.3
R30	Restaurant at Pearl Street Extension	21.9	9.3
R31	Moakley Federal Courthouse, 1 Courthouse Way	21.8	9.2
R32	Fan Pier Public Green	21.8	9.2
R33	Business at 25 Thomson Place, Boston	21.8	9.2
R34	Restaurant at 63 Melcher Street	21.9	9.3
R35	Wormwood Park, A Street, Boston	22.0	9.3
R36	Binford Street Park	21.9	9.3
R37	Gillette Park, Boston	21.9	9.3
R38	Restaurant at 98 A Street, Boston	22.0	9.3
R39	Diner at 75 W Broadway, Boston	21.9	9.3
R40	Flaherty Park, W. 3rd Street	21.8	9.2
R41	Tai Tung Park, Tyler Street	22.0	9.3
R42	Eliot Norton Park, Tremont Street	21.8	9.2
R43	Millicent Way Park	21.8	9.2
R44	Peters Park	21.8	9.2
R45	Dorchester Ave, 150 feet south of Summer Street	22.0	9.4

Receptor ID No.	Receptor Description	24-Hour $PM_{2.5}$ Concentration[a] ($\mu g/m^3$)	Annual $PM_{2.5}$ Concentration[b] ($\mu g/m^3$)
R46	Dorchester Ave, 800 feet south of Summer Street	22.1	9.4
R47	Dorchester Ave, 1500 feet south of Summer Street	22.2	9.4
R48	Dorchester Ave, 2100 feet south of Summer Street	22.0	9.3
R49	Fidelity Building at 245 Summer Street	22.0	9.4
R50	Fidelity Building at 245 Summer Street-ROOF	21.7	9.2

[a] - Concentrations include a 24-hour $PM_{2.5}$ background concentration of 21.7 $\mu g/m^3$.
[b] - Concentrations include an Annual $PM_{2.5}$ background concentration of 9.2 $\mu g/m^3$.
The National Ambient Air Quality Standards for $PM_{2.5}$ are: 24-hour = 35 $\mu g/m^3$ and Annual = 12 $\mu g/m^3$.

6. $PM_{2.5}$ Modeling Results for the 2035 No Build Alternative

The eighth highest modeled 24-hour $PM_{2.5}$ concentrations at each of the receptors analyzed for the 2035 No Build Alternative are presented in Table 5. The maximum modeled $PM_{2.5}$ 24-hour concentration was estimated to be 22.6 $\mu g/m^3$ and included a background concentration of 21.7 $\mu g/m^3$. This maximum 24-hour $PM_{2.5}$ concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled 24-hour $PM_{2.5}$ concentrations at all of the receptors modeled for the 2035 No Build Alternative were well below the 24-hour $PM_{2.5}$ National and Massachusetts standard of 35 $\mu g/m^3$.

The maximum modeled Annual $PM_{2.5}$ concentrations at each of the receptors analyzed for the 2035 No Build Alternative are also presented in Table 5. The maximum modeled $PM_{2.5}$ Annual concentration was estimated to be 9.5 $\mu g/m^3$ and included a background concentration of 9.2 $\mu g/m^3$. This maximum annual concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled Annual $PM_{2.5}$ concentrations at all of the receptors modeled for the 2035 No Build Alternative were well below the Annual $PM_{2.5}$ National and Massachusetts standard of 12 $\mu g/m^3$.

Table 5 - Maximum Modeled 24-Hour and Annual $PM_{2.5}$ Concentrations for the 2035 No Build Alternative

Receptor ID No.	Receptor Description	24-Hour $PM_{2.5}$ Concentration[a] ($\mu g/m^3$)	Annual $PM_{2.5}$ Concentration[b] ($\mu g/m^3$)
R1	800 Atlantic Avenue	22.6	9.5
R2	800 Atlantic Avenue-ROOF	21.7	9.2
R3	183 Beach Street	22.2	9.4
R4	183 Beach Street-ROOF	21.7	9.2
R5	711 Atlantic Ave	22.1	9.4
R6	711 Atlantic Ave-ROOF	21.8	9.2
R7	200 Essex Street	22.2	9.4
R8	200 Essex Street-ROOF	21.7	9.2
R9	1 Financial Center, Boston	22.2	9.4
R10	1 Financial Center, Boston-ROOF	21.7	9.2
R11	Dewey Square Plaza Farmer's Market	22.1	9.4
R12	201 South Street, Boston	22.2	9.4
R13	143 South Street, Boston	22.0	9.3
R14	89 South Street, Boston	21.9	9.3
R15	Leather District Park, Essex Street, Boston.	22.0	9.4
R16	Boston Fiduciary Trust Bldg. at 175 Federal St, Boston	22.1	9.3
R17	Rose Fitzgerald Kennedy Greenway Conservancy Bldg. at 185 Kneeland Street	22.4	9.4

Receptor ID No.	Receptor Description	24-Hour $PM_{2.5}$ Concentration[a] ($\mu g/m^3$)	Annual $PM_{2.5}$ Concentration[b] ($\mu g/m^3$)
R18	Reggie Wong Memorial Park, Kneeland Street, Boston	22.1	9.4
R19	150 Lincoln Street (office Bldg.)	22.1	9.4
R20	1 Lincoln Street (office Bldg.)	22.1	9.4
R21	100 Summer St, Boston,	21.9	9.3
R22	Dewey Square Park	22.1	9.4
R23	Park at Congress Street and Atlantic Avenue	22.1	9.4
R24	Fort Point Channel Parks	22.1	9.4
R25	Federal Reserve Bldg. at 600 Atlantic Avenue	22.0	9.4
R26	Federal Reserve Bldg.-ROOF	21.7	9.2
R27	Federal Reserve Bldg. (sitting area)	22.0	9.3
R28	280 Congress Street	22.1	9.4
R29	Park near Harbor Walk near Pearl Street Extension	21.9	9.3
R30	Restaurant at Pearl Street Extension	21.9	9.3
R31	Moakley Federal Courthouse, 1 Courthouse Way	21.8	9.2
R32	Fan Pier Public Green	21.8	9.2
R33	Business at 25 Thomson Place, Boston	21.8	9.2
R34	Restaurant at 63 Melcher Street	21.9	9.3
R35	Wormwood Park, A Street, Boston	22.0	9.4
R36	Binford Street Park	21.9	9.3
R37	Gillette Park, Boston	21.8	9.2
R38	Restaurant at 98 A Street, Boston	22.0	9.3
R39	Diner at 75 W Broadway, Boston	22.0	9.3
R40	Flaherty Park, W. 3rd Street	21.8	9.2
R41	Tai Tung Park, Tyler Street	22.0	9.3
R42	Eliot Norton Park, Tremont Street	21.8	9.2
R43	Millicent Way Park	21.8	9.2
R44	Peters Park	21.8	9.2
R45	Dorchester Ave, 150 feet south of Summer Street	21.9	9.3
R46	Dorchester Ave, 800 feet south of Summer Street	22.0	9.3
R47	Dorchester Ave, 1500 feet south of Summer Street	22.0	9.3
R48	Dorchester Ave, 2100 feet south of Summer Street	21.9	9.3
R49	Fidelity Building at 245 Summer Street	22.0	9.4
R50	Fidelity Building at 245 Summer Street-ROOF	21.7	9.2

[a] - Concentrations include a 24-hour $PM_{2.5}$ background concentration of 21.7 $\mu g/m^3$.
[b] - Concentrations include an Annual $PM_{2.5}$ background concentration of 9.2 $\mu g/m^3$.
The National Ambient Air Quality Standards for $PM_{2.5}$ are: 24-hour = 35 $\mu g/m^3$ and Annual = 12 $\mu g/m^3$.

7. $PM_{2.5}$ Modeling Results for Alternative 1 in 2035

The eighth highest modeled 24-hour $PM_{2.5}$ concentrations at each of the receptors analyzed for Alternative 1 in 2035 are presented in Table 6. The maximum modeled $PM_{2.5}$ 24-hour concentration was estimated to be 22.7 $\mu g/m^3$ and included a background concentration of 21.7 $\mu g/m^3$. This maximum 24-hour $PM_{2.5}$ concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled 24-hour $PM_{2.5}$ concentrations at all of the receptors modeled for Alternative 1 in 2035 were well below the 24-hour $PM_{2.5}$ National and Massachusetts standard of 35 $\mu g/m^3$.

The maximum modeled Annual $PM_{2.5}$ concentrations at each of the receptors analyzed for Alternative 1 in 2035 are also presented in Table 6. The maximum modeled $PM_{2.5}$ Annual concentration was estimated to be 9.5 $\mu g/m^3$ and included a background concentration of 9.2 $\mu g/m^3$. This maximum annual concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled Annual $PM_{2.5}$ concentrations at all of the receptors modeled for Alternative 1 in 2035 were well below the Annual $PM_{2.5}$ National and Massachusetts standard of 12 $\mu g/m^3$.

Table 6 - Maximum Modeled 24-Hour and Annual $PM_{2.5}$ Concentrations for Alternative 1 in 2035

Receptor ID No.	Receptor Description	24-Hour $PM_{2.5}$ Concentration[a] ($\mu g/m^3$)	Annual $PM_{2.5}$ Concentration[b] ($\mu g/m^3$)
R1	800 Atlantic Avenue	22.7	9.5
R2	800 Atlantic Avenue-ROOF	21.7	9.2
R3	183 Beach Street	22.2	9.4
R4	183 Beach Street-ROOF	21.7	9.2
R5	711 Atlantic Ave	22.1	9.3
R6	711 Atlantic Ave-ROOF	21.8	9.2
R7	200 Essex Street	22.1	9.4
R8	200 Essex Street-ROOF	21.7	9.2
R9	1 Financial Center, Boston	22.1	9.4
R10	1 Financial Center, Boston-ROOF	21.7	9.2
R11	Dewey Square Plaza Farmer's Market	22.1	9.4
R12	201 South Street, Boston	22.2	9.4
R13	143 South Street, Boston	22.0	9.3
R14	89 South Street, Boston	21.9	9.3
R15	Leather District Park, Essex Street, Boston.	22.0	9.4
R16	Boston Fiduciary Trust Bldg. at 175 Federal St, Boston	22.0	9.3
R17	Rose Fitzgerald Kennedy Greenway Conservancy Bldg. at 185 Kneeland Street	22.5	9.4
R18	Reggie Wong Memorial Park, Kneeland Street, Boston	22.1	9.4
R19	150 Lincoln Street (office Bldg.)	22.1	9.4
R20	1 Lincoln Street (office Bldg.)	22.1	9.4
R21	100 Summer St, Boston,	21.9	9.3
R22	Dewey Square Park	22.1	9.4
R23	Park at Congress Street and Atlantic Avenue	22.1	9.4
R24	Fort Point Channel Parks	22.1	9.4
R25	Federal Reserve Bldg. at 600 Atlantic Avenue	22.0	9.4
R26	Federal Reserve Bldg.-ROOF	21.7	9.2
R27	Federal Reserve Bldg. (sitting area)	22.0	9.3
R28	280 Congress Street	22.1	9.4
R29	Park near Harbor Walk near Pearl Street Extension	21.9	9.3
R30	Restaurant at Pearl Street Extension	21.9	9.3
R31	Moakley Federal Courthouse, 1 Courthouse Way	21.8	9.2
R32	Fan Pier Public Green	21.8	9.2
R33	Business at 25 Thomson Place, Boston	21.8	9.2
R34	Restaurant at 63 Melcher Street	21.9	9.3
R35	Wormwood Park, A Street, Boston	22.0	9.3
R36	Binford Street Park	21.9	9.3
R37	Gillette Park, Boston	21.8	9.3

Receptor ID No.	Receptor Description	24-Hour $PM_{2.5}$ Concentration[a] ($\mu g/m^3$)	Annual $PM_{2.5}$ Concentration[b] ($\mu g/m^3$)
R38	Restaurant at 98 A Street, Boston	22.0	9.3
R39	Diner at 75 W Broadway, Boston	21.9	9.3
R40	Flaherty Park, W. 3rd Street	21.8	9.2
R41	Tai Tung Park, Tyler Street	22.0	9.3
R42	Eliot Norton Park, Tremont Street	21.8	9.2
R43	Millicent Way Park	21.8	9.2
R44	Peters Park	21.8	9.2
R45	Dorchester Ave, 150 feet south of Summer Street	22.0	9.4
R46	Dorchester Ave, 800 feet south of Summer Street	22.1	9.4
R47	Dorchester Ave, 1500 feet south of Summer Street	22.1	9.4
R48	Dorchester Ave, 2100 feet south of Summer Street	22.0	9.3
R49	Fidelity Building at 245 Summer Street	22.0	9.3
R50	Fidelity Building at 245 Summer Street-ROOF	21.7	9.2

[a] - Concentrations include a 24-hour $PM_{2.5}$ background concentration of 21.7 $\mu g/m^3$.
[b] - Concentrations include an Annual $PM_{2.5}$ background concentration of 9.2 $\mu g/m^3$.
The National Ambient Air Quality Standards for $PM_{2.5}$ are: 24-hour = 35 $\mu g/m^3$ and Annual = 12 $\mu g/m^3$.

8. $PM_{2.5}$ Modeling Results for Alternative 3 in 2035

The eighth highest modeled 24-hour $PM_{2.5}$ concentrations at each of the receptors analyzed for Alternative 3 in 2035 are presented in Table 7. The maximum modeled $PM_{2.5}$ 24-hour concentration was estimated to be 22.7 $\mu g/m^3$ and included a background concentration of 21.7 $\mu g/m^3$. This maximum 24-hour $PM_{2.5}$ concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled 24-hour $PM_{2.5}$ concentrations at all of the receptors modeled for Alternative 3 in 2035 were well below the 24-hour $PM_{2.5}$ National and Massachusetts standard of 35 $\mu g/m^3$.

The maximum modeled Annual $PM_{2.5}$ concentrations at each of the receptors analyzed for Alternative 3 in 2035 are also presented in Table 7. The maximum modeled $PM_{2.5}$ Annual concentration was estimated to be 9.5 $\mu g/m^3$ and included a background concentration of 9.2 $\mu g/m^3$. This maximum annual concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled Annual $PM_{2.5}$ concentrations at all of the receptors modeled for Alternative 3 in 2035 were well below the Annual $PM_{2.5}$ National and Massachusetts standard of 12 $\mu g/m^3$.

Table 7 - Maximum Modeled 24-Hour and Annual $PM_{2.5}$ Concentrations for Alternative 3 in 2035

Receptor ID No.	Receptor Description	24-Hour $PM_{2.5}$ Concentration[a] ($\mu g/m^3$)	Annual $PM_{2.5}$ Concentration[b] ($\mu g/m^3$)
R1	800 Atlantic Avenue	22.7	9.5
R2	800 Atlantic Avenue-ROOF	21.7	9.2
R3	183 Beach Street	22.2	9.4
R4	183 Beach Street-ROOF	21.7	9.2
R5	711 Atlantic Ave	22.1	9.4
R6	711 Atlantic Ave-ROOF	21.8	9.2
R7	200 Essex Street	22.1	9.4
R8	200 Essex Street-ROOF	21.7	9.2
R9	1 Financial Center, Boston	22.2	9.4
R10	1 Financial Center, Boston-ROOF	21.7	9.2

Receptor ID No.	Receptor Description	24-Hour $PM_{2.5}$ Concentration[a] ($\mu g/m^3$)	Annual $PM_{2.5}$ Concentration[b] ($\mu g/m^3$)
R11	Dewey Square Plaza Farmer's Market	22.1	9.4
R12	201 South Street, Boston	22.3	9.4
R13	143 South Street, Boston	22.0	9.3
R14	89 South Street, Boston	21.9	9.3
R15	Leather District Park, Essex Street, Boston.	22.0	9.4
R16	Boston Fiduciary Trust Bldg. at 175 Federal St, Boston	22.1	9.3
R17	Rose Fitzgerald Kennedy Greenway Conservancy Bldg. at 185 Kneeland Street	22.5	9.5
R18	Reggie Wong Memorial Park, Kneeland Street, Boston	22.1	9.4
R19	150 Lincoln Street (office Bldg.)	22.1	9.4
R20	1 Lincoln Street (office Bldg.)	22.2	9.4
R21	100 Summer St, Boston,	21.9	9.3
R22	Dewey Square Park	22.1	9.4
R23	Park at Congress Street and Atlantic Avenue	22.1	9.4
R24	Fort Point Channel Parks	22.1	9.4
R25	Federal Reserve Bldg. at 600 Atlantic Avenue	22.0	9.4
R26	Federal Reserve Bldg.-ROOF	21.7	9.2
R27	Federal Reserve Bldg. (sitting area)	22.0	9.3
R28	280 Congress Street	22.1	9.4
R29	Park near Harbor Walk near Pearl Street Extension	21.9	9.3
R30	Restaurant at Pearl Street Extension	21.9	9.3
R31	Moakley Federal Courthouse, 1 Courthouse Way	21.8	9.2
R32	Fan Pier Public Green	21.8	9.2
R33	Business at 25 Thomson Place, Boston	21.8	9.2
R34	Restaurant at 63 Melcher Street	21.9	9.3
R35	Wormwood Park, A Street, Boston	22.0	9.3
R36	Binford Street Park	21.9	9.3
R37	Gillette Park, Boston	21.9	9.3
R38	Restaurant at 98 A Street, Boston	22.0	9.3
R39	Diner at 75 W Broadway, Boston	21.9	9.3
R40	Flaherty Park, W. 3rd Street	21.8	9.2
R41	Tai Tung Park, Tyler Street	22.0	9.3
R42	Eliot Norton Park, Tremont Street	21.8	9.2
R43	Millicent Way Park	21.8	9.2
R44	Peters Park	21.8	9.2
R45	Dorchester Ave, 150 feet south of Summer Street	22.0	9.4
R46	Dorchester Ave, 800 feet south of Summer Street	22.1	9.4
R47	Dorchester Ave, 1500 feet south of Summer Street	22.2	9.4
R48	Dorchester Ave, 2100 feet south of Summer Street	22.0	9.3
R49	Fidelity Building at 245 Summer Street	22.0	9.4
R50	Fidelity Building at 245 Summer Street-ROOF	21.7	9.2

[a] - Concentrations include a 24-hour $PM_{2.5}$ background concentration of 21.7 $\mu g/m^3$.
[b] - Concentrations include an Annual $PM_{2.5}$ background concentration of 9.2 $\mu g/m^3$.
The National Ambient Air Quality Standards for $PM_{2.5}$ are: 24-hour = 35 $\mu g/m^3$ and Annual = 12 $\mu g/m^3$.

9. Conclusion

All of the modeled 24-hour and Annual $PM_{2.5}$ concentrations were well below the National and Massachusetts $PM_{2.5}$ standards for all years and alternatives evaluated.

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Attachment S NO$_2$ Modeling Analysis

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1. Introduction

A quantitative NO_2 modeling analysis is required by MDEP for projects located in NO_2 Nonattainment areas. This area of Boston, and the entire state of Massachusetts, is in attainment of the NO_2 standards; and therefore a modeling analysis for NO_2 is not required for this project. However, this analysis was prepared to provide disclosure of potential harmful health effects of transportation-related pollutants emitted by the increase in rail operations due to the increase in the number of railroad tracks at South Station. NO_2 was chosen as the pollutant to be analyzed because the 1-hour NO_2 standard is the most stringent to meet and if the NO_2 standards are met, then the standards for all other criteria pollutants will be met. Even though this analysis is not required by any regulations, this quantitative NO_2 modeling analysis was prepared in accordance with the methodology described in the SSX Air Quality Analysis Protocol approved by Massachusetts Department of Environmental Protection (MassDEP) on June 4, 2014.

Emission factors for all sources evaluated in this analysis are given as oxides of nitrogen (NOx) and the modeled concentrations produced by AERMOD are generated as $\mu g/m^3$ of NOx. However, the ambient standards are for NO_2. Appendix W of 40 CFR Part 51 "Guideline on Air Quality Models" identifies a method that can be used to estimate NO_2 concentrations from modeled NOx concentrations. In this approach, an empirical ratio of NO_2 to NOx is derived and is then applied to the modeled 1-hour NOx concentrations. For this project, one full year of concurrent hourly NO_2 and NOx data measured at the MassDEP's Kenmore Square site for calendar year 2012 (the Existing Conditions year for the Project) was collected. For each hour of valid data, the NO_2 to NOx ratio was calculated and then averaged over the entire year. The average NO_2 to NOx ratio for the entire year was then multiplied by the modeled 1-hour NOx concentrations to compute the NO_2 concentrations.

The analysis focused on the emissions from the diesel trains operating at South Station, the motor vehicles on roadways in the vicinity of South Station, and intercity buses operating at the South Station Bus Terminal. The U.S. EPA's Locomotives Exhaust Emission Standards were used to determine the emission rates for the MBTA and Amtrak locomotives in 2012, 2025, and 2035. The U.S. EPA's MOVES emission factors program was used to determine emission rates from motor vehicles and intercity buses for the same calendar years. Background NO_2 concentration levels (approved by MassDEP) were used to estimate 1-hour and annual NO_2 impacts and were assumed to remain constant for all years analyzed. Individual modeling analyses were prepared for the 2012 Existing Conditions, 2025 No Build Alternative, 2025 Alternative 1, 2025 Alternative 3, 2035 No Build Alternative, 2035 Alternative 1, and the 2035 Alternative 3. The results of the analyses were compared to the National and Massachusetts 1-hour and annual NO_2 standards.

2. NO_2 Modeling Results for the 2012 Existing Conditions

The eighth highest modeled 1-hour NO_2 concentrations at each of the receptors analyzed for the 2012 Existing Conditions are presented in Table 1. The maximum modeled NO_2 1-hour concentration was estimated to be 166.6 ppb and included a background concentration of 51.1 ppb. This maximum 1-hour NO_2 concentration occurred at receptor R1 – 800 Atlantic Avenue. While there are exceedances of the 1-hour NO_2 standard at receptors R1, R3, R12, and R17, there are no exceedances of the 1-hour standard in any of the 2025 or 2035 analyses.

The maximum modeled annual NO_2 concentrations at each of the receptors analyzed for the 2012 Existing Conditions are also presented in Table 1. The maximum modeled NO_2 Annual concentration was estimated to be 23.8 ppb and included a background concentration of 19.5 ppb. This maximum annual concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled annual NO_2

concentrations at all of the receptors modeled for the 2012 Existing Conditions were well below the Annual NO_2 National and Massachusetts standard of 53 ppb.

Table 1 - Maximum Modeled 1-Hour and Annual NO_2 Concentrations for the 2012 Existing Conditions

Receptor ID No.	Receptor Description	1-Hour NO_2 Concentration[a] (ppb)	Annual NO_2 Concentration[b] (ppb)
R1	800 Atlantic Avenue	166.6	23.8
R2	800 Atlantic Avenue-ROOF	56.4	20.3
R3	183 Beach Street	109.3	22.4
R4	183 Beach Street-ROOF	60.2	20.1
R5	711 Atlantic Ave	91.5	21.5
R6	711 Atlantic Ave-ROOF	65.6	20.3
R7	200 Essex Street	86.0	21.3
R8	200 Essex Street-ROOF	57.0	20.0
R9	1 Financial Center, Boston	81.4	21.3
R10	1 Financial Center, Boston-ROOF	51.6	19.9
R11	Dewey Square Plaza Farmer's Market	76.5	21.8
R12	201 South Street, Boston	117.3	22.6
R13	143 South Street, Boston	88.3	21.4
R14	89 South Street, Boston	78.3	21.1
R15	Leather District Park, Essex Street, Boston.	73.7	21.2
R16	Boston Fiduciary Trust Bldg. at 175 Federal St, Boston	71.5	21.6
R17	Rose Fitzgerald Kennedy Greenway Conservancy Bldg. at 185 Kneeland Street	134.1	24.0
R18	Reggie Wong Memorial Park, Kneeland Street, Boston	91.4	22.7
R19	150 Lincoln Street (office Bldg.)	87.3	22.5
R20	1 Lincoln Street (office Bldg.)	75.9	21.0
R21	100 Summer St, Boston,	67.8	20.5
R22	Dewey Square Park	71.5	21.5
R23	Park at Congress Street and Atlantic Avenue	67.5	21.3
R24	Fort Point Channel Parks	67.3	21.0
R25	Federal Reserve Bldg. at 600 Atlantic Avenue	*73.4	21.0
R26	Federal Reserve Bldg.-ROOF	51.8	19.8
R27	Federal Reserve Bldg. (sitting area)	71.7	21.1
R28	280 Congress Street	68.0	21.1
R29	Park near Harbor Walk near Pearl Street Extension	64.6	20.5
R30	Restaurant at Pearl Street Extension	64.5	20.5
R31	Moakley Federal Courthouse, 1 Courthouse Way	58.2	19.8
R32	Fan Pier Public Green	56.2	19.8
R33	Business at 25 Thomson Place, Boston	59.1	20.1
R34	Restaurant at 63 Melcher Street	61.8	20.7
R35	Wormwood Park, A Street, Boston	65.0	21.0
R36	Binford Street Park	72.4	20.8
R37	Gillette Park, Boston	67.8	20.2
R38	Restaurant at 98 A Street, Boston	61.4	20.6
R39	Diner at 75 W Broadway, Boston	60.7	20.4

Receptor ID No.	Receptor Description	1-Hour NO_2 Concentration[a] (ppb)	Annual NO_2 Concentration[b] (ppb)
R40	Flaherty Park, W. 3rd Street	59.8	20.0
R41	Tai Tung Park, Tyler Street	76.8	20.4
R42	Eliot Norton Park, Tremont Street	61.9	19.8
R43	Millicent Way Park	60.1	19.7
R44	Peters Park	58.3	20.0
R45	Dorchester Ave, 150 feet south of Summer Street	73.7	21.4
R46	Dorchester Ave, 800 feet south of Summer Street	83.7	22.0
R47	Dorchester Ave, 1500 feet south of Summer Street	83.7	21.9
R48	Dorchester Ave, 2100 feet south of Summer Street	79.3	20.9
R49	Fidelity Building at 245 Summer Street	73.6	21.1
R50	Fidelity Building at 245 Summer Street-ROOF	55.4	20.4

[a] - Concentrations include a 1-hour NO_2 background concentration of 51.1 ppb.
[b] - Concentrations include an Annual NO_2 background concentration of 19.5 ppb.
The National Ambient Air Quality Standards for NO_2 are: 1-hour = 100 ppb and Annual = 53 ppb.

3. NO_2 Modeling Results for the 2025 No Build Alternative

The eighth highest modeled 1-hour NO_2 concentrations at each of the receptors analyzed for the 2025 No Build Alternative are presented in Table 2. The maximum modeled NO_2 1-hour concentration was estimated to be 80.7 ppb and included a background concentration of 51.1 ppb. This maximum 1-hour NO_2 concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled 1-hour NO_2 concentrations at all of the receptors modeled for the 2025 No Build Alternative were well below the 1-hour NO_2 National and Massachusetts standard of 100 ppb.

The maximum modeled Annual NO_2 concentrations at each of the receptors analyzed for the 2025 No Build Alternative are also presented in Table 2. The maximum modeled NO_2 Annual concentration was estimated to be 9.5 ppb and included a background concentration of 21.0 ppb. This maximum annual concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled Annual NO_2 concentrations at all of the receptors modeled for the 2025 No Build Alternative were well below the Annual NO_2 National and Massachusetts standard of 53 ppb.

Table 2 - Maximum Modeled 1-Hour and Annual NO_2 Concentrations for the 2025 No Build Alternative

Receptor ID No.	Receptor Description	1-Hour NO_2 Concentration[a] (ppb)	Annual NO_2 Concentration[b] (ppb)
R1	800 Atlantic Avenue	80.7	21.0
R2	800 Atlantic Avenue-ROOF	52.2	19.5
R3	183 Beach Street	66.4	20.4
R4	183 Beach Street-ROOF	52.9	19.6
R5	711 Atlantic Ave	61.5	20.3
R6	711 Atlantic Ave-ROOF	54.4	19.6
R7	200 Essex Street	61.0	20.3
R8	200 Essex Street-ROOF	52.5	19.6
R9	1 Financial Center, Boston	60.1	20.4
R10	1 Financial Center, Boston-ROOF	51.2	19.5
R11	Dewey Square Plaza Farmer's Market	58.7	20.4

Receptor ID No.	Receptor Description	1-Hour NO_2 Concentration[a] (ppb)	Annual NO_2 Concentration[b] (ppb)
R12	201 South Street, Boston	67.4	20.5
R13	143 South Street, Boston	59.6	20.1
R14	89 South Street, Boston	57.6	20.1
R15	Leather District Park, Essex Street, Boston.	57.1	20.3
R16	Boston Fiduciary Trust Bldg. at 175 Federal St, Boston	57.0	20.1
R17	Rose Fitzgerald Kennedy Greenway Conservancy Bldg. at 185 Kneeland Street	71.0	20.8
R18	Reggie Wong Memorial Park, Kneeland Street, Boston	60.6	20.5
R19	150 Lincoln Street (office Bldg.)	59.8	20.4
R20	1 Lincoln Street (office Bldg.)	58.1	20.2
R21	100 Summer St, Boston,	55.3	19.8
R22	Dewey Square Park	57.5	20.5
R23	Park at Congress Street and Atlantic Avenue	56.6	20.5
R24	Fort Point Channel Parks	56.6	20.2
R25	Federal Reserve Bldg. at 600 Atlantic Avenue	56.7	20.3
R26	Federal Reserve Bldg.-ROOF	51.3	19.5
R27	Federal Reserve Bldg. (sitting area)	56.3	20.1
R28	280 Congress Street	56.6	20.4
R29	Park near Harbor Walk near Pearl Street Extension	54.6	19.9
R30	Restaurant at Pearl Street Extension	54.7	20.0
R31	Moakley Federal Courthouse, 1 Courthouse Way	52.9	19.6
R32	Fan Pier Public Green	52.5	19.6
R33	Business at 25 Thomson Place, Boston	53.6	19.7
R34	Restaurant at 63 Melcher Street	54.4	20.0
R35	Wormwood Park, A Street, Boston	56.1	20.2
R36	Binford Street Park	56.1	19.9
R37	Gillette Park, Boston	55.0	19.7
R38	Restaurant at 98 A Street, Boston	55.6	20.1
R39	Diner at 75 W Broadway, Boston	54.9	20.0
R40	Flaherty Park, W. 3rd Street	53.4	19.7
R41	Tai Tung Park, Tyler Street	57.6	19.9
R42	Eliot Norton Park, Tremont Street	53.8	19.6
R43	Millicent Way Park	53.5	19.6
R44	Peters Park	53.0	19.6
R45	Dorchester Ave, 150 feet south of Summer Street	56.4	20.1
R46	Dorchester Ave, 800 feet south of Summer Street	58.7	20.2
R47	Dorchester Ave, 1500 feet south of Summer Street	58.8	20.2
R48	Dorchester Ave, 2100 feet south of Summer Street	57.8	19.9
R49	Fidelity Building at 245 Summer Street	56.2	20.2
R50	Fidelity Building at 245 Summer Street-ROOF	52.0	19.5

[a] - Concentrations include a 1-hour NO_2 background concentration of 51.1 ppb.
[b] - Concentrations include an Annual NO_2 background concentration of 19.5 ppb.
The National Ambient Air Quality Standards for NO_2 are: 1-hour = 100 ppb and Annual = 53 ppb.

4. NO_2 Modeling Results for Alternative 1 in 2025

The eighth highest modeled 1-hour NO_2 concentrations at each of the receptors analyzed for Alternative 1 in 2025 are presented in Table 3. The maximum modeled NO_2 1-hour concentration was estimated to be 80.7 ppb and included a background concentration of 51.1 ppb. This maximum 1-hour NO_2 concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled 1-hour NO_2 concentrations at all of the receptors modeled for Alternative 1 in 2025 were well below the 1-hour NO_2 National and Massachusetts standard of 100 ppb.

The maximum modeled Annual NO_2 concentrations at each of the receptors analyzed for Alternative 1 in 2025 are also presented in Table 3. The maximum modeled NO_2 Annual concentration was estimated to be 21.0 ppb and included a background concentration of 19.5 ppb. This maximum annual concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled Annual NO_2 concentrations at all of the receptors modeled for Alternative 1 in 2025 were well below the Annual NO_2 National and Massachusetts standard of 53 ppb.

Table 3 - Maximum Modeled 1-Hour and Annual NO_2 Concentrations for Alternative 1 in 2025

Receptor ID No.	Receptor Description	1-Hour NO_2 Concentration[a] (ppb)	Annual NO_2 Concentration[b] (ppb)
R1	800 Atlantic Avenue	80.7	21.0
R2	800 Atlantic Avenue-ROOF	52.1	19.5
R3	183 Beach Street	65.4	20.4
R4	183 Beach Street-ROOF	52.8	19.6
R5	711 Atlantic Ave	60.5	20.2
R6	711 Atlantic Ave-ROOF	54.0	19.6
R7	200 Essex Street	59.9	20.3
R8	200 Essex Street-ROOF	52.4	19.6
R9	1 Financial Center, Boston	59.3	20.4
R10	1 Financial Center, Boston-ROOF	51.3	19.5
R11	Dewey Square Plaza Farmer's Market	58.1	20.4
R12	201 South Street, Boston	67.4	20.5
R13	143 South Street, Boston	59.1	20.1
R14	89 South Street, Boston	57.2	20.1
R15	Leather District Park, Essex Street, Boston.	56.7	20.3
R16	Boston Fiduciary Trust Bldg. at 175 Federal St, Boston	56.6	20.1
R17	Rose Fitzgerald Kennedy Greenway Conservancy Bldg. at 185 Kneeland Street	70.9	20.8
R18	Reggie Wong Memorial Park, Kneeland Street, Boston	60.6	20.6
R19	150 Lincoln Street (office Bldg.)	59.6	20.4
R20	1 Lincoln Street (office Bldg.)	58.1	20.3
R21	100 Summer St, Boston,	55.1	19.8
R22	Dewey Square Park	57.2	20.5
R23	Park at Congress Street and Atlantic Avenue	56.5	20.5
R24	Fort Point Channel Parks	56.5	20.2
R25	Federal Reserve Bldg. at 600 Atlantic Avenue	56.3	20.2
R26	Federal Reserve Bldg.-ROOF	51.3	19.5
R27	Federal Reserve Bldg. (sitting area)	55.9	20.1
R28	280 Congress Street	56.6	20.4
R29	Park near Harbor Walk near Pearl Street Extension	54.4	19.9
R30	Restaurant at Pearl Street Extension	54.6	20.0

Receptor ID No.	Receptor Description	1-Hour NO_2 Concentration[a] (ppb)	Annual NO_2 Concentration[b] (ppb)
R31	Moakley Federal Courthouse, 1 Courthouse Way	52.9	19.6
R32	Fan Pier Public Green	52.5	19.6
R33	Business at 25 Thomson Place, Boston	53.4	19.7
R34	Restaurant at 63 Melcher Street	53.9	20.0
R35	Wormwood Park, A Street, Boston	55.5	20.1
R36	Binford Street Park	56.3	19.9
R37	Gillette Park, Boston	55.0	19.8
R38	Restaurant at 98 A Street, Boston	54.9	20.0
R39	Diner at 75 W Broadway, Boston	54.4	20.0
R40	Flaherty Park, W. 3rd Street	53.3	19.7
R41	Tai Tung Park, Tyler Street	58.3	19.9
R42	Eliot Norton Park, Tremont Street	54.0	19.6
R43	Millicent Way Park	53.5	19.6
R44	Peters Park	53.0	19.6
R45	Dorchester Ave, 150 feet south of Summer Street	56.6	20.3
R46	Dorchester Ave, 800 feet south of Summer Street	59.1	20.4
R47	Dorchester Ave, 1500 feet south of Summer Street	58.9	20.4
R48	Dorchester Ave, 2100 feet south of Summer Street	58.3	20.1
R49	Fidelity Building at 245 Summer Street	55.7	20.2
R50	Fidelity Building at 245 Summer Street-ROOF	51.9	19.5

[a] - Concentrations include a 1-hour NO_2 background concentration of 51.1 ppb.
[b] - Concentrations include an Annual NO_2 background concentration of 19.5 ppb.
The National Ambient Air Quality Standards for NO_2 are: 1-hour = 100 ppb and Annual = 53 ppb.

5. NO_2 Modeling Results for Alternative 3 in 2025

The eighth highest modeled 1-hour NO_2 concentrations at each of the receptors analyzed for Alternative 3 in 2025 are presented in Table 4. The maximum modeled NO_2 1-hour concentration was estimated to be 77.7 ppb and included a background concentration of 51.1 ppb. This maximum 1-hour NO_2 concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled 1-hour NO_2 concentrations at all of the receptors modeled for Alternative 3 in 2025 were well below the 1-hour NO_2 National and Massachusetts standard of 100 ppb.

The maximum modeled Annual NO_2 concentrations at each of the receptors analyzed for Alternative 3 in 2025 are also presented in Table 4. The maximum modeled NO_2 Annual concentration was estimated to be 21.0 ppb and included a background concentration of 19.5 ppb. This maximum annual concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled Annual NO_2 concentrations at all of the receptors modeled for Alternative 3 in 2025 were well below the Annual NO_2 National and Massachusetts standard of 53 ppb.

Table 4 - Maximum Modeled 1-Hour and Annual NO_2 Concentrations for Alternative 3 in 2025

Receptor ID No.	Receptor Description	1-Hour NO_2 Concentration[a] (ppb)	Annual NO_2 Concentration[b] (ppb)
R1	800 Atlantic Avenue	77.7	21.0
R2	800 Atlantic Avenue-ROOF	52.2	19.5
R3	183 Beach Street	65.3	20.4

Receptor ID No.	Receptor Description	1-Hour NO_2 Concentration[a] (ppb)	Annual NO_2 Concentration[b] (ppb)
R4	183 Beach Street-ROOF	52.9	19.6
R5	711 Atlantic Ave	60.6	20.3
R6	711 Atlantic Ave-ROOF	54.1	19.6
R7	200 Essex Street	60.0	20.3
R8	200 Essex Street-ROOF	52.4	19.6
R9	1 Financial Center, Boston	59.3	20.4
R10	1 Financial Center, Boston-ROOF	51.3	19.5
R11	Dewey Square Plaza Farmer's Market	58.2	20.4
R12	201 South Street, Boston	66.4	20.5
R13	143 South Street, Boston	58.9	20.1
R14	89 South Street, Boston	57.1	20.1
R15	Leather District Park, Essex Street, Boston.	56.7	20.3
R16	Boston Fiduciary Trust Bldg. at 175 Federal St, Boston	56.8	20.1
R17	Rose Fitzgerald Kennedy Greenway Conservancy Bldg. at 185 Kneeland Street	69.3	20.8
R18	Reggie Wong Memorial Park, Kneeland Street, Boston	60.0	20.5
R19	150 Lincoln Street (office Bldg.)	59.3	20.4
R20	1 Lincoln Street (office Bldg.)	58.1	20.3
R21	100 Summer St, Boston,	55.1	19.8
R22	Dewey Square Park	57.3	20.5
R23	Park at Congress Street and Atlantic Avenue	56.6	20.5
R24	Fort Point Channel Parks	56.7	20.2
R25	Federal Reserve Bldg. at 600 Atlantic Avenue	56.3	20.3
R26	Federal Reserve Bldg.-ROOF	51.3	19.5
R27	Federal Reserve Bldg. (sitting area)	55.9	20.1
R28	280 Congress Street	56.8	20.4
R29	Park near Harbor Walk near Pearl Street Extension	54.4	19.9
R30	Restaurant at Pearl Street Extension	54.6	20.1
R31	Moakley Federal Courthouse, 1 Courthouse Way	52.9	19.6
R32	Fan Pier Public Green	52.5	19.6
R33	Business at 25 Thomson Place, Boston	53.4	19.7
R34	Restaurant at 63 Melcher Street	53.9	20.0
R35	Wormwood Park, A Street, Boston	55.5	20.1
R36	Binford Street Park	56.1	19.9
R37	Gillette Park, Boston	55.0	19.8
R38	Restaurant at 98 A Street, Boston	55.0	20.0
R39	Diner at 75 W Broadway, Boston	54.5	20.0
R40	Flaherty Park, W. 3rd Street	53.4	19.7
R41	Tai Tung Park, Tyler Street	57.6	19.9
R42	Eliot Norton Park, Tremont Street	53.8	19.6
R43	Millicent Way Park	53.4	19.6
R44	Peters Park	53.0	19.6
R45	Dorchester Ave, 150 feet south of Summer Street	56.6	20.3
R46	Dorchester Ave, 800 feet south of Summer Street	58.9	20.4

Receptor ID No.	Receptor Description	1-Hour NO_2 Concentration[a] (ppb)	Annual NO_2 Concentration[b] (ppb)
R47	Dorchester Ave, 1500 feet south of Summer Street	59.1	20.4
R48	Dorchester Ave, 2100 feet south of Summer Street	58.4	20.1
R49	Fidelity Building at 245 Summer Street	55.8	20.2
R50	Fidelity Building at 245 Summer Street-ROOF	52.0	19.5

[a] - Concentrations include a 1-hour NO_2 background concentration of 51.1 ppb.
[b] - Concentrations include an Annual NO_2 background concentration of 19.5 ppb.
The National Ambient Air Quality Standards for NO_2 are: 1-hour = 100 ppb and Annual = 53 ppb.

6. NO_2 Modeling Results for the 2035 No Build Alternative

The eighth highest modeled 1-hour NO_2 concentrations at each of the receptors analyzed for the 2035 No Build Alternative are presented in Table 5. The maximum modeled NO_2 1-hour concentration was estimated to be 73.06 ppb and included a background concentration of 51.1 ppb. This maximum 1-hour NO_2 concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled 1-hour NO_2 concentrations at all of the receptors modeled for the 2035 No Build Alternative were well below the 1-hour NO_2 National and Massachusetts standard of 100 ppb.

The maximum modeled Annual NO_2 concentrations at each of the receptors analyzed for the 2035 No Build Alternative are also presented in Table 5. The maximum modeled NO_2 Annual concentration was estimated to be 20.9 ppb and included a background concentration of 19.5 ppb. This maximum annual concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled Annual NO_2 concentrations at all of the receptors modeled for the 2035 No Build Alternative were well below the Annual NO_2 National and Massachusetts standard of 53 ppb.

Table 5 - Maximum Modeled 1-Hour and Annual NO_2 Concentrations for the 2035 No Build Alternative

Receptor ID No.	Receptor Description	1-Hour NO_2 Concentration[a] (ppb)	Annual NO_2 Concentration[b] (ppb)
R1	800 Atlantic Avenue	73.0	20.9
R2	800 Atlantic Avenue-ROOF	52.1	19.5
R3	183 Beach Street	63.5	20.4
R4	183 Beach Street-ROOF	52.7	19.6
R5	711 Atlantic Ave	60.3	20.2
R6	711 Atlantic Ave-ROOF	53.8	19.6
R7	200 Essex Street	60.2	20.3
R8	200 Essex Street-ROOF	52.3	19.6
R9	1 Financial Center, Boston	59.7	20.4
R10	1 Financial Center, Boston-ROOF	51.2	19.5
R11	Dewey Square Plaza Farmer's Market	58.1	20.4
R12	201 South Street, Boston	63.5	20.4
R13	143 South Street, Boston	58.0	20.0
R14	89 South Street, Boston	56.7	20.0
R15	Leather District Park, Essex Street, Boston.	56.4	20.3
R16	Boston Fiduciary Trust Bldg. at 175 Federal St, Boston	56.5	20.1
R17	Rose Fitzgerald Kennedy Greenway Conservancy Bldg. at 185 Kneeland Street	65.8	20.5

Receptor ID No.	Receptor Description	1-Hour NO_2 Concentration[a] (ppb)	Annual NO_2 Concentration[b] (ppb)
R18	Reggie Wong Memorial Park, Kneeland Street, Boston	58.7	20.4
R19	150 Lincoln Street (office Bldg.)	58.1	20.3
R20	1 Lincoln Street (office Bldg.)	57.5	20.2
R21	100 Summer St, Boston,	54.8	19.8
R22	Dewey Square Park	57.3	20.5
R23	Park at Congress Street and Atlantic Avenue	56.4	20.4
R24	Fort Point Channel Parks	56.3	20.2
R25	Federal Reserve Bldg. at 600 Atlantic Avenue	55.8	20.2
R26	Federal Reserve Bldg.-ROOF	51.3	19.5
R27	Federal Reserve Bldg. (sitting area)	55.3	20.0
R28	280 Congress Street	56.3	20.4
R29	Park near Harbor Walk near Pearl Street Extension	54.1	19.9
R30	Restaurant at Pearl Street Extension	54.3	20.0
R31	Moakley Federal Courthouse, 1 Courthouse Way	52.7	19.6
R32	Fan Pier Public Green	52.4	19.6
R33	Business at 25 Thomson Place, Boston	53.4	19.7
R34	Restaurant at 63 Melcher Street	54.1	20.0
R35	Wormwood Park, A Street, Boston	55.8	20.2
R36	Binford Street Park	55.3	19.9
R37	Gillette Park, Boston	54.5	19.7
R38	Restaurant at 98 A Street, Boston	55.4	20.1
R39	Diner at 75 W Broadway, Boston	54.6	20.0
R40	Flaherty Park, W. 3rd Street	53.2	19.7
R41	Tai Tung Park, Tyler Street	56.7	19.8
R42	Eliot Norton Park, Tremont Street	53.5	19.6
R43	Millicent Way Park	53.2	19.6
R44	Peters Park	52.8	19.6
R45	Dorchester Ave, 150 feet south of Summer Street	55.6	20.1
R46	Dorchester Ave, 800 feet south of Summer Street	57.4	20.1
R47	Dorchester Ave, 1500 feet south of Summer Street	57.4	20.1
R48	Dorchester Ave, 2100 feet south of Summer Street	56.9	19.9
R49	Fidelity Building at 245 Summer Street	55.3	20.1
R50	Fidelity Building at 245 Summer Street-ROOF	51.9	19.5

[a] - Concentrations include a 1-hour NO_2 background concentration of 51.1 ppb.
[b] - Concentrations include an Annual NO_2 background concentration of 19.5 ppb.
The National Ambient Air Quality Standards for NO_2 are: 1-hour = 100 ppb and Annual = 53 ppb.

7. NO_2 Modeling Results for Alternative 1 in 2035

The eighth highest modeled 1-hour NO_2 concentrations at each of the receptors analyzed for Alternative 1 in 2035 are presented in Table 6. The maximum modeled NO_2 1-hour concentration was estimated to be 72.5 ppb and included a background concentration of 51.1 ppb. This maximum 1-hour NO_2 concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled 1-hour NO_2 concentrations at all of the receptors modeled for Alternative 1 in 2035 were well below the 1-hour NO_2 National and Massachusetts standard of 100 ppb.

The maximum modeled Annual NO_2 concentrations at each of the receptors analyzed for Alternative 1 in 2035 are also presented in Table 6. The maximum modeled NO_2 Annual concentration was estimated to be 20.8 ppb and included a background concentration of 19.5 ppb. This maximum annual concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled Annual NO_2 concentrations at all of the receptors modeled for Alternative 1 in 2035 were well below the Annual NO_2 National and Massachusetts standard of 53 ppb.

Table 6 - Maximum Modeled 1-Hour and Annual NO_2 Concentrations for Alternative 1 in 2035

Receptor ID No.	Receptor Description	1-Hour NO_2 Concentration[a] (ppb)	Annual NO_2 Concentration[b] (ppb)
R1	800 Atlantic Avenue	72.5	20.8
R2	800 Atlantic Avenue-ROOF	52.0	19.5
R3	183 Beach Street	62.2	20.3
R4	183 Beach Street-ROOF	52.6	19.6
R5	711 Atlantic Ave	59.0	20.2
R6	711 Atlantic Ave-ROOF	53.5	19.6
R7	200 Essex Street	58.9	20.3
R8	200 Essex Street-ROOF	52.2	19.5
R9	1 Financial Center, Boston	58.3	20.3
R10	1 Financial Center, Boston-ROOF	51.2	19.5
R11	Dewey Square Plaza Farmer's Market	57.4	20.3
R12	201 South Street, Boston	63.5	20.3
R13	143 South Street, Boston	57.4	20.0
R14	89 South Street, Boston	56.1	20.0
R15	Leather District Park, Essex Street, Boston.	56.1	20.2
R16	Boston Fiduciary Trust Bldg. at 175 Federal St, Boston	56.2	20.1
R17	Rose Fitzgerald Kennedy Greenway Conservancy Bldg. at 185 Kneeland Street	65.8	20.5
R18	Reggie Wong Memorial Park, Kneeland Street, Boston	58.6	20.4
R19	150 Lincoln Street (office Bldg.)	57.8	20.3
R20	1 Lincoln Street (office Bldg.)	57.4	20.2
R21	100 Summer St, Boston,	54.6	19.8
R22	Dewey Square Park	56.7	20.4
R23	Park at Congress Street and Atlantic Avenue	56.2	20.4
R24	Fort Point Channel Parks	56.3	20.2
R25	Federal Reserve Bldg. at 600 Atlantic Avenue	55.6	20.2
R26	Federal Reserve Bldg.-ROOF	51.2	19.5
R27	Federal Reserve Bldg. (sitting area)	55.1	20.1
R28	280 Congress Street	56.3	20.4
R29	Park near Harbor Walk near Pearl Street Extension	54.0	19.9
R30	Restaurant at Pearl Street Extension	54.2	20.0
R31	Moakley Federal Courthouse, 1 Courthouse Way	52.7	19.6
R32	Fan Pier Public Green	52.3	19.6
R33	Business at 25 Thomson Place, Boston	53.2	19.7
R34	Restaurant at 63 Melcher Street	53.8	20.0
R35	Wormwood Park, A Street, Boston	55.2	20.1
R36	Binford Street Park	55.5	19.9

Receptor ID No.	Receptor Description	1-Hour NO_2 Concentration[a] (ppb)	Annual NO_2 Concentration[b] (ppb)
R37	Gillette Park, Boston	54.5	19.8
R38	Restaurant at 98 A Street, Boston	54.6	20.0
R39	Diner at 75 W Broadway, Boston	54.1	20.0
R40	Flaherty Park, W. 3rd Street	53.1	19.7
R41	Tai Tung Park, Tyler Street	56.3	19.8
R42	Eliot Norton Park, Tremont Street	53.4	19.6
R43	Millicent Way Park	53.1	19.6
R44	Peters Park	52.7	19.6
R45	Dorchester Ave, 150 feet south of Summer Street	55.8	20.2
R46	Dorchester Ave, 800 feet south of Summer Street	57.6	20.4
R47	Dorchester Ave, 1500 feet south of Summer Street	57.5	20.3
R48	Dorchester Ave, 2100 feet south of Summer Street	57.5	20.1
R49	Fidelity Building at 245 Summer Street	55.1	20.2
R50	Fidelity Building at 245 Summer Street-ROOF	51.8	19.5

[a] - Concentrations include a 1-hour NO_2 background concentration of 51.1 ppb.
[b] - Concentrations include an Annual NO_2 background concentration of 19.5 ppb.
The National Ambient Air Quality Standards for NO_2 are: 1-hour = 100 ppb and Annual = 53 ppb.

8. NO_2 Modeling Results for Alternative 3 in 2035

The eighth highest modeled 1-hour NO_2 concentrations at each of the receptors analyzed for Alternative 3 in 2035 are presented in Table 7. The maximum modeled NO_2 1-hour concentration was estimated to be 74.2 ppb and included a background concentration of 51.1 ppb. This maximum 1-hour NO_2 concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled 1-hour NO_2 concentrations at all of the receptors modeled for Alternative 3 in 2035 were well below the 1-hour NO_2 National and Massachusetts standard of 100 ppb.

The maximum modeled Annual NO_2 concentrations at each of the receptors analyzed for Alternative 3 in 2035 are also presented in Table 7. The maximum modeled NO_2 Annual concentration was estimated to be 20.8 ppb and included a background concentration of 19.5 ppb. This maximum annual concentration occurred at receptor R1 – 800 Atlantic Avenue. All of the modeled Annual NO_2 concentrations at all of the receptors modeled for Alternative 3 in 2035 were well below the Annual NO_2 National and Massachusetts standard of 53 ppb.

Table 7 - Maximum Modeled 1-Hour and Annual NO_2 Concentrations for Alternative 3 in 2035

Receptor ID No.	Receptor Description	1-Hour NO_2 Concentration[a] (ppb)	Annual NO_2 Concentration[b] (ppb)
R1	800 Atlantic Avenue	74.2	20.8
R2	800 Atlantic Avenue-ROOF	52.0	19.5
R3	183 Beach Street	63.2	20.3
R4	183 Beach Street-ROOF	52.6	19.6
R5	711 Atlantic Ave	59.6	20.2
R6	711 Atlantic Ave-ROOF	53.7	19.6
R7	200 Essex Street	59.3	20.3
R8	200 Essex Street-ROOF	52.2	19.6
R9	1 Financial Center, Boston	58.7	20.4

Receptor ID No.	Receptor Description	1-Hour NO_2 Concentration[a] (ppb)	Annual NO_2 Concentration[b] (ppb)
R10	1 Financial Center, Boston-ROOF	51.2	19.5
R11	Dewey Square Plaza Farmer's Market	57.7	20.4
R12	201 South Street, Boston	64.2	20.4
R13	143 South Street, Boston	57.8	20.0
R14	89 South Street, Boston	56.4	20.1
R15	Leather District Park, Essex Street, Boston.	56.3	20.3
R16	Boston Fiduciary Trust Bldg. at 175 Federal St, Boston	56.4	20.1
R17	Rose Fitzgerald Kennedy Greenway Conservancy Bldg. at 185 Kneeland Street	67.0	20.6
R18	Reggie Wong Memorial Park, Kneeland Street, Boston	58.9	20.4
R19	150 Lincoln Street (office Bldg.)	58.2	20.3
R20	1 Lincoln Street (office Bldg.)	57.6	20.3
R21	100 Summer St, Boston,	54.7	19.8
R22	Dewey Square Park	56.9	20.5
R23	Park at Congress Street and Atlantic Avenue	56.4	20.5
R24	Fort Point Channel Parks	56.4	20.2
R25	Federal Reserve Bldg. at 600 Atlantic Avenue	55.8	20.2
R26	Federal Reserve Bldg.-ROOF	51.3	19.5
R27	Federal Reserve Bldg. (sitting area)	55.4	20.1
R28	280 Congress Street	56.5	20.4
R29	Park near Harbor Walk near Pearl Street Extension	54.1	19.9
R30	Restaurant at Pearl Street Extension	54.3	20.0
R31	Moakley Federal Courthouse, 1 Courthouse Way	52.8	19.6
R32	Fan Pier Public Green	52.4	19.6
R33	Business at 25 Thomson Place, Boston	53.3	19.7
R34	Restaurant at 63 Melcher Street	53.8	20.0
R35	Wormwood Park, A Street, Boston	55.3	20.1
R36	Binford Street Park	55.6	19.9
R37	Gillette Park, Boston	54.7	19.8
R38	Restaurant at 98 A Street, Boston	54.9	20.0
R39	Diner at 75 W Broadway, Boston	54.4	20.0
R40	Flaherty Park, W. 3rd Street	53.2	19.7
R41	Tai Tung Park, Tyler Street	56.9	19.9
R42	Eliot Norton Park, Tremont Street	53.5	19.6
R43	Millicent Way Park	53.2	19.6
R44	Peters Park	52.8	19.6
R45	Dorchester Ave, 150 feet south of Summer Street	56.1	20.3
R46	Dorchester Ave, 800 feet south of Summer Street	58.0	20.4
R47	Dorchester Ave, 1500 feet south of Summer Street	58.1	20.4
R48	Dorchester Ave, 2100 feet south of Summer Street	57.8	20.1
R49	Fidelity Building at 245 Summer Street	55.4	20.2
R50	Fidelity Building at 245 Summer Street-ROOF	51.8	19.5

[a] - Concentrations include a 1-hour NO_2 background concentration of 51.1 ppb.
[b] - Concentrations include an Annual NO_2 background concentration of 19.5 ppb.
The National Ambient Air Quality Standards for NO_2 are: 1-hour = 100 ppb and Annual = 53 ppb.

9. Conclusion

All of the modeled 1-hour and Annual NO_2 concentrations were well below the National and Massachusetts $PM_{2.5}$ standards for all future years and alternatives evaluated.

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Attachment T SSX Stationary Source GHG Table

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EUI Summary for Building Energy Modeling

End Use Category	Hotel GHG Baseline	Hotel GHG Mitigated	Residential GHG Baseline	Residential GHG Mitigated	Office/Retail GHG Baseline	Office/Retail GHG Mitigated	Terminal Expansion GHG Baseline	Terminal Expansion GHG Mitigated
Conditioned Area (sf)	280,000	280,000	280,000	280,000	440,000	440,000	205,000	205,000
Unconditioned Area (sf)	21,800	21,800	21,800	21,800	-	-	200,000	200,000
Description	EUI (kBtu/sf)	EUI (kBtu/sf)	EUI (kBtu/sf)	EUI (kBtu/sf)	EUI (kBtu/sf)	EUI (kBtu/sf)	EUI (kBtu/sf)	EUI (kBtu/sf)
Interior Lighting	10.43	8.35	6.26	5.01	7.18	4.91	18.81	15.05
Exterior Lighting	1.95	1.95	1.95	1.95	0.54	0.54	5.76	4.61
Process Loads	8.07	8.07	18.16	15.13	11.13	11.13	53.15	53.15
Space Heating	25.52	19.31	8.89	5.53	31.76	22.56	18.25	10.5
Space Cooling	7.05	1.63	9.27	2.27	2.82	2.34	7.49	6.65
Heat Rejection	-	0.42	-	0.47	0.38	0.34	0.98	1
Pumps	0.19	2.51	0.11	3.71	1.31	1.37	5.1	6.44
Fans	5.25	5.88	1.2	7.2	5.7	5.39	7.59	7.25
Service Hot Water	12.84	12.48	12.84	12.48	1.47	1.47	2.73	2.73
Total EUI	**71.3**	**60.6**	**58.7**	**53.7**	**62.3**	**50.1**	**119.9**	**107.4**

End Use Category	GHG Baseline Case EUI, kBtu/sf	GHG Mitigated Case EUI, kBtu/sf	CBECS/RECS Comparison EUI, kBtu/sf	CBECS/RECS Category
Hotel	71.3	60.6	132.1	Lodging
Residential	58.7	53.7	62.4	Apartments 5+ units
Office/Retail	62.3	50.1	73.5	Retail
			132.1	Office
Terminal Expansion	119.9	107.4	90.8	Public Assembly

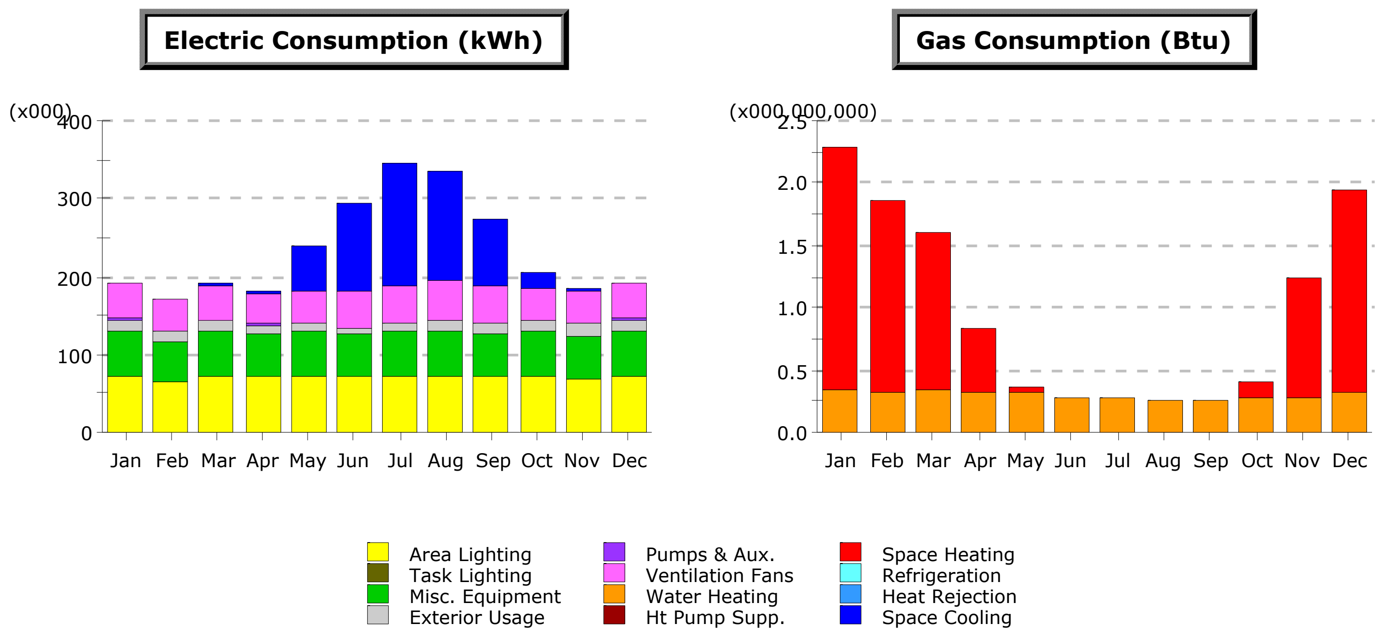
Project Related Stationary Source CO2 Emissions

Emissions Factors:		Source
Natural Gas CO2 Emissions (lbs/therm)	11.69	EIA voluntary Reporting of Greenhouse Gasses Program
Natural Gas CO2 Emissions (lbs/MBtu)	116.900	http://www.eia.gov/oiaf/1605/reporting_tools.html
Electricity CO2 Emissions (lbs/MWh)	719	ISO New England Electric Generator Air Emissions Report
Electricity CO2 Emissions (lbs/MBtu)	210.739	http://www.iso-ne.com/genrtion_resrcs/reports/emission/2012_em

	Gas Use (MBtu)	Electric Use (MBtu)	Gas CO2 Emissions (lbs)	Electric CO2 Emissions (lbs)	Total CO2 Emissions (tons)
Hotel Baseline (JD1)	10743	9222	1255798	1943476	1600
Hotel Proposed (JD1)	8899	8067	1040340	1700010	1370
Residential Baseline (JD2&3)	6083	10345	711114	2180073	1446
Residential Proposed (JD2&3)	5043	10005	589562	2108422	1349
Office/Retail Baseline (JD4-6)	14622	12782	1709277	2693601	2201
Office/Retail Proposed (JD4-6)	10575	11450	1236194	2412981	1825
SSX Baseline	4300	20270	502717	4271593	2387
SSX Proposed	2712	19299	317033	4066966	2192
Baseline	35748	52618	4178906	11088744	7634
Proposed	27230	48821	3183129	10288378	6736

	Water	Wastewater
Alternative 3 use, gpd	453,090	411,900
Energy use, kWh/year	33,076	195,447
CO_2 Emissions, tons/year	11.9	70.3

	TOTAL ENERGY USE (MBTU)										
	INTERIOR LIGHTING	MISC. EQUIPMENT	SPACE HEATING	SPACE COOLING	HEAT REJECTION	PUMPS	FANS	DHW	EXTERIOR LIGHTING	TOTAL	Percent Reduction
Hotel Baseline	2920	2259	7146	1975	0	53	1470	3596	546	19965	
Hotel Proposed	2337	2259	5405	456	117	704	1647	3494	546	16966	
Residential Baseline	1752	5084	2488	2597	0	32	336	3595	546	16428	
Residential Proposed	1402	4236	1550	634	131	1039	2017	3494	546	15048	
Office/Retail Baseline	3160	4895	13975	1241	165	575	2506	647	240	27403	
Office/Retail Proposed	2159	4895	9928	1030	151	604	2372	647	240	22025	
SSX Baseline	3856	10896	3741	1535	200	1045	1557	559	1180	24570	
SSX Proposed	3085	10896	2153	1363	204	1320	1487	559	945	22011	16%

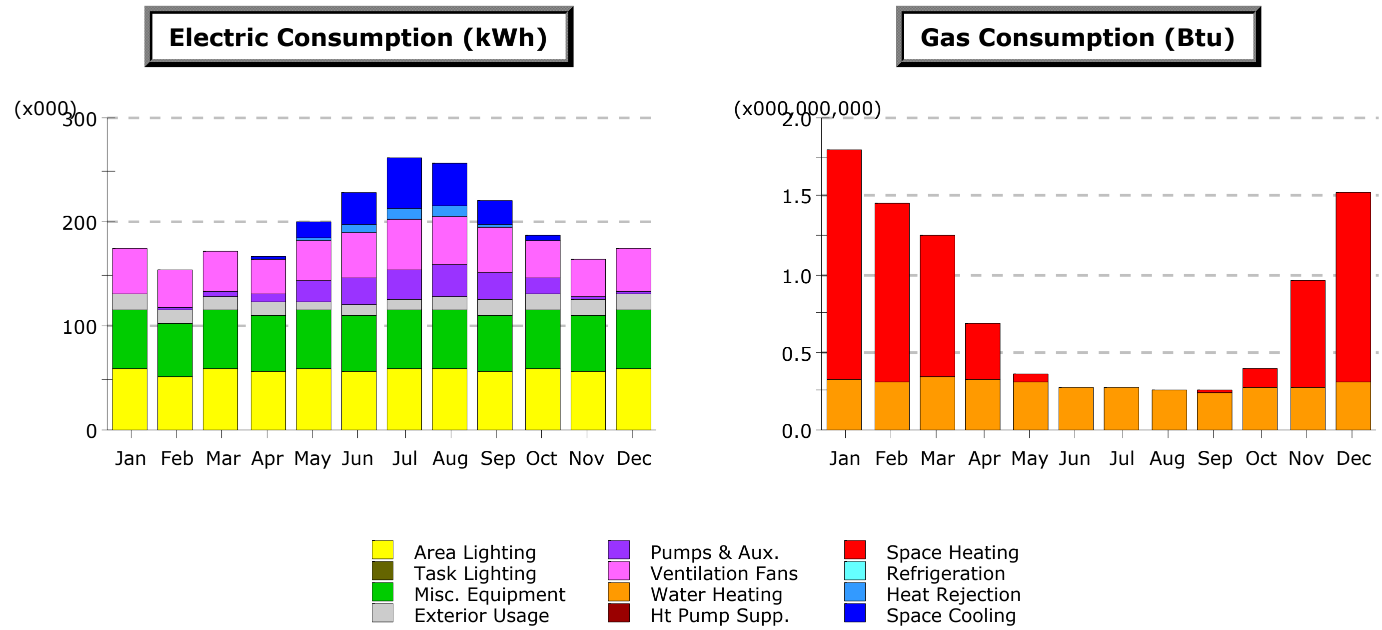


Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0.0	0.3	2.1	5.3	56.0	112.0	157.2	139.5	88.4	21.3	1.0	0.4	583.4
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	45.4	40.5	43.1	36.4	43.7	47.5	50.4	50.4	46.9	39.6	40.6	44.9	529.4
Pumps & Aux.	2.7	2.4	2.5	1.8	0.4	-	-	-	0.0	0.9	2.3	2.6	15.6
Ext. Usage	15.8	12.3	13.6	13.2	9.8	9.5	9.8	15.1	14.6	15.1	15.3	15.8	159.9
Misc. Equip.	56.2	50.8	56.2	54.5	56.2	54.4	56.3	56.2	54.4	56.3	54.2	56.3	662.0
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	72.7	65.6	72.6	70.5	72.6	70.4	72.8	72.6	70.4	72.8	70.0	72.8	855.6
Total	192.7	171.8	190.0	181.7	238.7	293.8	346.5	333.8	274.8	206.0	183.3	192.6	2,805.8

Gas Consumption (Btu x000,000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	1.96	1.56	1.26	0.50	0.05	-	-	-	-	0.14	0.95	1.63	8.05
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.33	0.31	0.35	0.33	0.32	0.29	0.28	0.27	0.26	0.27	0.28	0.31	3.60
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	2.29	1.87	1.61	0.83	0.37	0.29	0.28	0.27	0.26	0.42	1.24	1.94	11.65



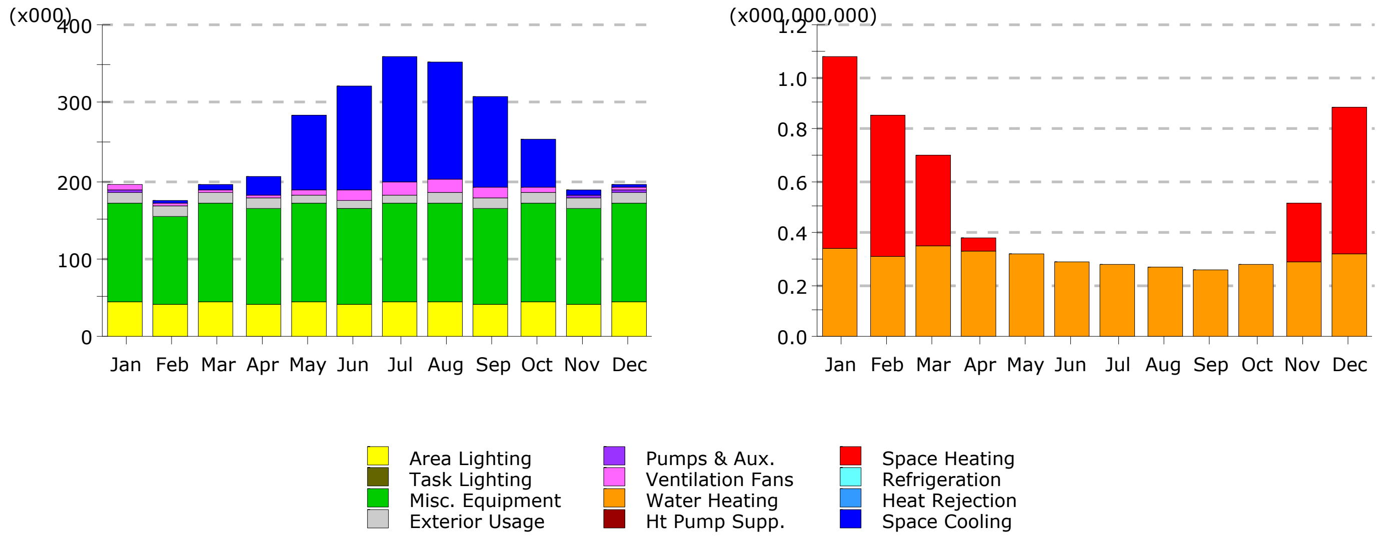
Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0.1	0.2	1.0	2.0	14.7	30.5	48.1	40.4	22.6	5.9	0.5	0.3	166.3
Heat Reject.	-	0.0	0.0	0.1	2.2	6.2	12.1	9.4	4.2	0.3	0.0	0.0	34.5
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	42.0	36.2	38.2	33.4	40.0	43.8	47.9	47.6	42.1	36.7	35.4	40.6	484.0
Pumps & Aux.	1.9	2.2	5.1	6.6	19.0	26.4	29.4	29.4	26.5	15.4	3.4	2.8	167.8
Ext. Usage	15.8	12.3	13.6	13.2	9.8	9.5	9.8	15.1	14.6	15.1	15.3	15.8	159.9
Misc. Equip.	56.2	50.8	56.2	54.5	56.2	54.4	56.3	56.2	54.4	56.3	54.2	56.3	662.0
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	58.2	52.5	58.1	56.4	58.1	56.3	58.3	58.1	56.3	58.3	56.0	58.3	684.8
Total	174.0	154.2	172.2	166.2	200.0	227.1	261.9	256.2	220.8	187.9	164.8	174.0	2,359.4

Gas Consumption (Btu x000,000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	1.48	1.15	0.92	0.37	0.05	-	-	-	0.00	0.12	0.68	1.22	5.99
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.32	0.30	0.34	0.32	0.31	0.28	0.27	0.26	0.25	0.27	0.28	0.31	3.49
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	1.80	1.46	1.25	0.69	0.36	0.28	0.27	0.26	0.25	0.39	0.96	1.53	9.49

Electric Consumption (kWh) **Gas Consumption (Btu)**

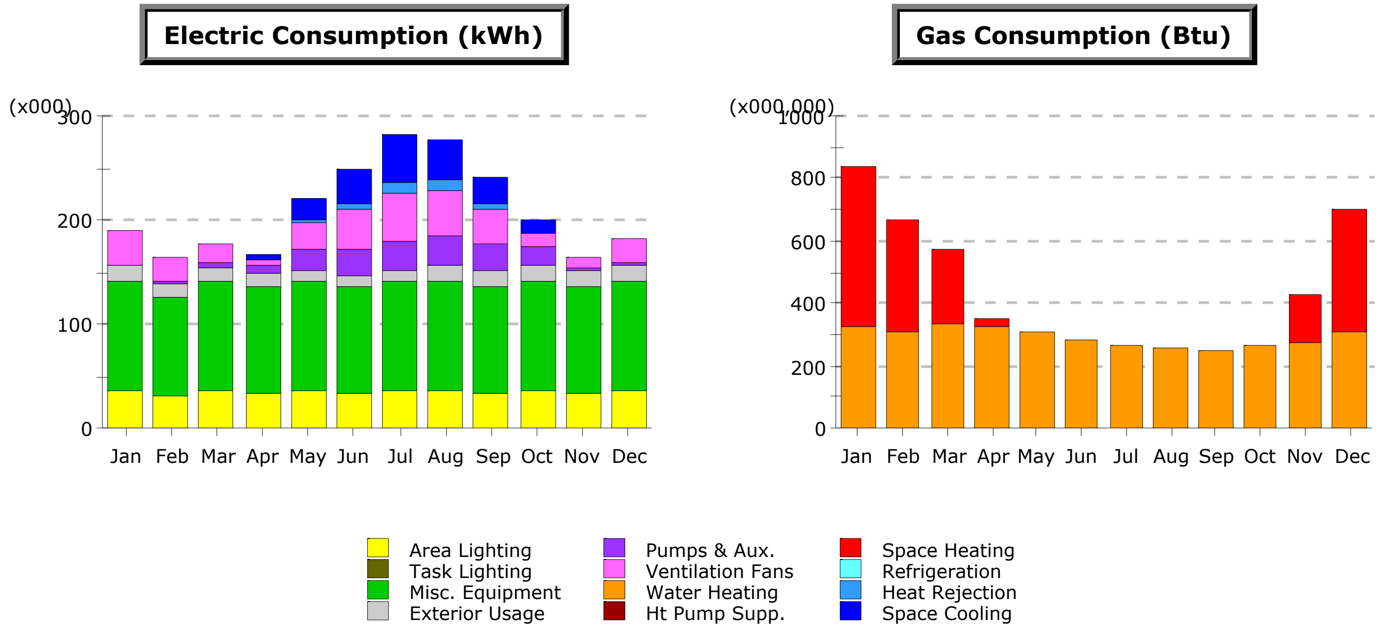


Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0.8	1.9	8.2	24.5	95.4	132.5	161.1	149.1	116.1	61.9	7.0	2.5	760.9
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	5.8	4.2	3.2	2.2	9.4	14.4	18.6	16.9	11.9	5.4	1.9	4.5	98.4
Pumps & Aux.	1.8	1.6	1.6	0.8	0.0	-	-	-	-	0.2	1.5	1.7	9.3
Ext. Usage	15.8	12.3	13.6	13.2	9.8	9.5	9.8	15.1	14.6	15.1	15.3	15.8	159.9
Misc. Equip.	126.5	114.2	126.4	122.7	126.4	122.5	126.6	126.4	122.5	126.6	121.9	126.6	1,489.5
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	43.6	39.4	43.5	42.3	43.6	42.2	43.7	43.6	42.2	43.7	42.0	43.7	513.4
Total	194.2	173.6	196.5	205.7	284.6	321.2	359.9	351.1	307.3	253.0	189.5	194.8	3,031.3

Gas Consumption (Btu x000,000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	0.74	0.54	0.35	0.05	0.00	-	-	-	-	0.00	0.23	0.57	2.49
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.33	0.31	0.35	0.33	0.32	0.29	0.28	0.27	0.26	0.27	0.28	0.31	3.59
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	1.08	0.85	0.70	0.37	0.32	0.29	0.28	0.27	0.26	0.28	0.52	0.89	6.08

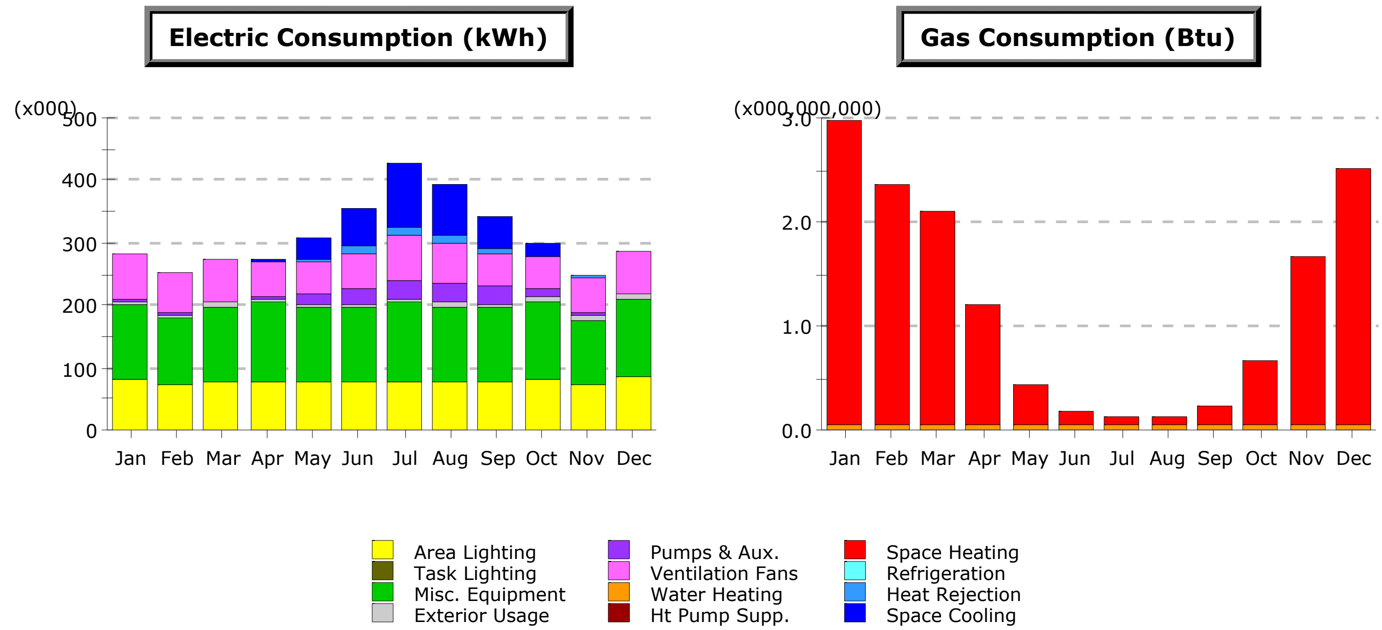


Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0.2	0.4	1.7	3.8	20.5	33.1	44.0	39.4	26.9	11.6	1.0	0.5	183.1
Heat Reject.	0.0	0.0	0.0	0.2	2.7	6.7	12.2	9.7	4.9	0.7	0.0	0.0	37.3
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	30.9	22.6	17.1	5.5	24.6	37.8	46.1	43.8	33.0	13.3	10.6	23.5	308.7
Pumps & Aux.	1.6	2.0	5.1	7.6	21.9	26.4	28.4	28.3	26.7	18.4	3.2	2.2	171.8
Ext. Usage	15.8	12.3	13.6	13.2	9.8	9.5	9.8	15.1	14.6	15.1	15.3	15.8	159.9
Misc. Equip.	105.4	95.2	105.4	102.2	105.4	102.1	105.5	105.4	102.1	105.5	101.6	105.5	1,241.3
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	34.9	31.5	34.8	33.9	34.9	33.8	35.0	34.9	33.8	35.0	33.6	35.0	410.9
Total	188.7	164.0	177.8	166.4	219.8	249.4	281.0	276.6	242.1	199.7	165.2	182.4	2,513.0

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	511.3	363.7	233.0	29.1	0.4	-	-	-	-	2.1	149.6	393.8	1,683.1
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	324.8	303.9	337.5	321.0	309.9	278.3	268.5	256.8	247.2	265.3	275.2	305.3	3,493.7
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	836.1	667.6	570.5	350.1	310.4	278.3	268.5	256.8	247.2	267.4	424.8	699.1	5,176.8

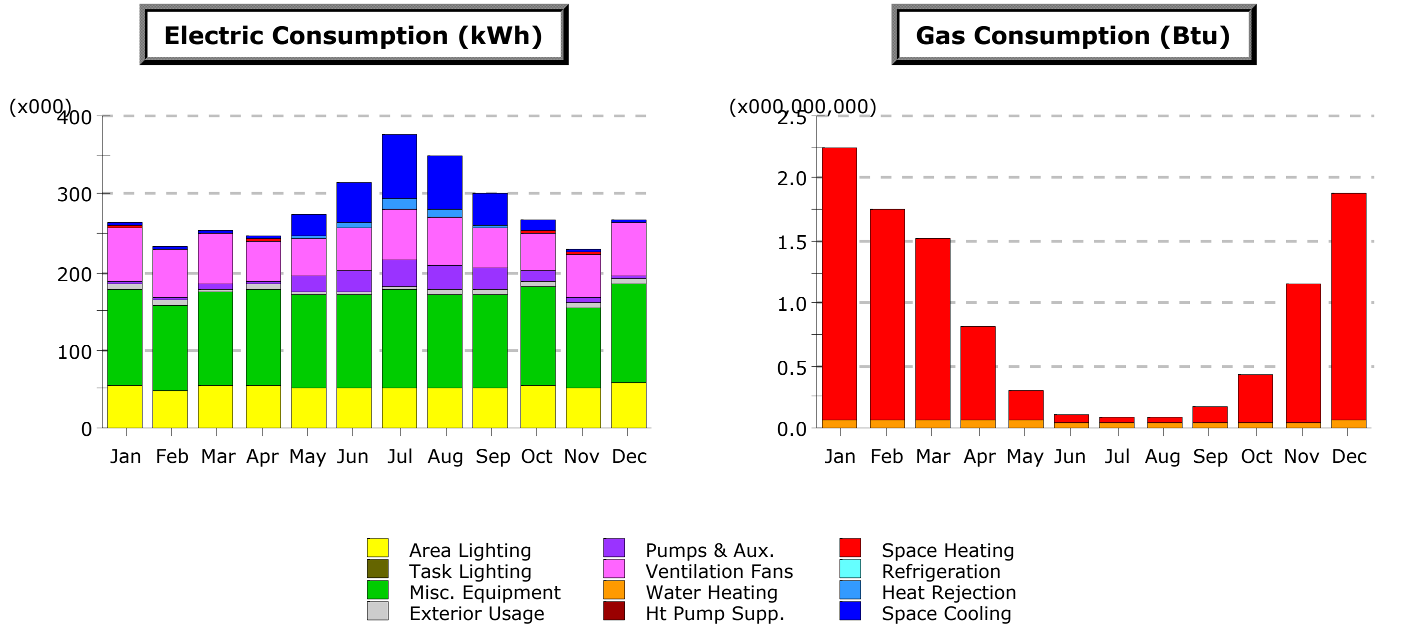


Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0.7	0.0	0.7	4.1	34.7	62.8	102.0	83.3	53.6	17.2	3.4	1.1	363.7
Heat Reject.	0.0	-	0.0	0.2	3.6	8.6	16.5	12.4	6.0	1.0	0.1	0.0	48.4
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	71.0	63.5	68.1	55.9	49.5	57.6	68.7	64.8	54.1	53.7	59.1	68.2	734.2
Pumps & Aux.	2.6	1.7	2.3	4.0	19.3	27.4	33.3	31.0	26.9	12.7	4.4	2.8	168.3
Ext. Usage	7.0	5.4	6.0	5.8	4.1	4.0	4.1	6.7	6.5	6.7	6.8	7.0	70.2
Misc. Equip.	120.2	108.7	120.2	124.8	120.2	119.8	125.3	120.2	119.8	125.2	104.5	125.3	1,434.3
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	79.7	71.0	77.8	79.0	76.5	75.3	78.7	76.6	76.3	80.5	70.9	83.6	926.0
Total	281.3	250.4	275.1	273.9	307.9	355.6	428.7	394.9	343.3	297.0	249.2	288.0	3,745.0

Gas Consumption (Btu x000,000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	2.92	2.31	2.04	1.15	0.38	0.12	0.08	0.09	0.19	0.61	1.62	2.47	13.97
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.65
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	2.98	2.37	2.10	1.21	0.44	0.17	0.13	0.13	0.24	0.66	1.66	2.52	14.62

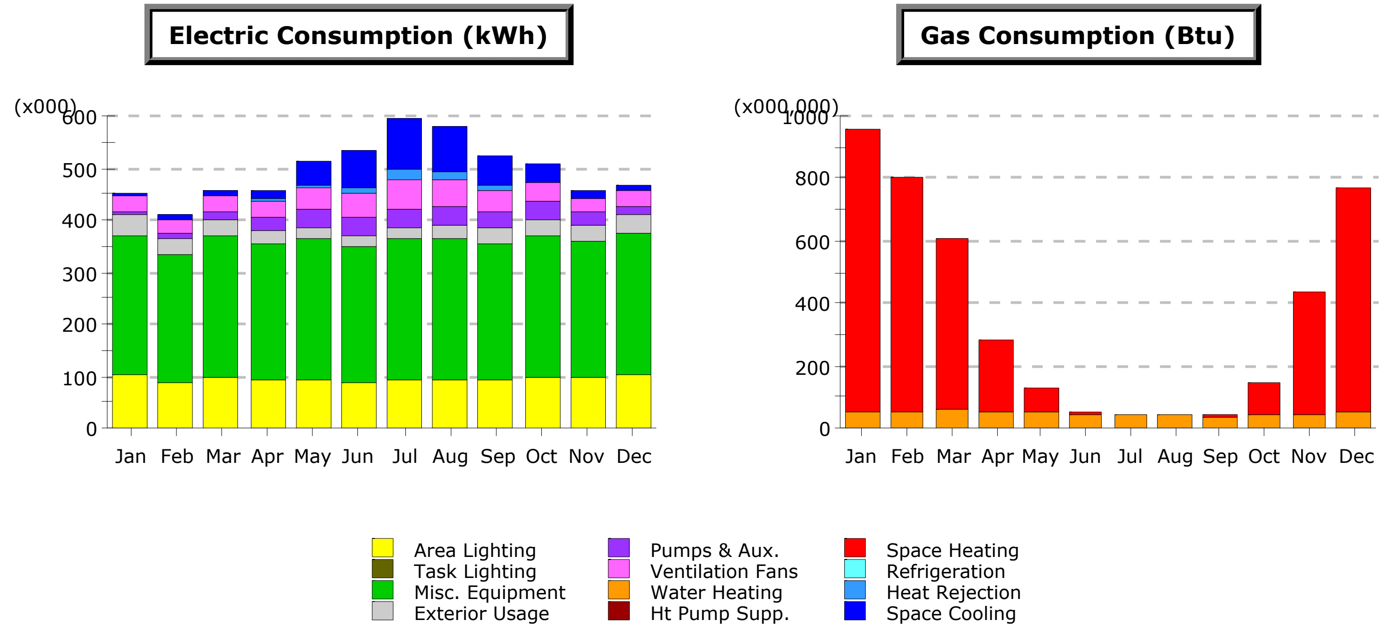


Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	3.1	2.5	3.3	5.0	27.3	49.9	81.6	66.3	40.7	14.0	4.6	3.3	301.7
Heat Reject.	0.0	-	0.0	0.2	3.3	7.9	15.2	11.5	5.3	0.9	0.0	0.0	44.4
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	2.3	1.9	1.9	1.2	0.4	0.2	0.1	0.1	0.3	0.8	1.6	2.1	12.8
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	68.5	60.9	64.5	51.7	46.5	54.5	64.8	61.0	51.6	50.4	55.4	65.2	694.8
Pumps & Aux.	5.3	3.9	4.1	5.2	19.0	26.7	32.3	30.0	26.4	13.2	5.7	5.1	177.0
Ext. Usage	7.0	5.4	6.0	5.8	4.1	4.0	4.1	6.7	6.5	6.7	6.8	7.0	70.2
Misc. Equip.	120.2	108.7	120.2	124.8	120.2	119.8	125.3	120.2	119.8	125.2	104.5	125.3	1,434.3
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	55.9	48.9	53.0	53.3	51.3	50.3	52.6	51.5	51.7	55.0	50.0	59.2	632.6
Total	262.2	232.2	253.1	247.2	272.2	313.4	376.0	347.3	302.2	266.2	228.7	267.1	3,367.7

Gas Consumption (Btu x000,000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	2.18	1.70	1.45	0.76	0.23	0.06	0.04	0.05	0.12	0.38	1.10	1.81	9.88
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.65
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	2.23	1.75	1.51	0.82	0.29	0.12	0.10	0.10	0.16	0.43	1.15	1.87	10.53

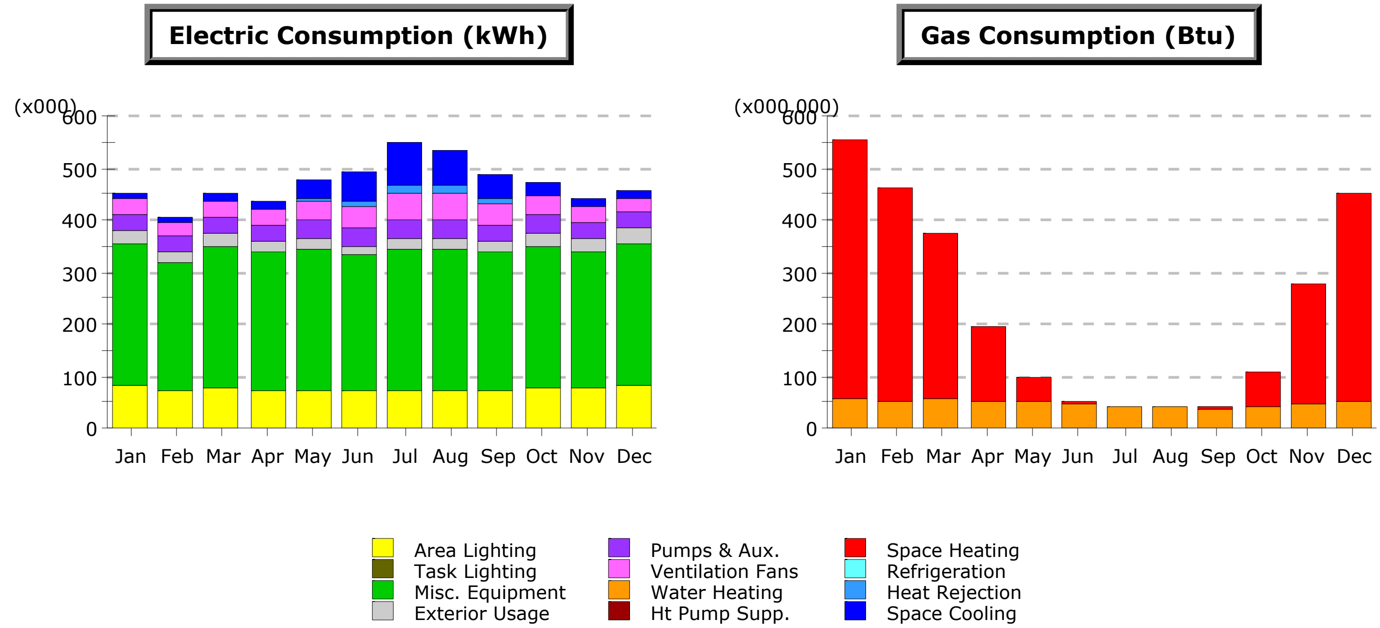


Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	5.6	6.6	9.8	19.2	45.1	68.8	97.2	84.1	57.0	32.0	14.4	10.0	449.9
Heat Reject.	0.1	0.1	0.2	0.7	4.7	10.1	18.0	14.5	7.6	2.2	0.5	0.2	58.7
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	28.0	26.1	30.1	30.9	43.0	48.3	56.3	54.3	44.2	37.4	28.3	28.9	456.1
Pumps & Aux.	10.2	11.5	17.1	27.0	32.4	33.5	36.2	35.3	32.2	31.4	22.7	16.8	306.3
Ext. Usage	36.1	30.2	30.1	25.7	23.6	21.3	22.6	25.3	27.8	32.2	34.1	36.9	345.7
Misc. Equip.	270.1	244.5	271.5	264.0	271.5	262.6	271.6	271.5	262.6	271.6	259.4	271.6	3,192.5
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	101.5	89.0	96.9	90.3	92.1	86.7	90.6	92.0	92.1	98.7	97.8	102.1	1,129.8
Total	451.6	408.0	455.7	457.9	512.3	531.2	592.4	576.9	523.6	505.5	457.3	466.5	5,939.0

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	900.8	751.2	547.8	228.7	75.1	9.7	-	1.5	8.5	107.7	387.3	722.8	3,741.2
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	53.9	51.0	56.8	52.1	50.7	43.7	40.8	39.0	37.0	40.2	45.3	48.8	559.2
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	954.7	802.2	604.6	280.8	125.7	53.4	40.8	40.5	45.5	147.9	432.6	771.7	4,300.4



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	12.1	11.4	14.2	18.5	36.0	55.1	80.7	69.4	45.8	26.4	15.7	14.0	399.3
Heat Reject.	0.3	0.3	0.4	1.0	4.9	9.8	17.4	14.0	7.8	2.6	0.8	0.5	59.8
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	1.2	1.0	0.9	0.5	0.2	0.0	0.0	0.0	0.0	0.2	0.7	1.0	5.7
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	27.7	25.6	29.3	30.0	40.7	45.6	52.8	51.0	41.4	35.6	27.6	28.3	435.5
Pumps & Aux.	31.0	28.1	31.6	31.3	33.4	33.2	35.8	34.8	32.7	33.0	31.0	30.8	386.7
Ext. Usage	28.9	24.2	24.1	20.6	18.9	17.0	18.1	20.2	22.2	25.7	27.3	29.5	276.8
Misc. Equip.	270.1	244.5	271.5	264.0	271.5	262.6	271.6	271.5	262.6	271.6	259.4	271.6	3,192.5
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	81.2	71.2	77.6	72.2	73.7	69.4	72.5	73.6	73.7	79.0	78.2	81.7	903.9
Total	452.5	406.2	449.6	438.1	479.2	492.7	548.9	534.5	486.2	474.2	440.8	457.3	5,660.2

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	500.3	412.0	315.3	142.0	49.2	6.2	1.7	1.6	6.2	66.8	229.6	402.5	2,133.3
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	53.9	51.0	56.8	52.1	50.7	43.7	40.8	39.0	37.0	40.2	45.4	48.8	559.3
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	554.2	463.0	372.1	194.0	99.9	49.9	42.5	40.6	43.2	107.0	274.9	451.3	2,692.6

Attachment U CBECS Sources Table

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Table C10. Consumption and Gross Energy Intensity by Climate Zone[a] for Non-Mall Buildings, 2003

	Sum of Major Fuel Consumption (trillion Btu)					Total Floorspace of Buildings (million square feet)					Energy Intensity for Sum of Major Fuels (thousand Btu/ square foot)				
	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
All Buildings*	990	1,761	1,134	1,213	724	10,622	17,335	11,504	15,739	9,584	93.2	101.6	98.5	77.0	75.5
Building Floorspace (Square Feet)															
1,001 to 5,000	143	187	90	170	95	1,313	1,709	1,010	1,915	975	108.7	109.6	88.8	89.0	97.9
5,001 to 10,000	110	137	91	156	69	1,248	1,725	1,077	2,024	959	88.1	79.3	84.6	77.1	71.7
10,001 to 25,000	183	286	146	166	118	2,406	3,506	1,498	3,176	2,073	75.9	81.6	97.6	52.3	56.9
25,001 to 50,000	146	212	125	152	107	1,547	2,424	1,382	2,381	1,647	94.4	87.6	90.3	63.7	64.8
50,001 to 100,000	149	273	183	191	118	1,480	2,780	2,011	2,352	1,668	100.8	98.0	90.8	81.2	70.6
100,001 to 200,000	117	336	187	283	141	1,311	2,889	1,881	2,597	1,538	89.4	116.3	99.2	109.1	91.7
200,001 to 500,000	129	226	168	136	94	1,150	2,007	1,678	1,612	1,047	111.8	112.5	99.8	84.1	89.6
Over 500,000	Q	272	254	132	Q	1,073	1,766	1,966	1,573	1,282	Q	153.8	129.4	83.9	Q
Principal Building Activity															
Education	141	238	131	186	123	1,537	2,800	1,403	2,435	1,698	91.6	85.2	93.5	76.6	72.6
Food Sales	Q	Q	Q	Q	Q	271	368	Q	273	Q	Q	Q	Q	Q	Q
Food Service	52	96	Q	134	Q	227	400	219	440	366	230.1	238.7	Q	305.4	Q
Health Care	96	161	108	145	83	475	784	564	844	496	202.4	205.8	191.4	171.9	167.7
Inpatient	65	127	Q	127	Q	262	450	323	592	278	246.1	283.3	Q	215.0	Q
Outpatient	Q	34	Q	Q	Q	213	334	240	252	218	Q	101.5	Q	Q	Q
Lodging	69	174	110	104	Q	768	1,314	1,132	1,275	608	90.1	132.1	Q	81.4	Q
Retail (Other Than Mall)	73	64	54	74	55	710	865	695	1,454	592	103.0	73.5	77.7	50.7	92.0
Office	145	364	298	162	165	1,593	3,165	3,125	2,341	1,985	90.7	114.9	95.4	69.3	83.2
Public Assembly	90	74	70	101	35	876	818	806	910	529	102.2	90.8	Q	111.1	65.8
Public Order and Safety	Q	Q	Q	Q	Q	Q	360	Q	Q	Q	Q	Q	Q	Q	Q
Religious Worship	26	62	26	31	19	408	1,320	499	1,039	488	62.9	46.9	52.8	29.4	38.2
Service	95	84	64	49	Q	944	1,185	644	969	308	100.4	71.2	99.5	50.3	Q
Warehouse and Storage	78	201	73	73	31	1,704	2,639	1,479	2,419	1,836	45.7	76.1	49.5	30.1	16.9
Other	Q	Q	Q	Q	Q	334	467	Q	Q	Q	Q	Q	Q	Q	Q
Vacant	Q	Q	Q	Q	Q	543	849	Q	569	318	Q	Q	Q	Q	Q
Year Constructed															
Before 1920	109	99	Q	Q	Q	1,227	1,413	731	290	Q	88.6	70.2	89.0	Q	Q
1920 to 1945	86	262	199	57	Q	1,089	2,266	1,985	1,239	405	79.3	115.5	100.2	45.7	Q
1946 to 1959	86	236	124	114	28	1,093	2,508	1,446	1,663	552	78.7	94.2	86.0	68.3	49.9
1960 to 1969	156	254	158	141	81	1,447	2,576	1,576	1,997	1,046	108.0	98.8	100.3	70.5	77.7
1970 to 1979	274	344	212	217	143	2,496	3,259	1,942	2,783	1,796	109.8	105.7	109.2	77.9	79.9
1980 to 1989	110	343	222	354	217	1,123	2,808	2,110	3,850	2,576	98.2	122.2	105.3	91.9	84.3
1990 to 1999	195	266	164	371	264	2,120	2,655	1,764	4,207	3,235	92.2	100.3	93.1	88.3	81.6
2000 to 2003	69	124	98	112	108	934	1,322	949	1,601	1,456	73.6	93.5	103.3	70.0	74.4
Census Region and Division															
Northeast	211	597	588	N	N	2,567	5,989	5,440	N	N	82.2	99.8	108.0	N	N
New England	62	282	N	N	N	Q	2,463	N	N	N	63.1	114.5	N	N	N
Middle Atlantic	Q	315	588	N	N	1,577	3,526	5,440	N	N	94.2	89.4	108.0	N	N
Midwest	573	1,112	114	N	N	5,910	10,584	1,609	N	N	97.0	105.1	70.5	N	N
East North Central	333	1,010	N	N	N	3,208	9,215	N	N	N	103.8	109.6	N	N	N
West North Central	240	102	114	N	N	2,702	Q	1,609	N	N	88.9	74.6	70.5	N	N
South	N	N	472	997	796	N	N	4,736	11,506	10,497	N	N	99.7	86.6	75.8
South Atlantic	N	N	311	635	296	N	N	3,065	7,126	3,807	N	N	101.4	89.0	77.7
East South Central	N	N	Q	Q	Q	N	N	Q	Q	Q	N	N	112.3	78.5	98.9
West South Central	N	N	Q	195	457	N	N	Q	2,255	6,258	N	N	Q	86.7	73.0
West	302	219	Q	389	84	3,052	2,234	718	6,125	692	99.0	98.2	96.4	63.5	121.0
Mountain	244	136	N	N	65	2,446	1,181	N	N	580	99.9	115.5	N	N	112.9
Pacific	Q	83	Q	389	Q	Q	Q	718	6,125	Q	95.1	78.8	96.4	63.5	Q

Table US1. Total Energy Consumption, Expenditures, and Intensities, 2005
Part 1: Housing Unit Characteristics and Energy Usage Indicators

Housing Unit Characteristics and Energy Usage Indicators	U.S. Households (millions)	Number of Members per Household	Floorspace per Household (Square Feet)	Energy Consumption[2] Total U.S. (quadrillion Btu)	Energy Consumption[2] Per Household (million Btu)	Energy Consumption[2] Per Household Member (million Btu)	Energy Consumption[2] Per Square Foot (thousand Btu)	Energy Expenditures[2] Total U.S. (billion Dollars)	Energy Expenditures[2] Per Household (Dollars)	Energy Expenditures[2] Per Household Member (Dollars)	Energy Expenditures[2] Per Square Foot (Dollars)
Climate Zone[1]											
Less than 2,000 CDD and--											
Greater than 7,000 HDD	10.9	2.49	2,534	1.29	117.9	47.4	46.5	21.67	1,982	797	0.78
5,500 to 7,000 HDD	26.1	2.50	2,346	3.00	115.0	45.9	49.0	49.37	1,894	756	0.81
4,000 to 5,499 HDD	27.3	2.60	2,205	2.78	101.7	39.1	46.1	50.74	1,859	715	0.84
Fewer than 4,000 HDD	24.0	2.61	1,966	1.83	76.4	29.2	38.8	38.05	1,587	607	0.81
2000 CDD or More and--											
Less than 4,000 HDD	22.8	2.60	1,971	1.65	72.4	27.9	36.7	41.23	1,808	696	0.92
Type of Housing Unit and Number of Bedrooms											
Single-Family Homes											
Detached	72.1	2.73	2,720	7.81	108.4	39.7	39.8	148.42	2,060	755	0.76
Less than 3 Bedrooms	12.3	2.06	1,917	1.09	89.0	43.3	46.4	20.50	1,671	812	0.87
3 Bedrooms	38.8	2.65	2,568	3.91	100.9	38.1	39.3	74.63	1,924	727	0.75
4 Bedrooms	17.1	3.14	3,370	2.18	127.5	40.6	37.8	41.47	2,424	771	0.72
5 or More Bedrooms	3.9	3.81	3,920	0.62	160.2	42.1	40.9	11.82	3,043	799	0.78
Attached	7.6	2.48	1,941	0.68	89.3	36.1	46.0	12.14	1,598	645	0.82
Less than 3 Bedrooms	3.5	2.03	1,414	0.26	74.1	36.5	52.4	4.62	1,320	650	0.93
3 Bedrooms	3.2	2.67	2,124	0.31	96.3	36.1	45.3	5.56	1,753	657	0.83
4 or More Bedrooms	0.9	3.53	3,307	0.11	123.1	34.9	37.2	1.95	2,116	600	0.64
Apartments in											
2 to 4 Unit Buildings	7.8	2.42	1,090	0.66	85.0	35.1	78.0	12.06	1,556	643	1.43
Less than 2 Bedrooms	2.0	1.71	809	0.16	79.1	46.3	97.8	2.65	1,346	788	1.66
2 Bedrooms	4.3	2.45	1,092	0.32	74.7	30.5	68.4	5.96	1,383	565	1.27
3 or More Bedrooms	1.5	3.29	1,459	0.18	123.0	37.4	84.3	3.45	2,342	712	1.60
5 or More Unit Buildings	16.7	2.04	872	0.91	54.4	26.7	62.4	18.03	1,077	528	1.24
Less than 2 Bedrooms	7.9	1.47	672	0.37	46.4	31.7	69.0	7.21	914	624	1.36
2 Bedrooms	7.4	2.34	978	0.45	60.7	25.9	62.1	8.88	1,195	510	1.22
3 or More Bedrooms	1.4	3.64	1,425	0.09	66.2	18.2	46.5	1.94	1,365	375	0.96
Mobile Homes	6.9	2.47	1,059	0.49	70.4	28.5	66.5	10.42	1,501	608	1.42
Less than 3 Bedrooms	3.5	2.05	838	0.22	63.0	30.8	75.2	4.64	1,339	654	1.60
3 or More Bedrooms	3.5	2.89	1,279	0.27	77.8	26.9	60.8	5.78	1,663	575	1.30

highlighted entries are used in EUI comparison

Attachment V Solar Study Attachments

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Alternative 1

Solar PV Financial Analysis Template
Inputs and Assumptions

Items in red require Proponent scrutiny

Project and Customer Cost Assumptions	**Value**	**Units**	**Source**
Solar Photovoltaic System Size			
Available Roof Area	70,000	sf	estimate
available area paneled (allowance for interpanel spacing, setback from roof edge, equipment shadow, etc.)	50%		estimate
Panel area	35,000	sf	calc.
Panel rating	12	W/sf DC	estimate
PV array	420	kW peak DC	calc.
Total System Cost/Watt			
installed cost	5.80	$/W rated DC	MassCEC database, average of 10 projects of closest capacity
multiplier for roof structure	1		estimate
Installed cost	5.80	$/W rated DC	calc.
Project Performance and Savings/ Cost Assumptions			
Annual Net Capacity Factor	not used: Used PVWatt output directly as 1st year output, cell D47		Model default represents estimate of MA average. Recent DOER info indicates 13.21% actual. {PVWatt is more project-specific.
Annual Production Degradation	model default		
Project Life	20	yrs	assumed
Depreciation Life	model default		
Electricity Revenue (Avoided Costs)	0.13	$/kWh	recent project experience
Electricity Revenue (Avoided Costs) Annual Adjustor	3%		assumed
Solar Renewable Energy Certificate (SREC) Auction Price	0.257		floor price from draft regulations
SREC Auction Opt-In Term	model default		
SREC Revenue Annual Adjustor	model default		
Annual Operations and Maintenance Cost Factor	model default		
Annual Operations and Maintenance Adjustor	model default		
Future Inverter Replacement Cost	model default		
Inverter Life, Replace Every X Years	15	yrs	industry standard
Tax Assumptions	model default		
Financing Assumptions			
% Financed w/ Cash	100%		assumed
% Financed w/ Loan	0%		calc.
Loan Interest Rate	9%		
Loan Period	20	yrs	
Customer Discount Rate	8%		

Alternative 1, Third Party Owned

Solar Photovoltaic Project Simple Financial Model

Key

Entry Cells	(green)
Calculation Cells (Not for Entry)	(yellow)

Select Taxable or Non-Taxable Entity	Taxable	
Project and Customer Cost Assumptions		
Solar Photovoltaic System Size	420000	Watts (DC STC)
Total System Cost/Watt	$ 5.800	$/Watt (DC STC)
Total System Cost	$ 2,436,000.00	
CEC Rebate Assumptions		
Rebate$ per/Watt	$ -	$/Watt (DC STC)
Total Rebate		
Project Performance and Savings/ Cost Assumptions		
Annual Net Capacity Factor	see Inputs and Assumptions	kW (DC STC) to kWh AC
Annual Production Degradation	0.50%	%
Project Life	20	Years
Depreciation Life	20	Years
Electricity Revenue (Avoided Costs)	$ 0.13	$/kWh
Electricity Revenue (Avoided Costs) Annual Adjustor	3.0%	%
Solar Renewable Energy Certificate (SREC) Auction Price	$ 0.257	$/kWh
SREC Auction Opt-In Term	10	Years (must be equal to or less than project life)
SREC Revenue Annual Adjustor	0.0%	%
SREC Contract Price		$/kWh
SREC Contract Term		Years (must be equal to or less than project life)
Annual Operations and Maintenance Cost Factor	$ 17.59	$/kW/Year
Annual Operations and Maintenance Cost	$ 7,388	$/Year
Annual Operations and Maintenance Adjustor	3.0%	%
Future Inverter Replacement Cost	$ 0.30	$/Watt (DC STC)
Inverter Life, Replace Every X Years	15	Year (must be equal to or less than project life)

Tax Assumptions	
Federal Tax Rate	35%
State Tax Rate	10%
Effective Tax Rate	42%
Federal Tax Credit	30%
State Tax Deduction	100%
5 Year Accelerated Depreciation Schedule (MACRS)	20.00%
Depreciation	20.00%
Asset Basis	
Gross Cost	$ 2,436,000
Rebate	$ -
Less 50% of Federal Tax Credit	$ (365,400)
Asset Basis	$ 2,070,600
Financing Assumptions	
% Financed w/ Cash	100%
% Financed w/ Loan	0%
Loan Interest Rate	9.00%
Loan Period	20
Net Cost	$ 2,436,000
Customer Discount Rate	8.00%
Loan	$ -

Solar Project Financial Analysis Summary	
Net Present Value	**$ (152,122)**
Simple Payback (100% Cash only)	**Year 8**
Estimated Return on Equity	**5.7%**

Alternative 1, MassDOT Owned

Solar Photovoltaic Project Simple Financial Model

Key

Entry Cells	
Calculation Cells (Not for Entry)	

Select Taxable or Non-Taxable Entity — Non-Taxable

Project and Customer Cost Assumptions

Solar Photovoltaic System Size	420000	Watts (DC STC)
Total System Cost/Watt	$ 5.800	$/Watt (DC STC)
Total System Cost	$ 2,436,000.00	

CEC Rebate Assumptions

Rebate$ per/Watt	$ -	$/Watt (DC STC)
Total Rebate		

Project Performance and Savings/ Cost Assumptions

Annual Net Capacity Factor	see Inputs and Assumptions	kW (DC STC) to kWh AC
Annual Production Degradation	0.50%	%
Project Life	20	Years
Depreciation Life	20	Years
Electricity Revenue (Avoided Costs)	$ 0.13	$/kWh
Electricity Revenue (Avoided Costs) Annual Adjustor	3.0%	%
Solar Renewable Energy Certificate (SREC) Auction Price	$ 0.257	$/kWh
SREC Auction Opt-In Term	10	Years (must be equal to or less than project life)
SREC Revenue Annual Adjustor	0.0%	%
SREC Contract Price		$/kWh
SREC Contract Term		Years (must be equal to or less than project life)
Annual Operations and Maintenance Cost Factor	$ 17.59	$/kW/Year
Annual Operations and Maintenance Cost	$ 7,388	$/Year
Annual Operations and Maintenance Adjustor	3.0%	%
Future Inverter Replacement Cost	$ 0.30	$/Watt (DC STC)
Inverter Life, Replace Every X Years	15	Year (must be equal to or less than project life)

Tax Assumptions

Federal Tax Rate	35%
State Tax Rate	10%
Effective Tax Rate	42%
Federal Tax Credit	30%
State Tax Deduction	100%
5 Year Accelerated Depreciation Schedule (MACRS)	20.00%
Depreciation	5.00%
Asset Basis	
Gross Cost	$ 2,436,000
Rebate	$ -
Less 50% of Federal Tax Credit	$ -
Asset Basis	$ 2,436,000

Financing Assumptions

% Financed w/ Cash	100%
% Financed w/ Loan	0%
Loan Interest Rate	9.00%
Loan Period	20
Net Cost	$ 2,436,000
Customer Discount Rate	8.00%
Loan	$ -

Solar Project Financial Analysis Summary

Net Present Value	**$ (1,078,731)**
Simple Payback (100% Cash only)	**Year**
Estimated Return on Equity	**-0.4%**

Cost Data is not used - see separate calcs for project specific costing

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at http://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

RESULTS

461,603 kWh per Year

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Energy Value ($)
January	2.22	22,045	2
February	3.27	30,035	3
March	3.99	39,666	4
April	4.76	44,633	4
May	5.73	53,467	5
June	5.85	51,508	5
July	6.19	55,338	6
August	5.59	50,929	5
September	4.64	41,336	4
October	3.42	32,375	3
November	2.42	22,021	2
December	1.95	18,249	2
Annual	**4.17**	**461,603**	**$ 46**

Location and Station Identification

Requested Location	Boston South Station
Weather Data Source	BOSTON LOGAN INT'L ARPT, MASSACHUSETTS (TMY3)
Latitude	42.37° N
Longitude	71.02° W

PV System Specifications *(Commercial)*

DC Rating	420 kW
DC to AC Derate Factor	0.77
Array Type	Fixed (roof mount)
Array Tilt	10°
Array Azimuth	180°

Initial Economic Comparison

Average Cost of Electricity Purchased from Utility	0.00 $/kWh
Cost of Electricity Generated by System	0.32 $/kWh

These values can be compared to get an idea of the cost-effectiveness of this system. However, system costs, system financing options (including 3rd party ownership) and complex utility rates can significantly change the relative value of the PV system.

Alternative 3

Solar PV Financial Analysis Template
Inputs and Assumptions

Items in red require Proponent scrutiny

Project and Customer Cost Assumptions	Value	Units	Source
Solar Photovoltaic System Size			
Available Roof Area	25,000	sf	estimate
available area paneled (allowance for interpanel spacing, setback from roof edge, equipment shadow, etc.)	50%		estimate
Panel area	12,500	sf	calc.
Panel rating	12	W/sf DC	estimate
PV array	150	kW peak DC	calc.
Total System Cost/Watt			
installed cost	6.30	$/W rated DC	MassCEC database, average of 10 projects of closest capacity
multiplier for roof structure	1		estimate
Installed cost	6.30	$/W rated DC	calc.
Project Performance and Savings/ Cost Assumptions			
Annual Net Capacity Factor	not used: Used PVWatt output directly as 1st year output, cell D47		Model default represents estimate of MA average. Recent DOER info indicates 13.21% actual. {PVWatt is more project-specific.
Annual Production Degradation	model default		
Project Life	20	yrs	assumed
Depreciation Life	model default		
Electricity Revenue (Avoided Costs)	0.13	$/kWh	recent project experience
Electricity Revenue (Avoided Costs) Annual Adjustor	3%		assumed
Solar Renewable Energy Certificate (SREC) Auction Price	0.257		floor price from draft regulations
SREC Auction Opt-In Term	model default		
SREC Revenue Annual Adjustor	model default		
Annual Operations and Maintenance Cost Factor	model default		
Annual Operations and Maintenance Adjustor	model default		
Future Inverter Replacement Cost	model default		
Inverter Life, Replace Every X Years	15	yrs	industry standard
Tax Assumptions	model default		
Financing Assumptions			
% Financed w/ Cash	100%		assumed
% Financed w/ Loan	0%		calc.
Loan Interest Rate	9%		
Loan Period	20	yrs	
Customer Discount Rate	8%		

Alternative 3, Third Party Owned

Solar Photovoltaic Project Simple Financial Model

Key

Entry Cells		
Calculation Cells (Not for Entry)		
Select Taxable or Non-Taxable Entity	Taxable	
Project and Customer Cost Assumptions		
Solar Photovoltaic System Size	150000	Watts (DC STC)
Total System Cost/Watt	$ 6.300	$/Watt (DC STC)
Total System Cost	$ 945,000.00	
CEC Rebate Assumptions		
Rebate$ per/Watt	$ -	$/Watt (DC STC)
Total Rebate		
Project Performance and Savings/ Cost Assumptions		
Annual Net Capacity Factor	see Inputs and Assumptions	kW (DC STC) to kWh AC
Annual Production Degradation	0.50%	%
Project Life	20	Years
Depreciation Life	20	Years
Electricity Revenue (Avoided Costs)	$ 0.13	$/kWh
Electricity Revenue (Avoided Costs) Annual Adjustor	3.0%	%
Solar Renewable Energy Certificate (SREC) Auction Price	$ 0.257	$/kWh
SREC Auction Opt-In Term	10	Years (must be equal to or less than project life)
SREC Revenue Annual Adjustor	0.0%	%
SREC Contract Price		$/kWh
SREC Contract Term		Years (must be equal to or less than project life)
Annual Operations and Maintenance Cost Factor	$ 17.59	$/kW/Year
Annual Operations and Maintenance Cost	$ 2,639	$/Year
Annual Operations and Maintenance Adjustor	3.0%	%
Future Inverter Replacement Cost	$ 0.30	$/Watt (DC STC)
Inverter Life, Replace Every X Years	15	Year (must be equal to or less than project life)

Tax Assumptions	
Federal Tax Rate	35%
State Tax Rate	10%
Effective Tax Rate	42%
Federal Tax Credit	30%
State Tax Deduction	100%
5 Year Accelerated Depreciation Schedule (MACRS)	20.00%
Depreciation	20.00%
Asset Basis	
Gross Cost	$ 945,000
Rebate	$ -
Less 50% of Federal Tax Credit	$ (141,750)
Asset Basis	$ 803,250
Financing Assumptions	
% Financed w/ Cash	100%
% Financed w/ Loan	0%
Loan Interest Rate	9.00%
Loan Period	20
Net Cost	$ 945,000
Customer Discount Rate	8.00%
Loan	$ -

Solar Project Financial Analysis Summary	
Net Present Value	**$ (83,477)**
Simple Payback (100% Cash only)	**Year 9**
Estimated Return on Equity	**4.7%**

Alternative 3, MassDOT Owned

Solar Photovoltaic Project Simple Financial Model

Key

Entry Cells	
Calculation Cells (Not for Entry)	

Select Taxable or Non-Taxable Entity	Non-Taxable	
Project and Customer Cost Assumptions		
Solar Photovoltaic System Size	150000	Watts (DC STC)
Total System Cost/Watt	$ 6.300	$/Watt (DC STC)
Total System Cost	$ 945,000.00	
CEC Rebate Assumptions		
Rebate$ per/Watt	$ -	$/Watt (DC STC)
Total Rebate		
Project Performance and Savings/ Cost Assumptions		
Annual Net Capacity Factor	see Inputs and Assumptions	kW (DC STC) to kWh AC
Annual Production Degradation	0.50%	%
Project Life	20	Years
Depreciation Life	20	Years
Electricity Revenue (Avoided Costs)	$ 0.13	$/kWh
Electricity Revenue (Avoided Costs) Annual Adjustor	3.0%	%
Solar Renewable Energy Certificate (SREC) Auction Price	$ 0.257	$/kWh
SREC Auction Opt-In Term	10	Years (must be equal to or less than project life)
SREC Revenue Annual Adjustor	0.0%	%
SREC Contract Price		$/kWh
SREC Contract Term		Years (must be equal to or less than project life)
Annual Operations and Maintenance Cost Factor	$ 17.59	$/kW/Year
Annual Operations and Maintenance Cost	$ 2,639	$/Year
Annual Operations and Maintenance Adjustor	3.0%	%
Future Inverter Replacement Cost	$ 0.30	$/Watt (DC STC)
Inverter Life, Replace Every X Years	15	Year (must be equal to or less than project life)

Tax Assumptions	
Federal Tax Rate	35%
State Tax Rate	10%
Effective Tax Rate	42%
Federal Tax Credit	30%
State Tax Deduction	100%
5 Year Accelerated Depreciation Schedule (MACRS)	20.00%
Depreciation	5.00%
Asset Basis	
Gross Cost	$ 945,000
Rebate	$ -
Less 50% of Federal Tax Credit	$ -
Asset Basis	$ 945,000
Financing Assumptions	
% Financed w/ Cash	100%
% Financed w/ Loan	0%
Loan Interest Rate	9.00%
Loan Period	20
Net Cost	$ 945,000
Customer Discount Rate	8.00%
Loan	$ -

Solar Project Financial Analysis Summary	
Net Present Value	$ (460,262)
Simple Payback (100% Cash only)	Year
Estimated Return on Equity	-1.3%

Cost Data is not used - see separate calcs for project specific costing

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at http://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

RESULTS

164,858 kWh per Year

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Energy Value ($)
January	2.22	7,873	1
February	3.27	10,727	1
March	3.99	14,167	1
April	4.76	15,940	2
May	5.73	19,096	2
June	5.85	18,396	2
July	6.19	19,764	2
August	5.59	18,189	2
September	4.64	14,763	1
October	3.42	11,562	1
November	2.42	7,865	1
December	1.95	6,517	1
Annual	**4.17**	**164,858**	**$ 16**

Location and Station Identification

Requested Location	Boston South Station
Weather Data Source	BOSTON LOGAN INT'L ARPT, MASSACHUSETTS (TMY3)
Latitude	42.37° N
Longitude	71.02° W

PV System Specifications *(Commercial)*

DC Rating	150 kW
DC to AC Derate Factor	0.77
Array Type	Fixed (roof mount)
Array Tilt	10°
Array Azimuth	180°

Initial Economic Comparison

Average Cost of Electricity Purchased from Utility	0.00 $/kWh
Cost of Electricity Generated by System	0.35 $/kWh

These values can be compared to get an idea of the cost-effectiveness of this system. However, system costs, system financing options (including 3rd party ownership) and complex utility rates can significantly change the relative value of the PV system.

Attachment W Layover Locomotive CO_2 Emissions

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	Number of Trains Per Day	Idle Time per Train (Hours)	Total Idling Time (Mins)	Idling Time (Secs)	Idling Emissions CO2 (grams/day)	One Way Max Moving Time (Mins)	Round Trip Max Moving Time (Hours)	Moving Emissions CO2 (grams/day)
WIDETT CIRCLE LAYOVER								
Existing Conditions	0	1:00	0	0	0.0	0	0.000	0.0
2025 No Build	0	1:00	0	0	0.0	0	0.000	0.0
2025 Build	30	1:00	1800	108000	12137796.0	5	0.167	2160895.5
2035 No Build	0	1:00	0	0	0.0	0	0.000	0.0
2035 Build	30	1:00	1800	108000	12137796.0	5	0.167	2160895.5
BEACON PARK YARD LAYOVER								
Existing Conditions	0	1:00	0	0	0.0	0	0.000	0.0
2025 No Build	0	1:00	0	0	0.0	0	0.000	0.0
2025 Build	20	1:00	1200	72000	8091864.0	11	0.367	3169313.4
2035 No Build	0	1:00	0	0	0.0	0	0.000	0.0
2035 Build	20	1:00	1200	72000	8091864.0	11	0.367	3169313.4
READVILLE YARD 2 LAYOVER								
Existing Conditions	10	1:00	600	36000	4045932.0	26	0.867	3745552.2
2025 No Build	10	1:00	600	36000	4045932.0	26	0.867	3745552.2
2025 Build	18	1:00	1080	64800	7282677.6	26	0.867	6741994.0
2035 No Build	10	1:00	600	36000	4045932.0	26	0.867	3745552.2
2035 Build	18	1:00	1080	64800	7282677.6	26	0.867	6741994.0

	Idling Trains CO2 (Tons/Yr)	Moving Trains CO2 (Tons/Yr)	Total Idling + Moving CO2 (Tons/Yr)
WIDETT CIRCLE LAYOVER			
Existing Conditions	0.0	0.0	0.0
2025 No Build	0.0	0.0	0.0
2025 Build	4883.5	869.4	5752.9
2035 No Build	0.0	0.0	0.0
2035 Build	4883.5	869.4	5752.9
BEACON PARK YARD LAYOVER (with 20 Trains)			
Existing Conditions	0.0	0.0	0.0
2025 No Build	0.0	0.0	0.0
2025 Build	3255.7	1275.1	4530.8
2035 No Build	0.0	0.0	0.0
2035 Build	3255.7	1275.1	4530.8
READVILLE YARD 2 LAYOVER			
Existing Conditions	1627.8	1507.0	3134.8
2025 No Build	1627.8	1507.0	3134.8
2025 Build	2930.1	2712.6	5642.7
2035 No Build	1627.8	1507.0	3134.8
2035 Build	2930.1	2712.6	5642.7

Average layover time of 60 minutes, 30 minutes after arrival plus 30 minutes before departure.

ASSUMPTIONS*:

Throttle Notch and Fuel Consumption rates are from:

Locomotive Emission Standards EPA-420-R-98-101 April 1998,

http://www.epa.gov/otaq/documents/420r98101.pdf

All MBTA locomotives use EMD 16-645E3B ENGINE

ASSUME ONLY IDLING AND NOTCH 1 WILL BE USED IN THE STUDY AREA

MBTA IDLING FUEL CONSUMPTION RATE	39.6	gallon/hr
MBTA MOVING FUEL CONSUMPTION RATE	42.3	gallon/hr
CO2 EMISSION RATE	10217	g/gallon fuel
MBTA Locomotives Idling Power Rating (hp)	17	

9b. MBTA Locomotives power rating at Notch 1 (hp) 105

http://www.epa.gov/nonroad/locomotv/420f09025.pdf

**Assumptions based on data from the Layover Facility Alternatives Analysis. Massachusetts Department of Transportation. March 2013.*

Attachment X CTPS Regional AQ Summary

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South Station Expansion

Summary Of Regional Air Quality Results

(Emissions in kilograms)

	AM (6 - 9 AM)					MD (9AM - 3PM)					PM (3 - 6 PM)					NT (6PM - 12AM)					DAILY				
Regional Total	Base Year	2035 No Build	2035 TIO	2035 MAX LU	2035 MIN LU	Base Year	2035 No Build	2035 TIO	2035 MAX LU	2035 MIN LU	Base Year	2035 No Build	2035 TIO	2035 MAX LU	2035 MIN LU	Base Year	2035 No Build	2035 TIO	2035 MAX LU	2035 MIN LU	Base Year	2035 No Build	2035 TIO	2035 MAX LU	2035 MIN LU
CO	79,439	59,564	59,312	59,358	59,347	129,305	97,569	97,464	97,452	97,434	92,533	69,153	68,929	68,993	68,999	104,684	80,222	80,121	80,092	80,092	406,062	306,605	305,923	305,991	305,969
NOx	14,211	5,557	5,542	5,546	5,545	25,010	9,559	9,547	9,545	9,544	16,130	6,217	6,202	6,207	6,207	17,353	6,823	6,814	6,813	6,813	73,535	28,984	28,933	28,939	28,936
VOC	2,276	1,176	1,170	1,172	1,171	4,003	2,033	2,029	2,028	2,028	2,812	1,451	1,445	1,448	1,447	2,790	1,435	1,433	1,433	1,432	11,914	6,127	6,110	6,113	6,112
CO2	9,000,438	7,931,175	7,893,681	7,905,345	7,903,596	15,682,012	13,915,673	13,892,829	13,886,869	13,884,783	11,492,867	10,137,071	10,098,195	10,116,586	10,114,115	11,595,023	10,068,696	10,052,719	10,051,186	10,049,831	47,813,393	42,095,665	41,980,474	42,003,037	41,995,375
SO2	229	202	201	201	201	401	355	354	354	354	293	259	258	258	258	296	257	257	257	257	1,220	1,072	1,069	1,070	1,070
PM10	377	182	182	182	182	623	236	235	235	235	374	164	163	164	164	387	198	197	197	197	1,761	780	780	780	780
PM2.5	384	196	196	196	196	628	254	254	254	254	380	177	177	177	177	392	210	210	210	210	1,800	854	853	853	853

Notes:

CO emissions assumed for January. Other emissions assumed for July.

Transit emission factors are from FTA 2013 New Starts guidance

FTA does not have transit emissions factors for SO2 nor PM10. Hence transit emissions for these 2 pollutants were not calculated.

FTA's transit emission factor for CO2 is for CO2 equivalents (CO2e). Hence, these CO2e numbers were incorporated into the overall CO2 totals

FTA provides emission factors for 2 types of diesel commuter rail locomotives - Used/Current and Brand New. The emissions in this chart were calculated assumed the used/current locomotive factors.

Daily emissions totals will not equal the sum of the 4 time periods because they also incorporate transit boat emissions, which was only available on a daily basis.

Emissions reductions from auto diversions due to South Coast Rail considered in this analysis.

Attachment Y Correspondence

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H J

The Commonwealth of Massachusetts

William Francis Galvin, Secretary of the Commonwealth
Massachusetts Historical Commission

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MEPA

April 9, 2013

Secretary Richard K. Sullivan, Jr.
Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston MA 02114

ATTN: Holly Johnson, MEPA Unit

RE: South Station Expansion Project, Summer Street & Atlantic Avenue, Boston (Downtown), MA; MHC# RC.53253, **EEA# 15028**

Dear Secretary Sullivan:

The Massachusetts Historical Commission (MHC) is in receipt of an Environmental Notification Form (ENF) for the project referenced above. The staff of the Massachusetts Historical Commission (MHC) has reviewed the information submitted and has the following comments.

This project involves the proposed expansion of terminal facilities at South Station ("SSX project"), including acquisition and demolition of the US Postal Service mail distribution facility located adjacent to South Station at 25 Dorchester Avenue, the proposed extension of the Boston Harborwalk along a reopened Dorchester Avenue, provisions for the potential future public/private redevelopment adjacent to and over an expanded South Station, and a provision for rail vehicle layover areas for both intercity and commuter rail services. The ENF notes that the SSX project, regardless of the alternative ultimately chosen, will involve funding and permitting from the Federal Railroad Administration (FRA) and other federal agencies, including the U.S. Department of Transportation, and is therefore subject to review under Section 106 of the National Historic Preservation Act (36 CFR 800), Section 4(f) of the Department of Transportation Act (23 CFR 774) and NEPA.

The proposed project site includes the South Station Head House (BOS.1517) which is individually listed on the State and National Registers of Historic Places, and is adjacent to the Leather District Historic District (BOS.AP) and the Fort Point Channel Historic District (BOS.CX), which are also listed in the State and National Registers.

The No Build Alternative included in the ENF would involve no private development or expansion of South Station beyond the previously proposed South Station Air Rights project. The South Station Air

Rights project (EEA# 3205/9131; MHC# RC.9138) was previously reviewed by the MHC. After consultation with the MBTA regarding this separate project, the MHC and the MBTA entered into a Memorandum of Agreement (MOA) for that project. The MHC expects that any potential changes to the separate air rights project would be subject to consultation with the MHC under the terms of the existing MOA.

The ENF notes that MassDOT has not currently identified a preferred build-out alternative for the SSX project, but that MassDOT will include an alternatives analysis in the Draft EIR. The MHC looks forward to receipt of the DEIR and to the FRA's identification of an Area of Potential Effects (APE), identification and evaluation of historic resources within the APE, and finding of effects for the project alternatives.

The Draft EIR and the FRA's identification, evaluation, and findings of effect should take into account the proposed demolition of the USPS General Mail Facility/South Postal Annex, as well as the potential physical effects on the South Station Head House through vibration and construction methods. The Draft EIR and FRA's Section 106 review should also take into account the potential visual, atmospheric, and physical effects (through shadow and wind) that the proposed new construction would have on surrounding historic properties (especially the South Station Head House) as part of the Joint/Private Development Minimum Build alternative and the Joint Private Development Maximum Build alternative. Studies should also be performed for the potential effects of the proposed Layover Facilities alternatives on any nearby historic properties.

The MHC expects that continued consultation with MassDOT, the MBTA, and the FRA will include MassDOT's preparation of a reconnaissance level architectural resources survey of the entire project site and architectural APE, as well as a Phase I Archaeological Reconnaissance Survey, as described in Attachment A, page 11 of the ENF. The MHC looks forward to the result of these surveys and continued consultation on this project.

These comments are offered to assist in compliance with Section 106 of the National Historic Preservation Act of 1966 (36 CFR 800), M.G.L. Chapter 9, Section 26-27C, (950 CMR 71.00) and MEPA (301 CMR 11). Please do not hesitate to contact Brandee Loughlin of my staff if you have any questions.

Sincerely,

Brona Simon

Brona Simon
State Historic Preservation Officer
Executive Director
Massachusetts Historical Commission

xc: Michelle Fishburne, Federal Railroad Administration
Mary Beth Mello, Federal Transit Adminstration
Katherine Fichter, MassDOT
Andrew Brennan, MBTA
Boston Landmarks Commission
Boston Preservation Alliance

Public Archaeology Laboratory

June 5, 2013

Brona Simon
State Historic Preservation Officer
Executive Director
Massachusetts Historical Commission
220 Morrissey Boulevard
Boston, Massachusetts 02125

Re: South Station Expansion Project, Boston, Massachusetts
Archaeological Reconnaissance Survey
PAL #2728, MHC #RC.53253

Dear Ms. Simon:

Enclosed please find an application for a permit to conduct an archaeological reconnaissance survey. This application concerns the MassDOT's South Station Expansion Project in Boston, Massachusetts. The project area is located on the Boston South, Newton, and Norwood, Massachusetts topographic quadrangles. We would like to begin investigations as soon as possible. Thank you in advance for your time and attention to this matter.

If you have any questions or concerns, please do not hesitate to contact Suzanne Cherau, Principal Investigator, or me, at your convenience.

Sincerely,

Deborah C. Cox

Deborah C. Cox, RPA
President

Enclosure

cc: Katherine Fichter, MassDOT (w/encl.)
Andrew Brennan, MBTA (w/encl.)
Joe Grilli, HNTB (w/encl.)

950 CMR: DEPARTMENT OF THE STATE SECRETARY

APPENDIX B
COMMONWEALTH OF MASSACHUSETTS

SECRETARY OF STATE: MASSACHUSETTS HISTORICAL COMMISSION

PERMIT APPLICATION: ARCHAEOLOGICAL FIELD INVESTIGATION

A. General Information

Pursuant to Section 27(c) of Chapter 9 of the General Laws and according to the regulations outlined in 950 CMR 70.00, a permit to conduct a field investigation is hereby requested.

1. Name(s): Suzanne Cherau

2. Institution: The Public Archaeology Laboratory, Inc.

   Address: 26 Main Street
   Pawtucket, Rhode Island 02860

3. Project Location:

   see attached proposal

4. Town(s): Boston

5. Attach a copy of a USGS quadrangle with the project area clearly marked.

   see attached

6. Property Owner(s): MBTA; City of Boston; Harvard University Beacon Yards, LLC; New Boston Food Market; Art Mortgage Borrower; National Railroad Passenger Corp.

7. The applicant affirms that the owner has been notified and has agreed that the applicant may perform the proposed field investigation.

8. The proposed field investigation is for a(n):

   a. Reconnaissance Survey
   b. Intensive Survey
   c. Site Examination
   d. Data Recovery

B. Professional Qualifications

1. Attach a personnel chart and project schedule as described in 950 CMR 70.11 (b).

a. Personnel

Principal Investigator(s): Suzanne Cherau

Project Archaeologist(s): Jennifer Banister

b. Schedule

Research: June – July 2013

Fieldwork: June 2013

Report: August 2013

2. Include copies of curriculum vitae of key personnel (unless already on file with the State Archaeologist).

C. Research Design

1. Attach a narrative description of the proposed Research Design according to the requirements of 950 CMR 70.11.

2. The Applicant agrees to perform the field investigations according to the standards outlined in 950 CMR 70.13.

3. The Applicant agrees to submit a Summary Report, prepared according to the standards outlined in 950 CMR 70.14 by: November 30, 2013

4. The specimens recovered during performance of the proposed field investigation will be curated at:

The Public Archaeology Laboratory, Inc.
26 Main Street
Pawtucket, Rhode Island 02860

SIGNATURE Suzanne G. Cherau June 5, 2013

APPLICANT(S) DATE

The Commonwealth of Massachusetts

William Francis Galvin, Secretary of the Commonwealth
Massachusetts Historical Commission

PERMIT TO CONDUCT ARCHAEOLOGICAL FIELD INVESTIGATION

Permit Number 3397 Date of Issue June 18, 2013

Expiration Date June 18, 2014

PAL is hereby authorized to conduct an archaeological field investigation pursuant to Section 27C of Chapter 9 of General Laws and according to the regulations outlined in 950 CMR 70.00.

South Station Expansion Project, Boston (Allston, Hyde Park, Downtown)

Project Location

Brona Simon

Brona Simon, State Archaeologist
Massachusetts Historical Commission

220 Morrissey Boulevard, Boston, Massachusetts 02125
(617) 727-8470 • Fax: (617) 727-5128
www.state.ma.us/sec/mhc

Attachment Z National Register of Historic Places Nomination Forms (Excerpted)

Attachment Z includes copies of National Register of Historic Places nomination forms (excerpted) that are on file at the MHC and BLC. Forms in Attachment Z are:

- Commercial Palace Historic District
- Fort Point Channel Historic District
- Fort Point Channel Historic District
- Leather District
- Russia Wharf Buildings
- South Station Headhouse

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NPS Form 10-900
(3-82)

OMB No. 1024-0018
Exp. 10-31-84

United States Department of the Interior
National Park Service

For NPS use only

received

date entered

National Register of Historic Places Inventory—Nomination Form

See instructions in *How to Complete National Register Forms*
Type all entries—complete applicable sections

1. Name

historic Commercial Palace Historic District

and/or common Same

2. Location

street & number bounded roughly by Bedford, Sumner, Devonshire, Franklin, Hawley & Chauncy Streets n/a not for publication

city, town Boston n/a vicinity of

state Massachusetts code 025 county Suffolk code 025

3. Classification

Category	Ownership	Status	Present Use	
X district	___ public	X occupied	___ agriculture	___ museum
___ building(s)	X private	___ unoccupied	X commercial	___ park
___ structure	___ both	___ work in progress	___ educational	___ private residence
___ site	**Public Acquisition**	**Accessible**	___ entertainment	___ religious
___ object	___ in process	___ yes: restricted	___ government	___ scientific
	n/a being considered	___ yes: unrestricted	___ industrial	___ transportation
		X no	___ military	___ other:

4. Owner of Property

name Multiple ownership (see continuation sheet)

street & number n/a

city, town Boston n/a vicinity of state Massachusetts

5. Location of Legal Description

courthouse, registry of deeds, etc. Registry of Deeds, Suffolk County Courthouse

street & number Pemberton Square

city, town Boston state Massachusetts

6. Representation in Existing Surveys

title Inventory of the Historic Assets of the Commonwealth of Massachusetts has this property been determined eligible? ___ yes ___ no

date 1980 ___ federal X state ___ county ___ local

depository for survey records Massachusetts Historical Commission

town 294 Washington Street, Boston state Massachusetts

Verbal Boundary Description

Beginning at the east side of Winthrop Square, extending to the northeast along Devonshire St., then turning west at the back lot line of #100 Franklin St., then along the alley north of Franklin St. to Hawley St., then turning to the southwest along Hawley St. and extending to Summer St., then proceeding to the southeast along Summer St. and turning to the southwest at Chauncy St., then turning to the east and following along Bedford St., then turning to the south at Columbia St. and following Columbia St. to the back lot line of #86-88 Bedford St., then turning east to the south lot line of #26-30 Lincoln St.; then following the rear lot lines of #20, 22-24, and 26-30 Lincoln St., #123-129, 131-135, and 137-139 Summer St. to South St., then turning to the north on South St. to Summer St., then turning to the northwest along Summer St. to Devonshire St.; then turning to the northeast along Devonshire St., returning to the starting point at Winthrop Square.

7. Description

Condition
___ excellent
_X_ good
_X_ fair
___ deteriorated
___ ruins
___ unexposed

Check one
___ unaltered
_X_ altered

Check one
_X_ original site
___ moved date n/a

Describe the present and original (if known) physical appearance

The Commercial Palace District is located at the junction of Boston's downtown retail and financial districts. Within the district, important focal points are found at Winthrop Square and at "Church Green", the historic name for the intersection of Bedford and Summer Streets. The district includes 60 commercial buildings lining Summer and Franklin Streets within the rough boundary streets of Hawley, Chauncy, Bedford, Lincoln, Devonshire and Franklin Streets. The position of the district at the eastern end of Summer Street just before the expressway access roads and the South Station Headhouse (NR-1975) make it particularly important as a vehicular and pedestrian entry point into the heart of the central city.

The area is generally characterized by a mixture of low-scale 19th century masonry commercial buildings and modern high rise office towers. Within the district boundaries, three fifths of the structures date from the years immediately after the Great Fire of 1872, when the city was quickly rebuilt with 4-6 story "commercial palaces" with facades of granite, marble, sandstone or brick, designed in a variety of styles including Italian Renaissance, Neo-Grec and Panel Brick. Despite the stylistic plurality characteristic of the Victorian era, these buildings form a strikingly cohesive 19th century urban streetscape because of the similarities in date of construction, scale, materials and fenestration patterns and the lack of setbacks.

Also characteristic of the area is its winding street pattern dating back to the colonial period. Although streets were widened after the Great Fire, the irregular pattern was not extensively changed; and oddly-shaped intersections at Church Green and Winthrop Square focus attention on buildings at these points. Similarly, the shape of Franklin Street intersected by Arch is a subtle reminder of the long gone 1790s Tontine Crescent, an elegrant brick residential group planned by Charles Bulfinch. A small park in front of the Beebe-Weld Building is the only landscaped open space in the district and contains the only street trees.

The Commercial Palace District is also notable for the intact quality of many of its storefronts, particularly those along Kingston Street. In most cases, buildings display one or more original decorative cast iron or carved stone piers.

The following descriptions of the sixty structures within the district are arranged in categories based on the Boston Landmarks Commission's evaluation system used for the city's Comprehensive Preservation Study. In all sections, buildings are listed in numerical order keyed to the district map (and in some cases grouped stylistically) rather than in order of importance. Categories used are:

NPS Form 10-900
(Rev. 10-90)

OMB No. 1024-0018

United States Department of the Interior
National Park Service

National Register of Historic Places Registration Form

This form is for use in nominating or requesting determinations for individual properties and districts. See instructions in How to Complete the National Register of Historic Places Registration Form (National Register Bulletin 16A). Complete each item by marking "x" in the appropriate box or by entering the information requested. If any item does not apply to the property being documented, enter "N/A" for "not applicable." For functions, architectural classification, materials, and areas of significance, enter only categories and subcategories from the instructions. Place additional entries and narrative items on continuation sheets (NPS Form 10-900a). Use a typewriter, word processor, or computer, to complete all items.

1. Name of Property

historic name Fort Point Channel HD

other names/site number

2. Location

street & number Necco Court, Thomson Place* A, Binford, Congress, Farnsworth, Melcher, Midway, Sleeper, Stillings, Summer Sts. n/a not for publication

* Thomson Place is the current name of the former Pittsburgh Street. It is alternatively spelled Thompson Place

city or town Boston (South Boston) n/a vicinity

state Massachusetts code MA county Suffolk code 025 zip code 02210

3. State/Federal Agency Certification

As the designated authority under the National Historic Preservation Act of 1986, as amended, I hereby certify that this ☑ nomination ☐ request for determination of eligibility meets the documentation standards for registering properties in the National Register of Historic Places and meets the procedural and professional requirements set forth in 36 CFR Part 60. In my opinion, the property ☑ meets ☐ does not meet the National Register Criteria. I recommend that this property be considered significant ☑ nationally ☑ statewide ☑ locally. (☐ See continuation sheet for additional comments.)

Betsy Friedberg, National Register Director 7/23/04

Signature of certifying official/Title for Cara H. Metz, State Historic Preservation Officer Date

Massachusetts Historical Commission

State or Federal agency and bureau

In my opinion, the property ☐ meets ☐ does not meet the National Register criteria. (☐ See continuation sheet for additional Comments.)

Signature of certifying official/Title Date

State or Federal agency and bureau

4. National Park Service Certification

I, hereby certify that this property is:

☐ entered in the National Register
☐ See continuation sheet.
☐ determined eligible for the National Register
☐ See continuation sheet.
☐ determined not eligible for the National Register
☐ removed from the National Register
☐ other (explain):

Signature of the Keeper

Date of Action

Fort Point Channel HD
Name of Property

Suffolk, MA
County and State

5. Classification

Ownership of Property
(Check as many boxes as apply)

x private
x public-local
_ public-State
_ public-Federal

Category of Property
(Check only one box)

_ building(s)
x district
_ site
_ structure
_ object

Number of Resources within Property
(Do not include previously listed resources in the count.)

Contributing	Noncontributing	
89	7	building
		sites
9	2	structures
		objects
98	9	Total

Name of related multiple property listing
(Enter "N/A" if property is not part of a multiple property listing.)

n/a

Number of contributing resources previously listed in the National Register

1 Congress St. Fire Station (NRIND, 1987)

6. Function or Use

Historic Functions
(Enter categories from instructions)

Commerce/Trade: warehouses
Industry/Processing/Extraction: manufacturing facility
Transportation: road-related, water-related

Current Functions
(Enter categories from instructions)

Domestic: multiple dwelling
Commerce/Trade: manufacturing facikity
Recreation/Culture: museums, studio
Landscape:
Transportation: road-related, water-related

7. Description

Architectural Classification
(Enter categories from instructions)

see district data sheet

Materials
(Enter categories from instructions)

foundation
walls
roof
other

Narrative Description
(Describe the historic and current condition of the property on one or more continuation sheets.)

8. Statement of Significance

Applicable National Register Criteria
(Mark "x" in one or more boxes for the criteria qualifying the property for National Register listing.)

x **A** Property is associated with events that have made a significant contribution to the broad patterns of our history.

_ **B** Property is associated with the lives of persons significant in our past.

x **C** Property embodies the distinctive characteristics of a type, period, or method of construction or represents the work of a master, or possesses high artistic values, or represents a significant and distinguishable entity whose components lack individual distinction.

_ **D** Property has yielded, or is likely to yield, information important in prehistory or history.

Criteria Considerations
(Mark "x" in all the boxes that apply.)

Property is:

_ **A** owned by religious institution or used for religious purposes.

_ **B** removed from its original location.

_ **C** a birthplace or grave.

_ **D** a cemetery.

_ **E** a reconstructed building, object, or structure.

_ **F** a commemorative property.

_ **G** less than 50 years of age or achieved significance within the past 50 years.

Narrative Statement of Significance
(Explain the significance of the property on one or more continuation sheets.)

Areas of Significance
(Enter categories from instructions)

Architecture
Transportation
Commerce
Community Planning & Development
Engineering
Industry
Maritime History

Period of Significance

1836-1954

Significant Dates

1836-1837 1875 1899

Significant Person
(Complete if Criterion B is marked above)

Cultural Affiliation

Architect/Builder

Morton Safford & Howard B. Prescott
(see continuation sheet)

9. Major Bibliographical References

(Cite the books, articles, and other sources used in preparing this form on one or more continuation sheets.)

Previous documentation on file (NPS):

_ preliminary determination of individual listing (36 CFR 67) has been requested
_ previously listed in the National Register
_ previously determined eligible by the National Register
_ designated a National Historic Landmark
_ recorded by Historic American Buildings Survey #___________________
_ recorded by Historic American Engineering Record #_________________________________

Primary location of additional data:

_ State Historic Preservation Office
_ Other State agency
_ Federal agency
_ Local government
_ University
_ Other
Name of repository:

10. Geographical Data

Acreage of Property 55 acres

UTM References See continuation sheet.
(Place additional UTM references on a continuation sheet)

	Zone	Easting	Northing
1.	19	331100	4691040
2.	19	331420	4690540
3.	19	331020	4689920
4.	19	330600	4690120

__ See continuation sheet

Verbal Boundary Description
(Describe the boundaries of the property on a continuation sheet.)

Boundary Justification
(Explain why the boundaries were selected on a continuation sheet.)

11. Form Prepared By

name/title Sara Wermeil/Susan Ceccacci research , Edward Gordon compiler, with Betsy Friedberg, NR Director, MHC

organization Massachusetts Historical Commission date June 2004

street & number 220 Morrissey Boulevard telephone 617-727-8470

city or town Boston state MA zip code 02125

Additional Documentation

Submit the following items with the completed form:

Continuation Sheets

Maps
A **USGS map** (7.5 or 15 minute series) indicating the property's location.
A **sketch map** for historic districts and properties having large acreage or numerous resources.

Photographs
Representative **black and white photographs** of the property.

Additional items (Check with the SHPO or FPO for any additional items)

Property Owner

(Complete this item at the request of the SHPO or FPO.)

name multiple

street & number ______ telephone ______

city or town ______ state ______ zip code ______

7.1 Description:

Architectural Classification (continued)

LATE 19TH AN EARLY 20TH CENTURY REVIVALS; Classical Revival, Renaissance Revival, Romanesque Revival
LATE VICTORIAN; Italianate, Queen Anne, Stylized Classical
LATE 19TH AND EARLY 20TH CENTURY AMERICAN MOVEMENTS: Industrial utilitarian

The Fort Point Channel National Register Historic District (abbreviated in this nomination as "FPCNRD") is a roughly 55-acre site located across Fort Point Channel from downtown Boston, at the northwest corner of South Boston. It contains 103 buildings and 11 structures (specifically, four bridges, a prominent chimney, and two sections of seawall along both sides of Fort Point Channel, a ca.1920s Boston Wharf Company roof sign, and a monumental milk bottle built to advertise a milk company). Eighty-nine buildings and 9 structures are considered contributing. The channel's three historic bridges, the Summer Street (1898-99), Northern Avenue (1908), and Congress Street (1930) bridges are rare examples of their types and deserve to be respectfully rehabilitated and preserved. The great majority of the buildings were built between 1880 and 1929 and are lofts constructed for warehousing and light manufacturing. Very few buildings have been constructed in the district since 1929. As representatives of original function, period of development, and building form, the area is remarkably uniform and distinctive. One resource, the Congress St. Fire Station, was listed in the National Register of Historic Places in 1987.

The seawalls **(photo # 1)** on both sides of Fort Point Channel were built according to boundaries adopted by the Board of Harbor Commissioners during the 1870s. The Boston Wharf Company (referred to in this nomination as "BWCo") filled the land on the east side of the channel, then built the streets, laid out lots, and also erected most of the buildings, which were designed by the company's staff architects. Most of the buildings located within the district postdate the company's 1880s reconfiguration as a real estate development company. While the land surrounding the district and many parcels within the district are now being redeveloped the district itself continues to have clear boundaries that correspond with its historic boundaries. The historic district is clearly recognizable.

In terms of historic architectural styles represented within the district, the predominance of Classical Revival styles is a consequence of the period within which many of the extant buildings were developed, the 1890s to 1920s. In addition to the Classical Revival style, earlier buildings of the district are rendered in a variety of architectural styles, including Italianate, Queen Anne, Renaissance Revival, Romanesque Revival and Industrial utilitarian modes. Most of the buildings within the district were designed by Morton D. Safford, the wharf company's staff architect from 1893 to 1917, and his successor Howard B. Prescott (1917 to 1939).

The method of construction used in the majority of the historic lofts is warehouse construction, a system of heavy timber framing that probably originated in New England. It most likely was derived from slow-burning construction, a system widely used in the region to build textile mills, which definitely was invented in New England. By the 1880s, local fire safety advocates were urging the transfer of slow-burning construction to commercial structures to improve their fire safety, and architects adapted it for urban lofts. The result was warehouse framing. The warehouse system of construction spread to cities around the country. For example, it was used by Boston-based Henry Hobson Richardson in his famous Marshall Field Wholesale

(continued)

Store in Chicago (1885-87, demolished). Thus, warehouse construction is a regional invention, and the district's lofts are valuable examples of the system, which spread from New England to cities around the nation.

One of the most distinctive aspects of the district's appearance is the difference in grade between Summer Street, the area's principal traffic artery, and the other streets of the district. Summer Street was built in conjunction with South Station railroad terminals (NR), and the relocation of tracks that formerly crossed Boston Wharf Company's site along with removal of the railroad bridge spanning the channel. Summer Street Bridge was erected roughly at the site of the old railroad bridge and the street was elevated so that it could continue above grade on a viaduct over the railroad yards part of Boston Wharf Co.'s site. The difference in grade is most apparent at the point where Summer Street is carried approximately 25 feet above A Street via a small steel bridge **(photo #44).** The Summer Street bridge at A Street is supported by abutment walls composed of battered granite blocks. Pedestrian access from A Street up to the level of Summer Street is gained via a metal stairway located adjacent to the bridge on the west side of A Street. Vehicular access is via Melcher St., which curves and slopes from Summer down to A Street **(photo #11).**

7.2 Topographical Development/ Bridge links between the FPCNRD in South Boston and Boston

The proposed Fort Point Channel National Register of Historic Places District is located across Fort Point Channel from downtown Boston, on the northwest side of South Boston. South Boston was originally a peninsula of 579.3 acres that was part of the separate town of Dorchester and known as Dorchester Neck. All land on the northern side of South Boston—essentially all land north of First Street, continuing for about one mile to Fan Pier—is made land that was created by enclosing the original marshes and shoals with seawalls and filling in behind them. The original (1630) northern shoreline of South Boston ran roughly along what is now West Second Street between Dorchester Avenue and B Street, between West First and West Second streets from B to Dorchester St., and north of West First Street between Dorchester Street and Farragut Road.

Several entities created the shoreline, including the Commonwealth of Massachusetts, Boston & Albany Railroad, and the Boston Wharf Company. Between 1855 and 1996, the construction of bridges across the roughly 1/10 mile-wide Fort Point Channel linked the FPCNRD section of South Boston with Boston proper. All the land of the Fort Point Channel National Register District was created by the Boston Wharf Company between the late 1830s and the early 20th century.

7.3 Bridges located within the FPCNRD

The four bridges located within the Fort Point Channel National Register District represent a century of American bridge design, from the late 1890s to the late 1990s. The bridges spanning the Channel serve as symbols of the fast-disappearing maritime and industrial heritage of Boston's seaport. All of the historic bridges were movable, to allow ships into the Channel. The Northern Avenue, Congress Street and Summer Street bridges along with the Evelyn Moakley Bridge (1996) currently serve as significant links between downtown and tourist destinations including the Boston Tea Party Museum, Children's Museum, Boston Fire Museum and the new Boston Convention Center. The Evelyn Moakley Bridge is a modern steel and concrete haunched girder bridge that is a noncontributing structure within the district. Additionally, the bridges provide vehicular and pedestrian access to the artists, business personnel and loft-dwellers who live and work in the district. The bridges also provide four alternative routes for evacuating the city in case of emergency.

(continued)

The opening of the Congress Street Bridge in 1875 was very important to the Boston Wharf Company. Congress Street, known as Eastern Avenue until 1881, was laid out across Boston Wharf Company land in 1879. The ready access the new bridge provided to downtown Boston influenced the BWCo's decision to concentrate its new building campaign in the northern end of the FPCNRD. The first bridge was replaced in 1930 with the present **Congress Street Bascule Bridge (Photo #3)**.

The significance of the Congress Street Bascule Bridge lies in its design as well as its technology. It is an overhead turning bascule bridge, of which only three survive in Massachusetts. The bridge was designed by Joseph B. Strauss, who also designed the Golden Gate Bridge (1937) in San Francisco. Ornamented by the noted architects Desmond and Lord, the cut-stone piers are carried above deck level and are topped with ornamental lanterns that give the bridge a unique architectural character. It is the largest and most highly ornamented of the three bridges of its type in Massachusetts. The other two bridges of this type are the First Street Bridge (1924) and the Cambridge Parkway Drawbridge (1957).

Extending 561 feet from Boston to South Boston, the Congress Street Bridge exemplifies a single leaf "trunion" bascule bridge that pivots on a fixed fulcrum. More specifically, according to HAER data, "the Congress Street Bascule Bridge is one of the few surviving electrically operated overhead counterweight Bascule drawbridges with a Warren-vertical pony truss." The prominent architectural firm of Desmond and Lord was responsible for the architectural design details of the bridge. Despite the loss of some of its operating equipment and deterioration of auxiliary structures (fenders), many original components (superstructure, lighting, gates and operating machinery) remain. The architectural characteristics of the bridge survive and preserve the original ornamental appearance of the bridge.

The T-shaped, soon-to-be-enlarged Tender's House, on the north side of the Congress Street Bridge is incorporated within the Boston Tea Party Ship Museum, a prominent feature adjacent to the existing structure. The Boston Tea Party Ship recently suffered a fire and awaits rehabilitation. A copy of the *Beaver* and constructed in Norway in 1971, it replicates one of three British East India Company ships boarded by an angry mob of Bostonians on December 16, 1773. Determined not to pay the British government's tax on tea, the colonists dumped wooden tea chests into Boston Harbor. The actual location of the original Tea Party ships—before landfill covered the location of their moorings—is the equivalent of several blocks to the west of the *Beaver's* present site. This replica is a popular Boston's tourist attraction that reportedly will be available to visitors in 2005. After the construction of the Congress Street Bridge, Fort Point Channel's next significant bridge construction project was the replacement of a mid-1850s railroad bridge with the Summer Street Bridge in 1900.

Situated at the center of the Fort Point Channel National Register District, the **Summer Street Bridge (Photo # 4)** is a rare movable type of bridge known as retractile draw, in which the moving span is pulled diagonally away from the navigable channel on several sets of rails powered by electric motors. Fewer than eight of these have been identified in the country and only four survive, two of which are on Summer Street in Boston (the second Summer Street example spans the Reserved Channel, further to the east in South Boston). According to HAER data, "The Summer Street Bridge represents the culmination of the evolution of a bridge type which was developed and primarily utilized in Boston. Retractile draws were primarily a Boston innovation, developed by Boston's Assistant City Engineer T. Willis Pratt (1812-1875)… The first retractile was erected over the Charles River in 1870…The Summer Street Bridge is a double draw and was built by the Berlin Iron Bridge Co. of Connecticut."

Between 1918 and 1990, the Summer Street Bridge was altered at least nine times. In 1918, for example, the bridge's floor beams were strengthened for street railway cars. Despite the loss of much of its operating equipment and auxiliary structures (gates, Tender's House, and pedestrian waiting shelters) several of the early components (superstructure, retractile rails, wheels and operating machinery on the south side) remain.

(continued)

One of only three surviving swing bridges built by the city of Boston in the late 19th and early 20th centuries, the **Northern Avenue bridge (Photo # 5)** is the only operable bridge of its type in Boston. It is a steel, rim-bearing swing bridge, the central section of which rotates through 90 degrees about an "island" in the center of the channel, allowing water traffic to pass through the Channel. The draw was originally powered by compressed air, with two air compressors installed by Walworth. According to HAER: "The bridge was designed by William Jackson, Chief of the Boston City Engineering Department and built by the New England Structural Company." The 80-foot-wide bridge originally carried two sidewalks, two roadways and a center lane, double-track freight railroad line.

7.4 FPCNRD Boundaries

Despite considerable redevelopment around the district, the area is clearly defined for the most part by its historic boundaries. It is bounded on the north and east by land formerly occupied by railroad yards and tracks, and on the west by the water and seawalls of the Fort Point Channel. Only at its southern end, in the A Street and Midway section, is the district defined by building demolitions. The boundaries are based on the period of development of the buildings that survive in and characterize the district today.

The district includes and continues across four bridges that span Fort Point Channel: the Northern Avenue Bridge at the northwestern corner of the district, the Evelyn Moakley Bridge (non contributing), the Congress Street Bridge, and the Summer Street Bridge.

7.5 Architectural Overview

Since the majority of the buildings in the district were built for the very practical purposes of warehousing, wholesaling and manufacturing, we might expect them to be utilitarian in appearance. Yet, while an interest in maximizing profit may have inclined the developers not to waste money on decoration, it did not preclude architectural treatment. Many buildings in the district are plain and simple with little allusion to style, but most have at least a few ornamental features that associate them with some recognizable style. Represented in the district are various architectural styles popular in the late 19th and early 20th centuries, including Italianate, Panel Brick, Romanesque, Classical Revival, and Early –20th-Century Stylized Classical. The styles most common here are the Classical Revival and Stylized Classical styles, which were popular during the period of greatest expansion—from the 1890s to the 1920s. A discussion of historic architectural styles in the district will be prefaced by a consideration of the predominant building type: lofts.

Building type: lofts

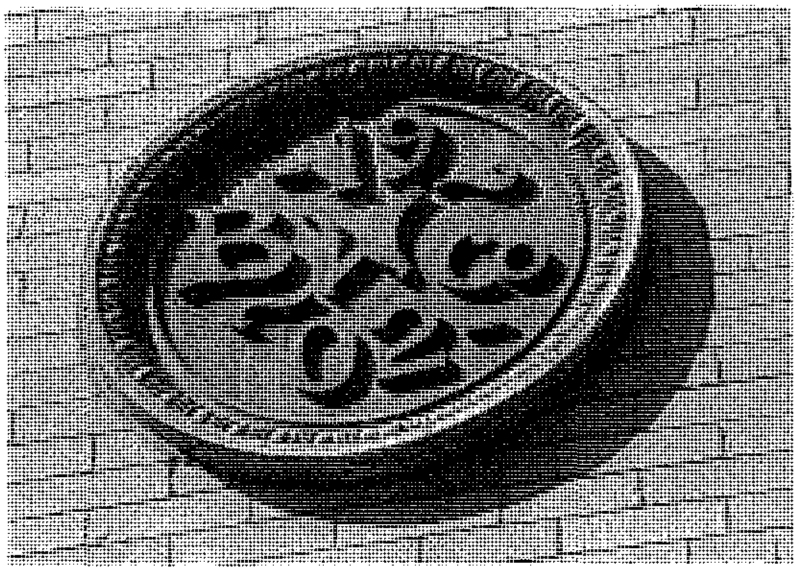
With a few exceptions, the buildings in the district can be classified as "lofts"—a common but overlooked building type found in cities around the United States. As defined in the 1901-1902 edition of Sturgis' *Illustrated Dictionary of Architecture and Building*, a loft is "any upper floor, as in a warehouse, when intended to be used more or less as one large workshop or storage space, and, hence, open throughout without elaborate finish."

The architectural historian Robert Bruegmann defines lofts as " all purpose commercial structures with large, open floors devoted to wholesaling, warehousing, and light manufacturing operations such as clothes making and printing." Writing about the lofts in Chicago's turn-of-the-century West Loop "warehouse district," he noted that such areas "constituted a major part of

(continued)

The Fort Point Channel Landmark District

Study Report



Boston Landmarks Commission
Environment Department
City of Boston

Report on the Potential Designation of

The Fort Point Channel Landmark District

as a Landmark District under Chapter 772 of the Acts of 1975, as amended

Approved by: Ellen J. Lipsey 9/23/08
Ellen J. Lipsey, Executive Director Date

Approved by: Susan D. Pranger 9/23/2008
Susan D. Pranger, Chairman Date

Contents

Introduction

The Fort Point Channel Study Committee hereby transmits to the Boston Landmarks Commission its report on the designation of the Fort Point Channel Landmark District. The designation of the Fort Point Channel Landmark District (FPCLD) was initiated in 2001 after a petition was submitted by registered voters to the Boston Landmarks Commission asking that the Commission designate the proposed landmark district under the provisions of Chapter 772 of the Acts of 1975, as amended. The purpose of such a designation is to recognize and to protect the architectural and historical characteristics that make an area distinctive and worthy of preservation.

As a result of the petition and at the request of the Boston Landmarks Commission, the Mayor appointed and the City Council confirmed a Study Committee to make recommendations to the Commission on the proposed Fort Point Channel Landmark District. The Fort Point Channel Study Committee, composed of five members from the Landmarks Commission and six property owners and residents from the Fort Point Channel study area, began its work together in late 2006 to evaluate the architectural and historical significance of the area, refine the potential boundaries, and develop standards and criteria for design review to ensure protection of the area.

All Study Committee meetings were held in or near the Study Area on a regular schedule. The meetings were open to the public and were well attended by residents, property owners, and other interested parties. At each meeting time was reserved for public comments. To increase public awareness and invite participation in the Study Committee's activities, a website was set up to post meeting agendas as well as to post and update the work of the study committee. In addition, three public meetings were held in the community to publicize the status of the report as the work of the Study Committee progressed. After more than a year and a half of study and deliberation, the Study Report was completed for the proposed Fort Point Channel Landmark District. On September 10, 2008, the nine attending members of the Study Committee voted unanimously to accept the Fort Point Channel Landmark District Study Report and submit it to the Boston Landmarks Commission.

<u>Intent of the District</u>

The Fort Point Channel Landmark District (FPCLD) is Boston's largest, most cohesive, and most significant collection of late nineteenth and early twentieth century loft buildings. The purpose of landmark district designation is to enrich and enhance the unique industrial heritage of the Fort Point Channel neighborhood expressed in its architectural form, architectural details, structures, street pattern and streetscapes. In order to achieve this, specific standards and criteria shall be adopted for the FPCLD to:

- Preserve buildings and groups of buildings that create a strong sense of character and architectural cohesiveness in the district;
- Support the adaptive reuse and rehabilitation of historic buildings;
- Protect and enhance the unique character of public view corridors, parks, open space and streetscapes;

- Encourage new construction and in-fill development that respects the scale, character and architectural and visual integrity of existing and potentially historic buildings; and
- Allow for contemporary interpretations of the urban heritage of the District.

<u>Summary</u>

The Fort Point Channel Study Committee has concluded that the proposed Fort Point Channel Landmark District (FPCLD) has architectural and historic significance for the following reasons:
The sites and structures that comprise the FPCLD exemplify a kind of enterprise – land-making and real estate development – that was characteristic of Boston and the region, and important to the economic and physical development of both the city and the region. In addition, the FPCLD is an excellent example of the kind of urban loft district that was found in and near the centers of the cities across the United States and played a vital part in the nation's economy. These wholesaling and warehousing districts often specialized in particular commodities produced or consumed in their regions. In New England, such a commodity was wool – the raw material of the region's woolen and worsted cloth manufacturers. Boston became the nation's most important wool marketplace, and the center of the wool trade was Summer Street in the FPCLD.

In addition, the structures that comprise the FPCLD are individually excellent examples of a building type – the urban loft – that was important in the economic history of the city and the region. The FPCLD lofts are also fine examples of a method of construction used in such buildings: warehouse construction. In their architecture, they are fine examples of styles popular in the city, region, and the nation during the late-19th and early 20th centuries interpreted for industrial buildings. More important than the quality of individual buildings is their collective effect. The district is distinctive, with integrity of location and setting: it is an unusually well-preserved, clearly bounded, and largely intact district with few incompatible buildings and a moderate amount of exterior alteration. In this respect, it serves as an important national example of an urban loft district from the Late Industrial Period.

Therefore, the Study Committee has concluded that the area described in Section 1.0 of the Study Report be designated as the Fort Point Channel Landmark District, as well as the related "A" Street Protection Area and the Seaport Boulevard Protection Area described in the same section.

The Committee has also recommended that the Standards and Criteria, which have been prepared to guide future physical changes to property and to open space within the district in order to protect the architectural integrity and character of the area, be adopted.

The Committee has further recommended that Fort Point Channel Landmark District Commission be established in accordance with Chapter 772 of the Acts of 1975, as amended, that district residents and members of the Boston Landmarks Commission be appointed to the Commission to review exterior changes to property in the district.

Study Committee Members:

David Berarducci (BLC), chairman
Valerie Burns (FPC representative)
Louis Casagrande (FPC representative)
Cyrus Field (BLC)
Thomas Herman (BLC)
Steve Hollinger (FPC representative)
Young Park (FPC representative)
Jeffry Pond (BLC)
Susan Pranger (BLC)
Pratap Talwar (FPC representative)
Michele Yeeles (FPC representative)

Boston Landmarks Commission staff assisting the Study Committee:

Ellen Lipsey, Executive Director
Roysin Bennett Younkin, Architectural Historian
Gary Russell, Staff Architect
Kathryn McLaughlin, Architectural Historian

Consultant for preparation of the preliminary study report, with funding provided by the Massachusetts Historical Commission:

Sara E. Wermiel, Industrial Historian, with assistance from
Susan McDaniel Ceccacci, Architectural Historian

1.0 Location

1.1 Boundaries of the Fort Point Channel Landmark District and Protection Areas

Note: For the purposes of orientation, Seaport Boulevard will be considered due North.

<u>The boundaries of the **Fort Point Channel Landmark District** starting at the northwest corner:</u>

1. The northern boundary, from west to east, begins at the northwestern edge of parcel #0602635000 (308 Congress Street), continues east following the northern edge of this lot and turns north to follow the western side of Sleeper Street, to the northeastern corner of parcel #0602636020 (no address), then turns east, crosses Sleeper Street and follows the rear, southern lot lines of properties on Seaport Boulevard to the corner parcel #0602652003 (44 Stillings Street), then turns south at the northeast corner of that parcel.

2. The eastern boundary, from north to south, begins at the northeastern corner of parcel #0602652003 (44 Stillings Street) and continues south along the eastern side of Stillings Street to the southwestern corner of parcel #0602651010 (29 Stillings Street), and follows the southern edge of that parcel east to Boston Wharf Road. The boundary then turns south and runs along the western side of Boston Wharf Road, which becomes West Service Road, until it reaches the southeast corner of parcel #0602761001 (319 A Street, Rear). The boundary then turns west and runs along the southern lot line of that parcel and parcel #0602761000 (319 A Street) until it reaches “A” Street. The boundary then turns south and runs south along the eastern side of “A” Street until it reaches the northern side of Wormwood Street. The boundary then turns east and runs along the northern side of Wormwood Street until it meets the southwest corner of the “A” Street Protection Area and turns south. The boundary then continues south in a straight line, crossing Wormwood Street and continues to the northeast corner of parcel #0602754010 (33 Wormwood Street). The boundary then runs along the eastern boundary of that parcel to Binford Street. The boundary then continues approximately 80 feet south, corresponding to the width of Binford Street at its western end. The boundary then turns west and runs along the southern side of Binford Street to the northeastern corner of parcel #0602751300 (35 Channel Center Street). The boundary then turns south and continues along the eastern lot lines of the properties on the east side of Channel Center Street and continues approximately 50 feet south of the building on parcel #0602750030 (50-52 Channel Center Street) to include the rights-of-way associated with Iron Street as approved in the Fort Point District 100 Acres Master Plan. The boundary then turns west.

3. The southern boundary, from east to west, begins approximately 50 feet south of the building on parcel #0602750030 (50-52 Channel Center Street) and continues west along the southern right-of-way boundary of Iron Street to the west side of “A” Street. The boundary then turns north.

4. The western boundary, from south to north, extends north along the western side of “A” Street, to the southeast corner of parcel # (0601166045 (no address) where it turns west and runs along the southern edge of that parcel to the western side of Necco Street where it turns north and continues along the western side of Necco Street to the rear of the buildings fronting the south side of Necco Place on parcel 0601165010 (244 “A” Street). The boundary then turns west and follows the rear of those buildings until it reaches the seawall. The boundary then turns north and follows the seawall back to the northwestern corner of parcel #0602635000 (308 Congress Street).

<u>The boundaries of the **Seaport Boulevard/Boston Wharf Road Protection Area** starting at the southwest corner:</u>

1. The western boundary, from south to north, extends from the southwest corner of parcel #0602637010 (64 Sleeper Street) north along the seawall to Seaport Boulevard.

2. The northern boundary, from west to east, extends along the southern side of Seaport Boulevard to Boston Wharf Road.

3. The eastern boundary, from north to south, extends south along the western side of Boston Wharf Road to the boundary of the Fort Point Channel Landmark District where it turns west.

4. The southern boundary, from east to west, follows the northern boundary of the Fort Point Channel Landmark district beginning at Boston Wharf Road and continuing west along the southern boundary of parcel # 0602651010 (29 Stillings Street) to the eastern side of Stillings Street where it turns north and follows the eastern side of Stillings Street, following the boundaries of the Fort Point Channel Landmark District, to the northeastern corner of parcel ##0602652003 (44 Stillings Street) and continues west along the southern lot lines of properties on Seaport Boulevard across Sleeper Street to the northeast corner of parcel #0602636020 (no address). The boundary then turns south and continues along the west side of Sleeper Street to the boundary of the Fort Point Channel Landmark District. The boundary then turns west and continues back to the seawall.

<u>The boundaries of the **“A” Street Protection Area** starting at the northwest corner.</u>

1. The northern boundary, from west to east, follows the boundary of the Fort

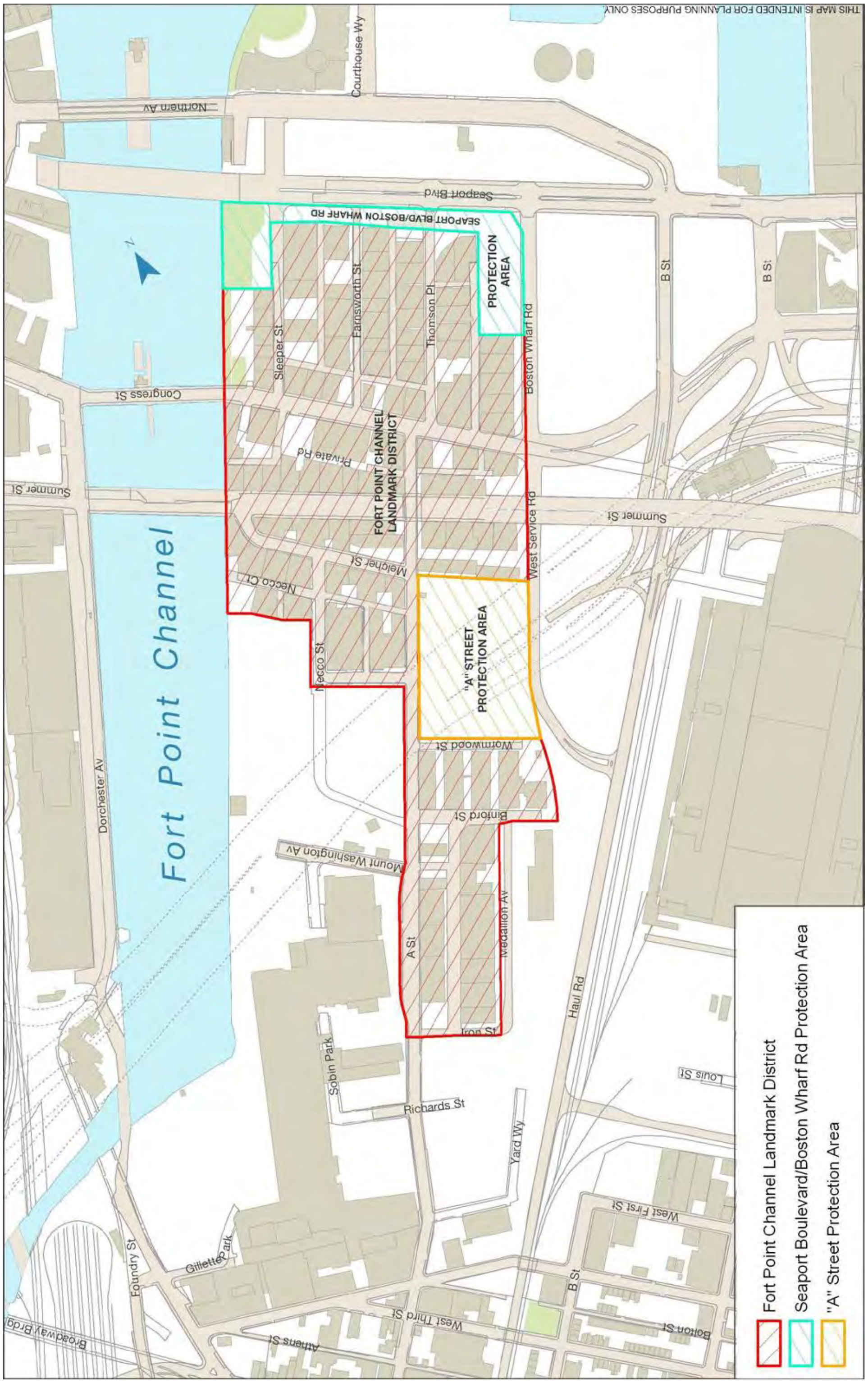
Point Channel Landmark District, extending along the southern lot lines of parcel #0602761000 (319 “A” Street) and parcel #0602761001 (319 A Street, Rear) to the west side of West Service Road.

2. The eastern boundary, from north to south, extends south along the west side of West Service Road in a straight line paralleling “A” Street to Wormwood Street.

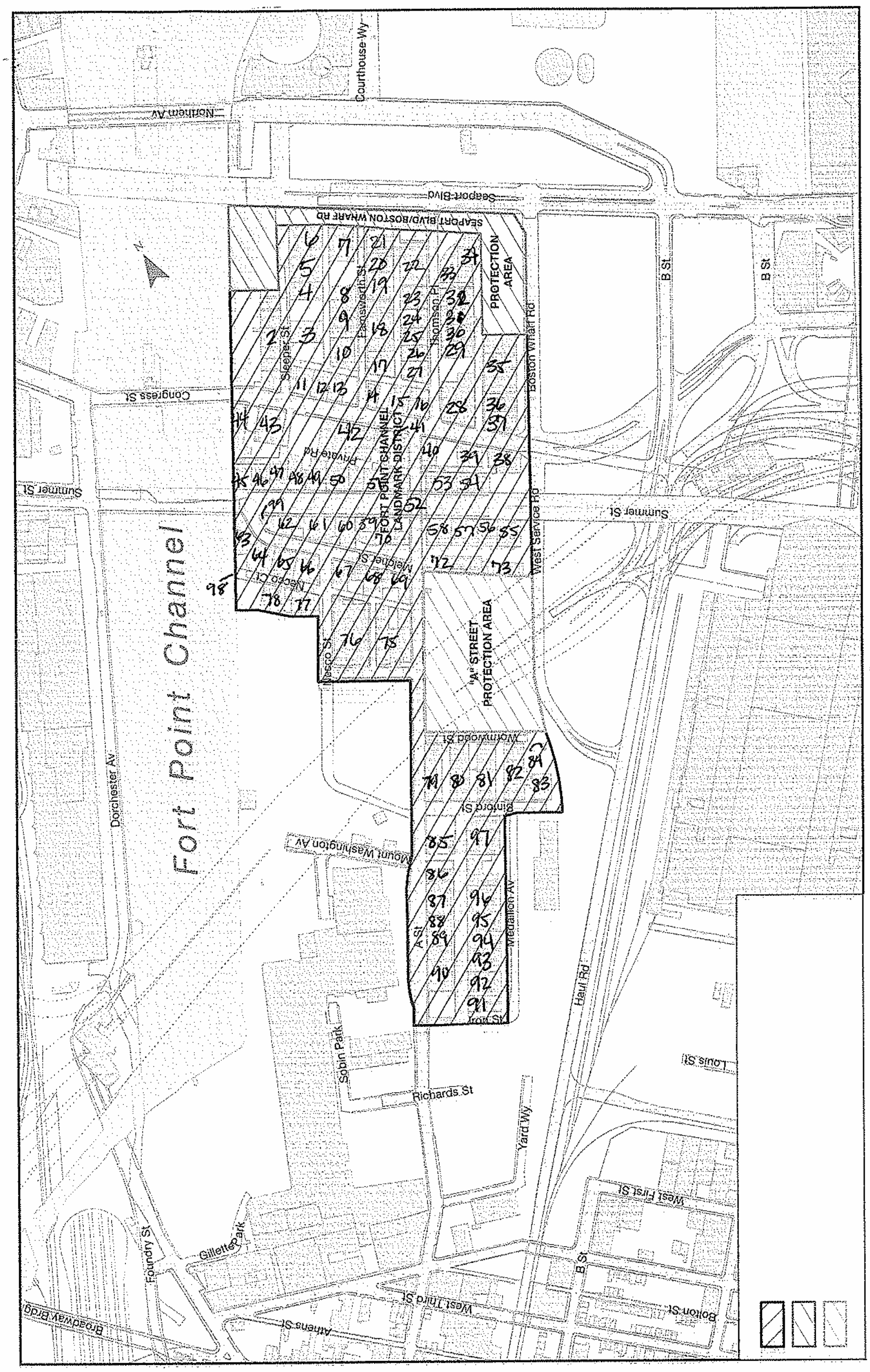
3. The southern boundary, from east to west, follows the boundary of the Fort Point Channel Landmark District and extends west along the north side of Wormwood Street to “A” Street.

4. The western boundary, from south to north, extends north along the east side of “A” Street back to the southwest corner of parcel #0602761000 (319 “A” Street).

1.2 Boundary Map



1.3 Map Showing Buildings Numbered for Reference in the Text.



1.4 Area in Which the Property is Located

Note: For orientation, Summer Street is considered an east-west street (it actually angles from northwest at Fort Point Channel to southeast). Thus, the even-numbered buildings on Summer Street are described as being on the north side, and A Street is described as a north-south street.

The Fort Point Channel Landmark District (FPCLD) is located across Fort Point Channel from downtown Boston, on the northwest side of South Boston. All land on the northern side of South Boston – essentially, all land north of First Street – is made-land that was created by enclosing the original marshes and shoals with seawalls and filling in behind them. Several entities created the shoreline, including the Commonwealth of Massachusetts, Boston & Albany Railroad, and the Boston Wharf Company (BWCo). All the land of the FPCLD was created by the BWCo.

Incorporated in 1836 for the purpose of building and operating wharves, BWCo evolved into an industrial real estate company at the end of the nineteenth century, as business conditions and opportunities changed. Between 1837 and 1882, BWCo filled in the marshes to which it had rights in phases, advancing from south to north. The FPCLD is part of this site – the northern section. BWCo not only made the land but also built the streets. Since the district is filled land, it is completely flat, except for the raised grade of Summer Street. The streets follow the grid pattern typical of South Boston with the notable exception of curving Melcher Street, which slopes from an elevated Summer Street at the end of the Summer Street Bridge down to grade at A Street. Three bridges connect the area to downtown Boston: from north to south these are the Evelyn Moakley, Summer Street, and Congress Street bridges. A Street is the main north-south street through the district and connects it with the residential neighborhood south of the district, around West Broadway. Summer and Congress streets are the main east-west streets.

Most of the buildings standing on this site today represent the latter stage of the company's history, when it became a real estate company. The great majority of the buildings are lofts constructed between the 1880s and 1920s, and most are 5-6 stories.

Despite considerable redevelopment around the district, the area is clearly defined, for the most part by its historic boundaries. It is bounded on the north and east by land formerly occupied by railroad yards and tracks, and by the water of the Fort Point Channel on the west. Only at its southern end, in the A Street and Channel Center Street section, is the district defined by recent building demolitions. The boundaries are based on the period of development of the buildings that survive in, and characterize, the district today.

FHR-8-300 (11-78)

United States Department of the Interior
Heritage Conservation and Recreation Service

National Register of Historic Places Inventory—Nomination Form

For HCRS use only
received OCT 13 1983
date entered

See instructions in *How to Complete National Register Forms*
Type all entries—complete applicable sections

1. Name

historic Leather District

and/or common same as above

2. Location

Roughly bounded by Atlantic Ave., Kneeland, Lincoln, and Essex Sts.

street & number South, Lincoln, Atlantic Ave., Kneeland, Essex, Tufts ~~Utica, Beach, & East Streets~~ N/A not for publication

city, town Boston N/A vicinity of ~~congressional district~~

state Ma. code 025 county Suffolk code 025

3. Classification

Category	Ownership	Status	Present Use	
X district	___ public	X occupied	___ agriculture	___ museum
___ building(s)	X private	___ unoccupied	X commercial	___ park
___ structure	___ both	___ work in progress	___ educational	X private residence
___ site	**Public Acquisition**	**Accessible**	___ entertainment	___ religious
___ object	___ in process	X yes: restricted	___ government	___ scientific
	N/A being considered	___ yes: unrestricted	___ industrial	___ transportation
		___ no	___ military	___ other:

4. Owner of Property

name Multiple - see continuation sheet

street & number

city, town N/A vicinity of state

5. Location of Legal Description

courthouse, registry of deeds, etc. Registry of Deeds - Suffolk County

street & number Pemberton Square

city, town Boston state Ma

6. Representation in Existing Surveys

title (a) Inventory of the Historic Assets ~~of The Commonwealth of Mass.~~ has this property been determined elegible? X yes DOE 9/3/80 ___ no

date June 1980 ___ federal X state ___ county X local

depository for survey records Massachusetts Historical Commission

city, town Boston state Ma.

(b) see continuation sheet

7. Description Leather District, Boston, MA

Condition		Check one	Check one	
___ excellent	___ deteriorated	___ unaltered	X original site	
X good	___ ruins	X altered	___ moved	date N/A
___ fair	___ unexposed			

Describe the present and original (if known) physical appearance

The Boston Leather District is located in the southernmost portion of Boston's Central Business District, and is largely bounded and isolated by the railroad yards on Atlantic Avenue to the east, the Surface Artery to the west and north, and the Massachusetts Turnpike ramps to the south. South Station (NR-1975) lies to the northeast. The District contains fifty-four parcels of land, on which stand mostly commercial buildings, along with a few living and working loft spaces for artists. The area was re-developed from a low-rent residential/commercial district for the shoe and leather trade, primarily during the 1880s and 1890s, with some later construction in the first quarter of the twentieth century largely located in the southermost blocks bounded by Kneeland Street. Romanesque Revival designs dominate the early years of construction, as does the Classical vocabulary at the turn of the century and beyond. Red brick and brownstone are the favored building materials, as well as lighter colored brick, terra cotta, granite, limestone and cast stone. The core of the district is remarkable for its intact quality, particularly its cast iron storefronts, and its harmony of design, scale, and materials. Most of these buildings are five or six stories in height and are characterized by continuous floor levels, band courses, and cornice lines. There are only three intrusions within the district: the buildings at 194-204 Lincoln Street (A), 47 -51 Utica Street (B), and 154-156 Kneeland Street (C).

The major buildings are described below in chronological order.

Centrally located in the district is <u>90-100 South Street</u> (1), designed in 1883 by A.S. Drisko. Romanesque Revival in style, it is significant as one of the two earliest extant structures within the Leather District. Actually a double building with identical treatments, it is constructed of red brick, retains its cast iron storefront, and features granite and brick corbelled belt courses, round arched fenestration at the 5th level, and a brick corbelled cornice. (Photo #2)

Close by is <u>114-122 South Street</u> (2), at the corner of Beach Street, also designed in 1883 by Lewis Weissbein and W.H. Jones. (Weissbein designed the Morse Block in 1880, now destroyed, the first commercial structure built during the district's re-development.) Of red brick construction, it features an intact cast iron storefront, brownstone trim including panels in the spandrels over the 2nd level, cast iron window mullions, and a corbelled cornice course over the 4th level. (Photo #2)

Between these two buildings is <u>102-112 South Street</u> (3), designed by Alden Frink in 1884, and unique as the only Queen Anne style structure in the entire Leather District. Another double building with virtually identical styling, it is rendered in red brick and features, in addition to its cast iron storefront, carved floral panels, terra cotta tiles, and stone sunbursts over the 3rd level. Round arched windows with sunbursts are located at the 5th level, and a triangular pediment caps each building. (Photo #2)

Facing these buildings on the west side of South Street is the block which is the most Richardsonian in nature. <u>141-157 South Street</u> (4), prominently sited at the corner of Beach, is a Richardsonian Romanesque structure designed in 1884 by John H.

8. Significance

Leather District, Boston, MA.

Period	Areas of Significance—Check and justify below			
___ prehistoric	___ archeology-prehistoric	___ community planning	___ landscape architecture	___ religion
___ 1400–1499	___ archeology-historic	___ conservation	___ law	___ science
___ 1500–1599	___ agriculture	___ economics	___ literature	___ sculpture
___ 1600–1699	X architecture	___ education	___ military	___ social/humanitarian
___ 1700–1799	___ art	___ engineering	___ music	___ theater
X 1800–1899	X commerce	___ exploration/settlement	___ philosophy	___ transportation
X 1900–	___ communications	x industry	___ politics/government	___ other (specify)
		___ invention		

Specific dates 1883 - 1919 **Builder/Architect** multiple

Statement of Significance (in one paragraph)

The Boston Leather District possesses integrity of location, design, setting, materials and workmanship. It is associated directly with the industrial development of Boston and New England,and also reflects Boston's vernacular reaction to concurrent architectural developments in Chicago. The Leather District is outstanding as Boston's most intact and homogeneous district of late nineteenth century vernacular commercial structures, as well as one of only a few such remaining in New England. Thus, the Leather District meets criteria A and C of the National Register of Historic Places.

The Leather District, located in what was known as the South Cove, was largely under water until the 1830s. During the eighteenth century wharves were built out along its original shoreline, and by 1814 were located from the end of Essex Street, around Windmill Point, to Kneeland Street. By 1830, the South Cove was a thriving commercial area centered around the wharves and distilling industry. A pivotal event for the South Cove's future was the extension of Sea Street in 1828 across the Cove, resulting in the shortest route to the relatively undeveloped South Boston. The South Cove area thereby became a natural target for new commercial development. Its strategic location close to the business district, Fort Point Channel, and Boston Harbor were contributing factors, but perhaps most important were its physical characteristics: dry flats at low tide and its proximity to a deep-water channel. The area was planned as a visionary development incorporating much-needed railroad terminals and related commercial development. In 1833, the South Cove Corporation was given a charter to fill in the Cove and provide a terminal for the Boston and Worcester Railroad. By 1836, one-half of the Cove was filled in, and by 1839 the filling had been completed, adding seventy-seven acres (including the present Chinatown) and a railroad terminal to the city. In 1838, the United States Hotel, designed by William Washburn, had been constructed to accomodate the railroad passengers, the largest hotel of its day in the country.

However, unforseen events prevented the planned commercial expansion in the area. The financial crash of 1837-38 created a tight money situation, causing the reluctance of commercial concerns to move into an unsure area; furthermore, the economic advantages of locating adjacent to railroad facilities were as yet unproven. Therefore, resulting from a need for low-cost housing to meet the great stream of immigration into Boston , housing which would additionally provide a sure income for the owners, the South Cove developed as a residential and related commercial area. Photographic evidence reveals that its architectural inclinations were probably similar to the original remnants of the Chinatown area: red brick row houses with pitched roofs, a vernacular version of the Greek Revival. The expendable nature of this low-cost housing, together with the area's independence from the railroads, were undoubtedly important factors contributing to the district's redevelopment in the 1880s.

As far back as Colonial days, the boot and shoe industry was one of the State's leading industries. At first, the shoemaker dealt directly with the market, making shoes to order with his own or the customer's leather. During the next phase, he manufactured many boots and shoes for a merchant to market at his own risk and profit. By 1810, 10% of Boston's shoe products were exported, many to the West Indies. Severe competition for orders made specialization necessary in order to secure rapid work. After 1820, the central shop system quickly developed; here the leather was cut, given out to workers to complete the "uppers", and given out again to the "makers" who would last and sew the boots and shoes. These were inspected in the central shops and then turned over to the Boston merchants. Business expanded enormously and great fortunes were made. However, all this halted during the financial crash of 1837-38, when 90% of the shoe merchants failed.

By 1840, a new trade had developed and stiff competition resulted from increased demands for stylistic variation as well as insistance upon quality. More refined specialization, as well as the desire for economy, led to the introduction of machinery into the shoe-making process. Generally, the manufacturer put machines into the central shops and the workers followed these machines.

The post-1850 expansion and its emphasis on the increasing economy of large- scale production, hastened the transition to the factory system in which all the shoe-making was done under one roof. Immense orders pushed production to its limit, and while the southern and south-western markets remained firm, new markets opened in California and Australia, a result of the gold rush. Only the lasting and bottoming of shoes outside the shop continued into this period. But when the McKay machine for sewing soles was introduced in the 1860s, and the Goodyear Welting Machine in 1875, the last remnants of this cottage industry disappeared.

Boston had been the marketing center for the shoe and leather industry from the early 19th century; it had begun to assume large proportions as far back as 1828 when total sales from Boston jobbing houses were over $1,000,000.

Buyers came from the shoe towns to purchase supplies, and by about 1830, the larger manufacturers began to open offices and stores in Boston. Soon, most of the leading merchants had established places of business there. For many years the American House on Hanover Street was the headquarters for the trade, its business center focused on the North and South Markets, Fulton, Blackstone, and Shoe and Leather Streets. By 1849, the trade had begun to move southward into Pearl Street, then principally occupied by wholesale dry goods houses; within a short time, this became its new center. Soon, "block after block of dwellings on High Street were levelled to make room for warehouses" (Herndon, p.8). In 1865, there were over 200 jobbing houses in Boston with annual domestic and foreign trade of over $50,000,000, fifty times the amount of 28 years previous. By 1860, New England was making not less than 80% of the shoes for domestic trade.

The great fire of November 10, 1872, which levelled Boston's Central Business District, also devastated the physical center of the shoe and leather industry. All of the wholesale shoe and leather houses, except for a few on Hanover Street, were burned; 229 wholesale shoe dealers, 189 leather concerns, and about 100 firms in related businesses were destroyed. The warehouses were full of winter goods, and the loss in goods and machinery was over $12,000,000, and in buildings, $1,500,000. There was a concern as to whether the insurance companies could stand the enormous losses, but considering the scale of the disaster, a relatively small number of concerns were ruined. The fire destroyed almost all the finished leather in the Eastern states, resulting in a price increase for hides and leather all over the country. After the fire, the district was rebuilt, and for several years, the trade continued to cling to it. It then spread to Summer Street, around Church Green, the New England Shoe and Leather Dealer Association (incorporated 1871) occupying new quarters in the Church Green Building. By 1880, the trade begun to take over the area now known as the Leather District.

Although the commercial re-development of the Leather District area was for the most part concurrent with architectural events in Chicago and New York, the stringent building codes resulting from the 1872 fire prohibited Boston's development along the same lines. The concern primarily for safety rather than linking safety with progress, led architects into a conservative reaction to the fire which severely limited development of new technology and use of new materials. Building heights were restricted by relationship to street widths, and party and fire wall regulations limited roof forms and structural types. These codes resulted in the predominance of mill construction, and precluded the type of structural innovations characterizing Chicago's post-fire rebuilding.

Along with restraints imposed by building regulations were functional demands imposed by the requirements of the leather industry, relating to efficient storage and movement of goods. The lowest section was often split level: both the high basement and display floor had huge glass windows set in cast-iron frames. These floors housed display of merchandise, reception areas, and fuel storage areas. In order to maximize floor space, entries were recessed into the buildings and located at the corners where possible, rather than sacrificing the floor area required by a building setback. The second floor, also given prominent windows, was occupied by the directors and was where business was transacted. The middle stories, characterized by generous floor space and large windows, served the storage or warehouse function for active merchandise. Because vertical transport was difficult, the top floor was generally reserved for storage of slow merchandise, and this function is usually reflected in the differing architectural treatment of this top level.

It is notable that although these buildings were constructed for general use rather than for a specific client, they were not speculatively built. Rather than simply hiring contractors to erect strictly utilitarian structures, there was real concern for architectural expression whereby <u>architects</u> were hired as designers. These architects were often lesser known, and the influences first of H.H. Richardson and later of Peabody & Stearns is apparent.

The Leather District buildings were constructed primarily during the 1880's and 1890's, and the area embodies the most intact and homogenous commercial district of such a size in the City.

The district is characterized largely by red brick structures with flat roofs, uniformly set back from the street, and featuring continuous floor levels, band courses, and cornice lines. Ornamentation is generally rendered in brownstone. Buildings constructed around 1900 and after were generally of lighter brick, characterizing the more up-to-date Classical Revival styles. The heart of the district is South Street, especially between East/Tufts and Beach Streets, a block that was constructed principally between 1883-88 and which retains the highest degree of architectural integrity. The east side of South Street was developed first, of particular note being the double building at #102-112 (3), the only structure within the district using the decorative vocabulary of the Queen Anne style. The west side is the most Richardsonian in nature, its development initiated by J. Franklin Faxon with the buildings at #141-157 (4). His sponsorship of this structure along with #121-123 (5) and the Beebe Building at #127-131, as well as 103-2 Lincoln Street, make him the largest developer in the district in addition to his numerous development sites elsewhere in Boston. Noteworthy is 141-157 South Street (4), a Richardsonian Romanesque structure which strongly claims its corner site and provides an anchor to this harmonious late 19th century block. Perhaps the most reflective of the Richardsonian style is the narrow building at 121-123 South Street (5), its fenestration organized within a single, monumental round arch.

Backing onto this block of South Street is the area of Lincoln Street between Beach and Tufts, which was developed between 1888-1893, and although the storefronts have been remodelled, most are of sympathetic styling. The five buildings at 104-144 Lincoln Street (6) were all constructed by the firm of Woodbury & Leighton. The largest and most successful contractors in New England during this period, they specialized in large public works. Number 130-2 Lincoln Street was designed by William Ralph Emerson, leading Boston architect, considered by many to be the inventor of the "Shingle Style" of architecture. Winslow and Wetherell, another prominent Boston firm, were designers of the three buildings at 134, 138-144, 146-154 (7) Lincoln Street.

Several 19th century structures on a much larger scale are located within the district. Among these are the 1894 Lincoln Building at 66-86 Lincoln Street (8), designed in the 2nd Renaissance Revival style by Willard T. Sears. This is actually the second commercial structure on the site, the first having been destroyed in the fire of 1888. Sears is perhaps best known for his partnership with Charles A. Cummings, designers of several landmarks in Boston. An original occupant of this building was the Commonwealth Shoe and Leather Company, originator of the famous "Bostonian" shoe. Another such structure is the Classical Revival/Beaux Arts South

Street building at 79-99 South Street, designed in 1899 by the prominent firm of Winslow, Wetherell & Bigelow. This building is particularly distinctive for its steel framing, one of only three such structures in the Leather District designed prior to 1900.

One of the most outstanding structures in the District is the 1899 Beaux Arts Albany Building (9) at 155-205 Lincoln StreetDominating its streetscape, it was one of the last major buildings to be erected in the District, and also utilizes the more modern steel frame construction techniques. It was designed by Peabody and Stearns, a partnership termed "the most important arbiters of building taste after H.H. Richardson" (Holden, p.114). Moreover, the construction was done by Norcross Bros., contractors for the majority of Richardson's works. It provides a striking though not incompatible contrast with the predominantly late-Victorian ambience of the District. Located here from 1901-1929 was the United Shoe Machinery Company, an 1899 consolidation of the three major shoe manufacturing companies, which by 1910, controlled 98% of the shoe machinery business in the United States, and by the late 1920s had subsidiary companies throughout the world. Another original occupant of the Albany Building was the Frank W. Whitcher Co., manufacturers of and dealers in shoe and leather findings. One of the oldest concerns of its kind in the United States, the business was originally founded by John Tillson who opened his shop in 1826 at 8 Hanover Street.

The Essex Hotel (10) at 687-695 Atlantic Avenue, designed in 1899 by prolific Boston architect Arthur Bowditch, was influenced by the design and structure of the Chicago School; however, its elaborate Beaux-Arts garb hides the very structural system that Chicago was attempting to emphasize. Formerly one of Boston's prominent hotels, it was built to receive the great flow of passengers from the newly erected South Union Terminal (South Station).

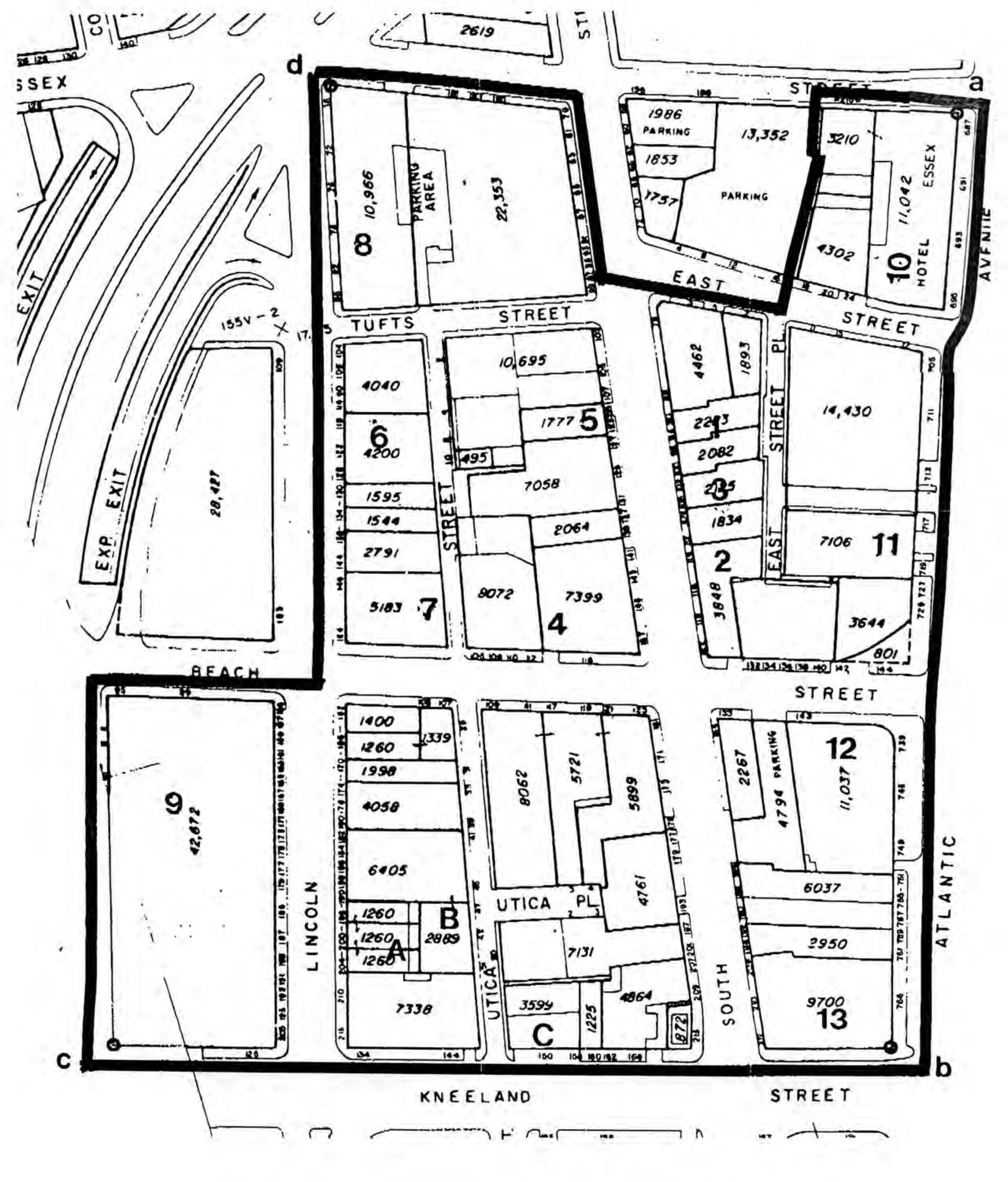
During the first twenty years of the 20th century, other buildings erected in the Leather District responded to the steel-frame skyscraper technique, though still clothed in classical garb. The Pilgrim Building (13) at 208-212 South Street, designed in 1919 by Monks and Johnson, is an excellent example of such a structure.

In 1929, the leather trade ranked 4th in total value of products, after printing and publishing, women's clothing, and foundry and machine shop products. At that time it was still "the great market, clearing house, and financial center for the entire New England shoe manufacturing industry" (Fifty Years, p.175), with over 100,000 pairs of shoes and slippers produced in a year. Today, the Leather District remains much as it did a half century ago, the architectural quality of the designs reflecting the importance of the leather industry to Boston's economy, while at the same time revealing Boston's conservative response to progressive technical developments elsewhere. Fortunately, much of the 20th century re-development passed it by, largely because of its siting, and it is currently the focus of City revitalization efforts.

Boston, Mass.
Scale 1" = 100'

N

a -19/330600/4690650
b -19/330520/4690430
c -19/330300/4690500
d -19/330450/4690700



BOS.1515

BOSTON LANDMARKS COMMISSION   Building Information Form   Form No. ___ Area CBD

ADDRESS 518-540 Atlantic   COR. 258-264 Congress

NAME Russia Building (present)   Library Bureau Building (original)

MAP No. 24N/13E   SUB AREA Financial

DATE 1897   source: perm 3-22-1897

ARCHITECT Peabody & Stearns   source: permit

BUILDER ~~unknown~~   source:

OWNER Boston Real Estate Trust (original)   present:

PHOTOGRAPHS 23/1, 23 2/6 *, 35 5/1-80 .

TYPE (residential) single double row 2-fam. 3-deck ten apt.
(non-residential) mercantile

NO. OF STORIES (1st to cornice) seven   plus

ROOF flat   cupola   dormers

MATERIALS (Frame) clapboards shingles stucco asphalt asbestos alum/vinyl
(Other) brick-buff stone granite concrete iron/steel/alum.

BRIEF DESCRIPTION 9x5 bay 2nd Renaissance Revival structure featuring 2 story granite base of pier & spandrel construction topped by band of Greek-key ornament. Central entrance pavillion with banded rustication rises full height from round-arched entry with console keystone & 8 tiger heads above; surmounted by pineapple-topped pediment at cornice. At upper levels, generally paired rectangular windows with flared lintels, and round arched at 7th level separated by modillioned band course. Bevelled corner bay with entrance recessed behind Doric Columns topped by stilted arches with console keystones.

EXTERIOR ALTERATION minor moderate drastic

CONDITION good fair poor   LOT AREA 18,446 sq. feet

NOTEWORTHY SITE CHARACTERISTICS Prominently sited at corner of Atlantic and Congress, its beveled corner responding to corner location; one of three stylistically similar buildings adjacent to each other, on old Russia Wharf site.

SIGNIFICANCE (cont'd on reverse)

Architecturally significant as design of Boston's most prominent firm of the period, as well as member of intact trio of commercial/industrial buildings located in area which has recently seen extensive change. Historically significant as site of old Russia Wharf located in vicinity of Boston Tea Party in 1773, and "subsequently headquarters for the prosperous Russian trade of merchant prince Thomas Russell (from 1784-1796) and Henderson Inches (from c. 1800-1857)."[1] Also

III FS JSG 01

III N MHK 6/80

Moved; date if known ____________

Themes (check as many as applicable)

Aboriginal		Conservation		Recreation	
Agricultural	x	Education		Religion	
Architectural		Exploration/ settlement		Science/ invention	
The Arts		Industry		Social/ humanitarian	
Commerce		Military		Transportation	
Communication		Political			
Community/ development					

Significance (include explanation of themes checked above)

exemplifies continued expansion of Boston onto filled land as city continued to prosper and develop as industrial metropolis.

After the Great Fire of 1872 burned the downtown and destroyed the Russia Wharf structures, the city decided to extend Congress St. over the wharf and "across a new bridge connecting downtown to areas being filled in South Boston."[1.] Permits were issued in 1897 for the Russia Building and its 2 neighbors to be constructed along this major passageway. Opening in 1898, the principle occupant of the Russia Building was the Library Bureau, manufacturers of the "Perfected Card System," library and office Supplies, with branches in other major cities. Other occupants were Wm. S. Best & Co, printers; Lothrop Publishing co; White, Son & Co., fancy leather & bookbinders supplies; manufacturers of dyestuffs & varnishes, a wool dealer, and a wholesale boots & shoes outfit. Clearly a miscellany of businesses, with emphasis on printing, publishing, and office supplies.

Robert Swain Peabody (1845-1917) & John Goddard Stearns (1843-1917) maintained a partnership for 40 years, and have been called "the most important arbiters of building taste after H.H. Richardson."[2.] Peabody graduated from Harvard, worked in the offices of Gridley J.F. Bryant, and was one of the group of first Americans to study at the Ecole des Beaux Arts in Paris. Stearns was educated at the Lawrence Scientific School, and continued his training in the office of Ware & Van Brunt. Peabody & Stearns also designed the Custom House Tower, the Exchange Building, and the Albany Building.

Preservation Consideration (accessibility, re-use possibilities, capacity for public use and enjoyment, protection, utilities, context)

Nominated for National Register Designation.

LISTED AS NATIONAL REGISTER 12-2-80

Bibliography and/or references (such as local histories, deeds, assessor's records, early maps, etc.)

1. National Register of Historic Places Inventory - Nomination Form, prepared by Wendy Frontiero.
2. Holden, Wheaton A., "The Peabody Touch: Peabody and Stearns of Boston, 1870-1917," Journal of the Society of Architectural Historians, v. XXXII, May, 1973, p. 114.
3. Boston Directories.
4. Architectural File, BPL, Art Reference.
5. SPNEA photo file, "Atlantic Ave."
6. Buildings Dept. Records.

CENTRAL ARTERY/THIRD HARBOR TUNNEL PROJECT
Updated Survey of Historic Resources

518-540 Atlantic Ave. CBD

Russia Wharf Buildings

LOCATION:

Map Number: 24-13

Subarea: Central Area

Corridor: primary

NATIONAL REGISTER STATUS

INDIVIDUAL STATUS:		DISTRICT STATUS:	
X	Individual NR-Listed 12/02/80		In NR District
	Individual DOE		In DOE District
	Individual NR-Eligible		In NR-Eligible District

Name of District: None

BOSTON LANDMARKS COMMISSION STATUS:

Landmark Status: None

Survey Category: 3

BLC District: None

Boston Affiliates, Inc.
January, 1989

Form 10-300
(Rev. 6-72)

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

STATE: Massachusetts

COUNTY: Suffolk

FOR NPS USE ONLY

ENTRY DATE

NATIONAL REGISTER OF HISTORIC PLACES
INVENTORY – NOMINATION FORM

(Type all entries - complete applicable sections)

SEE INSTRUCTIONS

1. NAME

COMMON:
South Station Headhouse (use for publication)

AND/OR HISTORIC:
South Union Terminal

2. LOCATION

STREET AND NUMBER:
Atlantic Avenue and Summer Street

CITY OR TOWN: Boston

CONGRESSIONAL DISTRICT: 9th

STATE: Massachusetts | CODE: 025 | COUNTY: Suffolk | CODE: 025

3. CLASSIFICATION

CATEGORY (Check One)	OWNERSHIP		STATUS	ACCESSIBLE TO THE PUBLIC
☐ District [X] Building ☐ Site ☐ Structure ☐ Object	[X] Public ☐ Private ☐ Both	Public Acquisition: ☐ In Process ☐ Being Considered	[X] Occupied ☐ Unoccupied ☐ Preservation work in progress	Yes: [X] Restricted ☐ Unrestricted ☐ No

PRESENT USE *(Check One or More as Appropriate)*

☐ Agricultural	☐ Government	☐ Park	[X] Transportation	☐ Comments
☐ Commercial	☐ Industrial	☐ Private Residence	☐ Other *(Specify)*	
☐ Educational	☐ Military	☐ Religious		
☐ Entertainment	☐ Museum	☐ Scientific		

4. OWNER OF PROPERTY

OWNER'S NAME:
Boston Redevelopment Authority

STREET AND NUMBER:
Boston City Hall

CITY OR TOWN: Boston

STATE: Massachusetts | CODE: 025

STATE: Massachusetts

5. LOCATION OF LEGAL DESCRIPTION

COURTHOUSE, REGISTRY OF DEEDS, ETC:
Suffolk County Registry of Deeds

STREET AND NUMBER:
Pemberton Square

CITY OR TOWN: Boston

STATE: Massachusetts | CODE: 025

COUNTY: Suffolk

6. REPRESENTATION IN EXISTING SURVEYS

TITLE OF SURVEY:
Inventory of the Historic Assets of the Commonwealth of Massachusetts

DATE OF SURVEY: 1974 ☐ Federal [X] State ☐ County ☐ Local

DEPOSITORY FOR SURVEY RECORDS:
Massachusetts Historical Commission

STREET AND NUMBER:
40 Beacon Street

CITY OR TOWN: Boston

STATE: Massachusetts | CODE: 025

FOR NPS USE ONLY

ENTRY NUMBER

DATE

AMENDED SECTION 7 - DESCRIPTION

(Number all entries)

The terminal is a 5 story, symmetrical brick structure. The building has a dominant curved headhouse, faced with granite, which was flanked by tan brick wings along Atlantic Avenue and Summer Street; its elbow-shape plan shielded the immense train shed and track facilities from public view. In elevation, the station is divided visually in two layers, giving a pronounced horizontal emphasis: the 2 lower floors are faced with rough-hewn granite and are separated by a continuous stringcourse from the upper floors, which are unified by smooth masonry vertical members in the Giant Order. (This bisection corresponds functionally to the public uses of the lower floors and to the company offices above; it also reflects the double decker track system with subway and suburban electric systems below the track level used for long distance runs.) A continuous entablature with a balustraded parapet is interrupted at the headhouse by an ornate clockpiece, topped by a monumental eagle, which continues the vertical orientation of the pedimented portico just below.

The headhouse has five symmetrically disposed major bays. Its central bay is framed by full-height piers and has 3 grand round arch entrances. The middle arch and accompanying piers project and support the large portico of paired Ionic columns with a triangular pediment. The lateral parts of this central bay and the next two secondary flanking bays continue the Giant Order colonnade behind which the window wall is recessed. In contrast to the columns, the pair of tertiary bays in the headhouse project slightly and are inset with a triple bank of rectangular windows. This latter pavillion motif was repeated at the termination of the wings which otherwise were long plain blocks. Their fenestration pattern on the lower level repeated the round arch theme set in the headhouse; on the upper tier, full height piers separate vertically-arranged rectangular window pairs.

The terminal complex has undergone considerable change, although the headhouse portion externally remains intact. The metal train shed, a combination of cantilevered arms plus floating middle truss, along with the two story metal covered midway, had to be demolished within 30 years due to deterioration. At the same time, interior alterations were made to the passenger waiting rooms and service areas. A single story extention to the Atlantic Avenue wing was demolished along with the full Atlantic Avenue wing and half of the Summer Street wing (from the terminating pavillion through and including the mid-pavillion).

The terminal is part of the South Station Urban Renewal

Project. Plans and prior commitments require the demolition of the remaining Summer Street wings leaving the entire headhouse as the primary gateway from the central business district to the new intermodal transportation center to be developed behind the headhouse. Although surface vehicular access ways will penetrate the site at the points of the wings, the lateral vision lines will be re-established by the Atlantic Avenue bus terminal and a new office building located on Summer Street.

8. SIGNIFICANCE

PERIOD *(Check One or More as Appropriate)*

- [ ] Pre-Columbian
- [ ] 15th Century
- [ ] 16th Century
- [ ] 17th Century
- [ ] 18th Century
- [x] 19th Century
- [ ] 20th Century

SPECIFIC DATE(S) *(If Applicable and Known)* 1896-1899

AREAS OF SIGNIFICANCE *(Check One or More as Appropriate)*

Aboriginal
- [ ] Prehistoric
- [ ] Historic
- [ ] Agriculture
- [x] Architecture
- [ ] Art
- [ ] Commerce
- [ ] Communications
- [ ] Conservation
- [ ] Education
- [ ] Engineering
- [ ] Industry
- [ ] Invention
- [ ] Landscape Architecture
- [ ] Literature
- [ ] Military
- [ ] Music
- [ ] Political
- [ ] Religion/Philosophy
- [ ] Science
- [ ] Sculpture
- [ ] Social/Humanitarian
- [ ] Theater
- [x] Transportation
- [ ] Urban Planning
- [ ] Other *(Specify)*

STATEMENT OF SIGNIFICANCE

The project for the South Union Station began in 1896 with the incorporation of the Boston Terminal Company, which was composed of the Boston and Albany Railroad Company, the New England Railroad Company, the Boston and Providence Railroad Corporation, the Old Colony Railroad Company and the New York, New Haven and Hartford Railroad Company, uniting the lines from the south of Boston. The trend toward consolidation gained momentum with the skyrocketing costs of maintaining individual lines. Following the North Station example, the new Boston Terminal Co. demolished the 1880 New England Station at Summer Street and Atlantic Avenue which had itself replaced the Boston, Hartford and Erie depot then only nine years old.

A year of planning proceded the construction of the new terminal and produced several important innovations in station planning and track layout. Two major considerations resulted in a prototypical "double decker" track system. First, the terminal site had size constraints due to the high land costs; second, public pressure demanded subway and electric service at the site for efficiency, economy, and minimal polluting effect. The suburban subway and electric lines were underground on a loop track, while the long distance passenger runs had 28 tracks at street level. (This piggyback system reached its acme several years later at New York's Grand Central.) Construction of the terminal took two years beginning in 1897. Dedicated in late December of 1898, the station opened publicly in January, 1899, and was the largest (and quickly the busiest) passenger station in the country. By 1916, South Station was handling 16 million more passengers than Grand Central Station in New York.

The train shed was distinguished technologically by its wide span, 570 feet in total. The engineer designer, J. Worcester, of the Terminal Company adapted the 1891-94 St. Louis Union Station example of an inverted arch/truss system with 5 segments, by combining a curved truss and cantilever arms to create a vast, open shed of only 3 segments. Unfortunately, the effect of pollutants within the shed seriously weakened the structure and forced its demolition in 1930. Numerous other new mechanical devices (track switches, furnaces, trial electric signal lights) as well as passenger amenities (restaurants, washrooms, travel services, etc.) were included in the station.

SEE INSTRUCTIONS

(Number all entries) 8. Significance (Cont'd)

In addition to its role in the evolution of station planning, South Station is also significant for its architecture. It was designed by Shepley, Rutan, and Coolidge and built by Norcross Brothers, who were contractors for the majority of H. H. Richardson's works and were the owners of multiple quarries that supplied granite for the architects. South Station was Boston's first (and only remaining) monumental public example of the Neo-classical Revival style. Although the firm was Richardson's successor, the major impetus for the station design comes not from his work but from C. B. Atwood's Terminal Station at the 1893 World's Columbian Exposition in Chicago. Active in Chicago during and after the Exposition, the Boston firm produced a considerable Neo-classical and Beaux Arts classical repertoire. South Station, a more restrained, sober and quiet design than their earlier classicizing works, established this trend in later railway terminals, including Pennsylvania Station, New York, and Union Station, Chicago - now both demolished. Boston had firmly rejected the mid-century picturesque station type: the only remnant was the clockpiece, no longer set high on a square tower, but just above the roofline. The clock, long a symbol of the railroad industry's reliance on punctuality and speed, was manufactured by the Edward Howard Clock Company of Roxbury and, later, Waltham. It is the largest and only remaining double, three-legged escapement mechanism in New England.

9. MAJOR BIBLIOGRAPHICAL REFERENCES

1. Alexander, E.P. Down at the Depot, New York: Clarkson Potter, 1970.
2. Boston Herald, September 5, 1897; October 18, 1964.
3. Francis, G.B. The South Terminal Station, Boston, Mass. reprinted from Proceedings, American Society of Engineers, December, 1899.
4. Meeks, C.L.V. The Railroad Station, An Architectural History, New Haven: Yale University Press, 1956.
5. Whitehill, W.H. Boston: A Topographical History, 2nd ed., Cambridge: Belknap Press of Harvard University, 1968.
6. Windsor, J., ed. The Memorial History of Boston, Boston: J.R. Osgood, 1880.

10. GEOGRAPHICAL DATA

LATITUDE AND LONGITUDE COORDINATES DEFINING A RECTANGLE LOCATING THE PROPERTY

CORNER	LATITUDE (Degrees Minutes Seconds)	LONGITUDE (Degrees Minutes Seconds)
NW	° ' "	° ' "
NE	° ' "	° ' "
SE	° ' "	° ' "
SW	° ' "	° ' "

OR

LATITUDE AND LONGITUDE COORDINATES DEFINING THE CENTER POINT OF A PROPERTY OF LESS THAN TEN ACRES

LATITUDE			LONGITUDE		
Degrees	Minutes	Seconds	Degrees	Minutes	Seconds
42°	21'	07.294"	71°	03'	20.393"

APPROXIMATE ACREAGE OF NOMINATED PROPERTY: 0.5

LIST ALL STATES AND COUNTIES FOR PROPERTIES OVERLAPPING STATE OR COUNTY BOUNDARIES

STATE:	CODE	COUNTY	CODE
STATE:	CODE	COUNTY:	CODE
STATE:	CODE	COUNTY:	CODE
STATE:	CODE	COUNTY:	CODE

11. FORM PREPARED BY

NAME AND TITLE:
Elizabeth Amadon, Executive Director, by Boston Landmarks Commission

ORGANIZATION: Massachusetts Historical Commission

DATE: October, 1974

STREET AND NUMBER: 40 Beacon Street

CITY OR TOWN: Boston

STATE: Massachusetts 02108

CODE: 025

12. STATE LIAISON OFFICER CERTIFICATION

As the designated State Liaison Officer for the National Historic Preservation Act of 1966 (Public Law 89-665), I hereby nominate this property for inclusion in the National Register and certify that it has been evaluated according to the criteria and procedures set forth by the National Park Service. The recommended level of significance of this nomination is:

National ☒ State ☐ Local ☐

Name Elizabeth R. Amadon
Elizabeth R. Amadon

Title State Historic Preservation Officer (designee)

Date October 31, 1974

NATIONAL REGISTER VERIFICATION

I hereby certify that this property is included in the National Register.

Director, Office of Archeology and Historic Preservation

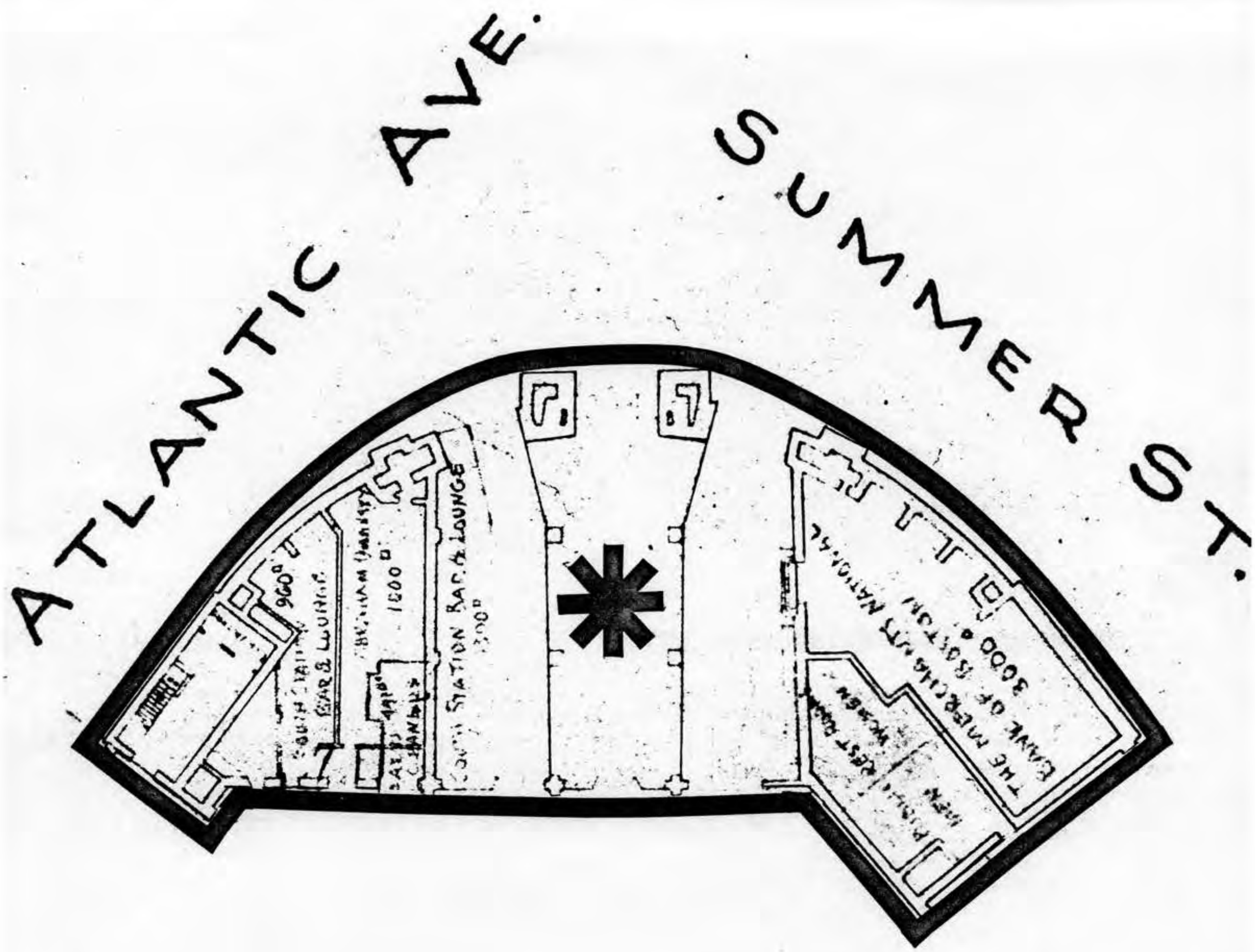
Date

ATTEST:

Keeper of The National Register

Date

SEE INSTRUCTIONS

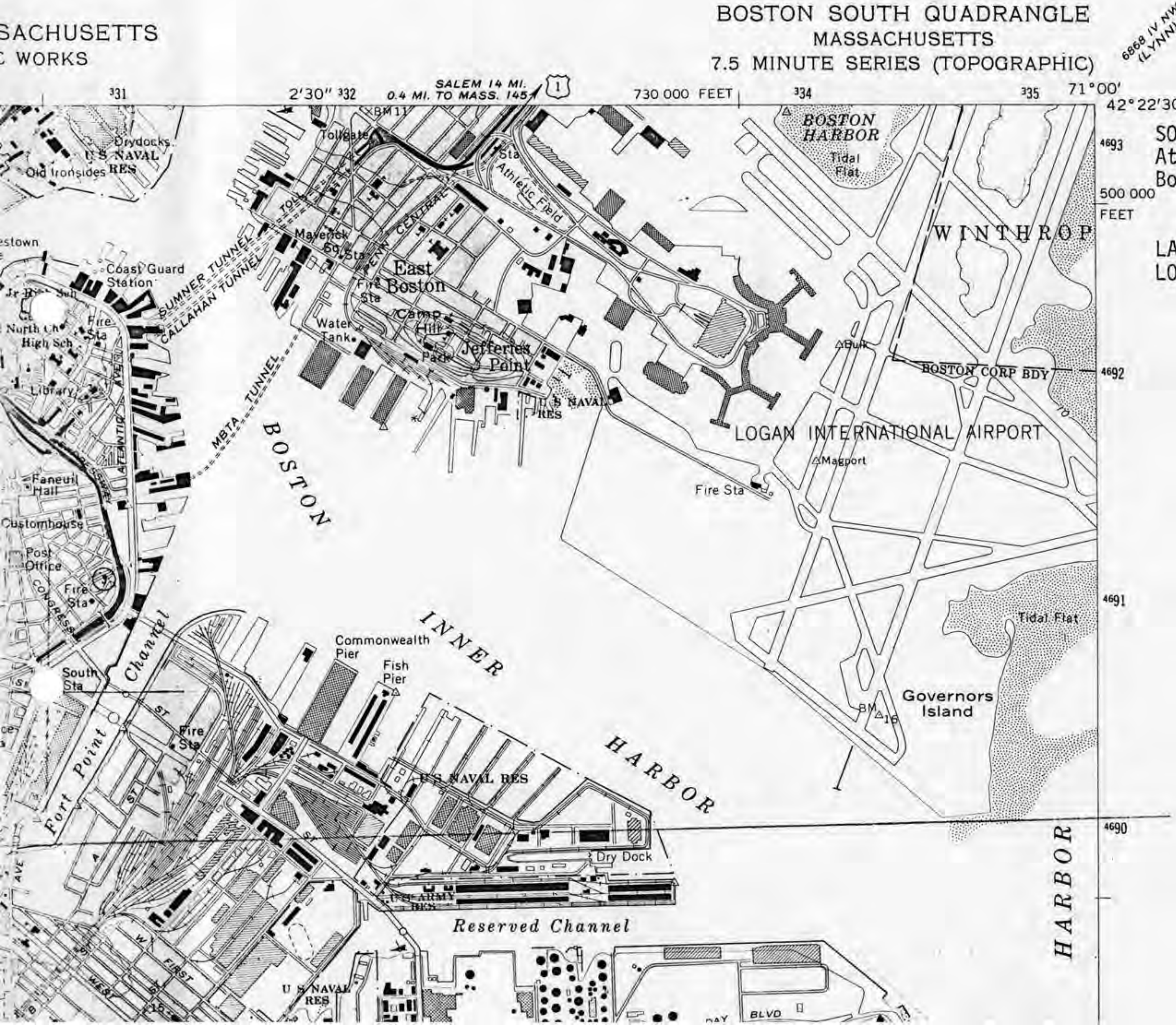


SOUTH STATION HEADHOUSE
Atlantic Avenue & Summer Street
Boston, Massachusetts

Scale: 1"= 40'

SOUTH STATION HEADHOUSE
Atlantic Avenue & Summer Street
Boston, Massachusetts

Scale: 1"=100'



SOUTH STATION HEADHOOUSE
Atlantic Ave. & Summer St.
Boston, Massachusetts

LAT: 42^0 21' 07.294"
LONG: 71^0 03' 20.393"

4690690

Attachment AA Inventory of Historic and Archaeological Assets of the Commonwealth Forms (Excerpted)

Attachment AA includes of Inventory of Historic and Archaeological Assets of the Commonwealth forms (excerpted) that are on file at the MHC and BLC. Forms in Attachment AA are:

- Chester Guild, Hide and Leather Machine Company
- Chinatown District
- Federal Reserve Bank of Boston
- Keystone Building
- Kneeland Street Steam Heating Plant
- MBTA Operations Center Power Substation
- South End Industrial Area
- 245 Summer Street
- USPS General Mail Facility/South Postal Annex
- Weld Building

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BOS.1793

BOSTON LANDMARKS COMMISSION Building Information Form Form No. ___ Area CBD

ADDRESS 51-53 High St. OPP. ~~COR.~~ 245 Purchase St.

NAME ___ present ___ original

MAP No. 24N/13E SUB AREA Financial

DATE c. 1873 source (No permit)

ARCHITECT unknown source

BUILDER unknown source

1874 Atlas
OWNER Chester Guild & Son original ___ present

PHOTOGRAPHS 26 3/1, *35 5/2-80

TYPE (residential) single double row 2-fam. 3-deck ten apt.
(non-residential) mercantile

NO. OF STORIES (1st to cornice) four plus above grade basement at rear

ROOF flat cupola ___ dormers ___

MATERIALS (Frame) clapboards shingles stucco asphalt asbestos alum/vinyl
(Other) brick stone granite concrete iron/steel/alum.

BRIEF DESCRIPTION Narrow 4 bay mercantile building with granite facade. Rectangular fenestration with beveled window edges; sill courses, and projecting band course between stories. Stone modillion block cornice. Rear facade of brick has fully exposed basement level, granite sill and lintel courses, and corbelled cornice; largely covered by advertising signs and firescape.

EXTERIOR ALTERATION minor moderate drastic storefront

CONDITION good fair poor lack of maintenance LOT AREA 2440 sq. feet

NOTEWORTHY SITE CHARACTERISTICS Buildings recently razed on northeastern side.

SIGNIFICANCE (cont'd on reverse)

Structure architecturally significant as early post-fire granite mercantile structure, once part of continuous granite-faced row down High and around corner on Federal Street. Also, historically significant as related to the leather industry, rebuilding in this area after devastation by Great Fire of 1872.

The 1874 Atlas indicates that this building was already occupying the site, and the 1883 Atlas pictures a streetscape wall of stone facades extending

III B JG 9/00
IV M+ MHK 6/80

CITY OF BOSTON
BOSTON LANDMARKS COMMISSION

CHINATOWN-SOUTH COVE
COMPREHENSIVE SURVEY PROJECT
FINAL SURVEY REPORT

Arthur Krim
Survey Systems
Cambridge MA 02139
July 11, 1997

CHINATOWN-SOUTH COVE
COMPREHENSIVE SURVEY PROJECT
METHODOLOGY STATEMENT

Survey Objectives

The objective of the Chinatown-South Cove Survey was to provide a comprehensive inventory of all properties and areas within the defined boundaries of the Chinatown-South Cove area within the limit of forty-five (45) inventory forms of the Massachusetts Historical Commission (MHC) standards. The survey was designed to update the previously existing inventory of the Boston Landmarks Commission (BLC) for the Theatre District (1979) and the Central Business District (1980), as well as an informal field survey of the Chinatown-South Cove area (1971). The survey iwas intended to explore significant urban themes for the area that included both social history and ethnic heritage in addition to traditional architectural history of all properties and areas within Chinatown-South Cove. The survey area boundaries included Essex Street (north), Edinboro-Hudson Streets to Tai Tung Village (east). Marginal Road (south) and Washington Street (west).

Assessment of Previous Research

Within the Chinatown-South Cove Survey Area, assessment of existing inventory forms in the Theatre and Central District surveys from 1979-1980 revealed a pattern that focused on the area north of Kneeland Street to Essex Street between Washington and Edinboro-Hudson Streets. These BLC inventory forms generally included the building date and architect from Boston Building Department files and some Suffolk County Deed research on selected buildings. A general sense of social and ethnic history was also included within an overview of Chinatown history. No specific effort had been made to date the 19th-century brick row buildings that formed the primary historic streetscapes within Chinatown beyond a general assessment of age.

For the area south of Kneeland Street, only the 1971 field survey of the Chinatown-South Cove area was available. Some of the 19th-century streetscapes had been inventoried on BLC forms with MHC numbers for the Tyler-Harvard-Hudson Streets area that included the Quincy School. However, these were general summaries without research or documentation of sources. For the area between Harrison Avenue and Washington Street, no inventory had been filed beyond the 1971 field survey. This included the brick row streetscapes on Oak Street and Johnny Court, and the New England Medical Center (NEMC) buildings on Bennet-Nassau-Harvard Streets, as well as St. James Church on Harrison Avenue.

Selection Criteria

The process of selecting properties for the Chinatown-South Cove inventory was based on the essential need to date and determine the 19th-century brick row streetscapes that form the primary historic resource of Boston Chinatown. While some of the these rows appeared to be carefully documented in the existing BLC files, the majority were only generally understood. A second group of buildings that were found in need of careful research were those in the New England Medical Center complex, all without dates or background historical context. A third group were the Kneeland Street garment loft buildings that had been overlooked in the Central District and Theatre District BLC surveys. Finally, the group of suspected 19th-century buildings on Essex and Washington Streets that appeared to warrant additional research for age and significance.

Beyond the dating of individual properties, was the larger need to assemble an ethnic and cultural history of the Chinatown-South Cove survey area. While, a general sense of the Chinatown development sequence was known, the sequence of Chinese immigration to Boston and links with other ethnic groups were only vaguely understood. Thus, a search for primary sources and contemporary records of easy access became a primary objective to understand the development of Boston Chinatown in a national perspective.

Finally, the additional need to update the existing BLC survey forms and include historic period signage for Chinatown restaurant locations, required revision of the Late Modern Period to 1960 as determined by the MHC. Even this recent date was taken with an expanded option that included a final period date at 1970-1975, bringing the need for BLC survey revision within the last twenty-five years.

Survey Procedures

The priorities for survey procedures involved a complex balance to determine accurate original dates on all buildings within the Chinatown-South Cove area and the need to develop a cultural history that brought the historic context to the recent past.

The first priority was to deed date all the 19th-century brick row streetscapes in Chinatown-South Cove so that the oldest properties could be securely identified. All existing BLC inventoried properties were examined and those with deed dates used as a base line. Unfortunately, only a few BLC forms matched this basic dating criteria, notably those at <u>5-7 Knapp Street.</u> Thus, a considerable effort was made to research all available brick row streetscapes at the Suffolk County Deed library in Boston. The basic source was the 1874 Hopkins <u>Atlas of Suffolk County,</u> that named all property

NARRATIVE HISTORY
CHINATOWN-SOUTH COVE
BOSTON, MASSACHUSETTS

AREA INTRODUCTION

The Chinatown-South Cove district is bounded by Essex Street (north), Washington Street (west), Marginal Road (south) and Hudson-Edinboro Streets (East) with an exception for Tai Tung Village at Harrison Avenue, Oak Street, Tyler Street and Tai Tung Street. The natural topography originally followed the neck of the Shawmut Peninsula along Washington Street to the tideline at Beach Street with a gentle slope still obvious from Washington Street east to Harrison Avenue at Bennet and Harvard Streets and from Essex Street south to Beach Street along Harrison Avenue. The natural flora at time of Contact was likely exposed tidemarsh grasses and possibly some hardwoods along the axis of Washington and Essex Streets.

FIRST PLANTATION PERIOD
1620-1675

Initial English settlement of the native Shawmut Peninsula was made in 1625 by Thomas Blackstone (now Boston Common) with organized settlement of Boston by the Massachusetts Bay Company in 1630 (now Court Street), beyond the bounds of the Chinatown-South Cove district. Within the district, the original course of the native trail along the Shawmut Neck followed the eastern tidemarsh shore along a natural slope to Beach Street. This slope is still intact at Bennet, Harvard and Nassau Streets and offers some archaeological potential of native shell fishing sites, especially in the sealed parking lots of Ash Street and Maple Place. The remainder of the trail is preserved in the alignment of Washington Street north from Beach Street to Essex Street. A series of five home lots were divided along the south (odd) side of Essex Street with surviving lot lines preserved in the alignment of Edinboro Street, Ping On Street, Oxford Street and Harrison Avenue to Beach Street. Limited archaeological potential for the 17th-century home lot sites might exist at the sealed parking lots at 33-37 Essex Street and 85-91 Essex Street.

COLONIAL PERIOD
1675-1780

During the Colonial Period, settlement within the district remained limited to the Essex Street home lots and the axis of Washington Street north of Beach Street. The axis of Washington Street was relocated directly north along the Shawmut Neck during the 18th-century to its present

STUDY RECOMMENDATIONS

The Chinatown-South Cove Survey Project has provided a detailed inventory of a unique American urban district combining architectural history with ethnic history in a preservation survey. The discovery of the full building sequence in Chinatown-South Cove provides a model for other ethnic urban districts in Boston and demonstrates the forces of change which have affected the area.

The primary recommendation is the nomination of much of the Chinatown-South Cove Area for the National Register of Historic Places. A list of twelve (12) such nominations has been included in this report (see above). In combined form these include two districts within Chinatown: 1) Old Chinatown at 28-38 Harrison Avenue/ 48-58 Beach Street/ 4-11 Oxford Place and 2) New Chinatown 2-22 Tyler Street with 3) the Chinese Merchants Association Building at 20 Hudson Street. Other National Register Nominations include: 4) the Quincy Grammar School at 88-90 Tyler Street/ 5) the Boston Dispensary at 25-37 Bennet Street, 6) St. James Church at 123 Harroison Avenue/ and 7) the Hudson Building at 75 Kneeland Street. Other areas of potential consideration include Oak Street and Johnny Court to Harrison Avenue/ and the Harvard-Hudson-Tyler Streets district near the Quincy School. These areas are critical to the survival of the 19th-century historic character of Chinatown as a symbolic center of the Boston Chinese community and to the origins of the New England Medical Center (NEMC) complex.

The Chinatown-South Cove survey has demonstrated that the forces of urban change have resulted from four factors: 1) Expansion of the Central Business District, 2) Expansion of the New England Medical Center, 3) Federal Interstate highway construction and 4) Demolition for public parking. This last factor is perhaps the least understood and potentially the most errosive of historic integrity of the survival building fabric. Within the year of the Chinatown-South Cove Survey (1996-1997) two historic brick row streetscapes have suffered demolition at 193-197 Harrison Avenue and 56-58 Tyler Street for NEMC parking, while a third area at 1-17 Nassau Street is awaiting demolition for parking expansion. Such loss of 19th-century streetscapes actually dates to the Early Modern Period with brick rows at 76-82 Harrison Avenue and 15-21 Tyler Street in 1938 as need for tourist restaurant parking became critical in Chinatown. Indeed, even the construction of the Shopper's Garage at 14-40 Beach Street in 1925 can be seen as an early auto-use conversion within the Chinatown-South Cove area. Although it is presumed that much of the current NEMC expansion has involved demolition of streetscapes for parking needs, in reality, many of these rows had actually been razed before the Second World War as land values declined along the Harrison Avenue elevated railway route.

- Chinatown (Expanded version, of Chinatown District identified in FEIS/R, also in Secondary Corridor and in South Bay/Fort Point Channel Area) (#19): Chinatown is largely a district of brick row houses built in the mid-19th century, around an area of Boston known as South Cove, Adjacent commercial and institutional structures were built more recently, into the mid-20th century. The development of the South Cove area started in 1833 to provide the Boston & Worcester Railroad with a terminal and rail yard. These early row houses were built in response to this development, and have housed successive waves of immigrants since then. The area has gained cultural significance from its 20th century history of occupancy by the Chinese who began arriving in Boston in the late 19th century.

  In order todetermine contributing buildings and the exact boundary of the district, in an area which would be differently affected by alignment revisions, it was necessary to do an original survey. The buildings found to be contributing appear to meet National Register standards for contributing buildings in a district which is potentially eligible under Criteria A and C for its historic associations with Chinese settlement and the buildings' qualities, which are similar to those which had already been surveyed in this district.

  does MHC have list of these?

  In addition to the contributing buildings previously included in the district, the following are newly identified in the updated survey:

  25-27 Edinboro Street
  29-33 Edinboro Street
  73-79 Essex Street
  6-18 Hudson'Street
  11-23 Hudson Street
  20 Hudson Street (Chinese Merchants Association Building): Built in 1949 and designed by Edward Chln-Park, this 4-story steel and concrete structure with a limestone veneered facade features oriental decorative motifs. Prominently sited at the entry way Into Chinatown and highly visible because of its strong massing and pagoda-crowned roof, the building's east end was truncated by construction of the Central Artery. It ls both culturally and architecturally significant as being built specifically for a major Chinese organization, by a Chinese architect, utilizing oriental motlfi.

  This building ls less than 50 years old, but lt may meet the test of being exceptionally important. If so, it appears to meet Criterion A for listing on the National Register for its association with the development of the Chinese community ln Boston; and Criterion C ln that lt embodies the distinctive characteristics of a type and period of construction. If not Individually eligible,

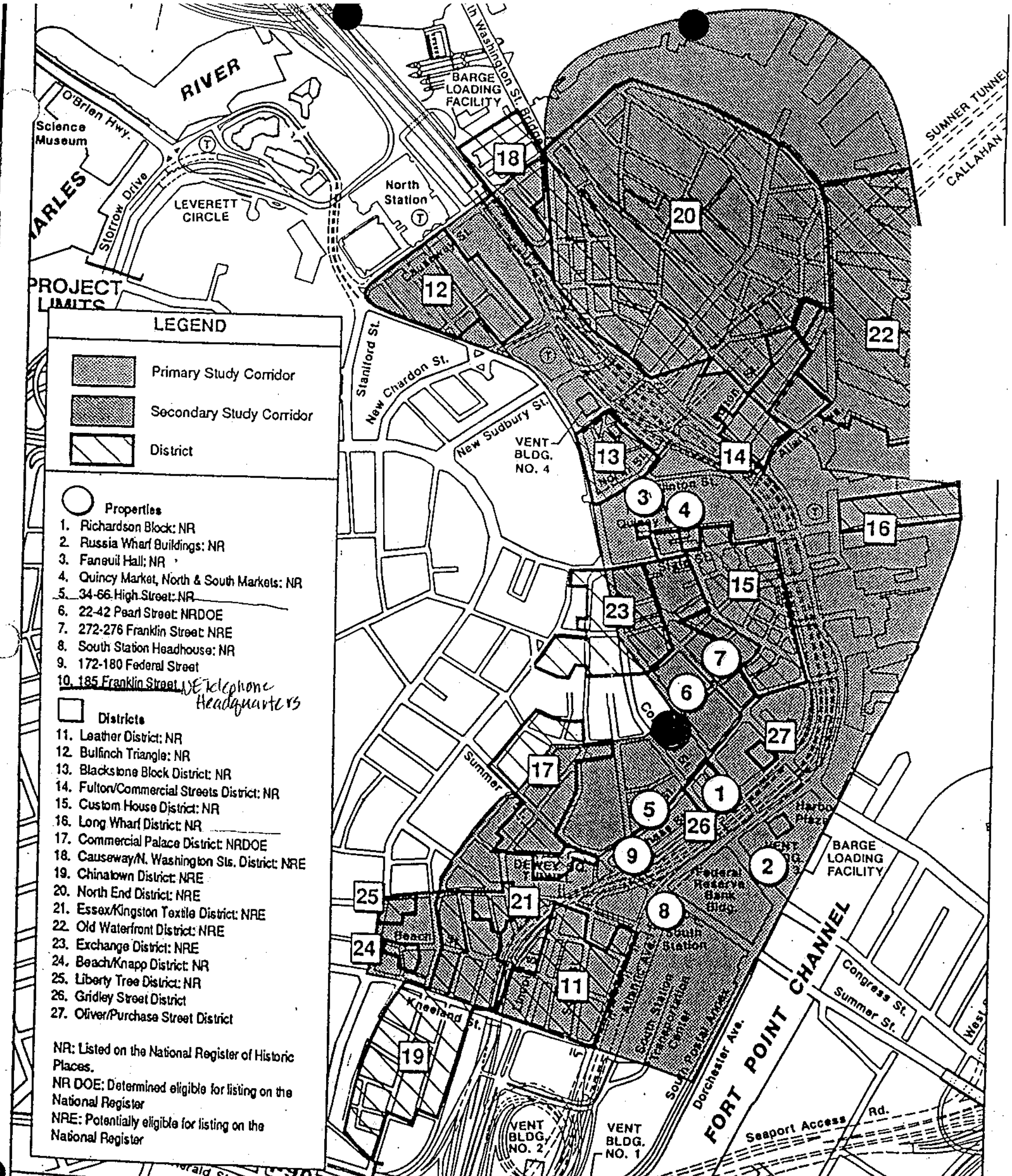

FIGURE 3

Structures Surveyed For The Central Area Historic Resources Inventory

The Commonwealth of Massachusetts Department of Public Works
Central Artery (I-93)/Third Harbor Tunnel (I-90) Project
SUPPLEMENTAL EIS

0 400 800 1200 Feet

BOS.1516

BOSTON LANDMARKS COMMISSION Building Information Form Form No. ___ Area CBD

ADDRESS 556-624 Atlantic Ave. COR. Summer St. Congress St. Dorchester Ave.

NAME Federal Reserve Bank of Boston
present original

MAP No. 24N/13E SUB AREA Financial

DATE Begun 1973 Bldg. permit 12-12-72
source

ARCHITECT Hugh Stubbins & Assoc. "
Le Messurier Assoc., eng. source

BUILDER Perini Corp Codman Survey
source

OWNER 1200 Realty Trust
original present

PHOTOGRAPHS 23 1/3, *35 1/4-80

TYPE (residential) single double row 2-fam. 3-deck ten apt.
(non-residential) offices, banking, & garage

NO. OF STORIES (1st to cornice) thirty-two plus 4 story low-rise section

ROOF flat cupola dormers

MATERIALS (Frame) clapboards shingles stucco asphalt asbestos alum/vinyl
(Other) brick stone concrete iron/steel/alum.

BRIEF DESCRIPTION Structural steel frame office tower with aluminum and glass skin. Main tower features corner piers with uninterrupted horizontal span of windows across two major facades, shielded by aluminum, eyebrow-like spandrels, triangular in section. 4 story low-rise section, aluminum clad and lacking fenestration, connected to main tower by linking unit of glass, resembling a greenhouse.

EXTERIOR ALTERATION minor moderate drastic

CONDITION good fair poor LOT AREA 212,743 sq. feet

NOTEWORTHY SITE CHARACTERISTICS Freestanding, on prominent site, incorporating enormous block fronted by brick pavillion and surrounded by landscaped area. Significant contribution to Boston's skyline.

SIGNIFICANCE (cont'd on reverse)

Significant example of office tower architecture in its design, materials, and use of site as people- oriented space. "Designed to unite a growing central business district with a major transportation interchange."[1] Stubbins states that "three main forces converged to shape the design of the complex: the importance of a clear expression of distinct but related functions in a unified scheme that would enhance a prime renewal area of downtown Boston, the need for well

N+ MHK 6/80

EXISTING STATE REGISTER DESIGNATIONS

DESIG CODE	DATE	NAME
none		

MAJOR CHANGES OR CORRECTIONS TO PAGE 1 BASE INFORMATION

Assessors Parcel ID: 0304340000
Assessors Address: 556 Atlantic Avenue
Date: 1972-74

ADDITIONAL ARCHITECTURAL DESCRIPTION

The Federal Reserve Bank complex occupies a full city block, with the main tower standing in the southwest corner and a low-rise 4-story section occupying the east and north sections of the site. The distinctive aluminum cladding reduces solar heat gain, and the projecting spandrels help to reduce glare and downdrafts. Unlike many office towers of its period, the tower's ground floor is set at-grade, so that the entrance level, plaza, and sidewalk are on a continuous plane.

The base of the tower contains a 2-story high, butt-glazed entry lobby surmounted by 2 aluminum-clad stories with a narrow band of continuous windows in the lower part, and a large-metal-clad projection over the entry area. The public entrance is offset in the west face of the lobby, with a pair of revolving doors encased in metal-clad, drum-shaped projections. A glazed link section, extending northward from the side of the tower, features a 1-story solid concrete base, surmounted by a vertical, glazed story, 6 sloped bands of glazing with aluminum piers, and a horizontal band of aluminum panels at the top.

The 4-story section to the east of the tower rises from a solid aluminum-clad wall on the first floor on all sides. At the back (east), the first floor projects towards Dorchester Ave and contains an entrance to an underground parking garage. The 2nd and 3rd stories cantilever over the ground floor on the Summer and Congress St sides, and the 4th floor opens to a roof garden on the east (Dorchester Ave) side. Horizontal bands of butt-glazed windows are located on the 2nd and 3rd floors along the south, east, and west elevations (Summer St, Dorchester Ave, and Congress St). Occasional security windows and services doors are located at ground level and along the Atlantic Avenue elevation of this building volume.

A small, irregularly shaped, free-standing structure at the east side of the parcel is a later addition. Two-stories high, it contains a security booth and loading docks and/or garage entrance bays on its south and north ends. It is clad in aluminum panels and has a curved glass façade with metal columns on its east (Dorchester Ave) side. The large setback area on the west (Atlantic Ave) side of the site incorporates raised and bermed planting areas, pre-cast and granite block walls, and decoratively paved plaza areas; a narrower setback area on the south (Summer St) side of the site is similarly elaborated. Halvorson Design Partnership was the landscape architect for this design; the firm has also designed Post Office Square Park in downtown Boston. Replacing the original, suburban-influenced park setting, the present landscape design for the Federal Reserve Bank was created to respond to post-9/11 security concerns while also addressing the property's lively urban design context.

The end piers of the tower contain service equipment such as elevators and wind bracing, with administrative functions set in-between. Banking operations are located in the low-rise block, with public spaces such as an auditorium and art gallery in the link structure.

ADDITIONAL HISTORICAL NARRATIVE

Established by Congress in 1913, the Federal Reserve System is the nation's quasi-public central bank. Its primary functions are to set monetary policy, supervise and regulate banking institutions, maintain a stable financial system, and provide financial services to the U.S. government, the public, and domestic and international financial institutions. Organized in 1914, the Federal Reserve Bank of Boston is one of 12 district banks across the country and serves the six New England states. Its first permanent location, an existing building at 53 State Street, was soon outgrown, and the Renaissance Revival structure at 22-42

Pearl Street (BOS.1938) was built for the Federal Reserve in 1920-22. The current building was constructed between 1972 and 1974, and occupied by the bank in 1977. The site was previously occupied by commercial warehouses, and construction of this landmark building helped extend Boston's financial district and revitalize the South Station area.

Architect Hugh Stubbins (1912-2006) began teaching at Harvard in 1940, at the invitation of Walter Gropius, and soon established his own firm, Hugh Stubbins & Associates, in Cambridge. His prolific practice (more than 800 buildings) encompassed Modernist houses, academic and other institutional buildings, and commercial structures, including a number of prominent skyscrapers around the world. Among his best-known projects are Congress Hall (now House of World Cultures) in Berlin (1957), Veterans Stadium in Philadelphia (1971), the Federal Reserve Bank in Boston (1972-74), Citicorp Center in New York (1976-78), the Ronald Reagan Presidential Library in California (1991), and the Yokohama Landmark Tower in Japan (1993). Stubbins received an AIA Honor Award in 1978 for Citicorp and the AIA Firm of the Year award in 1967. *The New York Times* architecture critic Paul Goldberger has called the Federal Reserve Bank in Boston one of the city's best modern buildings, and a late 20th c guidebook declares it to be "a true landmark building in the modern mode conveying the power and poetry of high technology." (Miller and Morgan: 78). Stubbins was also a partner in the consortium that designed the notable State Street Bank Building at 225-245 Franklin Street (BOS.1745).

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National Register of Historic Places Criteria Statement Form

Check all that apply:

☐ Individually eligible ☐ Eligible **only** in a historic district

☐ Contributing to a potential historic district ☐ Potential historic district

Criteria: ☐ **A** ☐ **B** ☐ **C** ☐ **D**

Criteria Considerations: ☐ **A** ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐ **F** ☐ **G**

Statement of Significance by W. Frontiero

In 2009, although not yet 50 years of age, the Federal Reserve Bank of Boston is significant for its associations with the architectural and economic renewal of downtown Boston and its waterfront in the late 20th century, and for its important role in the financial industry of New England. The building is an outstanding example of late 20th century office design by a nationally-known architect, Hugh Stubbins, and maintains an iconic presence on the Boston waterfront.

When it reaches 50 years of age, the property will merit National Register designation for its significance under criteria A and C on the local and state levels. Additional research would be necessary to demonstrate national level significance in the context of Stubbins' work and the significance of this property relative to the nationwide building programs of the Federal Reserve during this period. At this time, more research would be necessary to determine whether there presently exists a sufficient body of scholarly research and evaluation of the building and its role in the context of the architecture and economy of the city, state, and nation for it to meet the threshold of exceptional significance of the national Register Criteria Consideration G, for properties less than 50 years of age.

BOS.1794

BOSTON LANDMARKS COMMISSION   Building Information Form   Form No. ___ Area CBD

ADDRESS 73-103 High St.   COR. 225 Congress St. 197-225 Purchase St.

NAME Keystone Building
present   original

MAP No. 24N/13E   SUB AREA Financial

DATE 1968-70   Bldg. permit 10-2-68
source

ARCHITECT Pietro Belluschi & Emery Roth & Sons   N.Y.C. "
source

BUILDER Carl A. Morse, Inc. of Mass., N.Y.C. "
source

OWNER Keystone Centrose Assoc., N.Y.C.
original   present

PHOTOGRAPHS * 18 4/4-80

TYPE (residential) single double row 2-fam. 3-deck ten apt.
(non-residential) stores & offices.

NO. OF STORIES (1st to cornice) thirty-two   plus

ROOF flat   cupola   dormers

MATERIALS (Frame) clapboards shingles stucco asphalt asbestos alum/vinyl
(Other) brick (stone) Travertine Marble concrete iron/steel/alum.

BRIEF DESCRIPTION Polygonal modern office tower of steel frame construction with concrete fill over fluted metal deck; skin of bronze solar glass and light tan Italian Travertine marble. Structure distinguished by its connecting 3-sided window bays which rise from 3rd to top levels, and give building a corregated appearance along with emphasizing its verticality. Softly rounded corners carry the eye around.

EXTERIOR ALTERATION (minor) moderate drastic

CONDITION (good) fair poor   LOT AREA 28,680 sq. feet

NOTEWORTHY SITE CHARACTERISTICS Freestanding; adjusts to polygonally shaped site formed by street pattern. Faces expressway.

SIGNIFICANCE (cont'd on reverse)
Structure located on fringe of Financial District, and helps to extend the Financial-Retail area into the South Station area. Significant in its pioneering use of Travertine marble, the architects state that it is the first time that this decorative marble has been used as facing for a building; ordinarily, it is for interior use. A total of 14oo tons of the stone were cut from a quarry near Rome for this building.

MHK 6/80

EXISTING STATE REGISTER DESIGNATIONS

DESIG CODE	DATE	NAME
none		

MAJOR CHANGES OR CORRECTIONS TO PAGE 1 BASE INFORMATION

Assessors Parcel ID: 0304390000
Assessors Address: 73 High Street
Common Address: 99 High Street

ADDITIONAL ARCHITECTURAL DESCRIPTION

The trapezoidal building is 8 bays (along Congress St) by 9 bays (along High St), plus three canted bays at each comer. Its two-story high base, with a double-height ground floor, is recessed behind deep, engaged piers and is enclosed with bronzed curtain-wall construction with clear glass and spandrel panels. Upper floors are uniform, except for ventilation grilles at the 18th floor. Bay windows wrap around the building comers and give an undulating appearance to the facades.

The main entrance to the office levels is centered on the High Street façade, and features a diagonal recess with glass doors and butt-glazed windows above. Sloped, fixed metal awnings are mounted above the storefront windows along Congress and Purchase streets. The Purchase Street elevation contains two asymmetrical loading dock bays and a service entry bay; the entrance to an underground parking garage is located in a projection on the south side of the building.

ADDITIONAL HISTORICAL NARRATIVE

The Keystone Building was constructed as headquarters for Keystone Custodian Funds, inc. a financial organization that was founded in 1932. Belluschi and Roth worked together on two buildings in the downtown area, 73-103 High Street (BOS.1794) and the Boston Company Building (BOS.1669; One Boston Place).

Pietro Belluschi (1899-1994) was an important educator and practitioner in the modernist and regional styles of architecture. His career began in Portland, Oregon, in 1925, with commercial, residential, and religious buildings, including such projects as the Portland Art Museum, Finley Mortuary, and Equitable Building, all in Portland. From 1951 to 1965, Belluschi served as dean of architecture and planning at MIT, while continuing to design religious, office, academic, and cultural buildings—more than 1000 in a 50-year career. Belluschi often collaborated with other firms, including Pier Luigi Nervi (St. Mary's Cathedral in San Francisco), Eduardo Catalano (Julliard School of Music and Alice Tully Hall at Lincoln Center), Walter Gropius and Emery Roth and Sons (Pan American Building in NYC), and SOM (Symphony Hall in San Francisco). In Boston, Belluschi also designed the First Lutheran Church at Marlbourgh and Berkeley streets (1959) and 99 High Street (1968; BOS.1794). The AIA awarded Belluschi its Gold Medal in 1972.

Emery Roth & Sons was established in 1938 by the eponymous architect (1871-1948), and included his sons Julian (1901-1992) and Richard (1904-1987). In the first half of the 20th century, Roth was renowned for his large, fashionable apartment houses and hotels in New York City. After World War II, the well-known and prolific firm concentrated on large corporate office towers as well as luxury hotels and apartment complexes. Prominent projects from this period include the Look Building, General Motors Building (with Edward Durrell Stone), Pan Am Building (with Walter Gropius and Pietro Belluschi), Colgate-Palmolive Building, Sperry Rand Building, Citigroup Center (with Hugh Stubbins & Associates), and World Trade Center (with Minoru Yamasaki). In Boston, Emery Roth & Sons also designed the Saltonstall Building on Cambridge St (BOS.1616) and worked on the New England Merchants Bank at 28 State St with Edward Larrabee Barnes (BOS.2000).

Distinctive for its consistent, undulating façade and its use of marble as a cladding material, the building is also prominently sited along the Rose Kennedy Greenway. Although designed by two very prominent architects, the Keystone Building is not

Boston Landmarks Commission Building Information Form Form No. ____ Area CBD

USGS BOSTS 1829 SECT C

ADDRESS 155 Kneeland St. COR.

NAME Kneeland St. Steam Heating Plant
present original

MAP No. 24-13, 24-12 SUB AREA wholesale

DATE 1929-30
source

(Photo)

ARCHITECT Bigelow, Wadsworth, Hubbard & Smith
source

BUILDER
source

OWNER Boston Edison
original present

PHOTOGRAPHS

TYPE (residential) single double row 2-fam. 3-deck ten apt.
(non-residential) POWER PLANT

NO. OF STORIES (1st to cornice) ____ plus TOWERS

ROOF FLAT cupola ____ dormers ____

MATERIALS (Frame) clapboards shingles stucco asphalt asbestos alum/vinyl
(Other) brick stone ____ concrete iron/steel/alum.

BRIEF DESCRIPTION

Red brick 125 foot tall plant with twin 250 foot stacks..

EXTERIOR ALTERATION minor moderate drastic

CONDITION good fair poor ____ LOT AREA ____ sq. feet

NOTEWORTHY SITE CHARACTERISTICS

SIGNIFICANCE (cont'd on reverse)

Built in 1930, this highly visible twin-stack plant was Boston's first central steam plant.

(Map)

A

BOS.1829

CENTRAL ARTERY/THIRD HARBOR TUNNEL PROJECT
Updated Survey of Historic Resources

155 Kneeland St. CBD

Kneeland St. Steam Heating Plant

LOCATION:

Map Number: 24-12, 24-13

Subarea: South Bay/Fort Point Channel Area

Corridor: primary

NATIONAL REGISTER STATUS

INDIVIDUAL STATUS:		DISTRICT STATUS:	
___	Individual NR-Listed	___	In NR District
___	Individual DOE	___	In DOE District
X	Individual NR-Eligible determined by MHC 4/18/90	___	In NR-Eligible District

Name of District: None

BOSTON LANDMARKS COMMISSION STATUS:

Landmark Status: None

Survey Category: n/a

BLC District: None

Boston Affiliates, Inc.
January, 1989

X ref.

BOS.1792

BOSTON LANDMARKS COMMISSION Building Information Form Form No. ___ Area CBD

ADDRESS 35-49 High St OPP. COR. Between 265 & 245 Purchase St

NAME (T) Operations Center
present original

MAP No. 24N/13E SUB AREA Financial

DATE 1969 Bldg. permit 6-23-1969
source

ARCHITECT Jackson & Moreland "
source

BUILDER George A. Fuller Co.
source

OWNER MBTA
original present

PHOTOGRAPHS *26 3/2

TYPE (residential) single double row 2-fam. 3-deck ten apt.
(non-residential) power substation

NO. OF STORIES (1st to cornice) five plus

ROOF flat cupola dormers

MATERIALS (Frame) clapboards shingles stucco asphalt asbestos alum/vinyl
(Other) brick brown stone concrete iron/steel/alum.

BRIEF DESCRIPTION
Modern brick structure with windowless facade, and recessed entry gained by ramp leading across facade. Purchase St. facade similar.

EXTERIOR ALTERATION minor moderate drastic

CONDITION good fair poor LOT AREA 8435 sq. feet

NOTEWORTHY SITE CHARACTERISTICS Building has facade on opposite street.

SIGNIFICANCE (cont'd on reverse)

Non-contributory.

MHK 6/80

FORM A - AREA

Assessor's Sheets

USGS Quad \rca Letter Form Numbers in Area
Boston South RQ — See Area DataTable
Newton
Norwood

Massachusetts Historical Commission
Massachusetts Archives Facility
220 Morrissey Boulevard
Boston, Massachusetts 02125


Readville Carshops, Industrial Drive: Overview

Town Boston

Place *(neighborhood or village)* Hvde Park

Name of Area Readville

Present Use industrial, commercial, residential

Construction Dates or Period 1866 to late-20th c.

Overall Condition fair to good

Major Intrusions and Alterations some demolition and recentinfill

Acreage approx. 215 acres

Recorded by VI1A. MK. MKH. CMM

Organization The Public Archaeology Laboratory. Inc.

Date *(month/day/year)* July 1997

Sketch Map
Please see attached

Massachusetts Historical Commission
Massachusetts Archives Facility
220 Morrissey Boulevard
Boston, Massachusetts 02125

ARCHITECTURAL DESCRIPTION *(continued)*

interdependent facilities. It is the only surviving historic railroad shop complex in the city of Boston, and one of several of this type of resource remaining in New England.

Northeast of the J. Baker, Inc. Building at 65 Sprague Street (MHC 11082, 1902), the complex located at 50 Horne Street, Prudential Fastener (MHC 12898, late-19th c.) consists of three individual buildings arranged in a "C" and intersected by Horne Street. The 3-by-10-bay rectangular buildings are of brick masonry construction, rest on concrete foundations, with flat, built-up roofs, and are of 1- to 2-stories. The elevations are marked by slightly stepped-out buttresses and have aluminum flashing at the rooflines. The southern building contains an entrance on the southeast elevation consisting of a single-light replacement door. There is also a roll-up door located on this elevation. Windows are rectangular, aluminum, fixed-sash arranged in a combination of single and double pane. The center building features the main entrance in the southeast elevation and a roll-up door also located on this elevation. Window openings are bricked-in on the southeast and southwest elevations. The northern building contains a single steel door and a roll-up metal door on the southwest elevation. These buildings are in fair condition, and are minor examples of masonry warehouse structures.

Further northeast, off Hyde Park Avenue is Frank Kunkel & Son Hammered Forgings (MHC 12915, 1883) located on Wolcott Court. The building is a rectangular, 1-story, 1-by-13-bay, masonry-and-steel-frame building, with a gable roof. The elevations are articulated by brick piers placed between the bays. The main entrance is located on the west elevation and to the north of a large, metal, roll-up loading bay. Above this is painted "FRANK KUNKEL & SON HAMMERED FORGINGS ESTAB. 1883," arranged in three lines. Windows are rectangular, aluminum, fixed-sash, single-pane openings with bay-width concrete sills and lintels. The south elevation of the structure has been modified to an office building appearance, with a metal, standing-seam shed-roof over the entrance consisting of double metal-and-glass doors, skylights, and replacement windows. To the south of this structure is a 1½-story, end-gable building, clad in corrugated metal with an asphalt-shingle roof. An entrance is located on the south elevation along with a large, metal roll-up door. An additional roll-up door is located on the west elevation. The last two bays on the east elevation are smaller and contain a standing-seam metal roof. The building has been extensively modified and derives most of its remaining character and association from the painted FRANK KUNKEL sign.

To the east is the Standard Oil Co. Depot Complex (after 24 Wolcott Street) (MHC 12916, early 20th c.). The complex consists of six rectangular and masonry-and-steel-frame buildings on the north side of Wolcott Street. The main building, at the southwest corner of the site, is a 2-story, 3-by-3-bay building with a 1-story, shed-roof ell to the west. The main entrance is on the facade (E) and contains a massive concrete sill and lintel over bay-width doors. Above the entrance is a beam for a block-and-tackle hoist extending from the second floor with the opening boarded up. Windows are rectangular, 3/3 double-hung sash in segmental-arch openings with concrete sills. "STANDARD OIL CO." is painted on the south elevation. The second building in the complex, to the east, is a rectangular, 6-by-3-bay structure. A stepped brick parapet runs above the roofline. The main entrance is located in a shed-roof porch in the south bay of the west elevation. Three paneled roll-up doors are located in the three north bays of the west elevation. Windows are 6/6 double-hung sash, with concrete sills and lintels. A brick chimney is located at the west elevation. The third building, at the northeast corner, is a 4-by-1-bay building of timber-frame construction with a high concrete foundation with heavy piers, sheathed in ribbed metal, with a south-sloping shed roof. A brick chimney and service door are located on the east elevation. To

ARCHITECTURAL DESCRIPTION ***(continued)***

the east of this building is a 1-story, concrete-block, shed-roof ell. The fourth building is located in the northern half of the complex. It is a brick, 3-by-2-bay, 1-story building. The main entrance is located in a larger central bay of the facade (S). The windows contain concrete lintels. A number "4" is painted on the facade. The fifth building is a smaller, end-gable, brick building with corbeled returns on the south elevation, located east of the fourth. The west elevation features a tall window with a concrete lintel above. The building has the number "5" painted on the lintel above the door. The sixth building is a 1-story, shed-roof, timber-frame building, with a stone foundation, at the northwest corner. Sheathed in ribbed metal, it is in very poor condition. Taken individually these are small, unremarkable examples of brick industrial buildings. Together, however, they comprise an unusual, intact example of an early-20th century urban industrial petroleum depot.

Continuing further north is the E.C. Morris Safe Co. Building at 1693-1715 Hyde Park Avenue (MHC 10984, 1893). The building contains two components connected by a party wall. The south section, Worth Filing and Storage Specialists, is a rectangular, 15-by-12-bay, masonry building with a flat roof. There are two loading docks with paired, metal roll-up doors on the east elevation. The segmental-arch window openings have been bricked in on all elevations and contain concrete sills. The section is relatively unremarkable, except for a 2-story, square tower at the southwest corner of the building. The Orleans Packing and Shipping section is rectangular with 14 bays. A 10-by-5-bay extension is located at the northwest corner. The main entrance contains a single-light, wood-frame door in the east elevation of the northwest addition. Rectangular window openings in this section contain steel, multi-pane sash on the north elevation, and have been bricked over on the east elevation. The west elevation contains a raised concrete rail dock with deep bracketed awnings. This sprawling multi-component building is in fair condition and is a typical example of a late nineteenth-century brick industrial building, with details such as window shape, brick trim, and eaves similar to other buildings in the area.

North of this building, the Boston Woodworks Building at 1666 Hyde Park Avenue (MHC 12905, ca. 1950), is a rectangular, 2-story, steel-frame building, resting on a stone foundation with corrugated-metal siding, resting on a stone foundation. The building comprises three Quonset huts joined lengthwise, with their widths to the street. There are two entrances, the first is centered in the facade (W) and consists of a single door with simple surrounds reached by concrete steps. The second entrance is located in the south bay of the west elevation. There is a loading bay located on each outside bay consisting of a raised truck dock with roll-up, panel doors. There is a small roll-up door in the east bay of the north elevation and another roll-up in a shed-roof addition at the east end of the north elevation. This building is in good condition, and is an unusual example of a Quonset hut used for an industrial function. The triple-arch, siamesed-roof construction is highly unusual.

Continuing north, Royal Finishing at 1667 Hyde Park Avenue (MHC 12906, mid-to-late 20th c.), is a building consisting of three distinct components, resting on concrete foundations, with flat, built-up roofs. The primary structure, located along Hyde Park Avenue is a 2-story, 3-by-5 bay, masonry-and-steel-frame building. The central section is a low, 1-story, 9-bay-long building, clad in corrugated metal with brick and concrete-block shed additions to the north. The western block is a high, corrugated-metal-clad building with bands of multi-pane windows along the roofline, similar to the addition at Metropolitan Motors/Hyde Park Truck Repair at 1661 Hyde Park Avenue (MHC 12904, mid-to-late 20th c.). The main entrance, centered on the east elevation, is reached by concrete steps. A loading dock with a wood-paneled, roll-up door is located in the north bay of the east elevation. One metal roll-up door is recessed

HISTORICAL NARRATIVE *(continued)*

In the late 1840s industrial activity increased, and according to the state census in 1845, mills in the area produced cotton cloth, woolen products, starch, chemical preparations, chronometers, cordage, and confectionary. Until it burned in 1855, the Dorchester Cotton and Iron Co.'s (1811) cotton mill was the town's largest manufacturer. In 1865, by benefiting from wartime contracts, the Hyde Park Woolen Co.'s (1862) mill became the area's largest employer. The surge in manufacturing activities of the textile industry, especially the Dedham Manufacturing Co. were responsible for the incorporation of Hyde Park as a separate town in 1868 (MHC 1980:10). Gradually, during the late-19th century, a switch from textile to other industrial concerns occurred in Hyde Park. Industrial activity along the Neponset River continued to expand during the late 19th century in Readville due in large part to the railroad maintenance facilities of the Readville Car Shops (MHC 11076; 11082; 12907-16, 1902).

The original Dedham Cotton Manufacturing Co.'s mill (no longer extant) was built on the fifth and last water power privilege granted on Mother Brook and the only privilege located in Readville. The original company was begun in 1815 by Samuel Dexter, a Dedham lawyer who also served as a Congressman and Secretary of War in John Adams' administration. For the first five years, the company operated as a cottage industry, employing workers to weave cloth out of their homes. However by 1820, the factory system went into effect when 30 female workers were brought from Maine to staff this first mill. The mill was purchased by James Read sometime before 1847. Read, a member of the Boston firm Read and Chadwick, already owned the next mill upstream, the Norfolk Manufacturing Co. along with Taft's brother, Ezra. Read became the largest stockholder in the Dedham Cotton Manufacturing Co., and in 1847 the Dedham Low Plains school district voted to rename itself "Readville" in Read's honor. The mill closed briefly during the Civil War due to cotton shortages. After the war it was reopened and the earliest building now on the property, a steam-powered mill, was added in 1866. The mill continued under different owners in the manufacturing of cotton cloth, and in 1922 began processing wool. By the 1950s the mill was used for non-textile purposes, and the early-19th century portion of the mill burned in the 1960s (Stott 1983 [*The Dedham Cotton Manufacturing Co.*]). The mill has been converted to apartments owned by the Mother Brook Trust.

In 1855, Readville became a railroad junction with the connection of the Midland Railroad (1850) and the Boston and Providence Railroad (1835). Railroad activity spawned further suburban development, and increased industrial and railroad-related activities in Readville (MHC 1980:9). In the 1890s, the New York, New Haven and Hartford Railroad, which had consisted of many smaller local lines with maintenance performed at scattered locations, decided to concentrate all maintenance activity in one central location for greater economy and convenience. The Readville shops site, nine miles from Boston, was chosen for its location in an angular parcel within the tracks of the main line and the Dedham Branch.

Plans for the car shops called for the efficient movement of material through the site. This was accomplished through such machinery as a transfer table to move cars between the 10 parallel tracks servicing the Paint and Erecting Shops. The surrounding blacksmith, truck and cabinet shops were linked by an electric trolley transporting products and materials through the site. The 70-acre site could service

HISTORICAL NARRATIVE ***(continued)***

machine department (1879) are no longer extant. The earliest part of the present complex was a machine shop constructed in 1881. The business was expanded in 1899-1901 when two, 3-story additions were constructed. In 1906 an author remarked "the company's fame is worldwide on their special machines for the use of sugar refiners, rubber and leather manufacturers and other industries." The company closed in 1957 (Stott 1983 [*American Tool & Machine Company*]). Since that time the complex has continued to be used for warehousing and manufacturing, with ACME Industrial Equipment Co. the present tenant.

Another metalworking industry located in Hyde Park was Frank Kunkel & Son Hammered Forgings on Wolcott Court (MHC 12915, 1883) established in the town in 1883.

In 1874, two years after American Tool & Machine Co.(MHC 10981, 1881) constructed its foundry, John T. Robinson and Charles Spring began manufacturing paper box machinery. . The present location, the John T. Robinson & Co. Complex at 1476 River Street (MHC 11073, 1888) was not begun until 1888 when the business, relocated from Cleary Square to Hyde Park and the oldest building of the present complex, a machine shop, was completed. The building expanded about 1900 when an ell along Reservation Road was constructed. The business was in operation until about 1978. The Sterling Corrugated Box Co., Inc. was a similar company to locate in Hyde Park, closer to the Readville Car Shops (MHC 11076; 11082; 12907-16, 1902), most likely to take advantage of the site's close proximity to rail lines.

In the 1890s industrial firms continued to leave Boston and relocate to Hyde Park. Among these firms was the E. C. Morris Safe Company at 1693-1715 Hyde Park Avenue (MHC 10984, 1893) and the former G. W. Stafford Company at 1679-1683 Hyde Park Avenue (no longer extant), which needed more space to accommodate its growing operation and chose Hyde Park because of its proximity to railroad lines. Head of the G.W. Stafford Company at the time, and instrumental in its decision to relocate was Robert Bleakie, also head of the Hyde Park Woolen Mills (no longer extant). It was reported just after construction, that the plant was the largest and most complete safe plant ever built, and the only completely electrified plant of its type. The plant closed in 1896 and was reopened as what was ultimately known as the George W. Stafford Company, an automatic loom manufacturing concern. In 1911 another building was added to the site, a foundry designed by Providence architect C.R. Makepeace. The building continued to be used for this purpose until 1931 when it was divided into smaller spaces for manufacturing and warehouse purposes. At the present the building is used by Orleans Packing and Distributing (Stott 1983 [*E. C. Morris Safe Company/G. W. Stafford Company*]).

Support industries also prospered in Hyde Park which supplied oils and lubricants for machine shops, cranes, rail car bearings, and other machinery in the area. An example of this is the Standard Oil Company Depot Complex (after 24 Wolcott Street) (MHC 12916, early 20th c.).

The year 1903 marked the climax of industrial expansion in the Readville area, and suburban expansion from Boston fostered continued residential development. During that year the B. F. Sturtevant Blower

FORM A - AREA

Assessor's Sheets

USGS Quad
Boston South

Area Letter
RK

Form Numbers in Area
(see area data sheet)

Massachusetts Historical Commission
Massachusetts Archives Facility
220 Morrissey Boulevard
Boston, Massachusetts 02125

Photograph

560 Harrison Avenue (BOS.1478)

Town Boston

Place *(neighborhood or village)* South End

Name of Area South End

Present Use industrial, residential, and commercial

Construction Dates or Period 1875-ca. 1920

Overall Condition fair to good

Major Intrusions and Alterations some demolition and infill

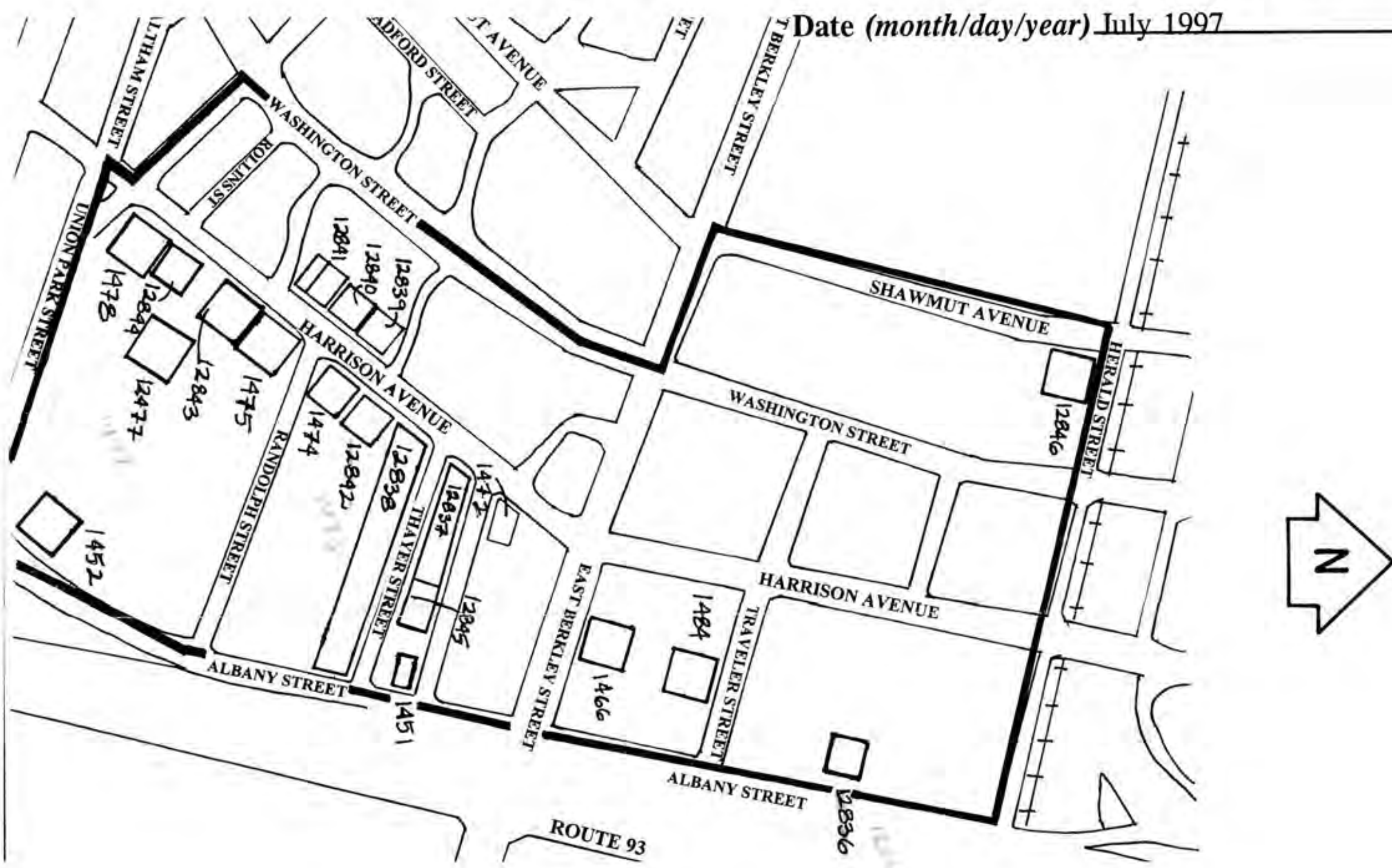
Acreage approximately 83 acres

Recorded by VHA, MK, MKH, CMM

Organization The Public Archaeology Laboratory, Inc.

Date *(month/day/year)* July 1997

Sketch Map



AREA FORM

ARCHITECTURAL DESCRIPTION X *see continuation sheet*

The South End Industrial Area comprises approximately 83 acres located south of Chinatown and the Massachusetts Turnpike Extension, south of downtown Boston. The roughly L-shaped area is bounded on the east by Albany Street, on the north by Herald Street, to the west by Shawmut Street and Harrison Avenue, and to the south by Union Park Street. Located north of the Lower Roxbury Area (MHC RS). The area includes 20 buildings, most of which can be described as masonry-clad, multi-story, rectangular factory, machine-shop, and warehouse buildings with flat-roofs, regular fenestration patterns, brick and granite trim. The first floors typically contain heavy granite and iron structural members allowing wide bays for display of merchandise and movement of raw materials and finished products through the building. Historically, the main industries of the area included furniture making, with pianos a specialty. The area also includes a significant early electrical generating station, the former Boston Elevated Railway Co. Central Power Station at 540A Harrison Avenue (MHC 1477, 1892). Most structures are in fair to good condition, and the area benefits from significant adaptive reuse as well as mixed use of its industrial structures. The following descriptions begin at the north end of Harrison Avenue, proceed south to Union Park Avenue, return north along Albany Street, and end on Shawmut Street.

Beginning at the north-most building on Harrison Avenue, the James L. Jenks Building at 434 Harrison Avenue (MHC 1472, ca. 1880) is a 5-story, trapezoidal, 3-by-9-bay, flat-roof, brick masonry building. The facade is articulated by rounded corners and full-height brick piers with stone bases and capitals. The main entrance is located in the north bay of the facade (W) and consists of a round brick arch containing two wood-panel doors separated by a wood panel under a multi-light arched transom. Additional entrances are located on the facade consisting of single,

HISTORICAL NARRATIVE X *see continuation sheet*

Boston's readily available coastal access provided the source of its early commercial growth. In the 18th century, the old South End, the area west of Congress Street referred to now as the Leather District, consisted of fields, gardens, and large houses (Stott 1983 [*Boston Proper*]). As the shoreline advanced due to filling, industries followed in its path. In 1842, the area east of Harrison Avenue contained port facilities (Sampson, Davenport and Co. 1848). By 1852, the southern portion of Albany Street had been constructed, and both Albany Street and Harrison Avenue had waterfront access along their lengths (McIntyre 1852). Because of continued eastward filling in South Bay, Albany Street replaced Harrison Avenue as the waterfront thoroughfare by 1866, and dock facilities were located on the east side of the street (Sampson, Davenport and Co. 1866). As the 19th century continued, the shoreline moved further away from Albany Street, although the area retained port facilities. Filling continued into the 20th century, and by the 1950s, with the construction of the Southeast Expressway, all that remained of South Bay was a narrow channel draining the Roxbury Canal (Office of Public Archaeology 1989:196)

The majority of the present-day South End was developed in mid-to-late 19th century, beginning in the 1850s as part of real estate speculation on the newly-filled land auctioned off by the city. Then known as the "New South End," it was envisioned as a middle- and upper-middle-class neighborhood by its founders. However, the industrial activity on the southern and eastern boundaries attracted more laborers than Boston professionals (BRA n.d. [*Background and Overview of Boston's South End*]). Early development concentrated along Washington Street and remnants can be seen in the London-Style residential buildings along Union Park Street (MHC 1980:2). Further impetus for the development of the South End came in the 1860s with the construction of Boston City Hospital south of the area's boundaries along Albany Street in 1864. Most of Boston's industrial development in the last

BIBLIOGRAPHY and/or REFERENCES X *see continuation sheet*

Boston Redevelopment Authority. *South End*. Boston, MA, n.d.
Massachusetts Historical Commission. *MHC Reconnaissance Survey Report*. Boston, MA, 1980.
Office of Public Archaeology, Boston University. *Phase I Archaeological Investigations of the Central Artery/Third Harbor Tunnel Project in Boston, Massachusetts*. Boston, MA, 1989.
Stott, Peter. *"A Guide to the Industrial Archaeology of Massachusetts: Middlesex , Norfolk and Suffolk Counties,"* unpublished manuscript and papers, Boston: Massachusetts Historical Commission, 1983.
Stott, Peter. "Economic and Industrial Development: Historic and Archaeological Resources of the Boston Area." Boston: Massachusetts Historical Commission, 1982.

X Recommended for listing on the National Register of Historic Places. ***If checked, you must attach a completed National Register Criteria Statement form.***

BOSTON LANDMARKS COMMISSION Building Information Form Form No. ___ Area CBD

ADDRESS 245 S ummer St. COR. Dorchester Ave.

NAME Stone & Webster Building
present original

MAP No. 24N/13E SUB AREA Wholesale

DATE 1973 permit 5-13-1973
source

ARCHITECT Welton Becket & Assoc., N.Y.C. permit
source

BUILDER Aberthaw Construction Co. permit
source

BRA
OWNER Cabot, Cabot & Forbes Co.
original present

PHOTOGRAPHS *345/5-80

TYPE (residential) single double row 2-fam. 3-deck ten apt.
(non-residential) Bank and offices

NO. OF STORIES (1st to cornice) fourteen plus

ROOF flat cupola dormers

MATERIALS (Frame) clapboards shingles stucco asphalt asbestos alum/vinyl
(Other) brick stone concrete (iron/steel/alum.)

BRIEF DESCRIPTION
International style steel frame office block with metal and glass skin. Pedestrian level recessed behind piers, and upper levels present sheer facade. Continuous fenestration creates ribbon effect across facades.

EXTERIOR ALTERATION (minor) moderate drastic

CONDITION (good) fair poor LOT AREA sq. feet

NOTEWORTHY SITE CHARACTERISTICS Freestanding structure faces new Federal Reserve Bank Building, and is flanked by South Station and Fort Point Channel.

SIGNIFICANCE (cont'd on reverse)
Like the new Federal Reserve Bank Building, the Stone and Webster Building has effectively extended the financial area into the South Station area. Because of its relatively low profile and uncomplicated facades, it presents a non-competing backdrop for the monumental, Classical Revival South Station Headhouse.

Welton Becket and Assoc., a New York based firm, also designed the new Blue Cross/Blue

MHK 6/80

rehab 1979

BOSTON LANDMARKS COMMISSION Building Information Form Form No. ___ Area CBD

ADDRESS 25-35 Dorchester COR.

NAME U.S.P.O. S outh Postal Annex & Addition
present original

MAP No. 24N/13E SUB AREA Wholesale

DATE Addition: 1966 permit 9-29-66
source

ARCHITECT Addition: Pederson & Tilney permit
source

BUILDER Addition: McCloskey-Leasell "
source

OWNER Post Office/U.S. Government
original present

PHOTOGRAPHS $34^5/6$, $*34^6/1$-80

TYPE (residential) single double row 2-fam. 3-deck ten apt.
(non-residential) U.S. Post Office

NO. OF STORIES (1st to cornice) 4 & 3 plus basement

ROOF flat cupola dormers

MATERIALS (Frame) clapboards shingles stucco asphalt asbestos alum/vinyl
(Other) brick stone concrete iron/steel/alum.

BRIEF DESCRIPTION 2 part structure. Original building rectangular, metal-clad box, grey in color, with horizontal white banding. Two, vertically parallel rows of aluminum ventilator ducts on facade. Yellow metal railing at roof. Addition is red brick & concrete box; concrete above-grade basement features entry bays recessed into facade. Horizontal concrete bands over 1st & 2nd levels.

EXTERIOR ALTERATION minor moderate drastic

CONDITION good fair poor LOT AREA sq. feet

NOTEWORTHY SITE CHARACTERISTICS extends along Fort Point Channel

SIGNIFICANCE (cont'd on reverse)

Structures do not contribute architecturally to surrounding area.

There is no permit available for the original structure. It was probably constructed in the 1950s.

VI M- MHK 6/80

U.S. POSTAL SERVICE

Historic, Architectural & Archeological Significance Survey

FT—CBD
1694

1. General Information

a. Facility Name United States Post Office	b. Historic/Original Name United States Post Office	
c. Finance/Subloc. No.	d. Site Size *(Sq. Ft.)* 103,840 square feet	e. Lot, Block Lot 5365, Block 5
f. Property Address *(Include county & ZIP code)* General Mail Facility 25 Dorchester Avenue (Suffolk County) Boston, Ma. 02205 - South Postal Annex	g. Building Size *(Sq. Ft.)* 103,840 square feet	h. Building Size *(Dimensions)* 590'-0"x176'-1 3/8"
	i. Is Building Open to Public? Yes	
j. Address of Office with Building Records *(Name and address of field office, region, etc. with official file.)* U.S. Postal Service 1050 Waltham St., Lexington, Ma. 02173	k. Original Use of the Building Post Office	
	l. Present Use Post Office	

2. Property Appearance

a. Description of General Area *(Describe neighborhood, historic district, land use & direct or indirect effect upon other building of historic interest. If more space is needed, attach additional sheets.)*

The General Mail Facility is located in a very diverse area of the City of Boston. Within the general vicinity are office buildings, warehouse buildings, retail facilities, banking, a major transportation center and the Fort Point Channel. The channel is an historic area being the site of the Boston Tea Party. Across the channel are other warehouses and retail units and the recently conceived Children's Museum which is an excellent example of adaptive reuse.

b. General Condition of Property *(Site and Building)*

The site on which this Postal Facility is located is totally covered with the building. Dorchester Avenue which runs along the East side (front) of the site has been taken for use by the Postal Department. Therefore, there is no substantial landscaping area. But on the North side of the site between the building and the Stone and Webster offices, some unused land does exist that could perhaps be planted, paved, and utilized. The property is well maintained and is in very good condition.

c. Description of Building Material *(Roofs, walls, foundation, interior features, floor and ceiling, etc.)*

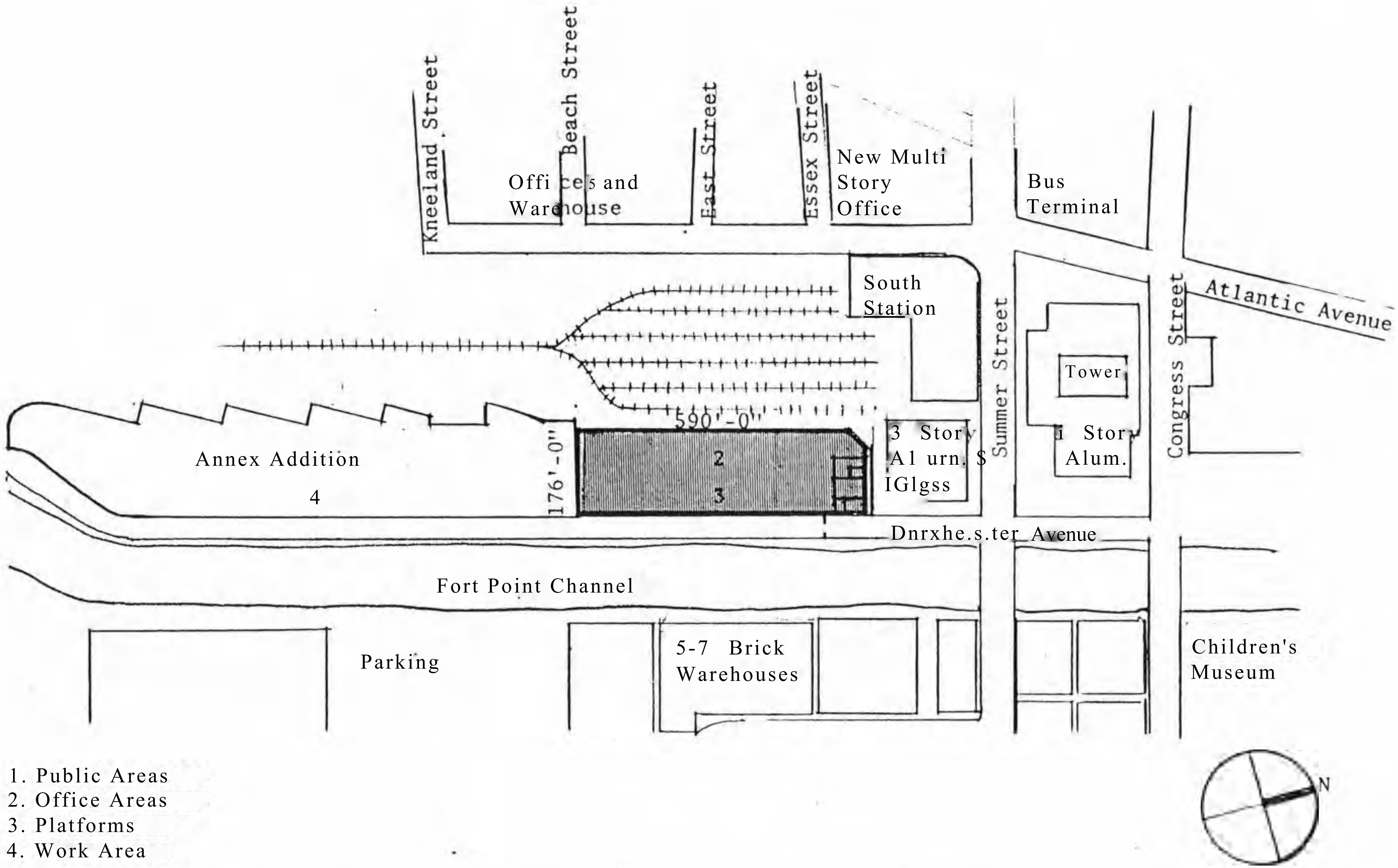
The renovated General Mail Facility now has a aluminum panel skin. At the entrance on the first floor the East facade has floor to ceiling glass and the North wall consists of a corrugated metal panel in a half arch configuration with a vaulted skylight cutting through at the two o'clock position. The majority of the aluminum panel is a dark bronze and there are horizontal bands of varying widths at different levels around the building. At four locations along the East elevation, there are protrusions through the skin that appear to be vents for the work areas. At the fourth floor level are the only windows that remain in the***

d. Description of Floorplan *(Attach drawings if available.)* SEE ATTACHED PLAN.

***rehabilitated structure. They are paired, in most instances, and are shaped to resemble port holes. The West facade for the most part is concealed from view by train tracks and canopies. The lobby is done in the same style as the exterior. The floor is 1" x 1" ceramic tile and the base is painted steel plate. The walls are dark bronze aluminum panels to match the exterior. Signage in the lobby is very well executed. White lettering on blue aluminum panels hang over both the self-serve and service counters. The service counters and writing tables are finished with a wood grain plastic laminate.

e. Description of unusual or unique subterranean features *(Basement, tunnels, vaults, shelters, etc.)*

Partial basement.



1. Public Areas
2. Office Areas
3. Platforms
4. Work Area

1
General Mail Facility * South Boston, Massachusetts

BOSTON LANDMARKS COMMISSION Building Information Form Form No.___ Area CBD

ADDRESS 172-180 Federal COR. 31-5 High St. 265-271 Purchase St.

NAME Weld Building / same
present original

MAP No. 24N/13E SUB AREA Financial

DATE 1900 permit 3-6-1900
source

ARCHITECT ~~Shepley, Rutan & Coolidge permit~~
source
1987 rooftop addition: August Associates, Architect

BUILDER Norcross Brothers Centros Management, bld. managers
permit
source

OWNER Weld Estate
original present

PHOTOGRAPHS 174/5, 174/6*-80

TYPE (residential) single double row 2-fam. 3-deck ten apt.
(non-residential) stores & offices

NO. OF STORIES (1st to cornice) five plus

ROOF flat cupola dormers

MATERIALS (Frame) clapboards shingles stucco asphalt asbestos alum/vinyl
(Other) brick yellow-orange stone limestone concrete iron/steel/alum.

BRIEF DESCRIPTION 16x9x14 bay Classical Revival commercial building, featuring central entry with polished granite Doric columns set in antis within granite enframement, supporting entablature with console brackets & surmounting wrought iron balustrade. 2nd level of stone, ornamented with round medallions & pendant swags flanking double windows at outer corners. Upper levels feature flanking 3-bay projecting pavillions with stone window enframements & projecting keystones. Central section has paired windows separated by projecting brick piers supporting stone entablature with modillioned cornice.

EXTERIOR ALTERATION minor moderate drastic
storefronts

CONDITION good fair poor LOT AREA 10,094 sq. feet

NOTEWORTHY SITE CHARACTERISTICS Located at end of block, its 3 facades formally finished, all in similar fashion. Faces small landscaped brick plaza & Fiduciary Trust Building.

SIGNIFICANCE (cont'd on reverse)

Structure architecturally significant as work of major Boston architectural firm, as well as being handsome example of turn of the century Classical Revival style office building, and as being one of few remaining early structures in an otherwise much modified area.

George F. Shepley (1860-1903), Charles H. Rutan 1851-1914), & Charles A. Coolidge (1858-1936), all trained in the office of H.H. Richardson, their partnership serving as successor firm after his

changed to III
BLC 9/86

IV N- MHK 6/80

BOS.1722

CENTRAL ARTERY/THIRD HARBOR TUNNEL PROJECT
Updated Survey of Historic Resources

172-180 Federal St. CBD

Weld Building

LOCATION:

Map Number: 24-13

Subarea: Central Area

Corridor: primary

NATIONAL REGISTER STATUS

INDIVIDUAL STATUS:		DISTRICT STATUS:	
___	Individual NR-Listed	___	In NR District
___	Individual DOE	___	In DOE District
X	Individual NR-Eligible determined by MHC 4/18/90	___	In NR-Eligible District

Name of District: None

BOSTON LANDMARKS COMMISSION STATUS:

Landmark Status: None

Survey Category: 3

BLC District: None

Boston Affiliates, Inc.
January, 1989

Attachment BB Inventory of Historic and Archaeological Assets of the Commonwealth Area Form for Properties Previously Not Surveyed

Attachment BB includes copies of Inventory of Historic and Archaeological Assets of the Commonwealth forms (excerpted) for properties not previously surveyed.

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FORM A - AREA

MASSACHUSETTS HISTORICAL COMMISSION
MASSACHUSETTS ARCHIVES BUILDING
220 MORRISSEY BOULEVARD
BOSTON, MASSACHUSETTS 02125

Assessor's Sheets	USGS Quad	Area Letter	Form Numbers in Area
See continuation sheet	Boston South		See Continuation Sheet

Photograph

Town/City: Boston

Place *(neighborhood or village):* Fort Point Channel

Name of Area: Gillette Complex

Present Use: Manufacturing

Construction Dates or Period: Circa 1910 – 2000

Overall Condition: Good

Major Intrusions and Alterations: None

Acreage: Approximately 37

Recorded by: Brian Lever

Organization: Epsilon Associates, Inc.

Date *(month/year):* April 2014

Locus Map

See continuation sheet

☒ *see continuation sheet*

☒ Recommended for listing in the National Register of Historic Places.
If checked, you must attach a completed National Register Criteria Statement form.

Use as much space as necessary to complete the following entries, allowing text to flow onto additional continuation sheets.

ARCHITECTURAL DESCRIPTION

Describe architectural, structural and landscape features and evaluate in terms of other areas within the community.

The Gillette Complex totals approximately 37 acres in the Fort Point neighborhood of Boston. It is bounded on the northeast by Necco Street and Necco Court, on the southeast by A Street, on the southwest by West Second Street and the northwest by Dorchester Avenue and the Fort Point Channel. The surrounding neighborhood is a mix of commercial and light industrial properties largely consisting of multi-story masonry buildings with some mixed-use buildings having residential units on their upper stories. Also in the immediate area, but in smaller numbers are some multi-story wood frame and masonry multi-family residences.

The Gillette Complex consists of 17 parcels of land with 20 buildings that are freestanding, attached, or semidetached with connecting passageways. As well as the buildings, the property also has large parking lots, landscaped areas, and the Binford Street Park along the Fort Point Channel. The tree-lined harborwalk also runs along the property at the shoreline of the Fort Point Channel and tree-lined areas are also seen on a portion of A Street, Necco Street, and Dorchester Avenue. The property is accessed from the surrounding streets as well as an interior street network including Mt. Washington Avenue, Granite Street, Binford Street, Baldwin Street, Baldwin Place, and Richards Street, where there are loading docks as well as tractor trailer storage.

At the time of Gillette's first occupying the property, the Fort Point Channel ended further south within the present parking lot to the north of Building 12. By 1938, a park with baseball diamond was located adjacent the Channel north of Building 1 and by 1955 a portion of this area was converted into a parking lot. The southernmost section of the Channel was filled in by 1969 and the new area used as parking lot. As Gillette's operations expanded the complex grew, first east and west along West Second Street and then northward taking over property that was previously used by the Domino Sugar Refinery and the New England Confectionary Company (NECCO) including Building 19 (MHC# 15353) and Building 20 (MHC# 15354) which are listed on the National Register of Historic Places as part of the Fort Point Channel Historic District.

In the 1990s the complex's landscape was changed dramatically with the construction of the I-90 tunnel under Fort Point Channel. The Gillette Complex had used since 1926 an intake structure at the shoreline of the Channel to provide seawater into the manufacturing plant for the purpose of cooling equipment. The intake structure was removed and the parking lot north of Buildings 14, 16, and 17 was excavated for the construction of the tunnel. When the tunnel was completed, the parking lots were restored and a new intake structure (Building 18) was constructed along with the Binford Street Park and the Harborwalk.

Please note: for the purposes of architectural descriptions buildings have been labeled by numbers according to the included locus map. The Gillette Company used letter designations to refer to buildings within its complex and those designations are not available at the time of documentation. To avoid confusion with Gillette designations, number designations are used to describe buildings in the complex.

Building 1 built in 1923 rises nine stories from a granite block foundation to a flat roof and is five by three bays. The building has a roughly rectangular footprint and is attached to Building 2 on the east elevation and has matching details and features to it with the exception of the ninth story, entrances on West Second Street, and lacking a parapet. The ninth story (a later addition) is set back from the eave. The brick and concrete exterior features multi light replacement aluminum windows some of which have been infilled with louvers and vents as well as vertically laid brick lintels and concrete sills. Brick columns separate sets of windows and concrete cornices separate the first two stories and the eighth story, wrapping around the building. At the rear (northeast elevation) are large brick columns with recessed brick panels and a recent single-story seven by four bay glass and metal-clad addition serving as the employee gym. The building features an entrance on Dorchester Avenue with concrete steps and pipe rails leading to a set of steel double doors with a steel panel above.

Building 2 built in 1918 rises eight stories from a granite block foundation to a flat roof and is ten by three bays. The building has a rectangular footprint and is attached to Building 1 on the west elevation with matching details and features except lacking a ninth story and having a parapet as well as entrances on West Second Street. The building is also attached to Building 3 on the north elevation with an open rectangular courtyard between them. The brick and concrete exterior features multi-light replacement aluminum windows, some of which have been infilled with louvers and vents, as well as vertically laid and jack arch brick lintels and concrete sills. Brick columns separate sets of windows and concrete cornices separate the first two stories and the eighth story wrapping around the building. A brick and concrete parapet runs east from the main entrance along the roof edge. The building has two entrances on West Second Street, the main entrance with its projecting brickwork features a set of replacement steel double doors flanked by recessed concrete panels with a recessed concrete panel above the door with "1918" inscribed in it, below a four light replacement aluminum transom and a pair of concrete brackets supporting concrete entablature. A second entrance east of the main entrance is recessed and features a pair of replacement steel double doors.

Building 3 built in 1926 rises eight stories to a flat roof and is ten by six bays with a roughly rectangular footprint. The building is attached to Building 2 at two locations at the east and west ends of the south elevation with an open rectangular courtyard between them and also abuts Buildings 1, 5, and 12. The building is similarly detailed to Building 2 with a brick and concrete exterior featuring multi-light replacement aluminum windows some of which have been infilled with louvers and vents, brick columns separating sets of windows, and concrete cornices separating the first two stories and the eighth story wrapping around the building. A brick and concrete parapet wraps around the rooftop. Located atop the connections to Building 2 are brick clad hip roofed rooftop entrances. A recent glass enclosed two-story, one by ten bay addition with a curving north elevation is at the rear of the building connecting to Building 12.

Building 4 built circa 1910 rises six stories from a brick foundation to a flat roof and is five by four bays with a rectangular footprint. The building is connected to Building 2 with a six-story corrugated metal clad addition that also serves as a loading dock off of the west elevation. The building also abuts Building 6 on the east elevation and Building 5 on the north elevation. The brick and granite exterior features multi light replacement aluminum windows some of which have been infilled with louvers and vents as well as vertically laid brick lintels and granite sills. Brick columns separate sets of windows and a brick parapet wraps around portions of the roof. There are two entrances to West Second Street, one has been infilled with brick and the other has a set of steel double doors with a four light aluminum transom above.

Building 5 built circa 1910 rises five stories from to a flat roof and is approximately 10 by 12 bays with a rectangular footprint. The building is obscured from view by abutting Buildings 3, 4, and 7 as well as connector additions to buildings 12 and 13 at the rear. The building features a brick exterior and singular window openings.

Building 6 built 1917 rises six stories from a concrete foundation to a flat roof and is five by eight bays with a rectangular footprint. The building abuts Building 7 on the north elevation, Building 8 on the east elevation and Building 4 on the west elevation. The brick, concrete, and granite exterior features multi light replacement aluminum windows, some of which have been infilled with louvers and vents as well as concrete lintels and granite sills. Concrete columns separate sets of windows and a band of concrete runs across the front (south) elevation. There are two entrances to West Second Street, one has a roll-up steel overhead door and the other has a set of steel double doors with a four light aluminum transom above.

Building 7 built circa 1910 rises five stories from to a flat roof and is approximately 10 by 12 bays with a rectangular footprint. The building is obscured from view by abutting Buildings 9, 6, and 5 as well as connector addition to buildings 12 and 13 at the rear. The building features a brick exterior and singular window openings.

Building 8 built in 1926 rises one-story to a flat roof and is approximately nine by four bays with a rectangular footprint. The building abuts Building 6 on the west elevation and Building nine on the north elevation with an entry court and loading area off of the east elevation. The building features a brick exterior and tripartite aluminum replacement windows with concrete sills separated by brick columns. The building has one former entrance on West Second Street that has been infilled with brick with an adjacent single aluminum replacement window and another entrance off of the east elevation with a pair of steel replacement double doors and a concrete landing.

Building 9 built in 1926 rises nine stories to a flat roof and is seven by four bays with an “L” shaped footprint. The building abuts Building 10 on the west elevation, Building 8 on the south elevation, Building 6 on the east elevation, and Building 14 on the north elevation. The brick, metal panel, and concrete exterior features multi light replacement windows with concrete columns separating windows and horizontal bands of concrete delineating floors. The roof features the terminus of a stairtower as well as a small penthouse.

Building 10 built circa 1985 rises two stories from a concrete foundation to a flat roof. The main block is five by seven bays with a roughly rectangular footprint and a two-story, three by three bay wing off of the west elevation connecting to Building 9. The building also abuts Building 11 on the north elevation. The brick exterior features an overhanging second story, sets of five single pane aluminum windows and bands of horizontal granite panels wrapping around the building. The roof features a penthouse at the northern end of the building. The building has one entrance directly onto West Second Street with a single steel door accessed by a concrete ramp. Another person entrance is adjacent the loading dock off of the east elevation with a glass door with flanking sidelights and a transom above, this area is accessed off of West Second Street via an entry court and parking area. The building also has a single steel door entrance off of A Street.

Building 11 built circa 1969 and 2000 rises two stories from a concrete foundation to a flat roof. The approximately seven by 13 bay building has a rectangular footprint and is substantially altered from its initial construction. The building abuts Building 10 on the south elevation and Building 14 on the west elevation. The brick and concrete exterior is similar to Building 10 on a portion the east elevation, which changes in style from primarily brick for roughly 1/3 of the elevation to brick and concrete for the remaining 2/3’s of the elevation. The brick and concrete sections are similar to Gillette Building’s 6 and 9 with concrete columns separating sets of windows along the east and north elevations. A concrete watertable and a band of concrete at the roofline also wrap around a portion of the building.

Building 12 built in 1928 rises five stories to a flat roof with a rectangular footprint and has been substantially modified over its history with subsequent additions. The building is also obscured by the abutting buildings and additions. The building abuts Buildings 13 and 14 on the east elevation and Buildings 3 and 5 on the south elevation. The present five-story building is approximately 170 feet long by 130 feet wide. The building has a mixture of metal cladding on later shorter additions surrounding the original five-story building with a brick exterior. The flat roof features a skylight. In approximately 1960, a two-story addition off of the south elevation and a three-story addition off of the west elevation were constructed and in approximately 1970, a four-story addition off of the north elevation was constructed with the present smokestack.

Building 13 was built in 1914 with a main block that rises six stories to a flat roof and is approximately seven by six bays with a roughly rectangular footprint. The northeast corner of the building is clipped at an angle giving the building a slightly irregular footprint. The building is obscured from view by abutting Buildings 7, 12, and 14 as well as subsequent additions. The brick exterior features singular and paired window openings separated by brick columns. A brick chimney is located on the east elevation and two rooftop penthouses are located at the northern end of the roof. In approximately 1960, a two-story addition was added off of the south elevation connecting the building to Building 7.

Building 14 was built from 1961 through 1963 and rises two stories to a flat roof and measures approximately 1000 feet long and 200 feet wide. The brick building has three exposed elevations, east, west, and north. The east elevation has a flat brick surface with large sets of multiple single pane rectangular windows at the second story, some of which have been infilled with mechanical equipment as well as entrances on the first story. This elevation also abuts Buildings 11, 15, and 16, and has some small one-story additions and containment units. The north and west elevations are designed to fan outward from the building with brick walls at an angle to the main block and have their openings infilled with two-story sections of glass block windows with transoms above. Some of these openings also have entrances on the first story.

Building 15 was built in approximately 2000 rising roughly four stories high to a flat roof. The building abuts Building 14 on the east elevation. The building measures roughly 300 feet long by 100 feet wide, the rectangular building is clad in corrugated metal siding and devoid of window openings.

Building 16 was built circa 1985 and rises two stories from a concrete foundation to a flat roof measuring approximately 250 feet long by 130 feet wide. The building abuts Building 14 on the west elevation and Building 17 on the north elevation. The concrete exterior is similar to Gillette Building's 6, 9 and 11 with concrete columns separating sets of windows however no brick is used, instead there are alternating concrete panels on the exterior. A concrete watertable and a band of concrete at the roofline also wrap around a portion of the building. Two small one-story additions have been constructed off of the south elevation. The larger six by two bay addition features an entrance via a short staircase.

Building 17 was built circa 1950 with a circa 1985 addition. The building rises one-story from a concrete foundation with a main block measuring approximately 150 feet long by 180 feet wide. The brick exterior features a concrete watertable and sets of rectangular single pane windows. A brick chimney is located at the northern end of the roof. The circa 1985 addition is located off of the south elevation and measures roughly 70 feet long by 180 feet wide, this addition abuts Building 16 and has similar details with concrete columns separating sets of windows on the brick exterior. A concrete watertable and a band of concrete at the roofline also wrap around a portion of the building.

Building 18 was built in 1995 rising one-story from a concrete foundation to a flat roof adorned with a concrete cornice. The building measures roughly 60 feet long by 70 feet wide. The west elevation facing Fort Point Channel is the most highly stylized with projecting segmental arched windows openings topped with brick entablature and concrete sills below. The tripartite windows are either singular or ganged and have arched transoms. The south elevation has two steel entry doors accessed via a steel staircase. At the northwest corner of the building is a small porch with a brick column, concrete landing, pair of steel doors, and a steel staircase.

Building 19 was built in 1907 in Classical Revival style. The six-story brick building rises from a brick foundation to a flat roof and is six by five bays. The front (north) elevation is the most highly detailed. On the first two stories are rectangular or jack arch paired windows with sandstone, granite or cast iron lintels and sandstone sills. Brick corbelling and a sandstone cornice separate the first two stories from the remainder of the building. On the upper three stories paired segmental arched window openings with brick and sandstone lintels and sandstone sills. On the sixth story are paired rectangular window openings with sandstone lintels and sills. Elsewhere on the building are singular segmental arched window openings with brick lintels and sandstone sills. Many of the original wood two-over-two double hung windows have been replaced with one-over-one replacements or infilled with brick. Door openings on the front façade are located at the first and second stories and consist of pairs of original wood panel double doors with transoms above, later replacement steel replacement doors, or have been infilled. Decorative corbelling is present between sets of windows at the sixth story below brick dentil detail and the cornice and a round cast iron plaque inscribed with “BWCo 1907” for the Boston Wharf Company and 1907 date of construction. A corrugated sheet metal passageway connects this building to 19-27 Melcher Street from the third through sixth stories on the north elevation with another corrugated sheet metal passageway connecting this building to Building 20 from the third through sixth stories on the east elevation. A metal fire escape is also located on the east elevation. The rear elevation only has window openings on the third through the sixth stories. The roof features a brick parapet and a corbelled brick chimney.

Building 20 was built in 1907 in Classical Revival style. The six-story brick building rises from a brick foundation to a flat roof and is six by five bays. The front (north) and east elevations are the most highly detailed. On the first two stories are rectangular or jack arch paired windows with sandstone, granite or cast iron lintels and sandstone sills. Brick corbelling and a sandstone cornice separate the first two stories from the remainder of the building. On the upper three stories paired segmental arched window openings with brick and sandstone lintels and sandstone sills. On the sixth story are paired rectangular window openings with sandstone lintels and sills. Elsewhere on the building are singular segmental arched or rectangular window openings with brick lintels and sandstone sills. Many of the original wood two-over-two double hung windows have been replaced with one-over-one replacements or infilled with brick. Door openings on the front façade are located at the first and second stories and consist of pairs of original wood panel double doors with transoms above, later replacement steel replacement doors, or have been infilled. Decorative corbelling is present between sets of windows at the sixth story below brick dentil detail and the cornice (portions of which have been lost) and a round cast iron plaque inscribed with “BWCo 1907” for the Boston Wharf Company and 1907 date of construction. A corrugated sheet metal passageway connects this building to Building 19 from the third through sixth stories and an iron fire escape connects all stories on the east elevation. Unlike Building 19, this building has rectangular windows on its rear elevation and they are grouped in sets of three windows are in on the third and fourth stories, with every other story having only one opening. The roof features a brick parapet and a corbelled brick chimney.

HISTORICAL NARRATIVE

Explain historical development of the area. Discuss how this relates to the historical development of the community.

The area in and around the Gillette Complex has been the site of industrial development since the 1870s with the construction of the seawalls along the Fort Point Channel. North of the Gillette Complex, the Boston Wharf Company filled in land and laid out streets for development constructing numerous buildings including Buildings 19 and 20 of the Gillette Complex, which are representative of the Late Industrial Period (1870-1915) that occurred in the area. With the completion of the Fort Point Channel, the area became a magnet for the shipping and manufacturing industries. Warehouses were constructed by the Boston Wharf Company and others for storage of materials before loading onto ships. By the 1880s, numerous manufacturers came to the area including Chase & Company, predecessor of the New England Confectionary Company (NECCO), which began operations on Congress and Melcher Streets. Also nearby were the Tremont Electric Lighting Company on Congress Street in approximately 1905, C.L Hauthaway & Sons on A Street in the1890s, and the Boston Button Company at 326 A Street in approximately 1890. Most buildings were multi-story brick construction due to the potential fire hazard from industrial works and the creation of Boston building and zoning codes requiring fire protection.

By 1899, the area in and around the present Gillette Complex was home to numerous industries and dozens of buildings built by the Boston Wharf Company. In many cases, the Boston Wharf Company retained ownership and leased factory or industrial space. On the Gillette site itself, were the Whittier Machine Company, American (later Domino) Sugar Refining Company, George Miles Iron Works, Moore and Wyman Elevator Machine Works, Metropolitan Coal Company, and others. It was in this industrial area that King Camp Gillette (1885-1932) set up his company.

Gillette, originally from Fond du Lac, Wisconsin, started his career at the age of 17 as a traveling hardware salesman. His family had moved to Chicago when he was a child and then later to New York City. An inventive person, Gillette held patents prior to the famous razor for which he is known and occasionally improved the items he sold. Frustrated with his single edged razor, Gillette contemplated using a sharpened piece of sheet steel that could be disposed of when dull. In partnership with inventor William Nickerson, they formed the Gillette Safety Razor Company and started production in 1903 with a patent granted the design in 1904. Prior to Gillette’s invention, shaving utilized a single blade straight razor, which was used until dull and then resharpened. The use of the straight razor was problematic on trains or ships due to the potential of cutting oneself. Additionally, the long single blade was difficult to control and if the blade was nicked or damaged it required replacement.

The company initially suffered from financial troubles in creating the necessary equipment and infrastructure for the new razor, but with the backing of investors in particular John Joyce, who had worked with Gillette before, they began production. The 1903 initial sales consisted of a razor with one blade for five dollars with a package of 20 blades costing an additional dollar. Dismal sales for the first year prompted Gillette, who was still working as a traveling salesman, to give up. However, appreciative customers began contacting the company and 90,000 razors and 10,000 packets of blades were sold in 1904. Gillette who had sold a majority share of his stock to Joyce regained a controlling interest in the company and became President. The company's sales continued to improve as it devoted significant funds to advertising including testimonials from baseball players. Patent fights and infighting with Joyce prompted Gillette to sell two-thirds of his holdings to him in 1910 for $900,000 and a yearly salary as well as retaining the title of President, largely for advertising and ceremonial purposes. According to the 1910 Bromley atlas of Boston, the Gillette Safety Razor Company occupied four buildings on West Second Street adjacent the Boston Ice Company. Remaining buildings from this period are Buildings 5, 6, and 7 which served as manufacturing areas.

While largely out of the management role, Gillette still served as company ambassador and proposed innovative ideas like giving American soldiers entering WWI free razors. The company ultimately sold razors at cost to the government including a shaving metal case. With the increased demand, Building 6 was built in 1917 replacing an earlier building and adding more manufacturing space. By the end of the war, three and a half million razors and 32 million blades had been sold. Efforts like these created future customers. Other ideas such as keeping the one dollar price, but reducing the number of blades from 20 to 12 per packet increased profits. The company also offered older versions of the razor at lower prices. Free razors were also given away with other non-Gillette products like Wrigleys gum. During the late 1920s competition and patent fights caused the company to merge with competitor Henry Gaiseman. Sales continued to increase prompting the expansion of the company's facilities. In 1918 Building 2 was constructed to increase manufacturing area with additional buildings north of it for machine shops and storage completed by 1923. Also in 1923 Building 1 was constructed for additional manufacturing area. In 1926 the machine shops and storage buildings north of Building 2 were replaced by Building 3 with Buildings 8 and 9 also completed that year all for additional manufacturing area. This phase of expansion lasted for approximately 30 years as the company endured the Great Depression and WWII.

Gillette had moved to California in the mid-1920s and as he got older his desire to stay involved in the company waned. Financial troubles prompted Gillette to sell his remaining interest in the company, but he held on and ultimately resigned as President in 1931. Unfortunately by this time the Great Depression and other issues had used up most of his fortune. The company however survived the Depression without King Gillette and continued its sports sponsorship and advertising relationship. It also created the first blade dispenser in 1946. By the 1950s prosperity resumed for the company and demand for its products increased including an adjustable razor. The company also began producing other items including shaving cream and antiperspirant. By the 1960s, the company began again to expand its operations acquiring parcels to the north along A Street. During this time, the company acquired two buildings: Building 12, a 1928 brick compressor house and Building 13, a 1914 brick storage and office building previously owned by Crane Company, which manufactured steam fitters supplies. The company also constructed Building 14, the main manufacturing area and also the largest building of the complex from 1961 through 1963, on property formerly owned by the Domino Sugar Company. During the 1960s and 1970s the company focused on refining the development of its razors including adjustable heads and spring mounted blades.

The 1980s were another period of physical growth for the company. In approximately 1985 Building 10 was constructed on the site of previous buildings adding additional office space and Building 16 was added to the end of Building 14 on a newly acquired parcel and the complex expanded further north. Building 17 a circa 1955 light industrial building was also acquired and an addition constructed off of its south elevation connecting it to Building 16.

During the 1990s as the company increased its line of shaving products, the complex was affected by the Big Dig and the construction of the Massachusetts Turnpike tunnel through the property. To accomplish this task the northern end of the property was excavated and the tunnel constructed while temporary dams around Fort Point Channel held back the seawater. The completion of the tunnel also resulted in the completion of Building 18 in 1995, as the new intake for seawater used as a machine coolant in the complex. The original 1926 intake was removed during construction. The current outflow of seawater can be seen in a culvert east of Building 14 as the seawater (slightly warmer from being used as a non-contact coolant) is returned to the Channel.

During the early 2000s the company increased its line of manual and power razors and continued the northward expansion of the complex by acquiring Buildings 19 and 20 both former NECCO candy company buildings that are listed on the National Register of Historic Places.

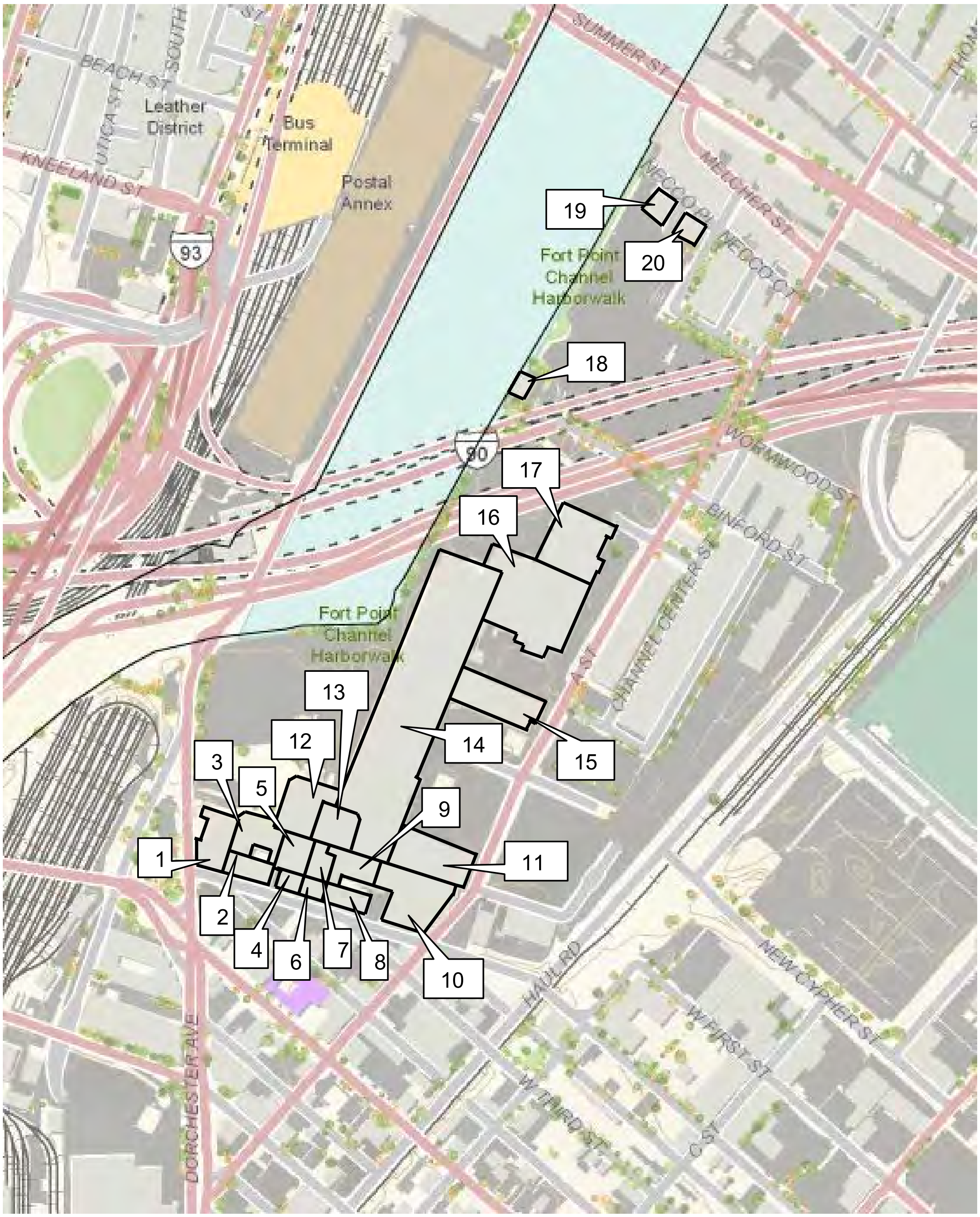
AREA FORM DATA SHEET

BUILDING NUMBER / USE	ADDRESS	CONSTRUCTION DATE	OWNER	ASSESSOR'S SHEET	MHC NUMBER
Building 1	20 Gillette Park	1923	Gillette Manufacturing USA	0601169000	
Building 1	Dorchester Avenue	1923	Mass Bay Transportation Authority	0601169005	
Building 2	20 Gillette Park	1918	Gillette Manufacturing USA	0601169000	
Building 3	20 Gillette Park	1926	Gillette Manufacturing USA	0601169000	
Building 4	20 Gillette Park	Circa 1910	Gillette Manufacturing USA	0601169000	
Building 5	20 Gillette Park	Circa 1910	Gillette Manufacturing USA	0601169000	
Building 6	20 Gillette Park	1917	Gillette Manufacturing USA	0601169000	
Building 7	20 Gillette Park	Circa 1910	Gillette Manufacturing USA	0601169000	
Building 8	20 Gillette Park	1926	Gillette Manufacturing USA	0601169000	
Building 9	20 Gillette Park	1926	Gillette Manufacturing USA	0601169000	
Building 10	20 Gillette Park	Circa 1985	Gillette Manufacturing USA	0601169000	
Building 11	20 Gillette Park	Circa 1969/2000	Gillette Manufacturing USA	0601169000	
Building 11	A Street	Circa 1969/2000	Gillette Manufacturing	0601169004	
Building 12	20 Gillette Park	1928/Circa 1960/1970	Gillette Manufacturing USA	0601169000	
Building 12	Gillette Park	1928/Circa 1960/1970	Gillette Company	0601170000	
Building 13	20 Gillette Park	1914	Gillette Manufacturing USA	0601169000	
Building 14	20 Gillette Park	1961-1963	Gillette Manufacturing USA	0601169000	
Building 14	Sobin Park	1961-1963	Gillette Manufacturing USA	0601169001	
Building 14	Sobin Park	1961-1963	The Gillette Company	0602738000	
Building 15	Sobin Park	Circa 2000	The Gillette Company	0602738000	
Building 15	50-76 Sobin Park	Circa 2000	Gillette Manufacturing	0602731000	
Building 15	172-174 A Street	Circa 2000	Gillette Manufacturing	0602743000	
Building 15	176-178 A Street	Circa 2000	Gillette Manufacturing	0602742000	
Building 15	182 A Street	Circa 2000	Gillette Manufacturing	0602741000	

AREA FORM DATA SHEET

BUILDING NUMBER / USE	ADDRESS	CONSTRUCTION DATE	OWNER	ASSESSOR'S SHEET	MHC NUMBER
Building 16	Sobin Park	Circa 1985	The Gillette Company	0602738000	
Building 16	44-48 Sobin Park	Circa 1985	Gillette Manufacturing	0602736000	
Building 16	20 Sobin Park	Circa 1985	Gillette Manufacturing	0602739000	
Building 17	20 Sobin Park	Circa 1950/1985	Gillette Manufacturing	0602739000	
Building 18	Binford Street	1995	Gillette Company	0601168001	
Building 19	244-284 A Street	1907	Gillette Company	0601165010	15353
Building 20	244-284 A Street	1907	Gillette Company	0601165010	15354
Parking Lot	A Street	NA	Gillette Manufacturing	0602745000	
Building 15 Loading Dock and Parking Lot	168-170 A Street	NA	Gillette Manufacturing	0602744000	
Access Road to Binford Street Park and Gillette Complex	MT Washington Avenue	NA	Gillette Company	0601168002	
Parking Lot and Emergency Access to Mass Pike	232 A Street	NA	Gillette Company	0601165100	

LOCUS MAP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Beach St
South
Utica St
Leather District
Bus Terminal
Kneeland St
Postal Annex
93
Fort Point Channel Harborwalk
Melcher St
Necco Ct
90
Wormwood St
Binford St
A St
Channel Center St
Haul Rd
Dorchester Ave
New Cypher St
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[Delete this page if no Criteria Statement is prepared]

National Register of Historic Places Criteria Statement Form

Check all that apply:

☐ Individually eligible ☐ Eligible **only** in a historic district

☐ Contributing to a potential historic district ☒ Potential historic district

Criteria: ☒ **A** ☐ **B** ☒ **C** ☐ **D**

Criteria Considerations: ☐ **A** ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐ **F** ☐ **G**

Statement of Significance by Brian Lever, Epsilon Associates, Inc.
The criteria that are checked in the above sections must be justified here.

The Gillette complex consists of 20 buildings that were constructed from circa 1910 through 2000. The Gillette Company was and remains an important manufacturer in the Boston area. The complex's development is part of a pattern of industrial development seen along the South Boston waterfront in the late nineteenth and early twentieth centuries. The complex is associated with the founder of the Gillette Company, King Camp Gillette, a noted inventor, and is the site of innovations in shaving technology and personal hygiene. While some buildings have been altered with later additions and/or replacement windows and doors, the majority of the complex is intact. Later development such as Building 14 is part of the expansion of facilities and associated with the company's growth in the mid-to late twentieth century. The complex is recommended eligible under Criterion A for its importance in the industrial history of Boston and the development of manufacturing along the Fort Point Channel. The complex is also recommended eligible under Criterion C as an important example of industrial architecture from the early through the mid-twentieth century. Buildings 19 and 20 are already listed in the National Register of Historic Places as part of the Fort Point Channel Historic District.

Attachment CC Visual Simulation Technical Report

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1. Introduction

The *Visual Simulation Technical Report* presents a visual assessment of the SSX project alternatives at the South Station site. The visual simulations in this report were used to assess visual impacts of the SSX project upon historic resources within the South Station site Area of Potential Effect (APE) in Appendix 13 – *Historic Architectural Resources*. Visual assessments were conducted for the No Build Alternative; Alternative 2 – Joint/Private Development Minimum Build; and Alternative 3 – Joint/Private Development Maximum Build. Per the Chapter 91 regulations, Alternative 1 would be considered a Non-Water Dependent Infrastructure Facility and the requirements of 310 CMR 9.51 through 9.53 do not apply to Non-Water Dependent Infrastructure Facilities. As such, MassDOT was not required to assess the impacts of Alternative 1 with respect to visual, wind, shadow, or open space.

2. Existing Conditions

The historic South Station headhouse faces multi-story commercial buildings flanking Atlantic Avenue and Summer Street at Dewey Square. As shown in Figure 1, the headhouse is highly visible from the open plazas of Dewey Square and the Federal Reserve building across Summer Street. The headhouse has a lower profile in the Boston skyline in comparison to the adjacent buildings, including the Federal Reserve building, One Financial Center across Atlantic Avenue, and 245 Summer Street on the same block.

To the west, South Station extends along Atlantic Avenue. Adjacent to South Station along Atlantic Avenue is the five-story South Station Bus Terminal. From the southwest, views of South Station, which are largely from I-93, are dominated by the extensive rail infrastructure network of Tower 1 interlocking. As shown in Figure 2, views of Dorchester Avenue include the narrow sidewalk and metal railing delineating the edge of Fort Point Channel and the USPS General Mail Facility (GMF).

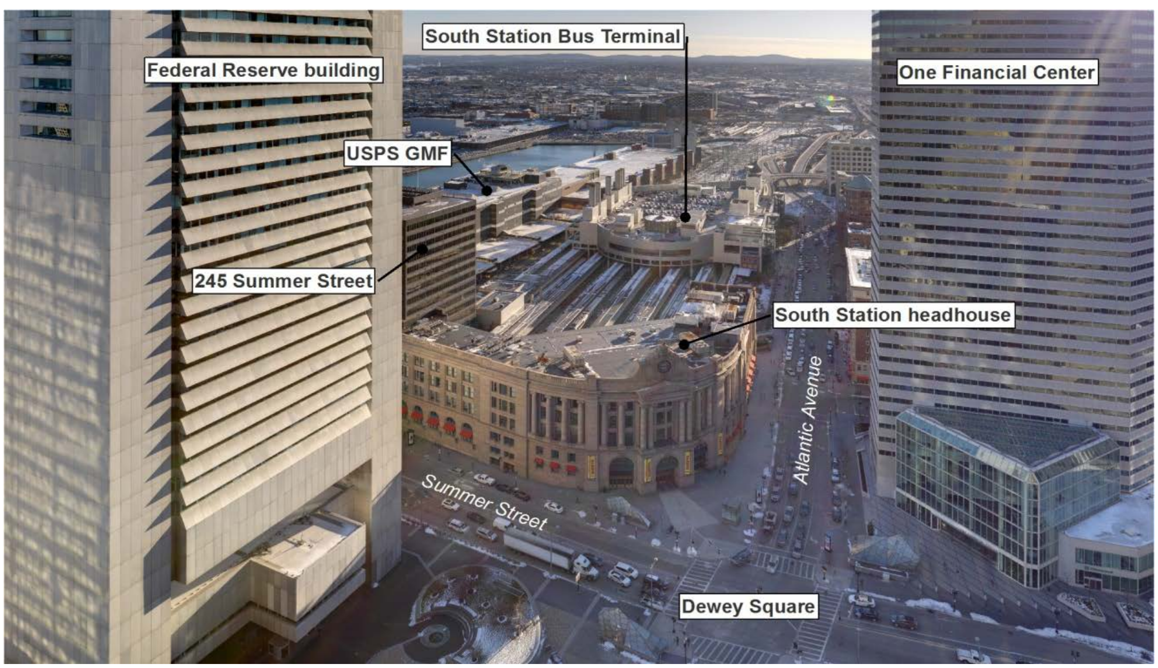

Figure 1—Existing Conditions: View of South Station Headhouse, looking south from Dewey Square

Figure 2—Existing Conditions: View of Dorchester Avenue, looking south from Summer Street

3. South Station Site Alternatives

No Build Alternative

A future condition at the South Station site is the planned South Station Air Rights (SSAR) project.[1] The SSAR project includes a high-rise tower (Phase I) behind the headhouse, rising approximately 670 feet in height from grade. Three smaller mid-rise towers (Phase II and Phase III) will extend south over the bus terminal along Atlantic Avenue. These three towers will be taller than the existing South Station headhouse, but will be similar in height to 245 Summer Street.

In the No Build Alternative, the proposed SSAR project structures would be a major feature in Dewey Square, particularly SSAR Phase I. SSAR Phase II and III would be visible from Atlantic Avenue and generally would be in scale with the existing buildings of the Leather District.

Alternative 2 – Joint/Private Development Minimum Build

In Alternative 2, future private development could include approximately 660,000 sf of mixed uses consisting of residential, office, and commercial uses, including retail and hotel, located in six separate buildings with open space and plazas. Building heights could range up to approximately 12 stories (reaching a maximum height of approximately 142 feet).

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[1] The South Station Air Rights project was approved by the Secretary of the Executive Office of Energy and Environmental Affairs (EEA) in 2006 (EEA No. 3205/9131).

Alternative 3 – Joint/Private Development Maximum Build

In Alternative 3, future private development could include approximately 2,000,000 sf of mixed uses consisting of residential, office, and commercial uses, including retail and hotel uses, located in six separate buildings with open space and plazas. Building heights could range up to approximately 21 stories (not exceeding a maximum height of 290 feet).

4. Visual Simulations

The SSX project massings were simulated on existing photographs of the South Station area to visualize the potential impacts of the project alternatives (Alternatives 2 and 3) on the South Station site and surrounding area. Multiple views of the South Station area were assessed. For comparative purposes, descriptions of the views of the existing conditions and the No Build Alternative are provided.

4.1. View of South Station from Purchase Street

Figure 3 provides a view of South Station looking south from Purchase Street in all conditions.

Existing Conditions

The existing South Station headhouse can be seen on Dewey Square along with the One Financial Center Tower to the right. Also visible are the mid-rise buildings of the Leather District facing Atlantic Avenue.

No Build Alternative

The existing South Station headhouse can be seen on Dewey Square and the SSAR project structures would be visible behind the headhouse, particularly SSAR Phase I. SSAR Phases II and III would be seen fronting Atlantic Avenue and generally would be in scale with the existing buildings of the Leather District.

Alternative 2 – Joint/Private Development Minimum Build

SSAR Phase I would obscure the view of the proposed SSX project on Dorchester Avenue. The existing South Station headhouse can be seen on Dewey Square and the SSAR project structures would be visible behind the headhouse, particularly SSAR Phase I. SSAR Phases II and III would be seen fronting Atlantic Avenue and generally would be in scale with the existing buildings of the Leather District.

Alternative 3 – Joint/Private Development Maximum Build

SSAR Phase I would obscure the view of the proposed SSX project on Dorchester Avenue. The existing South Station headhouse can be seen on Dewey Square and the SSAR project structures would be visible behind the headhouse, particularly SSAR Phase I. SSAR Phases II and III would be seen fronting Atlantic Avenue and generally would be in scale with the existing buildings of the Leather District.

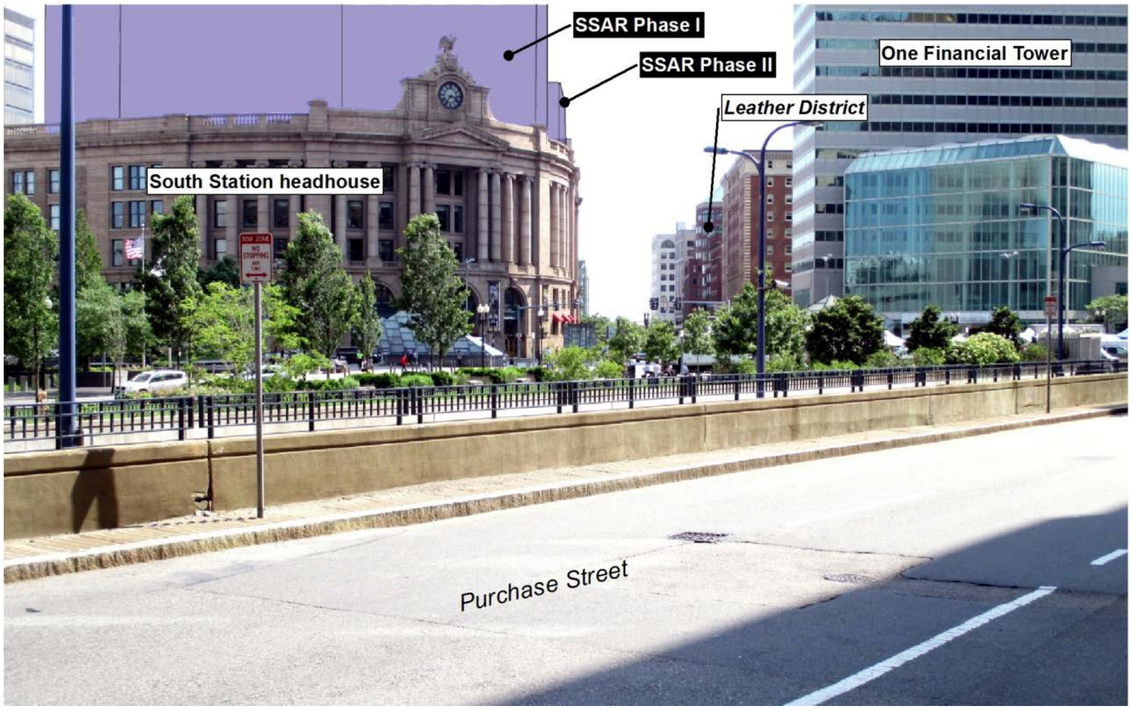

Figure 3—View of South Station looking south from Purchase Street – No Build and Build Alternatives

4.2. View of South Station from Dewey Square

Figure 4 provides a view of South Station from Dewey Square looking southeast along Summer Street in all build conditions.

Existing Conditions

The South Station headhouse faces Dewey Square and the 245 Summer Street building is just beyond the headhouse. The Federal Reserve building is to the left on the north side of Summer Street.

No Build Alternative

The South Station headhouse faces Summer Street and the 245 Summer Street building is just beyond the headhouse. The Federal Reserve building is to the left on the north side of Summer Street. SSAR Phase I would be visible rising above the South Station headhouse.

Alternative 2 – Joint/Private Development Minimum Build

SSAR Phase I would be visible rising above the existing South Station headhouse and would obscure the proposed SSX project on Dorchester Avenue.

Alternative 3 – Joint/Private Development Maximum Build

SSAR Phase I would be visible rising above the existing South Station headhouse and would obscure the proposed SSX project on Dorchester Avenue.

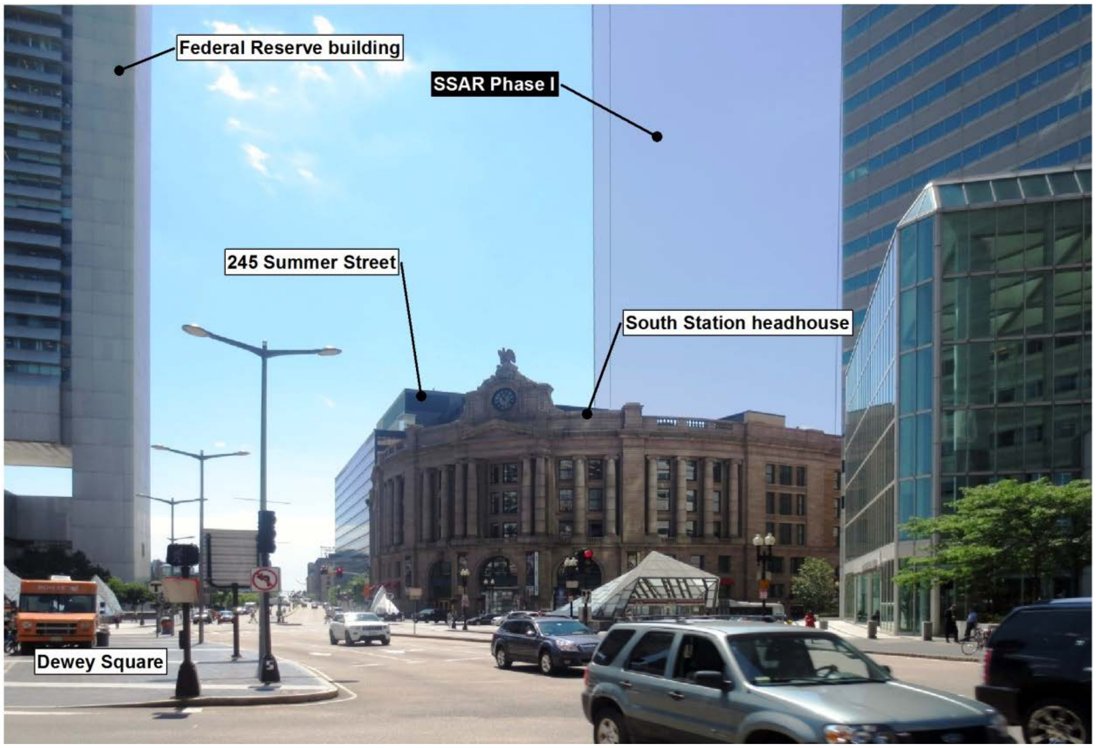

Figure 4—View of South Station from Dewey Square looking southeast along Summer Street – No Build and Build Alternatives

4.3. View of South Station Site from Surface Artery

Figure 5 provides a view of the South Station site looking southeast along Essex Street from Surface Road in all build conditions.

Existing Conditions

The existing South Station headhouse can be seen at the end of the Essex Street corridor as viewed from Chinatown. Essex Street is framed by the mid-rise buildings of the Leather District on the right and One Financial Center on the left.

No Build Alternative

SSAR Phase I would be seen down Essex Street beyond the South Station headhouse and is similar in size to One Financial Center.

Alternative 2 – Joint/Private Development Minimum Build

SSAR Phase I, which can be seen down Essex Street beyond the South Station headhouse, is similar in size to One Financial Center, and obscures the view of the proposed SSX project.

Alternative 3 – Joint/Private Development Maximum Build

SSAR Phase I, which can be seen down Essex Street beyond the South Station headhouse, is similar in size to One Financial Center, and obscures the view of the proposed SSX project .

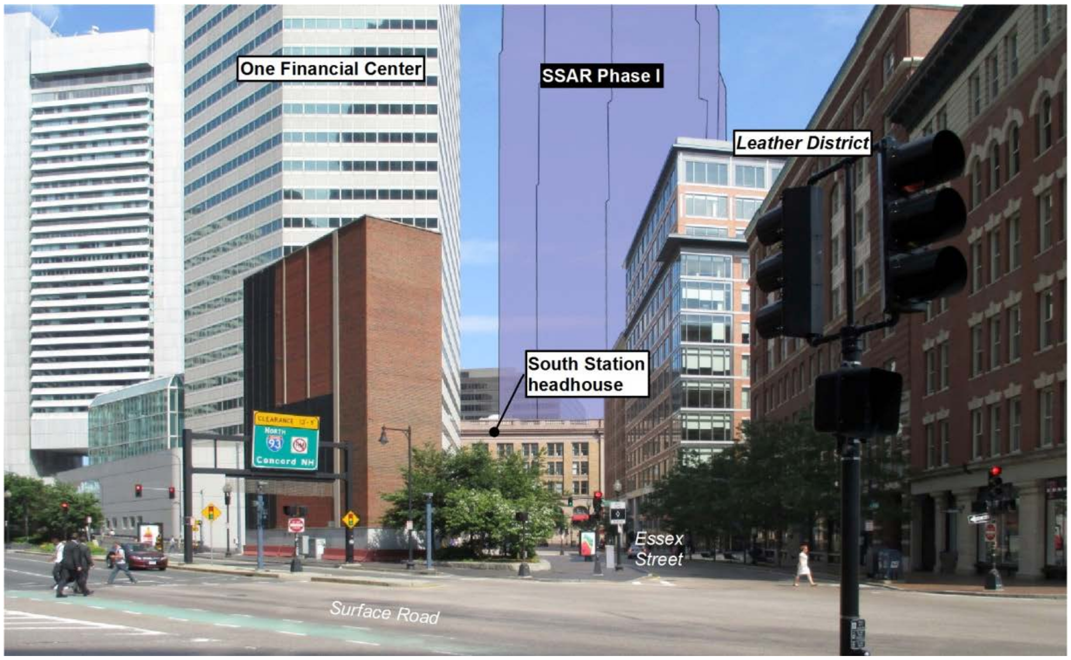

Figure 5—View of South Station site looking southeast along Essex Street from the Surface Artery – No Build and Build Alternatives

4.4. View of South Station Site from Hudson Street

Figure 6, Figure 7, and Figure 8 provide views of the South Station site looking east from Hudson Street in Chinatown.

Existing Conditions

Midrise buildings of the Leather District and on Kneeland Street (Boston Thermal Steam Generation Plant) can be seen over the I-90/I-93 entrance ramp. The existing South Station headhouse is not visible.

No Build Alternative

SSAR Phase I, II, and III would be seen over the Leather District buildings. The existing South Station headhouse is not visible. (See Figure 6)

Alternative 2 – Joint/Private Development Minimum Build

The proposed SSX project would be visible beyond the Boston Thermal Steam Generation Plant. The existing South Station headhouse is not visible. SSAR Phase I, II, and III would be seen over the Leather District buildings. (See Figure 7)

Alternative 3 – Joint/Private Development Maximum Build

The SSX project would be seen over the Leather District buildings and would be comparable in scale to surrounding buildings. The existing South Station headhouse is not visible. SSAR Phase I, II, and III would also be seen and would partially obscure views of the SSX project. (See Figure 8)

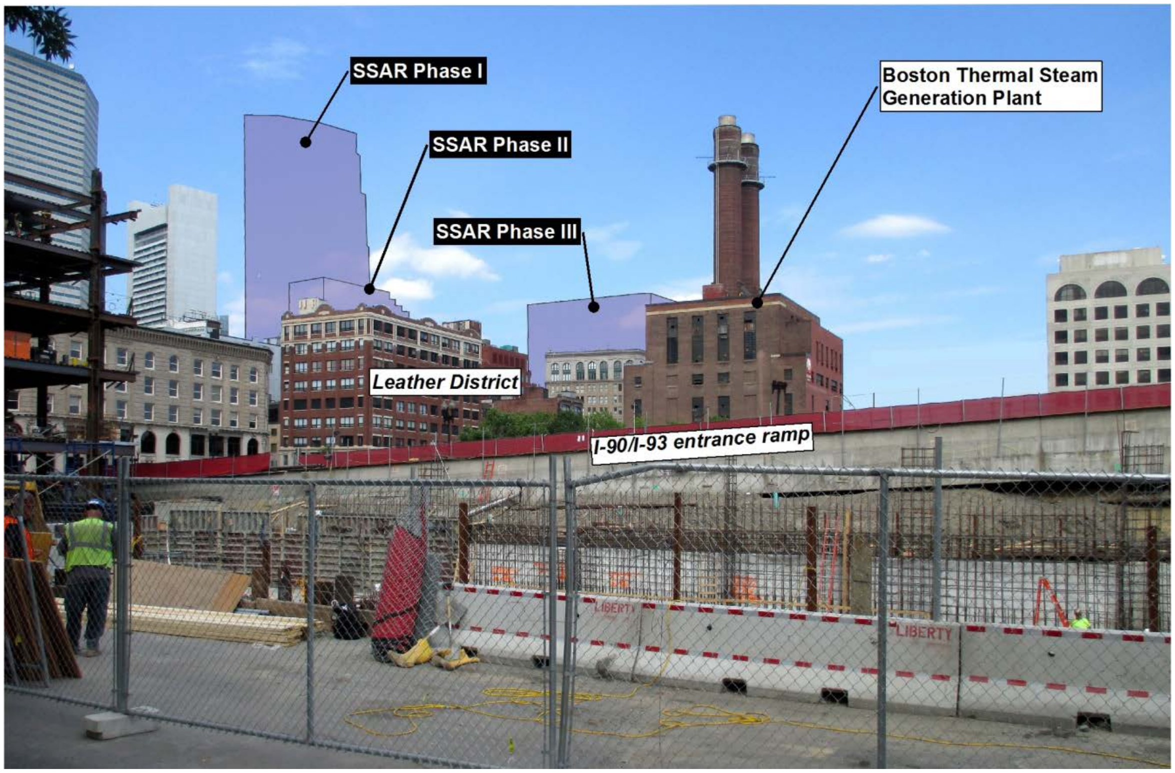

Figure 6—View of South Station site looking east from Hudson Street in Chinatown – No Build Alternative

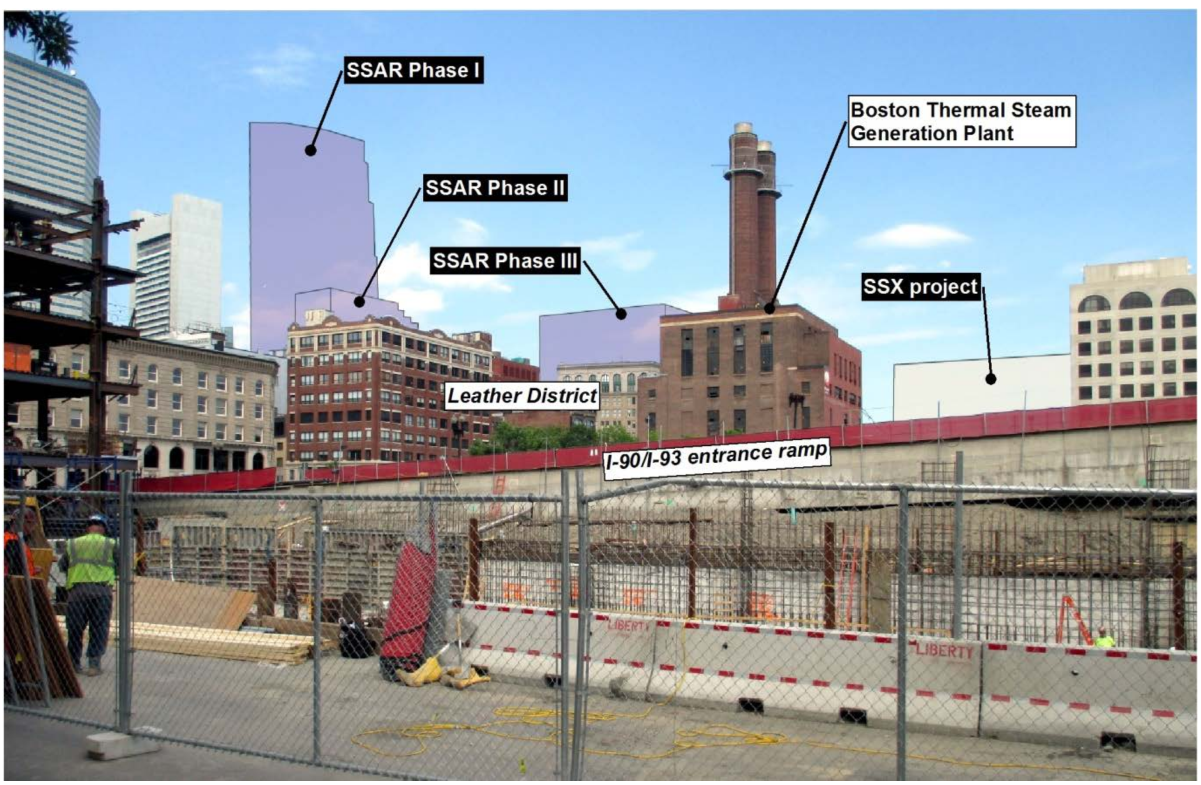

Figure 7—View of South Station site looking east from Hudson Street in Chinatown – Alternative 2

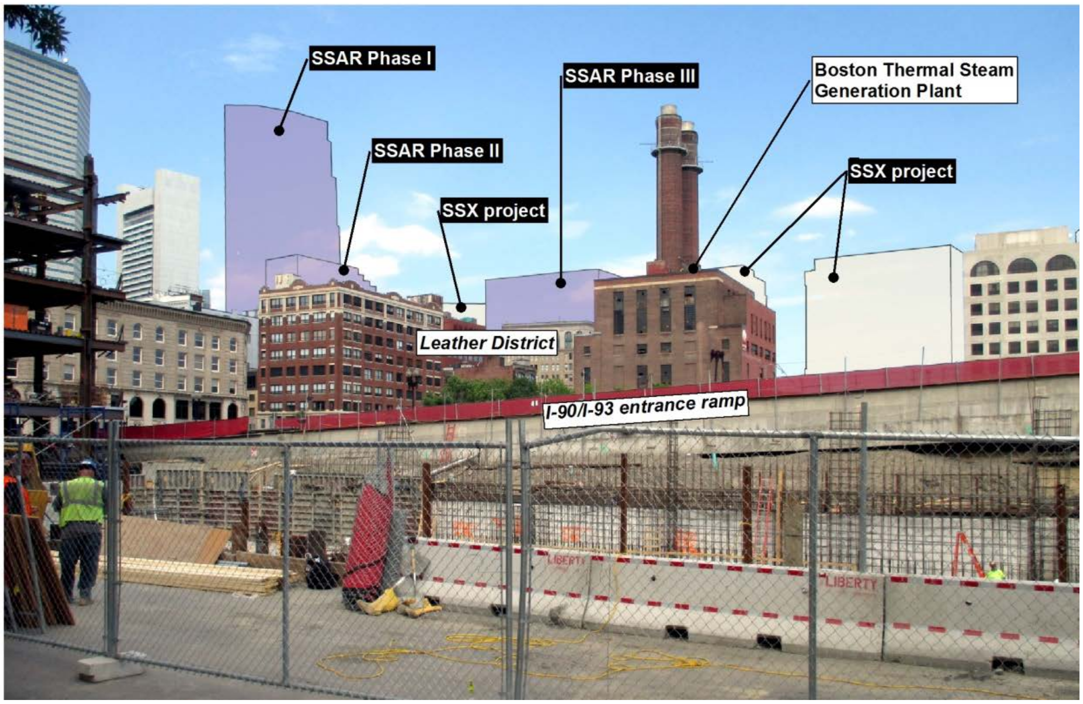

Figure 8—View of South Station site looking east from Hudson Street in Chinatown - Alternative 3

4.5. View of South Station Site from Gillette

Figure 9, Figure 10, and Figure 11 provide views of the South Station site at Fort Point Channel looking north from Gillette.

Existing Conditions

Mid-rise buildings, including the USPS GMF, 245 Summer Street, and Russia Wharf, provide the foreground for the towers of the Financial District. The Boston Wharf Company Buildings and the Federal Courthouse can be seen to the right of Fort Point Channel.

No Build Alternative

SSAR Phase I would be seen in the background rising above the USPS GMF and the existing South Station headhouse, which is not visible. (See Figure 9)

Alternative 2 – Joint/Private Development Minimum Build

The SSX project would create a new building facade along Dorchester Avenue. The project would be similar in size to 245 Summer Street. SSAR Phase I would be seen in the background beyond the SSX project. The existing South Station headhouse is not visible. (See Figure 10)

Alternative 3 – Joint/Private Development Maximum Build

The SSX project would create a new building facade along Dorchester Avenue. The SSX project in Alternative 3 would be taller than the 245 Summer Street Building. The existing headhouse and the SSAR project would not be visible. (See Figure 11)

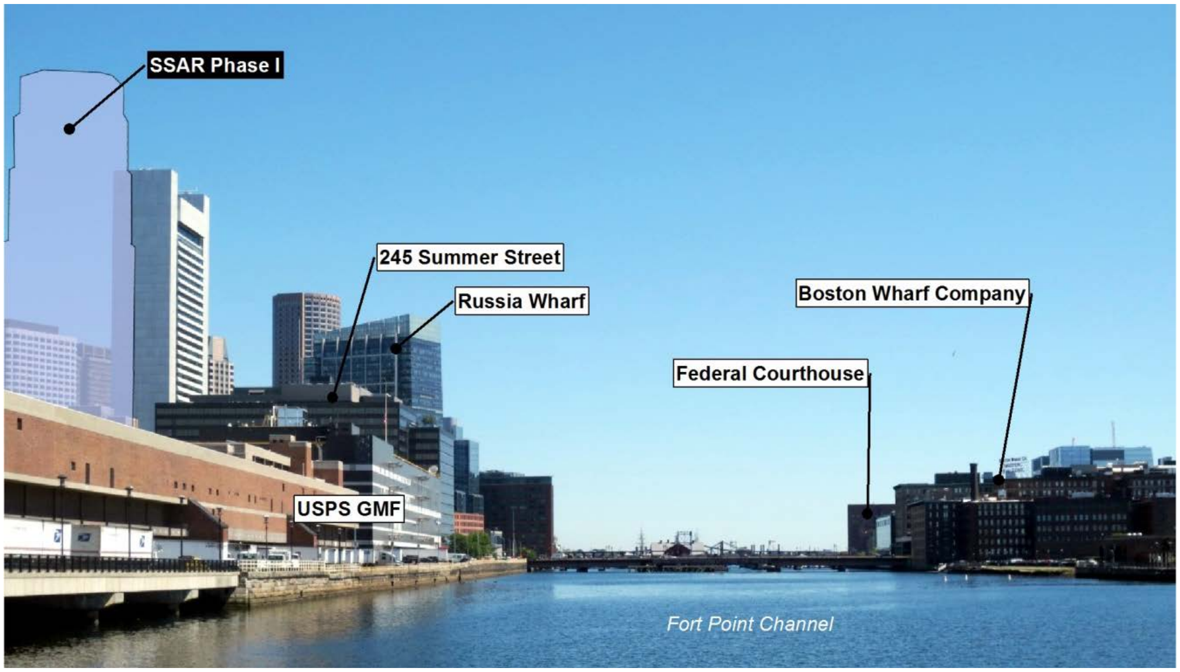

Figure 9—View of South Station site at Fort Point Channel looking north from Gillette – No Build Alternative

Figure 10—View of South Station site at Fort Point Channel looking north from Gillette – Alternative 2

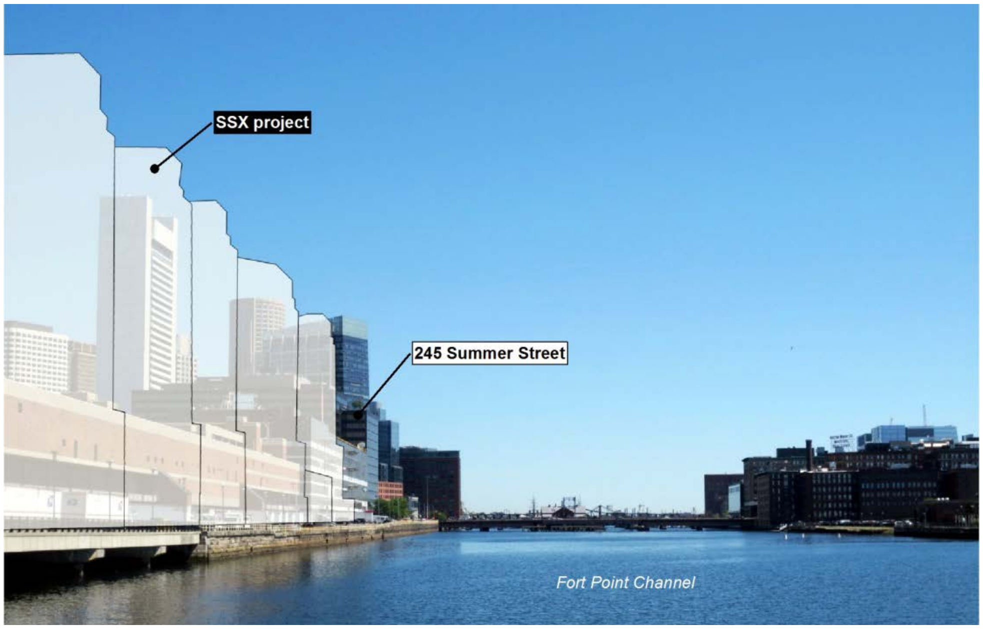

Figure 11—View of South Station site at Fort Point Channel looking north from Gillette – Alternative 3

4.6. View of South Station Site from Summer Street in South Boston Waterfront

Figure 12, Figure 13, and Figure 14 present views of the South Station site from the South Boston Waterfront neighborhood, looking northwest down Summer Street across Fort Point Channel.

Existing Conditions

The USPS GMF and 245 Summer Street can be seen along Summer Street. The existing South Station headhouse is visible just beyond 245 Summer Street and the Federal Reserve building is across Summer Street on the right.

No Build Alternative

SSAR Phase I and II can be clearly seen beyond 245 Summer Street. The USPS GMF and the South Station headhouse would be visible. SSAR Phase I would be similar in scale to the facing Federal Reserve Bank to the right. (See Figure 12)

Alternative 2 – Joint/Private Development Minimum Build

The SSX project would be visible in front of SSAR Phase II. SSAR Phase I and the existing South Station headhouse can be seen beyond 245 Summer Street. SSAR Phase I would be similar in scale to Federal Reserve building. (See Figure 13)

Alternative 3 – Joint/Private Development Maximum Build

The SSX project would be visible in front of SSAR Phase II and similar in scale to 245 Summer Street. SSAR Phase I and the existing South Station headhouse can be seen beyond 245 Summer Street. SSAR Phase I would be similar in scale to Federal Reserve building. (See Figure 14)

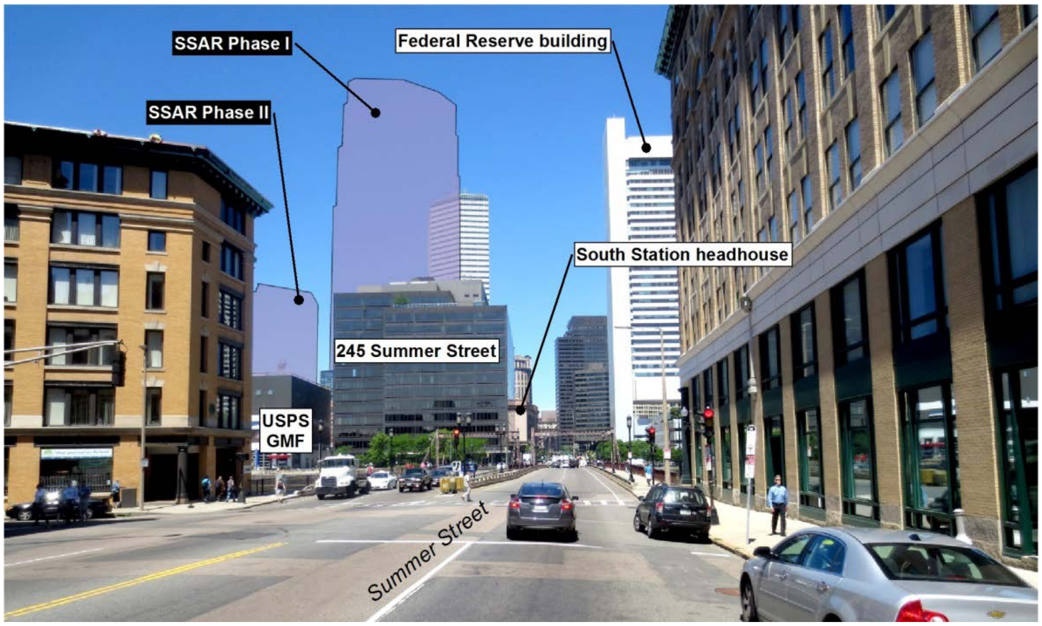

Figure 12—View of South Station site from South Boston Waterfront, looking northwest on Summer Street across Fort Point Channel – No Build Alternative

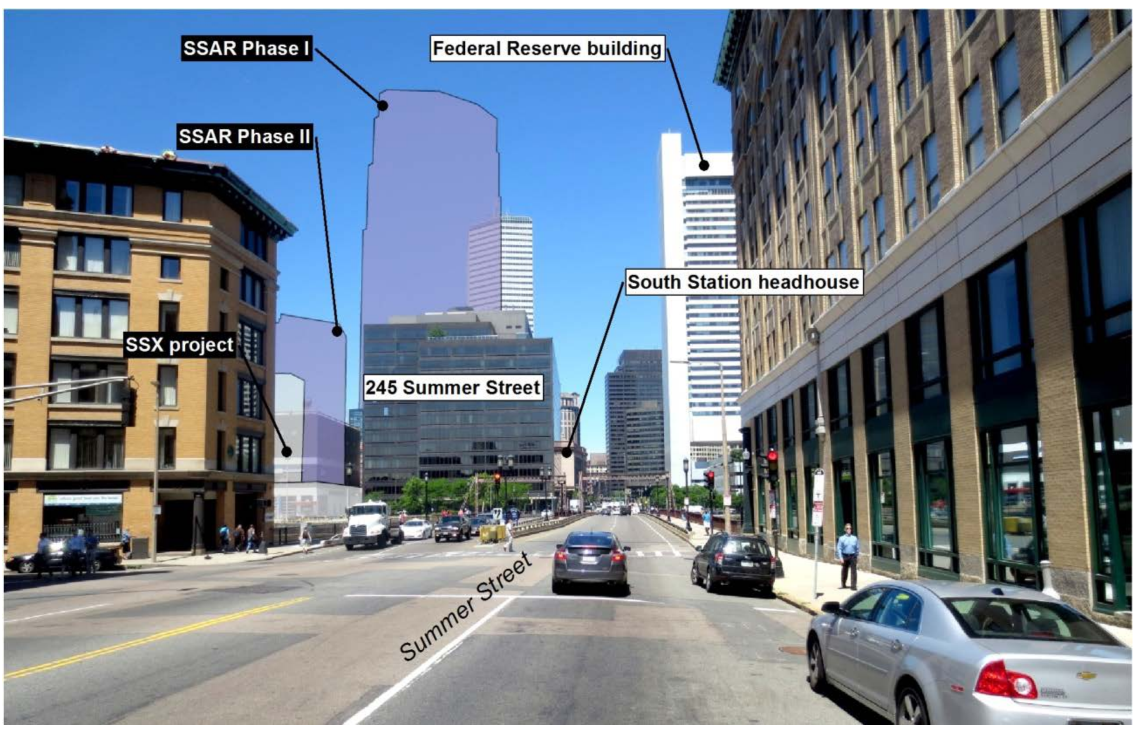

Figure 13—View of South Station site from South Boston Waterfront, looking northwest on Summer Street across Fort Point Channel – Alternative 2

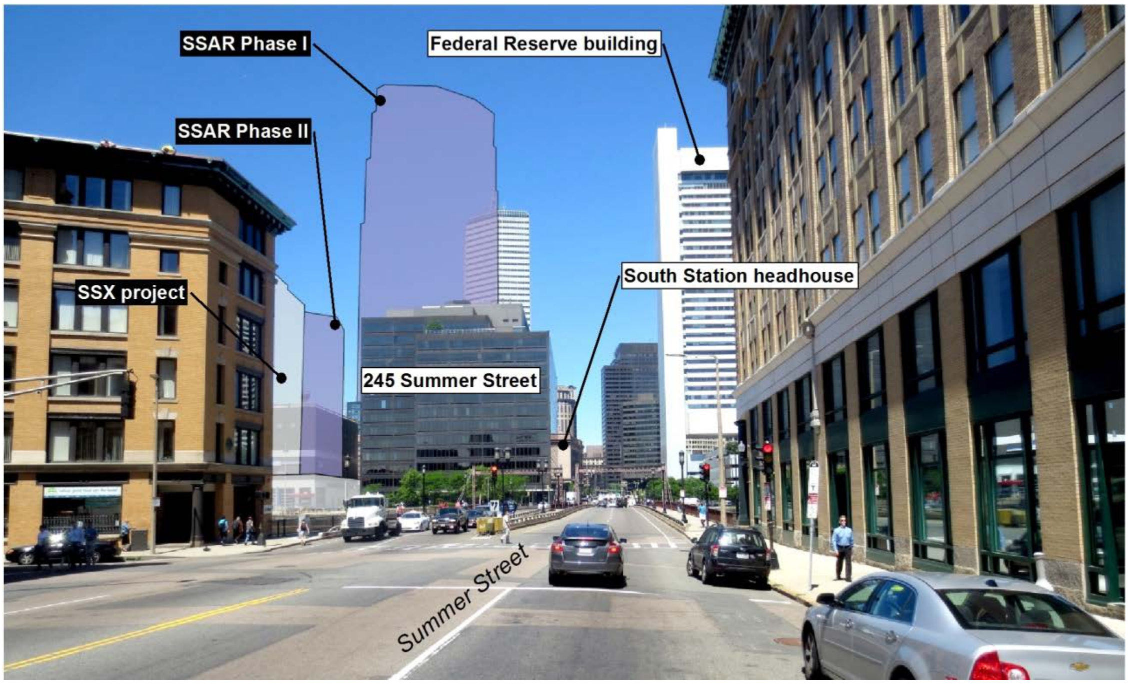

Figure 14—View of South Station site from South Boston Waterfront looking northwest on Summer Street across Fort Point Channel – Alternative 3

4.7. View of South Station Site from directly across Fort Point Channel

Figure 15, Figure 16, and Figure 17 present views of the South Station site from the South Boston Waterfront neighborhood, looking west from the Harborwalk directly across Fort Point Channel.

Existing Conditions

Mid-rise buildings, including the USPS GMF and 245 Summer Street can be seen across Fort Point Channel and the towers of the Financial District can be seen beyond.

No Build Alternative

The SSAR project is visible beyond the USPS GMF and 245 Summer Street. SSAR Phase II and Phase III would be comparable in scale to 245 Summer Street. SSAR Phase I would be seen in the background rising above the SSX project and would be similar in scale to the Federal Reserve building. (See Figure 15)

Alternative 2 – Joint/Private Development Minimum Build

The SSX project would create a new building facade along Dorchester Avenue. The SSX project would be in scale with 245 Summer Street and the SSAR Phase II and Phase III structures. The SSAR project would be seen in the background above the SSX project and Phase I would be similar in scale to the Federal Reserve building. (See Figure 16)

Alternative 3 – Joint/Private Development Maximum Build

The SSX project would create a new building facade along Dorchester Avenue. The SSX project in Alternative 3 would be rise above both the 245 Summer Street building and SSAR Phase II. SSAR Phase III would be visible beyond the SSX headhouse expansion. SSAR Phase I would be seen in the background rising above the SSX project and would be similar in scale to the Federal Reserve building. (See Figure 17)

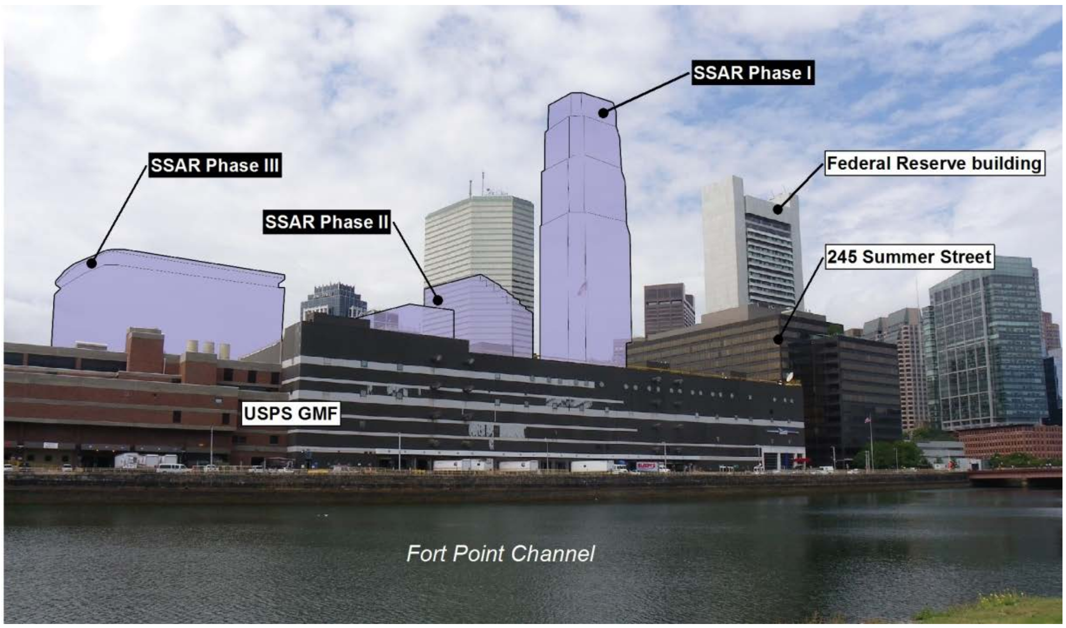

Figure 15—View of South Station site from the Harborwalk, directly across Fort Point Channel - No Build Alternative

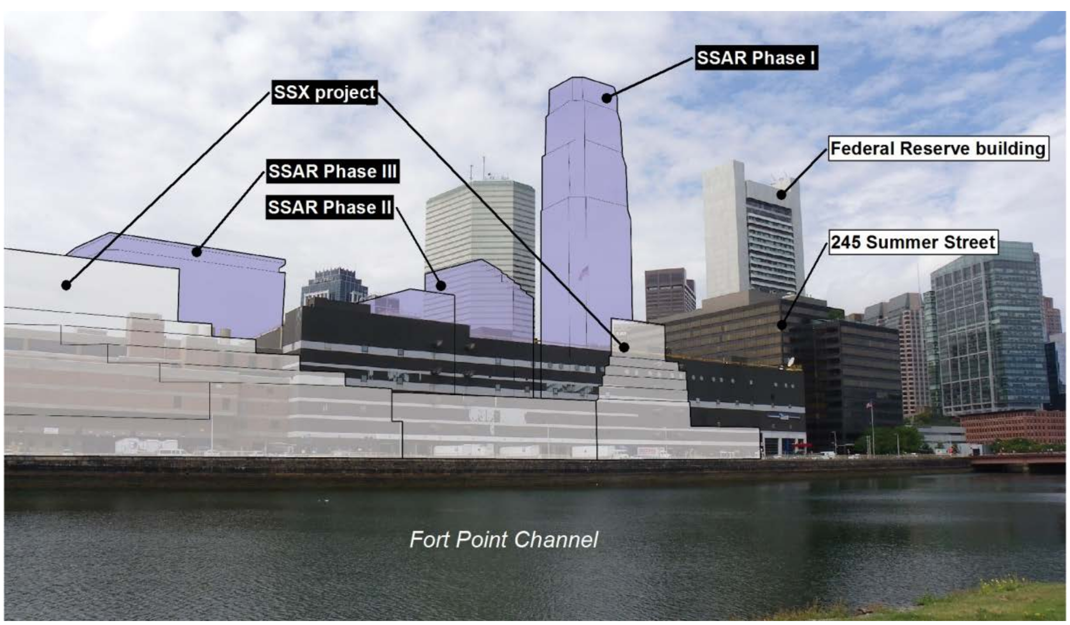

Figure 16—View of South Station site from the Harborwalk, directly across Fort Point Channel - Alternative 2

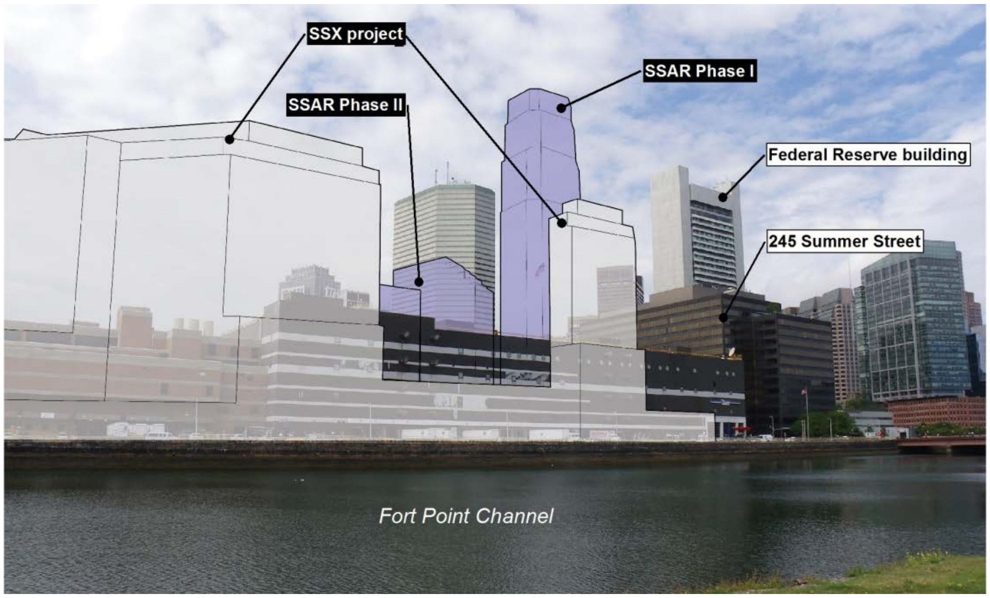

Figure 17—View of South Station site from the Harborwalk, directly across Fort Point Channel - Alternative 3

4.8. View of South Station Site from Congress Street Bridge

Figure 18, Figure 19, and Figure 20 present views of the South Station site, looking south from the Congress Street Bridge over Fort Point Channel.

Existing Conditions

The 245 Summer Street Building is in the center of the view, with the USPS GMF extending along Fort Point Channel and the existing South Station headhouse to the right.

No Build Alternative

The 245 Summer Street Building is in the center of the view, with the USPS GMF extending along Fort Point Channel and the existing South Station headhouse to the right. The SSAR project would be seen in the background. (See Figure 18)

Alternative 2 – Joint/Private Development Minimum Build

The SSX project would be visible to the left of 245 Summer Street and the existing headhouse and would extend along Dorchester Avenue to the I-90 Vent Building. The project would be similar in size to 245 Summer Street. SSAR Phase I and III would be seen in the background. (See Figure 19)

Alternative 3 – Joint/Private Development Maximum Build

The SSX project would be visible to the left of 245 Summer Street and the existing headhouse and would extend along Dorchester Avenue to the I-90 Vent Building. The project would be similar in size to 245 Summer Street. SSAR Phase I would be seen beyond 245 Summer Street. (Figure 20)

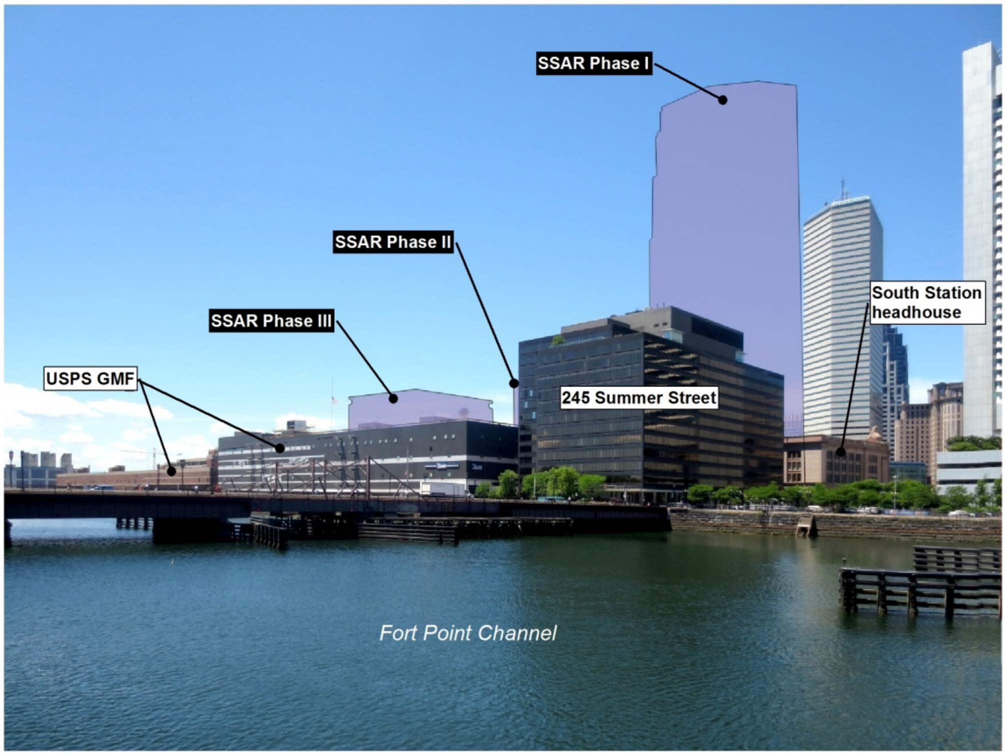

Figure 18—View of South Station site looking south from Congress Street Bridge on Fort Point Channel – No Build Alternative

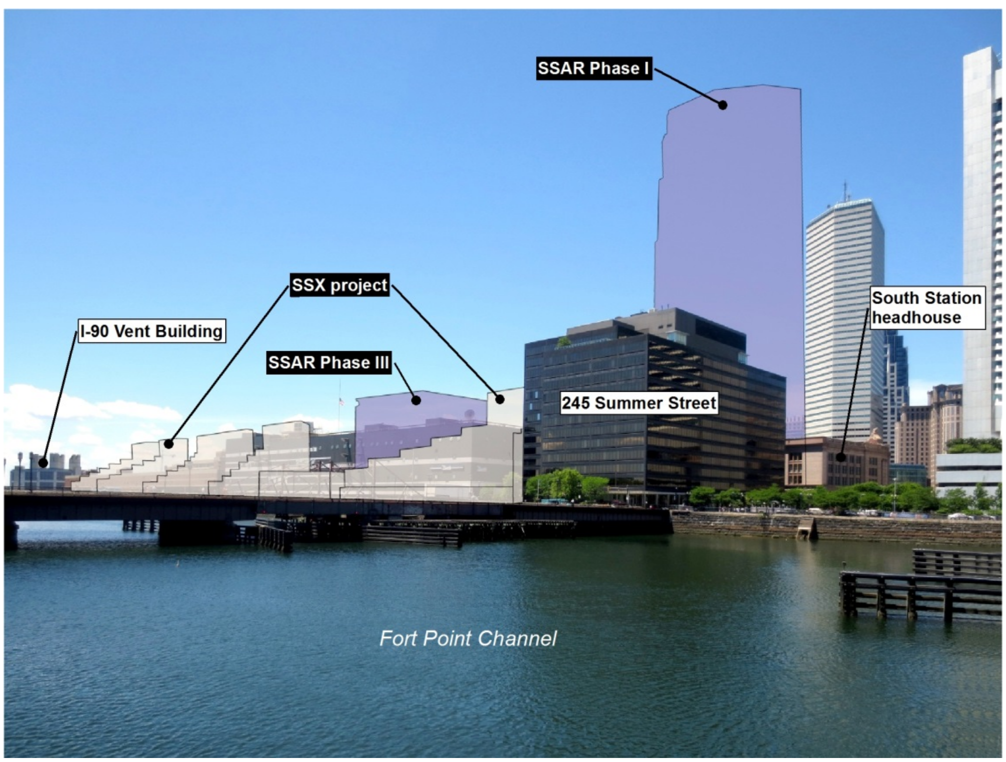

Figure 19—View of South Station site looking south from Congress Street Bridge on Fort Point Channel – Alternative 2

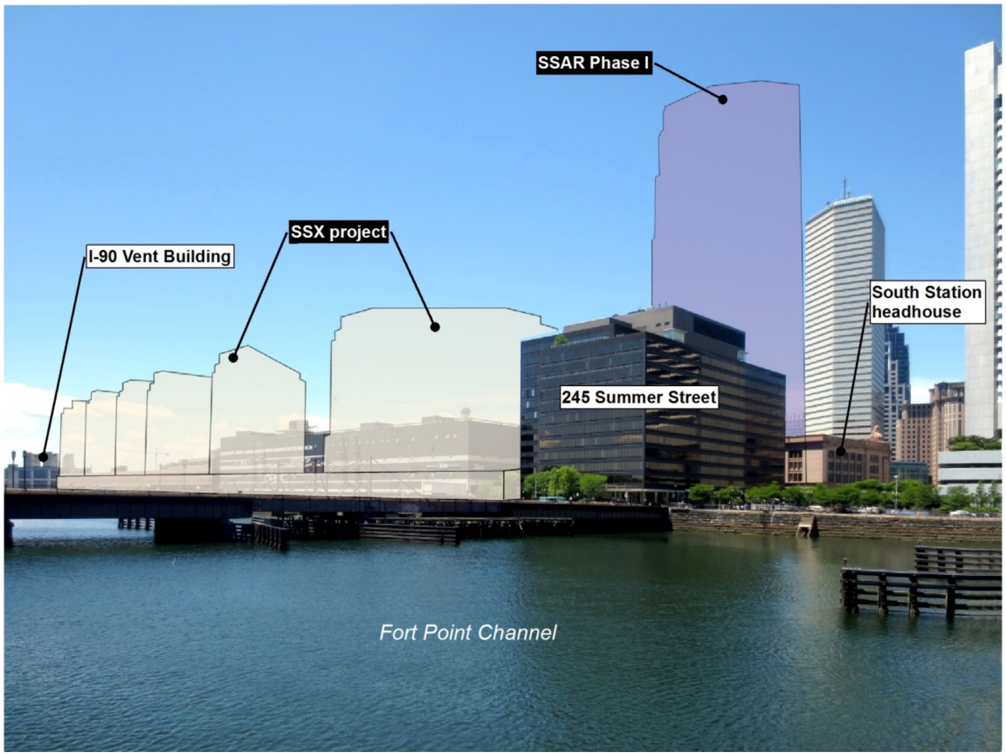

Figure 20**—View of South Station site looking south from Congress Street Bridge on Fort Point Channel – Alternative 3**