Chapter 8—ENVIRONMENTAL JUSTICE ANALYSIS

8.1 BACKGROUND

This section provides an overview of the environmental justice (EJ) analysis for the Massachusetts Turnpike Boston Ramps and Bowker Overpass Study, including a brief description of the methodology used by the Central Transportation Planning Staff (CTPS) to analyze EJ effects. This chapter also summarizes the effects of each build alternative on the EJ population zones near the Massachusetts Turnpike. Staff performed statistical analysis to determine whether the impact on the EJ areas is statistically significant compared to the impact on the non-EJ areas in the required categories of accessibility, mobility, and air quality.

EJ is based on the principle that all people have a right to be protected from harmful environmental effects and to enjoy a clean, healthy environment. EJ concerns the equal protection and meaningful involvement of all people with respect to the development, implementation, and enforcement of environmental laws, regulations, policies, and equitable distribution of environmental benefits.

The Commonwealth of Massachusetts' Executive Office of Energy and Environmental Affairs (EEA) has established an EJ policy to help address the disproportionate share of environmental burdens experienced by lower-income populations and minority communities. The policy is designed to help ensure the protection of these groups from harmful environmental effects. It also aims to promote community involvement in planning and decision making to maintain and/or enhance the quality of affected neighborhoods in terms of the environment. The EJ policy directs state resources to serve (but not be limited to) minority and low-income populations and neighborhoods across the state. These resources will ensure that EJ populations have a strong voice in environmental decision making; receive the full protection afforded them through existing environmental rules and regulations; and increase access to investments that will enhance equality of life in low-income and minority communities by restoring degraded natural resources, enhancing open space, and building urban park networks.

The "EJ Assessment," is a detailed, system-level analysis conducted with the statewide transportation model. This assessment is based on the Boston Region Metropolitan Planning Organization's (MPO) assessment of projects contained in its Long-Range Transportation Plan (LRTP). It examines the distribution of benefits and burdens brought on by proposed transportation projects among EJ and non-EJ population

zones in the MPO region. Its purpose is to determine if there are disproportionate burdens on protected minority and low-income populations, respectively.

8.2 METHODOLOGY

8.2.1 EJ Area Definition

The Federal Transit Authority's (FTA) Title VI circular defines a predominantly minority area as a geographic area where the proportion of minority persons present exceeds the average proportion of minority persons in the recipient's service area. The geographic area referenced by the MPO and CTPS is a transportation analysis zone (TAZ)—an aggregate of census geography based on population and number of trips that is used to model transportation behavior. For Title VI purposes, when identifying benefits and burdens of proposed transportation projects, the MPO has defined a minority TAZ as one whose minority population (nonwhite and Hispanic of all races) is greater than the overall MPO region's average minority population of 27.8%.

FTA's EJ circular and the Federal Highway Administration's (FHWA) EJ guidance define a low-income person as one whose median household income is at or below the Department of Health and Human Services' poverty guidelines. Metropolitan planning organizations also are allowed to use their own definitions or thresholds, or a percentage of median income for their regions, as long as their definitions meet or exceed the federal definition. The Boston Region MPO defines the low-income threshold for an individual as one living in a household whose median income is 60% or less than the median MPO household income. According to the 2006–2010 American Community Survey, the regional MPO household income is $70,829. Therefore, the MPO's low-income threshold is $42,497. (The poverty guideline for a family of four was $23,050 when this threshold was developed.) This income threshold is used for all of the MPO's EJ analyses conducted for the LRTP and the Transportation Improvement Plan (TIP).

The EJ study area is defined as one-half mile on either side of the Massachusetts Turnpike between Essex Street in Brookline to the west and Shawmut Avenue in Boston to the east. (Note: Cambridge TAZs on the north side of the Charles River are not included.) Only a fraction of some TAZs is included in the buffer area. TAZs that have less than 50% of their area in the buffer were not included unless the proportion of minority residents in the TAZ exceeds the regional average of 27.8% and/or average household income is less than or equal to 60% of the median household income ($42,497) for the region.

Figure 8-1 shows the 94 TAZs included in the study area and indicates those that are considered to be either minority, low-income, or both. Thirty-seven TAZs are neither

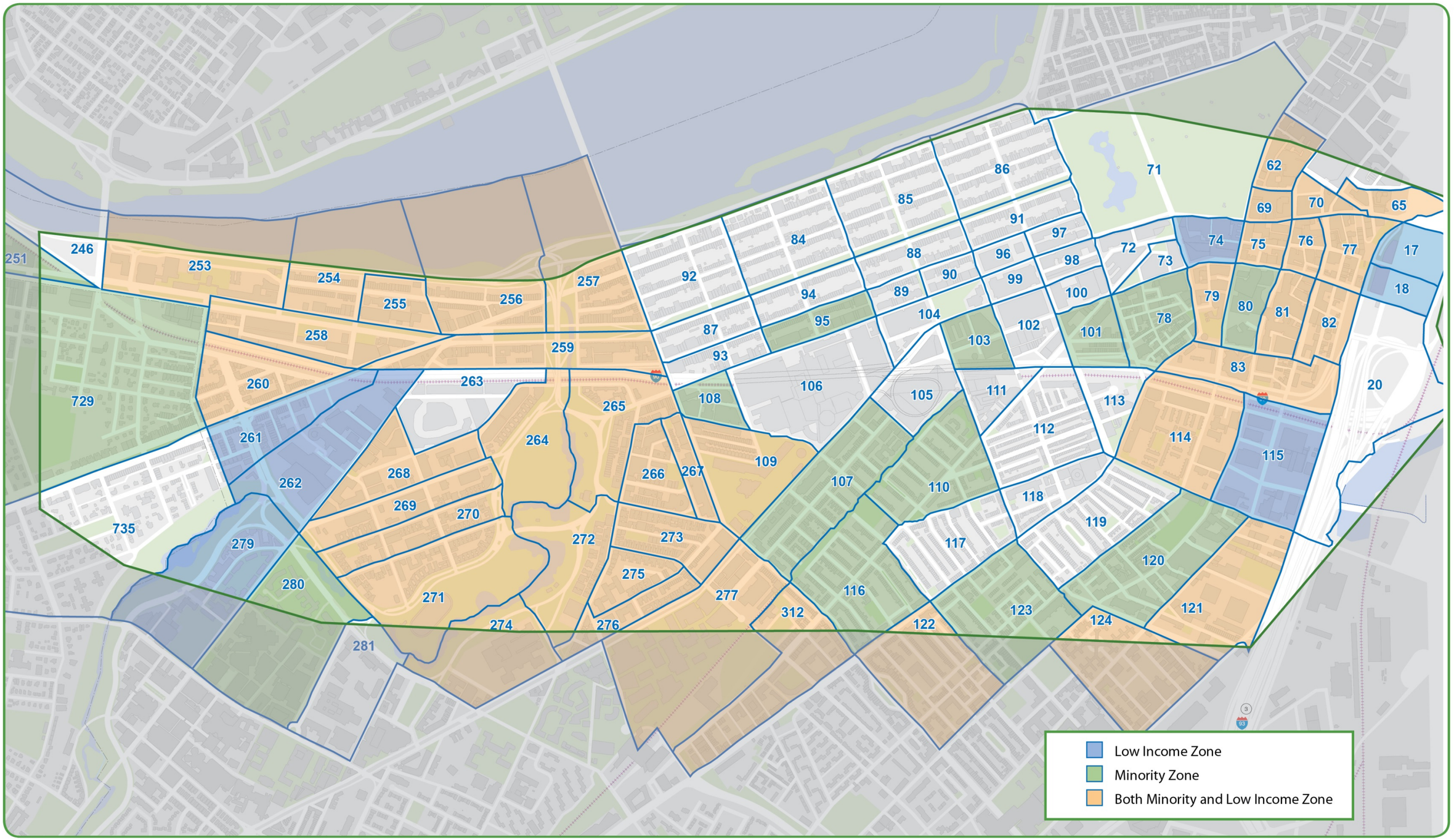

FIGURE 8-1
Massachusetts Turnpike Boston Ramps and Bowker Overpass
Environmental Justice Study Area

massDOT
Massachusetts Department of Transportation

low-income nor minority; five are low-income; 14 are minority; and 38 are both low-income and minority.

Note that all build alternatives were modeled using 2035 demographic projections. These assumed that the characteristics of the residential populations in the project area would remain the same as those observed in the 2010 US Census, and that the EJ population's growth rate would be the same as that forecasted by the Metropolitan Area Planning Council for the overall population of the region.

8.2.2 Performance Measures

Three categories of performance measures were used in the EJ analysis as indicators of benefits and burdens for EJ and non-EJ TAZs. One of the three performance measures was transit populations. However, this study's proposed changes apply to the roadway network, with no changes to the transit network. Therefore, the EJ analysis for the Massachusetts Turnpike Boston Ramps and Bowker Overpass study focuses on auto trips travelling to and from the study area TAZs. The three categories of performance measures for this study are:

- Accessibility to jobs and needed services
- Mobility and congestion
- Environmental impacts

Accessibility is determined both by the ability to reach desired destinations and the ease of doing so. An accessibility analysis for an EJ study looks at the number of basic, retail, and service employment opportunities, health-care facilities, and colleges that can be reached within 20 minutes by car; and examines the average travel time from EJ TAZs to these establishments.

The mobility and congestion analysis focuses on the average door-to-door travel time under congested conditions for auto trips travelling from and to EJ TAZs. The types of door-to-door travel times examined are:

- Highway production time—The average travel time of all auto trips departing from a TAZ
- Highway attraction time—The average travel time of all auto trips arriving at a TAZ

The environmental impact analysis focuses on the effect of roadway or transit projects on the regional and local air quality. The air-quality analysis for EJ studies examines the volume of carbon monoxide (CO) and fine particulate matter (PM2.5) emitted per square mile, and average vehicle-miles traveled under congested traffic conditions.

In order to evaluate the degree of benefits and burdens brought by roadway projects to the accessibility, mobility, and air quality for EJ and non-EJ neighborhoods, CTPS conducted t-test analyses to determine whether the differences were statistically significant. Two sample t-tests of each performance measure were conducted between a sample of EJ and non-EJ TAZs in the study area. In statistical-significance testing, the p-value is the probability of obtaining a test statistic at least as extreme as the one that was actually observed, assuming that the null hypothesis is true. If the null hypothesis is rejected, the result is considered statistically significant. In this study, the base hypothesis is that there is no significant difference in the benefits and burdens between EJ and non-EJ TAZs. The significance level is 0.05. If the p-value is greater than or equal to 0.05, the difference of benefits or burdens brought by a roadway alternative between EJ and non-EJ neighborhoods is statistically insignificant. If the p-value were less than 0.05, the benefits or burdens would be considered statistically significant.

EJ assessments were done for minority TAZs and low-income TAZs separately to satisfy both the FTA's Title VI and EJ circulars. FTA circulars were chosen—despite that the primary mode of the project related to vehicular travel—because of their more robust analytic techniques, in CTPS's opinion. Using FTA circulars also allows for consistency across all such analyses performed by the agency.

Build alternatives are listed in Table 8-1 below.

TABLE 8-1
Build Alternatives

Bowker Overpass Alternatives
1. Bowker overpass removed
2. Bowker overpass at grade
3. New regional access
4. New regional and local access
Back Bay Alternatives
1. New westbound off-ramp to Berkeley Street
2. New westbound off-ramp to Trinity Place/Stuart Street
3. New westbound off-ramp to Brookline Avenue
4. New eastbound on-ramp from the Bowker Overpass

8.3 SUMMARY OF RESULTS

The study area, defined to include TAZs within one-half mile of the Massachusetts Turnpike, encompasses 94 TAZs. Of the total number of TAZs, 37 are neither low-income nor minority; 5 are low-income; 14 are minority; and 38 are both low-income and minority.

The differences were calculated between the eight build- and no-build alternatives for each TAZ. In the accessibility and mobility analyses, the benefits and burdens were averaged by the number of residents in each zone. In the air-quality analysis, they were weighted by the size of the zone. All results were aggregated to the study area for EJ and non-EJ TAZs, respectively. Results focus on six-hour peak periods only. Minority and low-income TAZs were analyzed separately to comply with both Title VI and EJ requirements.

8.3.1 Accessibility Analysis

Results from the accessibility analysis are summarized in Tables 8-2 through 8-5. Table 8-2 compares the number of jobs and services available within 20 minutes by car for minority and non-minority TAZs in the no-build alternative with those in each build alternative. It also summarizes the average travel time from minority and non-minority TAZs to reach these jobs and services. Table 8-3 compares access to medical facilities and higher education institutions. Tables 8-4 and 8-5 provide the same type of information for low-income and non-low-income TAZs.

In general, access to employment decreases slightly for minority TAZs and increases slightly for non-minority TAZs. Average roadway times remain essentially unchanged between no-build and build alternatives. Of note is access to employment under Bowker Alternative 4: New Regional and Local Access, where the number of jobs within a 20-minute drive of minority TAZs decreases more than under any other build alternative. Access to service jobs also decreases for non-minority TAZs under this alternative. While there are statistically significant differences in several build alternatives, they likely would fall within the model's margin of error, as the changes from the no-build alternative are less than 2.5% for both minority and non-minority TAZs. The differences in access to medical facilities and colleges and the average amount of time it takes to access these facilities from minority TAZs are negligible.

Access to employment for low-income TAZs remains relatively unchanged in the build alternatives. Of note is Bowker Alternative 4: New Regional and Local Access, where access to basic employment increases by 6% and access to retail and service employment decreases slightly. While there are statistically significant differences in several alternatives, there likely would not be disproportionate differences.

Average travel times to employment for low-income TAZs remain basically the same. Of note is Bowker Alternative 4: New Regional and Local Access, where average travel times decrease by 5%.

Access to medical facilities and higher education remains relatively the same for low-income TAZs. Of note is Bowker Alternative 4: New Regional and Local Access, where access to available hospital beds decreases by 5%. Again, while there are

TABLE 8-2
Employment Accessibility Summary, Minority and Non-Minority TAZs: No-build and Build Alternatives

Location	Basic Employment				Retail Employment				Service Employment			
	Number of Available Basic Jobs/Service by Auto		Average Roadway Time (Minutes)		Number of Available Retail Jobs/Service by Auto		Average Roadway Time (Minutes)		Number of Available Service Jobs/Service by Auto		Average Roadway Time (Minutes)	
	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority
No-build	97,097	102,695	12.7	12.5	96,037	98,024	11.5	11.2	639,423	648,789	10.9	10.4
Bowker Overpass Alternatives												
Alternative 1: Bowker overpass removed	96,809	102,786	12.8	12.5	95,812	98,020	11.6	11.2	637,844	649,838	10.9	10.4
Alternative 2: Bowker overpass at-grade	96,780	102,681	12.8	12.5	95,831	97,928	11.6	11.2	637,635	648,481	10.9	10.4
Alternative 3: New regional access	96,242	103,050	12.7	12.5	95,412	98,029	11.6	11.2	636,070	649,406	11.0	10.4
Alternative 4: New regional and local access	94,787	102,372	12.8	12.6	94,529	97,541	11.7	11.3	631,284	645,152	11.0	10.5
Back Bay Alternatives												
Alternative 1: New westbound off-ramp to Berkley	96,977	104,003	12.8	12.6	95,995	98,261	11.6	11.2	638,716	650,721	11.0	10.5
Alternative 2: New westbound off-ramp to Trinity Place/Berkley St.	97,037	103,995	12.8	12.6	95,974	98,274	11.6	11.2	638,948	650,750	10.9	10.5
Alternative 3: New westbound off-ramp to Brookline Avenue	97,166	102,971	12.7	12.5	96,073	98,104	11.5	11.2	639,382	649,987	10.9	10.4
Alternative 4: New eastbound on-ramp from the Bowker Overpass	97,350	103,105	12.7	12.5	96,172	98,163	11.5	11.2	639,985	649,261	10.9	10.4
Changes Between No-build and Build Alternatives												
Bowker Overpass Alternatives												
Alternative 1: Bowker overpass removed	-0.3%	0.1%	0.8%	0.0%	-0.2%	0.0%	0.9%	0.0%	-0.2%	0.2%	0.0%	0.0%
Alternative 2: Bowker overpass at-grade	-0.3%	0.0%	0.8%	0.0%	-0.2%	-0.1%	0.9%	0.0%	-0.3%	0.0%	0.0%	0.0%
Alternative 3: New regional access	-0.9%	0.3%	0.0%	0.0%	-0.7%	0.0%	0.9%	0.0%	-0.5%	0.1%	0.9%	0.0%
Alternative 4: New regional and local access	-2.4%	-0.3%	0.8%	0.8%	-1.6%	-0.5%	1.7%	0.9%	-1.3%	-0.6%	0.9%	1.0%
Back Bay Alternatives												
Alternative 1: New westbound off-ramp to Berkley	-0.1%	1.3%	0.8%	0.8%	0.0%	0.2%	0.9%	0.0%	-0.1%	0.3%	0.9%	1.0%
Alternative 2: New westbound off-ramp to Trinity Place/Berkley St.	-0.1%	1.3%	0.8%	0.8%	-0.1%	0.3%	0.9%	0.0%	-0.1%	0.3%	0.0%	1.0%
Alternative 3: New westbound off-ramp to Brookline Avenue	0.1%	0.3%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%
Alternative 4: New eastbound on-ramp from the Bowker Overpass	0.3%	0.4%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%

TABLE 8-3
Colleges and Hospital Bed Accessibility Summary, Minority and Non-Minority TAZs: No-build and Build Alternatives

Location	Access to Medical Facilities				Access to High Education			
	Number of Available Hospital Beds by Auto		Average Roadway Time (Minutes)		Number of Available College Enrollment by Auto		Average Roadway Time (Minutes)	
	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority
No-build	8,498	9,022	11.3	11.5	102,250	103,952	9.5	9.3
Bowker Overpass Alternatives								
Alternative 1: Bowker overpass removed	8,489	9,020	11.3	11.6	101,931	103,952	9.5	9.4
Alternative 2: Bowker overpass at-grade	8,486	9,010	11.3	11.6	101,990	103,952	9.5	9.4
Alternative 3: New regional access	8,404	8,994	11.3	11.6	102,261	104,006	9.7	9.4
Alternative 4: New regional and local access	8,176	8,886	11.2	11.5	101,299	103,379	9.6	9.4
Back Bay Alternatives								
Alternative 1: New westbound off-ramp to Berkley	8,501	9,019	11.3	11.6	101,691	103,952	9.4	9.4
Alternative 2: New westbound off-ramp to Trinity Place/Berkley St.	8,497	9,045	11.3	11.6	101,728	103,950	9.4	9.4
Alternative 3: New westbound off-ramp to Brookline Avenue	8,504	9,032	11.3	11.6	102,524	103,948	9.5	9.4
Alternative 4: New eastbound on-ramp from the Bowker Overpass	8,514	9,033	11.3	11.5	102,279	103,987	9.5	9.4
Changes Between No-build and Build Alternatives								
Bowker Overpass Alternatives								
Alternative 1: Bowker overpass removed	-0.1%	0.0%	0.0%	0.9%	-0.3%	0.0%	0.0%	1.1%
Alternative 2: Bowker overpass at-grade	-0.1%	-0.1%	0.0%	0.9%	-0.3%	0.0%	0.0%	1.1%
Alternative 3: New regional access	-1.1%	-0.3%	0.0%	0.9%	0.0%	0.1%	2.1%	1.1%
Alternative 4: New regional and local access	-3.8%	-1.5%	-0.9%	0.0%	-0.9%	-0.6%	1.1%	1.1%
Back Bay Alternatives								
Alternative 1: New westbound off-ramp to Berkley	0.0%	0.0%	0.0%	0.9%	-0.5%	0.0%	-1.1%	1.1%
Alternative 2: New westbound off-ramp to Trinity Place/Berkley St.	0.0%	0.3%	0.0%	0.9%	-0.5%	0.0%	-1.1%	1.1%
Alternative 3: New westbound off-ramp to Brookline Avenue	0.1%	0.1%	0.0%	0.9%	0.3%	0.0%	0.0%	1.1%
Alternative 4: New eastbound on-ramp from the Bowker Overpass	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%

TABLE 8-4
Employment Accessibility Summary, Low-Income and Non-Low-Income TAZs: No-build and Build Alternatives

Location	Basic Employment				Retail Employment				Service Employment			
	Number of Available Basic Jobs/Service by Auto		Average Roadway Time (Minutes)		Number of Available Retail Jobs/Service by Auto		Average Roadway Time (Minutes)		Number of Available Service Jobs/Service by Auto		Average Roadway Time (Minutes)	
	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority
No-build	97,456	100,242	12.76	12.58	96,147	97,178	11.50	11.36	639,515	645,379	10.87	10.68
Bowker Overpass Alternatives												
Alternative 1: Bowker overpass removed	97,222	100,127	12.78	12.58	95,948	97,060	11.52	11.37	637,998	645,424	10.87	10.69
Alternative 2: Bowker overpass at-grade	97,187	100,056	12.79	12.58	95,945	97,037	11.54	11.37	637,647	644,663	10.88	10.68
Alternative 3: New regional access	96,624	100,141	12.73	12.58	95,439	97,076	11.55	11.39	635,810	645,087	10.89	10.70
Alternative 4: New regional and local access	103,541	101,778	12.07	12.18	94,550	96,960	11.40	11.15	640,506	642,849	10.29	10.20
Back Bay Alternatives												
Alternative 1: New westbound off-ramp to Berkley	97,433	100,917	12.79	12.65	96,139	97,270	11.53	11.40	639,072	646,026	10.90	10.73
Alternative 2: New westbound off-ramp to Trinity Place/Berkley St.	97,519	100,898	12.79	12.64	96,084	97,316	11.52	11.39	639,345	646,070	10.89	10.72
Alternative 3: New westbound off-ramp to Brookline Avenue	97,592	100,355	12.72	12.59	96,192	97,228	11.49	11.38	639,636	645,924	10.84	10.70
Alternative 4: New eastbound on-ramp from the Bowker Overpass	97,810	100,460	12.74	12.58	96,312	97,272	11.49	11.37	640,257	645,638	10.84	10.68
Changes Between No-build and Build Alternatives												
Bowker Overpass Alternatives												
Alternative 1: Bowker overpass removed	-0.2%	-0.1%	0.2%	0.0%	-0.2%	-0.1%	0.2%	0.1%	-0.2%	0.0%	0.0%	0.1%
Alternative 2: Bowker overpass at-grade	-0.3%	-0.2%	0.2%	0.0%	-0.2%	-0.1%	0.3%	0.1%	-0.3%	-0.1%	0.1%	0.0%
Alternative 3: New regional access	-0.9%	-0.1%	-0.2%	0.0%	-0.7%	-0.1%	0.4%	0.3%	-0.6%	0.0%	0.2%	0.2%
Alternative 4: New regional and local access	6.2%	1.5%	-5.4%	-3.2%	-1.7%	-0.2%	-0.9%	-1.9%	0.2%	-0.4%	-5.3%	-4.5%
Back Bay Alternatives												
Alternative 1: New westbound off-ramp to Berkley	0.0%	0.7%	0.2%	0.6%	0.0%	0.1%	0.3%	0.4%	-0.1%	0.1%	0.3%	0.5%
Alternative 2: New westbound off-ramp to Trinity Place/Berkley St.	0.1%	0.7%	0.2%	0.5%	-0.1%	0.1%	0.2%	0.3%	0.0%	0.1%	0.2%	0.4%
Alternative 3: New westbound off-ramp to Brookline Avenue	0.1%	0.1%	-0.3%	0.1%	0.0%	0.1%	-0.1%	0.2%	0.0%	0.1%	-0.3%	0.2%
Alternative 4: New eastbound on-ramp from the Bowker Overpass	0.4%	0.2%	-0.2%	0.0%	0.2%	0.1%	-0.1%	0.1%	0.1%	0.0%	-0.3%	0.0%

TABLE 8-5
Colleges and Hospital Bed Accessibility Summary, Low-Income and Non-Low-Income TAZs: No-build and Build Alternatives

Location	Access to Medical Facilities				Access to High Education			
	Number of Available Hospital Beds by Auto		Average Roadway Time (Minutes)		Number of Available College Enrollment by Auto		Average Roadway Time (Minutes)	
	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority
No-build	8,513	8,818	11.28	11.55	101,682	104,132	9.38	9.53
Bowker Overpass Alternatives								
Alternative 1: Bowker overpass removed	8,503	8,815	11.28	11.56	101,281	104,132	9.37	9.56
Alternative 2: Bowker overpass at-grade	8,495	8,816	11.28	11.57	101,355	104,132	9.41	9.57
Alternative 3: New regional access	8,391	8,805	11.24	11.57	101,693	104,170	9.60	9.61
Alternative 4: New regional and local access	8,071	8,781	11.01	11.64	100,648	103,539	9.57	9.60
Back Bay Alternatives								
Alternative 1: New westbound off-ramp to Berkley	8,521	8,811	11.29	11.55	101,318	103,669	9.36	9.52
Alternative 2: New westbound off-ramp to Trinity Place/Berkley St.	8,514	8,829	11.27	11.56	101,364	103,669	9.36	9.51
Alternative 3: New westbound off-ramp to Brookline Avenue	8,521	8,823	11.27	11.56	102,027	104,129	9.41	9.55
Alternative 4: New eastbound on-ramp from the Bowker Overpass	8,535	8,823	11.27	11.54	101,718	104,154	9.35	9.53
Changes Between No-build and Build Alternatives								
Bowker Overpass Alternatives								
Alternative 1: Bowker overpass removed	-0.1%	0.0%	0.0%	0.1%	-0.4%	0.0%	-0.1%	0.3%
Alternative 2: Bowker overpass at-grade	-0.2%	0.0%	0.0%	0.2%	-0.3%	0.0%	0.3%	0.4%
Alternative 3: New regional access	-1.4%	-0.1%	-0.4%	0.2%	0.0%	0.0%	2.3%	0.8%
Alternative 4: New regional and local access	-5.2%	-0.4%	-2.4%	0.8%	-1.0%	-0.6%	2.0%	0.7%
Back Bay Alternatives								
Alternative 1: New westbound off-ramp to Berkley	0.1%	-0.1%	0.1%	0.0%	-0.4%	-0.4%	-0.2%	-0.1%
Alternative 2: New westbound off-ramp to Trinity Place/Berkley St.	0.0%	0.1%	-0.1%	0.1%	-0.3%	-0.4%	-0.2%	-0.2%
Alternative 3: New westbound off-ramp to Brookline Avenue	0.1%	0.1%	-0.1%	0.1%	0.3%	0.0%	0.3%	0.2%
Alternative 4: New eastbound on-ramp from the Bowker Overpass	0.3%	0.1%	-0.1%	-0.1%	0.0%	0.0%	-0.3%	0.0%

statistically significant differences in several alternatives, they likely would not be disproportionate differences. Average travel times remain relatively the same, with differences likely within the model's margin of error.

8.3.2 Mobility Analysis

Results from the mobility analysis are summarized in Table 8-6. In both the no-build and build alternatives travel times from minority TAZs are three minutes less than those from non-minority TAZs and remain essentially unchanged under all build alternatives. The average travel time to minority TAZs is two minutes shorter than it is to non-minority TAZs in the no-build alternative. The travel times remain essentially unchanged under the build alternatives.

The average travel time from low-income TAZs is approximately two- and one-half minutes shorter than it is from non-low-income TAZs in the no-build alternative. This proportion is not appreciably different from most build alternatives. Bowker Alternative 4: New Regional and Local Access, has the highest average travel times for both low-income and non-low-income TAZs. While there are some statistically significant differences, they do not represent practical differences, as the changes are less than 1.5%.

The average travel time to low-income TAZs is also consistently lower (almost two minutes) than it is for non-low-income TAZs under the no-build alternative and all build alternatives. While the increases are small, Bowker Alternative 4: New Regional and Local Access, has the highest average travel times for both low-income and non-low-income TAZs.

8.3.3 Environmental Impact Analysis

Results of environmental impact analyses are shown in Tables 8-7 and 8-8. These analyses focused on the impact to air quality with respect to congested roadway conditions. Overall, minority TAZs have more vehicle-miles traveled and CO emissions than non-minority TAZs under the no-build and build alternatives. Fine particulate matter pollution is the same for minority and non-minority TAZs under the no-build alternative. There are no statistically significant differences for minority TAZs among the build alternatives.

Low-income TAZs generally have more vehicle-miles traveled and CO emissions, and fine particulate matter pollution than non-low-income TAZs under the no-build and build alternatives. This is because low-income TAZs usually are located within highly traveled areas with dense stop-and-go traffic. There are no statistically significant differences for low-income TAZs among the build alternatives.

8.3.4 Bicycle and Pedestrian Impacts

Proposed pedestrian and bicycle regional connectivity improvements in the Bowker Overpass area and the Charles River Basin were qualitatively assessed for impacts on minority and low-income TAZs. The Overpass is located in TAZs that are both low-income and minority. Proposed sidewalk and crosswalk improvements and path connections will directly benefit these populations. Enhanced street connections and proposed paths in the Charles River Basin should benefit all populations.

8.4 CONCLUSION

The environmental-justice analysis indicates that the proposed alternatives would have minimal differences in accessibility, mobility, and environmental impacts when no-build and build alternatives are compared for both EJ-population TAZs and non–EJ TAZs. None of the proposed alternatives likely would place a disproportionate burden on the EJ-population TAZs.

TABLE 8-6
Mobility Summary:
No-build and Build Alternatives

Location	Minority and Non-Minority TAZs				Low-Income and Non Low-Income TAZs			
	Average Auto Production Time (Minutes)		Average Auto Attraction Time (Minutes)		Average Auto Production Time (Minutes)		Average Auto Attraction Time (Minutes)	
	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority
No-build	13.0	16.2	21.7	24.1	12.80	15.29	21.71	23.26
Bowker Overpass Alternatives								
Alternative 1: Bowker overpass removed	13.0	16.2	21.7	24.1	12.83	15.30	21.71	23.26
Alternative 2: Bowker overpass at-grade	13.0	16.2	21.7	24.2	12.84	15.30	21.72	23.27
Alternative 3: New regional access	13.1	16.2	21.7	24.2	12.90	15.32	21.76	23.27
Alternative 4: New regional and local access	13.1	16.3	21.8	24.2	12.98	15.40	21.88	23.35
Back Bay Alternatives								
Alternative 1: New westbound off-ramp to Berkley	13.0	16.2	21.7	24.1	12.80	15.30	21.68	23.24
Alternative 2: New westbound off-ramp to Trinity Place/Berkley St.	13.0	16.2	21.7	24.1	12.80	15.29	21.69	23.24
Alternative 3: New westbound off-ramp to Brookline Avenue	13.0	16.2	21.7	24.1	12.78	15.29	21.68	23.25
Alternative 4: New eastbound on-ramp from the Bowker Overpass	12.9	16.2	21.6	24.1	12.78	15.28	21.65	23.24
Changes Between No-build and Build Alternatives								
Bowker Overpass Alternatives								
Alternative 1: Bowker overpass removed	0.0%	0.0%	0.0%	0.0%	0.2%	0.1%	0.0%	0.0%
Alternative 2: Bowker overpass at-grade	0.0%	0.0%	0.0%	0.4%	0.3%	0.1%	0.0%	0.0%
Alternative 3: New regional access	0.8%	0.0%	0.0%	0.4%	0.8%	0.2%	0.2%	0.0%
Alternative 4: New regional and local access	0.8%	0.6%	0.5%	0.4%	1.4%	0.7%	0.8%	0.4%
Back Bay Alternatives								
Alternative 1: New westbound off-ramp to Berkley	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	-0.1%	-0.1%
Alternative 2: New westbound off-ramp to Trinity Place/Berkley St.	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.1%
Alternative 3: New westbound off-ramp to Brookline Avenue	0.0%	0.0%	0.0%	0.0%	-0.2%	0.0%	-0.1%	0.0%
Alternative 4: New eastbound on-ramp from the Bowker Overpass	-0.8%	0.0%	-0.5%	0.0%	-0.2%	-0.1%	-0.3%	-0.1%

TABLE 8-7
Air-Quality Summary, Minority and Non-Minority TAZs: No-build and Build Alternatives

Location	CO per Square Mile ($kg/mile^2$)		PM2.5 per Square Mile ($kg/mile^2$)		VMT per Square Mile		Congested VMT Per Square Mile	
	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority
No-build	471	435	37	37	138,400	126,740	2,158	1,860
Bowker Overpass Alternatives								
Alternative 1: Bowker overpass removed	466	435	37	37	136,517	126,913	2,135	1,858
Alternative 2: Bowker overpass at-grade	467	435	37	37	137,195	126,598	2,142	1,852
Alternative 3: New regional access	458	440	37	38	134,317	128,349	2,121	1,632
Alternative 4: New regional and local access	452	452	37	38	133,420	131,345	2,105	1,803
Back Bay Alternatives								
Alternative 1: New westbound off-ramp to Berkley	453	431	37	37	133,388	125,457	2,103	1,872
Alternative 2: New westbound off-ramp to Trinity Place/Berkley St.	451	431	37	37	133,234	125,072	2,077	1,914
Alternative 3: New westbound off-ramp to Brookline Avenue	451	430	37	37	132,680	125,884	2,031	1,929
Alternative 4: New eastbound on-ramp from the Bowker Overpass	451	430	37	37	132,980	125,862	2,022	1,925
Changes Between No-build and Build Alternatives								
Bowker Overpass Alternatives								
Alternative 1: Bowker overpass removed	-1.1%	0.0%	0.0%	0.0%	-1.4%	0.1%	-1.1%	-0.1%
Alternative 2: Bowker overpass at-grade	-0.8%	0.0%	0.0%	0.0%	-0.9%	-0.1%	-0.7%	-0.4%
Alternative 3: New regional access	-2.8%	1.1%	0.0%	2.7%	-3.0%	1.3%	-1.7%	-12.3%
Alternative 4: New regional and local access	-4.0%	3.9%	0.0%	2.7%	-3.6%	3.6%	-2.5%	-3.1%
Back Bay Alternatives								
Alternative 1: New westbound off-ramp to Berkley	-3.8%	-0.9%	0.0%	0.0%	-3.6%	-1.0%	-2.5%	0.6%
Alternative 2: New westbound off-ramp to Trinity Place/Berkley St.	-4.2%	-0.9%	0.0%	0.0%	-3.7%	-1.3%	-3.8%	2.9%
Alternative 3: New westbound off-ramp to Brookline Avenue	-4.2%	-1.1%	0.0%	0.0%	-4.1%	-0.7%	-5.9%	3.7%
Alternative 4: New eastbound on-ramp from the Bowker Overpass	-4.2%	-1.1%	0.0%	0.0%	-3.9%	-0.7%	-6.3%	3.5%

TABLE 8-8
Air-Quality Summary, Low-Income and Non-Low-Income TAZs:
No-build and Build Alternatives

Location	CO per Square Mile (kg/mile^2)		PM2.5 per Square Mile (kg/mile^2)		VMT per Square Mile		Congested VMT Per Square Mile	
	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority	Minority	Non-Minority
No-build	577	302	45	27	170,147	87,439	2,585	1,382
Bowker Overpass Alternatives								
Alternative 1: Bowker overpass removed	571	303	45	27	167,655	87,723	2,555	1,381
Alternative 2: Bowker overpass at-grade	572	303	45	27	168,506	87,520	2,582	1,352
Alternative 3: New regional access	561	307	44	27	164,362	89,379	2,533	1,241
Alternative 4: New regional and local access	550	318	44	28	162,633	92,148	2,491	1,382
Back Bay Alternatives								
Alternative 1: New westbound off-ramp to Berkley	553	302	44	27	163,568	86,991	2,494	1,419
Alternative 2: New westbound off-ramp to Trinity Place/Berkley St.	553	299	44	27	163,542	86,511	2,491	1,405
Alternative 3: New westbound off-ramp to Brookline Avenue	552	299	44	27	162,904	86,960	2,439	1,407
Alternative 4: New eastbound on-ramp from the Bowker Overpass	553	299	44	27	163,258	86,976	2,449	1,377
Changes Between No-build and Build Alternatives								
Bowker Overpass Alternatives								
Alternative 1: Bowker overpass removed	-1.0%	0.3%	0.0%	0.0%	-1.5%	0.3%	-1.2%	-0.1%
Alternative 2: Bowker overpass at-grade	-0.9%	0.3%	0.0%	0.0%	-1.0%	0.1%	-0.1%	-2.2%
Alternative 3: New regional access	-2.8%	1.7%	-2.2%	0.0%	-3.4%	2.2%	-2.0%	-10.2%
Alternative 4: New regional and local access	-4.7%	5.3%	-2.2%	3.7%	-4.4%	5.4%	-3.6%	0.0%
Back Bay Alternatives								
Alternative 1: New westbound off-ramp to Berkley	-4.2%	0.0%	-2.2%	0.0%	-3.9%	-0.5%	-3.5%	2.7%
Alternative 2: New westbound off-ramp to Trinity Place/Berkley St.	-4.2%	-1.0%	-2.2%	0.0%	-3.9%	-1.1%	-3.6%	1.7%
Alternative 3: New westbound off-ramp to Brookline Avenue	-4.3%	-1.0%	-2.2%	0.0%	-4.3%	-0.5%	-5.6%	1.8%
Alternative 4: New eastbound on-ramp from the Bowker Overpass	-4.2%	-1.0%	-2.2%	0.0%	-4.0%	-0.5%	-5.3%	-0.4%