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Environmental Justice Analysis

TECHNICAL MEMORANDUM

DATE: December 31, 2019
TO: Rail Vision Project Team
FROM: Betsy Harvey, Central Transportation Planning Staff
RE: Rail Vision Environmental Justice Analysis

The purpose of this environmental justice (EJ) analysis is to assess six Rail Vision build alternatives to determine whether they may cause disproportionate burdens for minority or low-income populations (collectively referred to as EJ populations) in the study area. Disproportionate burdens and disproportionate benefits refer to potential future adverse effects that would disproportionately affect minority or low-income populations compared to nonminority or non-low-income populations, respectively. Adverse effects may be either a delay or denial of benefits (disproportionate benefits) or an imposition of burdens (disproportionate burdens). This EJ analysis assessed a suite of nine metrics to identify any likely disproportionate benefits or burdens that are projected to occur by 2040.

This EJ analysis is in response to requirements set forth by the National Environmental Policy Act and the Massachusetts Environmental Policy Act. In addition, the EJ Executive Order, *Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations*, directs recipients of federal funding to identify and address any potential disproportionately high and adverse environmental and human health effects resulting from their investments.

1 METHODOLOGY

1.1 Study Area

The study area encompasses most of eastern Massachusetts. It includes the 175 towns in Bristol, Essex, Middlesex, Suffolk, and Worcester counties. Figures 1 and 2 show the municipalities within the study area. The systemwide analysis assesses impacts to the entire minority or low-income population within the study area; it does not assess impacts to minority or low-income populations in individual municipalities. Additionally, the analysis examines each alternative, not individual commuter rail lines.

1.2 Minority and Low-Income Populations Defined

A minority person is defined as someone who identifies as American Indian or Alaska Native; Asian; Native Hawaiian or other Pacific Islander; Black or African American; some other race other than White; and/or Hispanic or Latino/a/x in the 2010 US Census. Within the study area, 26.2 percent of the population identifies as minority. The low-income population includes people in households for which the annual household income is less than or equal to 60 percent of the study area median, as reported in the 2010–14 American Community Survey (ACS).¹ This threshold equals \$44,152. Within the study area, 31.9 percent of households are considered low-income.

For the purposes of the analysis, it was assumed that the distribution of the minority population would remain unchanged in 2040 and that the growth rate would be the same as that forecast for the overall population in the region. For the low-income population, the analysis used a forecast of the distribution of various income categories in 2040.²

Transportation analysis zones (TAZs) are the geographic basis for this EJ analysis; there are 3,604 TAZs in the study area.³ Figures 1 and 2 show the TAZs in the study area where the minority population is 26.2 percent or greater and/or where the median household income is equal to or less than \$44,152 overlaid on urban rail stations and key stations.⁴ The difference in how the minority and low-income populations are geographically distributed throughout the region helps explain some of the differences between the EJ analysis results for the two populations.

¹ Data from the 2010–14 ACS were used because ACS data must be adjusted to the 2010 population and household totals in order to assign census populations and households to transportation analysis zones (TAZs).

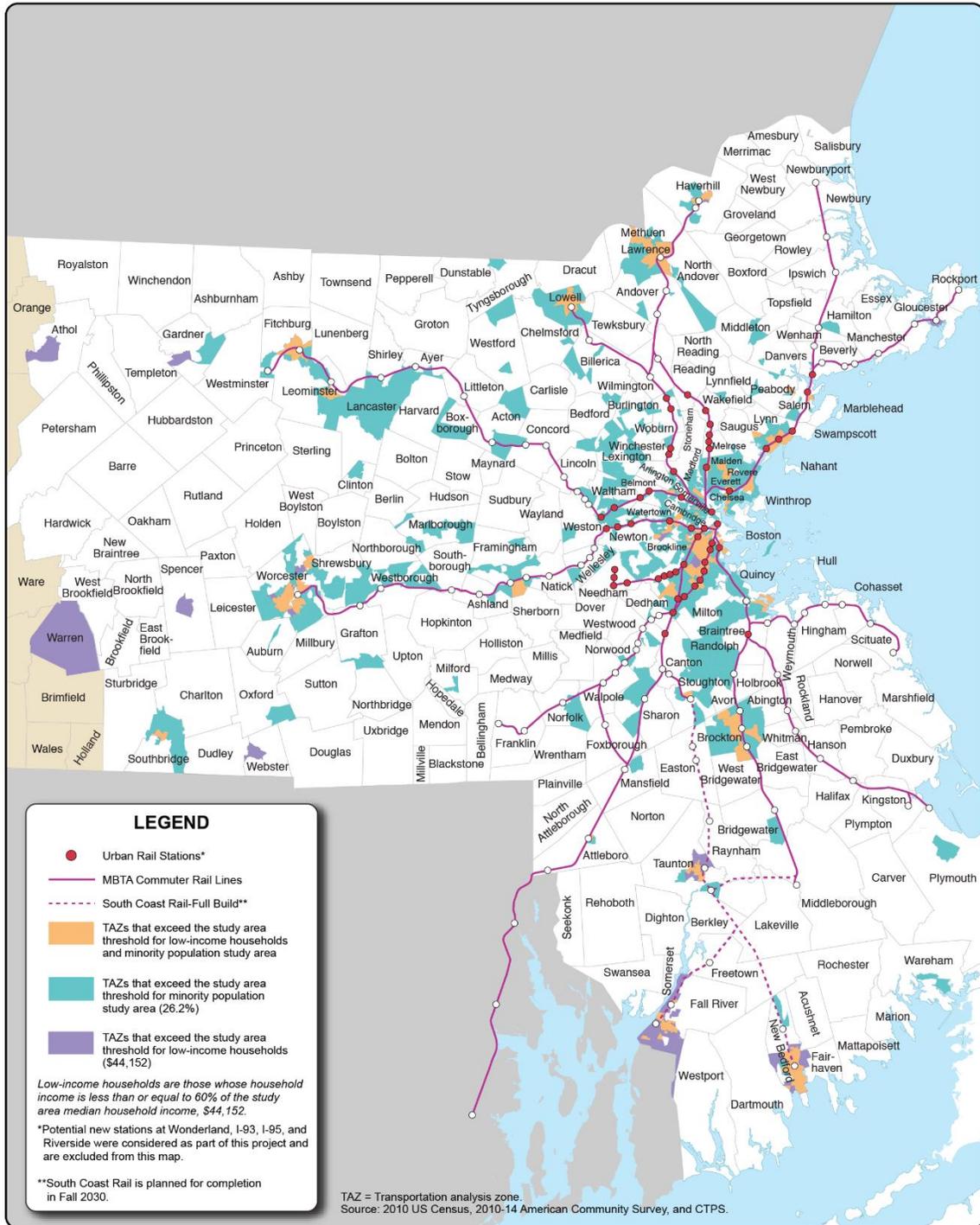
² The household income categories are as follows:

- Low: \$35,000 or less
- Medium-low: \$35,001 to \$75,000
- Medium-high: \$75,001 to \$125,000
- High: \$125,001 or more

³ The TAZ is the unit of geography most commonly used in regional travel demand models.

The spatial extent of TAZs typically ranges from very large (less densely developed) areas in suburban communities to areas as small as city blocks or buildings in more densely developed central business districts.

⁴ Key stations are stations that are located in dense areas outside of central Boston and/or locations that provide regional access and transit connectivity. Urban rail stations are stations located in dense areas directly surrounding Boston, generally within Route 128.

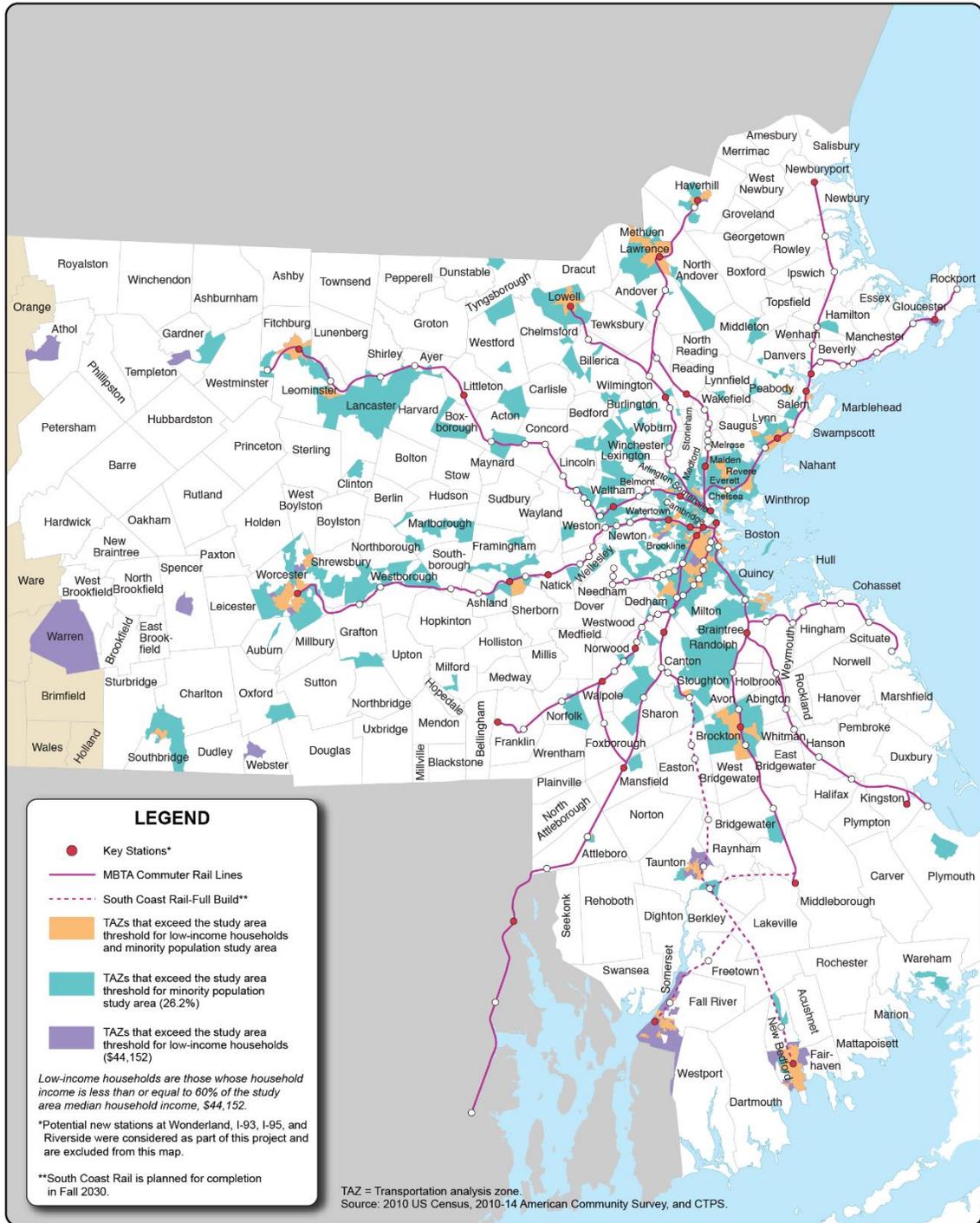


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Figure 1
Environmental Justice Transportation
Analysis Zones and Urban Rail Stations

Rail Vision
Environmental
Justice Analysis



BOSTON REGION MPO

Figure 2
Environmental Justice Transportation Analysis Zones and Key Stations

Rail Vision Environmental Justice Analysis

1.3 Conducting the Environmental Justice Analysis

As part of the Boston Region MPO's 2019 Long-Range Transportation Plan (LRTP), *Destination 2040*, CTPS revised its approach to conducting EJ analyses to better reflect the likelihood and magnitude of potential impacts to minority populations and low-income populations that may occur as a result of transportation investments. This approach was used for this EJ analysis. It relies on using a forecasting error to determine when impacts would likely be outside of the bounds of the uncertainty inherent to travel demand modeling.⁵

As in any attempt to forecast the future, travel demand modeling is subject to uncertainty. The regional travel demand model used to conduct the EJ analysis is a complex assembly of data inputs, assumed travel behaviors, statistical relationships, and algorithms. A forecasting error is a statistical measure of the difference between a forecasted value for a metric and its "true" value. It is unknown for the unobserved future; however, an interval of values can be estimated (upper and lower bounds), with a high degree of confidence, within which the true value of the metric should lie.

Values indicating impacts to the EJ or non-EJ population—whether benefits or burdens—that fall outside of the upper and lower bounds identified with the forecasting error are considered likely to occur; those that do not are considered unlikely to occur. Therefore, when the results of the analysis show that there will be no benefit or burden for the EJ population, the value is less than the forecasting error. In such a case, we cannot say with a high degree of confidence that the impact will actually occur. Conversely, when the results show there will be a benefit or a burden, the value is greater than the forecasting error and there is a high degree of confidence that the projected impact will occur.

Accounting for uncertainty in the EJ analysis is important because of the need to address disproportionate benefits or burdens if the analysis finds that impacts are likely to occur. If the model predicts such an impact, it is important to be confident that the forecasted impact is due to real and likely project impacts and not just an artifact of the modeling process. Knowing the uncertainty concerning a forecasted metric is particularly important when forecasting to distant future years, say 20 years or more, as is the case with Rail Vision. By using this approach, this methodology will help decision-makers understand the model's limitations—as no travel demand model can predict future impacts with certainty—and ensure Rail Vision's decision-making process reflects these limitations as well as the model's strengths. If the EJ analysis predicts that an impact exceeds the forecasting error, the MBTA can be confident that it will likely

⁵ The forecasting error for each metric can be found in Exhibit A.

occur. Resources can then be allocated to address these impacts rather than impacts that are unlikely to occur. This new approach will also give the public more confidence in the results. Using forecasting error is an objective and consistent way to quantify the significance of any given impact.

Metrics

This analysis assessed nine metrics within three categories—access to opportunities metrics, mobility metrics, and environmental metrics—on the minority, nonminority, low-income, and non-low-income populations in the study area:

- Access to opportunities metrics⁶
 - Access to jobs within a 60-minute transit trip
 - Access to retail opportunities within a 60-minute transit trip
 - Access to two- and four-year institutes of higher education within a 40-minute transit trip
- Mobility metrics
 - Average travel time for transit trips produced in the study area TAZs
 - Average travel time for transit trips attracted to study area TAZs
 - Average travel time for highway trips produced in study area TAZs⁷
 - Average travel time for highway trips attracted to study area TAZs
- Environmental metrics
 - Carbon monoxide (CO) emissions per square mile
 - Congested vehicle-miles traveled (VMT) per square mile

The access to opportunities metrics measure the number of destinations (jobs, retail, and education) that are reachable within a given travel time by transit for every TAZ within the study area. The population-weighted average number of destinations was calculated for the total minority, nonminority, low-income, and non-low-income populations within the study area, based on each population's respective share within each TAZ. The access to retail opportunities metric uses retail jobs as a proxy for retail opportunities, and the access to higher education

⁶ The access to jobs and retail metrics were developed for *Destination 2040*, and reflect the unweighted average travel times to jobs reported in the ACS. Given a lack of data about average travel times to institutes of higher education, the travel time threshold of 40 minutes remained unchanged from the previous LRTP.

⁷ Highway trips consist of automobile and truck trips taken on any road in the study area. It does not include bus trips.

metric uses enrollment in two- and four-year institutes of higher education as a proxy for institutions of higher education.

The mobility metrics measure the door-to-door travel time for mode-specific trips produced in and attracted to TAZs in the study area. Population-weighted average travel times were calculated for minority, nonminority, low-income, and non-low-income populations, based on their respective shares within all TAZs in the study area. Trips attracted to TAZs are those trips attracted to destinations such as retail, employment, and education institutes within the study area. They originate from either households within the study area or from outside of the study area. Trips produced in TAZs are those trips generated by households (trip generation varies based on household income, the number of cars available to the household, and the number of people in the household, among other characteristics). The trips end either within another TAZ in the study area or outside of the study area.

The two environmental metrics assess congested VMT and CO emissions per square mile. Both are calculated based on highway trips, not transit trips. Congested VMT is defined as the VMT for links in which the volume-to-capacity ratio exceeds 0.75. To account for variations in TAZ sizes and to reflect the concentration of emissions, each of the environmental metrics was normalized by the area of the TAZ and thereby expressed as a per square mile measure.

Identifying Potential Disproportionate Benefits and Burdens

The EJ analysis methodology involved comparing the projected impacts on minority populations to those on nonminority populations and those on low-income populations to those on non-low-income populations. First, for each Rail Vision alternative two model scenarios for the year 2040 were run that analyzed each of the nine metrics. One scenario was run in which the transportation network included the alternative's improvements (build scenario), and one scenario was run where the transportation network did not include the improvements (no-build scenario). Each scenario model run produced results for each population.

Then, no-build scenario results were subtracted from the build scenario results for each population to determine projected impacts of that alternative. An impact to either an EJ or non-EJ population that was greater than the forecasting error meant that there would be an impact to that population. Then, if there was an impact, it was determined whether the impact was a benefit (such as a decrease in CO emissions) or a burden (such as an increase in CO emissions).

Finally, the benefit or burden for the EJ population was compared to that of the respective non-EJ population. If the EJ population was projected to receive a greater burden than the non-EJ population, then a disproportionate burden was indicated. If the non-EJ population was projected to receive less of a benefit than the non-EJ population, then a disproportionate benefit was indicated. (The forecasting error was applied only to the projected impact of each alternative on each of the four populations, as the purpose of the forecasting error is to distinguish between those impacts that are likely to occur and those that are not likely to occur. The determination of a benefit or burden for the EJ population is made separately, after the forecasting error is taken into consideration.)

2 ANALYSIS RESULTS

2.1 Alternatives 1, 2, and 3

Alternative 1 would optimize the current transit system by providing frequent, bi-directional service where major infrastructure investments would not be needed to do so. The Middleborough Line would also be extended to New Bedford and Fall River as a result of the South Coast Rail project. Benefits for riders would include improved reliability and improved off-peak frequency.

In Alternative 2, the Providence/Stoughton Line between Boston and Providence would be electrified. Service frequency would increase most at key stations, with typical frequencies of 15 to 30 minutes. The Middleborough Line would also be extended to New Bedford and Fall River as a result of the South Coast Rail project, and service would be added to Foxboro Station. If Alternative 2 were implemented, transit riders would likely benefit from more frequent service to key stations and drivers would likely experience shorter commute times if there is a mode shift to commuter rail.

Alternative 3 would electrify the entire commuter rail network. Service frequency would increase most at key stations, with typical frequencies of 15 minutes. New expansion projects would include South Station Expansion, South Coast Rail (Full Build), and shuttle service every 15 minutes on the Grand Junction Line. Benefits of Alternative 3 would likely include more frequent service to key stations, shorter commute times for drivers if there is a mode shift to commuter rail, and reduced emissions.

Access to Opportunities Metrics

Table 1 shows the results for the access to jobs, access to retail opportunities, and access to higher education metrics for Alternatives 1, 2, and 3. These results show that the projected impacts for all four populations are within the forecasting error. Therefore, there are no disproportionate benefits or burdens for the minority or low-income populations across any of the metrics.

**Table 1
Access to Opportunities Metric Results for Alternatives 1, 2, and 3**

	Access to Jobs by Transit		Access to Retail Opportunities by Transit		Access to Higher Education by Transit	
	Disproportionate		Disproportionate		Disproportionate	
	Impact on EJ	Benefit or	Impact on EJ	Benefit or	Impact EJ	Benefit or
Population	Population	Burden?	Population	Burden?	Population	Burden
Minority Nonminority	None	No	None	No	None	No
Low-income Non-low-income	None	No	None	No	None	No

Notes: The minority and nonminority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to jobs is calculated for those within a 60-minute transit trip and is reported in number of jobs. Access to retail opportunities is calculated for those within a 60-minute transit trip and is reported in number of retail jobs. Access to higher education is calculated for those within a 40-minute transit trip and is reported in number of students enrolled in two- and four-year institutes of higher education. EJ = environmental justice.

Source: Central Transportation Planning Staff.

Mobility Metrics

Tables 2 and 3 show the results for the transit and highway trip attraction and production metrics for Alternatives 1, 2, and 3. These results show that the projected impacts for all four populations are within the forecasting error. Therefore, there are no disproportionate benefits or burdens for the minority or low-income populations across any of the metrics.

**Table 2
Mobility Metric Results for Transit Trips for Alternatives 1, 2, and 3**

	Average Transit Travel Time: Trip Attractions		Average Transit Travel Time: Trip Productions	
	Impact on EJ Population	Disproportionate Benefit or Burden?	Impact on EJ Population	Disproportionate Benefit or Burden?
Minority Nonminority	None	No	None	No
Low-income Non-low-income	None	No	None	No

Note: The minority and nonminority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

**Table 3
Mobility Metric Results for Highway Trips for Alternatives 1, 2, and 3**

	Average Highway Travel Time: Trip Attractions		Average Highway Travel Time: Trip Productions	
	Impact on EJ Population	Disproportionate Benefit or Burden?	Impact on EJ Population	Disproportionate Benefit or Burden?
Minority Nonminority	None	No	None	No
Low-income Non-low-income	None	No	None	No

Note: The minority and nonminority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Environmental Metrics

Table 4 shows the EJ analysis results for the congested VMT per square mile and CO emissions per square mile metrics for Alternatives 1, 2, and 3. These results show that the projected impacts for all four populations are within the forecasting error. Therefore, there are no disproportionate benefits or burdens for the minority or low-income populations for either metric.

**Table 4
Environmental Metric Results for Alternatives 1, 2, and 3**

	Congested VMT		Carbon Monoxide	
	Impact on EJ Population	Disproportionate Benefit or Burden?	Impact on EJ Population	Disproportionate Benefit or Burden?
Minority Nonminority	None	No	None	No
Low-income Non-low-income	None	No	None	No

Note: The minority and nonminority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Congested VMT is determined by analyzing the volume-to-capacity ratio on the roads within each TAZ. Those with a ratio of 0.75 or greater are considered congested. CO emissions are per square mile and are reported in kilograms.

CO = carbon monoxide. EJ = environmental justice. TAZ = transportation analysis zone. VMT = vehicle-miles traveled.

Source: Central Transportation Planning Staff.

2.2 Alternative 4

Alternative 4 would replace part of the existing commuter rail fleet with diesel multiple units. Service frequency would increase at urban rail stations, with typical frequencies of 15 minutes. New expansion projects would include the South Station Expansion and the extension of the Middleborough Line to New Bedford and Fall River as a result of the South Coast Rail project. Benefits of Alternative 4 would likely include faster and more frequent service to urban rail stations.

Access to Opportunities Metrics

Table 5 shows the results for the access to jobs, access to retail opportunities, and access to higher education metrics for Alternative 4. The results project a greater increase in the number of jobs accessible by a 60-minute transit trip for the minority population than for the nonminority population. Therefore, there is no disproportionate benefit or burden. The number of jobs within a 60-minute transit trip is projected to increase for the low-income population, although the increase is expected to be less than that for the non-low-income population, resulting in a disproportionate benefit. These results are likely a result of the increased service to urban rail stations near locations where high shares of minority and low-income populations live. However, service improvements will likely also benefit high shares of non-low-income populations that use commuter rail, resulting in this population benefiting more than the low-income population. Given this result,

if Alternative 4 were pursued, additional work would need to be done to mitigate these disproportionate benefits.

The results for access to retail opportunities and higher education show that the projected impacts for all four populations are within the forecasting error. Therefore, there are no disproportionate benefits or burdens for the minority or low-income populations for either metric.

**Table 5
Access to Opportunities Metric Results for Alternative 4**

Population	Access to Jobs by Transit		Access to Retail Opportunities by Transit		Access to Higher Education by Transit	
	Impact on EJ Population	Disproportionate Benefit or Burden?	Impact on EJ Population	Disproportionate Benefit or Burden?	Impact EJ Population	Disproportionate Benefit or Burden
Minority Nonminority	Benefit	No	None	No	None	No
Low-income Non-low-income	Benefit	Disproportionate Benefit	None	No	None	No

Note: The minority and nonminority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to jobs is calculated for those within a 60-minute transit trip and is reported in number of jobs. Access to retail opportunities is calculated for those within a 60-minute transit trip and is reported in number of retail jobs. Access to higher education is calculated for those within a 40-minute transit trip and is reported in number of students enrolled in two- and four-year institutes of higher education. EJ = environmental justice.

Source: Central Transportation Planning Staff.

Mobility Metrics

Tables 6 and 7 show the results for the transit and highway trip attraction and production metrics. The results show that the projected impacts for all four populations are within the forecasting error. Therefore, there are no disproportionate benefits or burdens for the minority or low-income populations across any of the metrics.

**Table 6
Mobility Metric Results for Transit Trips for Alternative 4**

	Average Transit Travel Time: Trip Attractions		Average Transit Travel Time: Trip Productions	
	Impact on EJ Population	Disproportionate Benefit or Burden?	Impact on EJ Population	Disproportionate Benefit or Burden?
Minority Nonminority	None	No	None	No
Low-income Non-low-income	None	No	None	No

Note: The minority and nonminority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

**Table 7
Mobility Metric Results for Highway Trips for Alternative 4**

	Average Highway Travel Time: Trip Attractions		Average Highway Travel Time: Trip Productions	
	Impact on EJ Population	Disproportionate Benefit or Burden?	Impact on EJ Population	Disproportionate Benefit or Burden?
Minority Nonminority	None	No	None	No
Low-income Non-low-income	None	No	None	No

Note: The minority and nonminority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Travel times are in minutes.

Source: Central Transportation Planning Staff.

Environmental Metrics

Table 8 shows the results for the congested VMT per square mile and CO emissions per square mile metrics. The results show that the projected impacts for all four populations are within the forecasting error. Therefore, there are no disproportionate benefits or burdens for the minority or low-income populations for either metric.

**Table 8
Environmental Metric Results for Alternative 4**

	Congested VMT		Carbon Monoxide	
	Impact on EJ	Disproportionate	Impact on EJ	Disproportionate
Population	Population	Benefit or Burden?	Population	Benefit or Burden?
Minority Nonminority	None	No	None	No
Low-income Non-low-income	None	No	None	No

Note: The minority and nonminority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Congested VMT is determined by analyzing the volume-to-capacity ratio on the roads within each TAZ. Those with a ratio of 0.75 or greater are considered congested.

CO = carbon monoxide. EJ = environmental justice. TAZ = transportation analysis zone. VMT = vehicle-miles traveled.

Source: Central Transportation Planning Staff.

2.3 Alternative 5

Alternative 5 would electrify the urban rail stations, the Providence/Stoughton Line, and the new South Coast Rail Line. Service frequency would increase at urban rail stations, with typical frequencies of 15 minutes. New expansion projects would include the South Station Expansion, the South Coast Rail (Full Build), and shuttle service every 15 minutes on the Grand Junction Line. Benefits to riders would include faster and more frequent service and reduced emissions.

Access to Opportunities Metrics

Table 9 shows the results for the access to jobs, access to retail opportunities, and access to higher education metrics. The number of jobs that are accessible within a 60-minute transit trip is projected to increase for both the minority and nonminority populations, but to a greater extent for the minority population. Therefore, there is no disproportionate benefit or burden. The number of jobs reachable within a 60-minute transit trip is also projected to increase for the low-income population, although this number is expected to be less than that for the non-low-income population, resulting in a disproportionate benefit. These results are likely due to the increased service to urban rail stations near locations where high shares of minority and low-income populations live. However, service improvements will likely also benefit high shares of non-low-income populations that use commuter rail, resulting in this population benefiting more than the low-income population. Given this result, if Alternative 5 were pursued, additional work would need to be done to mitigate the disproportionate benefit.

The results for the access to retail opportunities and higher education metrics show that the projected impacts for all four populations are within the forecasting error. Therefore, there are no disproportionate benefits or burdens for the minority or low-income populations for either metric.

**Table 9
Access to Opportunities Metric Results for Alternative 5**

	Access to Jobs by Transit		Access to Retail Opportunities by Transit		Access to Higher Education by Transit	
	Disproportionate Impact on EJ Population	Benefit or Burden?	Disproportionate Impact on EJ Population	Benefit or Burden?	Disproportionate Impact EJ Population	Benefit or Burden
Minority	Benefit	No	None	No	None	No
Nonminority						
Low-income	Benefit	Disproportionate	None	No	None	No
Non-low-income		Benefit				

Note: The minority and nonminority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to jobs is calculated for those within a 60-minute transit trip and is reported in number of jobs. Access to retail opportunities is calculated for those within a 60-minute transit trip and is reported in number of retail jobs. Access higher education is calculated for those within a 40-minute transit trip and is reported in number of students enrolled in two- and four-year institutes of higher education. EJ = environmental justice.

Source: Central Transportation Planning Staff.

Mobility Metrics

Tables 10 and 11 show the results for the transit and highway trip attraction and production metrics. The results show that the projected impacts for all four populations are within the forecasting error. Therefore, there are no disproportionate benefits or burdens for the minority or low-income populations across any of the metrics.

**Table 10
Mobility Metric Results for Transit Trips for Alternative 5**

	Average Transit Travel Time: Trip Attractions		Average Transit Travel Time: Trip Productions	
	Impact on EJ Population	Disproportionate Benefit or Burden?	Impact on EJ Population	Disproportionate Benefit or Burden?
Minority Nonminority	None	No	None	No
Low-income Non-low-income	None	No	None	No

Note: The minority and nonminority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

**Table 11
Mobility Metric Results for Highway Trips for Alternative 5**

	Average Highway Travel Time: Trip Attractions		Average Highway Travel Time: Trip Productions	
	Impact on EJ Population	Disproportionate Benefit or Burden?	Impact on EJ Population	Disproportionate Benefit or Burden?
Minority Nonminority	None	No	None	No
Low-income Non-low-income	None	No	None	No

Note: The minority and nonminority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Environmental Metrics

Table 12 shows the results for the congested VMT per square mile metric and the results for the CO emissions per square mile metric. The results show that the projected impacts for all four populations are within the forecasting error. Therefore, there are no disproportionate benefits or burdens for the minority or low-income populations for either metric.

**Table 12
Environmental Metric Results for Alternative 5**

	Congested VMT		Carbon Monoxide	
	Impact on EJ	Disproportionate	Impact on EJ	Disproportionate
Population	Population	Benefit or Burden?	Population	Benefit or Burden?
Minority Nonminority	None	No	None	No
Low-income Non-low-income	None	No	None	No

Note: The minority and nonminority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Congested VMT is determined by analyzing the volume-to-capacity ratio on the roads within each TAZ. Those with a ratio of 0.75 or greater are considered congested. CO emissions are per square mile and are reported in kilograms.

CO = carbon monoxide. EJ = environmental justice. TAZ = transportation analysis zone. VMT = vehicle-miles traveled.

Source: Central Transportation Planning Staff.

2.5 Alternative 5B

Alternative 5B is a variation on Alternative 5. Like Alternative 5, Alternative 5B would electrify urban rail stations, the Providence/Stoughton Line, and the new South Coast Rail Line. Service frequency would increase at urban rail stations, with typical frequencies of 15 minutes. New expansion projects would include the South Station Expansion, the South Coast Rail (Full Build), and the provision of shuttle service every 15 minutes on the Grand Junction Line. Benefits for riders would include faster and more frequent service and reduced emissions.

In addition to these changes, Alternative 5B would implement a new fare structure. Trips between Zone 1A urban rail stations would continue to cost \$2.40. Trips from Zone 1A urban rail stations to urban rail stations outside of Zone 1A would cost \$3.40. Trips that start and end at urban rail stations outside of Zone 1A would cost \$3.40, unless the current fare between the two stations is less. Fares between urban rail stations and non-urban rail stations or between two non-urban rail stations would remain as they currently are.

Access to Opportunities Metrics

Table 13 shows the results for the access to jobs, retail opportunities, and higher education metrics. The number of jobs that are within a 60-minute transit trip for the minority population is projected to increase more than for the nonminority population. Therefore, there is no disproportionate benefit or burden for the minority population. The number of jobs reachable within a 60-minute transit trip

for the low-income population is also projected to increase, although the increase is expected to be less than that for the non-low-income population, resulting in a disproportionate benefit.

The number of retail opportunities that are within a 60-minute transit trip is projected to increase for the minority population more so than for the nonminority population, so there is no disproportionate benefit or burden. For the low-income population, the projected impact is within the forecasting error for both the low-income and non-low-income populations. Therefore, there is no disproportionate benefit or burden.

For access to higher education, the projected impact is within the forecasting error for the minority and nonminority populations. Therefore, there is no disproportionate benefit or burden. Access to higher education within a 40-minute transit trip is also projected to increase for the low-income population, although the increase is expected to be less than that for the non-low-income population, resulting in a disproportionate benefit.

These results are likely due to Alternative 5B's implementation of not only the same infrastructure improvements planned for Alternative 5, but also the implementation of a fare structure described above. The new fare structure may increase the ability of EJ populations to access more jobs, retail opportunities, and higher education because of lower fares. Many of the urban rail stations are near minority and low-income populations. However, service improvements will likely also benefit high shares of non-low-income populations that use commuter rail, resulting in this population benefiting more than the low-income population with regards to access to jobs and access to higher education. Given this result, if Alternative 5B were pursued, additional work would need to be done to mitigate these disproportionate benefits.

**Table 13
Access to Opportunities Metric Results for Alternative 5B**

Population	Access to Jobs by Transit		Access to Retail Opportunities by Transit		Access to Higher Education by Transit	
	Impact on EJ Population	Disproportionate Benefit or Burden?	Impact on EJ Population	Disproportionate Benefit or Burden?	Impact EJ Population	Disproportionate Benefit or Burden
Minority Nonminority	Benefit	No	Benefit	No	None	No
Low-income Non-low- income	Benefit	Disproportionate Benefit	None	No	Benefit	Disproportionate Benefit

Note: The minority and nonminority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to jobs is calculated for those within a 60-minute transit trip and is reported in number of jobs. Access to retail opportunities is calculated for those within a 60-minute transit trip and is reported in number of retail jobs. Access to higher education is calculated for those within a 40-minute transit trip and is reported in number of students enrolled in two- and four-year institutes of higher education. EJ = environmental justice.

Source: Central Transportation Planning Staff.

Mobility Metrics

Tables 14 and 15 show the results for the transit and highway trip attraction and production metrics. The results show that the projected impacts for all four populations are within the forecasting error. Therefore, there are no disproportionate benefits or burdens for the minority or low-income populations across any of the metrics.

**Table 14
Mobility Metric Results for Transit Trips for Alternative 5B**

	Average Transit Travel Time: Trip Attractions		Average Transit Travel Time: Trip Productions	
	Impact on EJ Population	Disproportionate Benefit or Burden?	Impact on EJ Population	Disproportionate Benefit or Burden?
Minority Nonminority	None	No	None	No
Low-income Non-low-income	None	No	None	No

Note: The minority and nonminority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

**Table 15
Mobility Metric Results for Highway Trips for Alternative 5B**

	Average Highway Travel Time: Trip Attractions		Average Highway Travel Time: Trip Productions	
	Impact on EJ Population	Disproportionate Benefit or Burden?	Impact on EJ Population	Disproportionate Benefit or Burden?
Minority Nonminority	None	No	None	No
Low-income Non-low-income	None	No	None	No

Note: The minority and nonminority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Environmental Metrics

Table 16 shows the results for congested VMT per square mile CO emissions per square mile. The results show that the projected impacts for all four populations are within the forecasting error. Therefore, there are no disproportionate benefits or burdens for the minority or low-income populations for either metric.

**Table 16
Environmental Metric Results for Alternative 5B**

Population	Congested VMT		Carbon Monoxide	
	Impact on EJ Population	Disproportionate Benefit or Burden?	Impact on EJ Population	Disproportionate Benefit or Burden?
Minority Nonminority	None	No	None	No
Low-income Non-low-income	None	No	None	No

Note: The minority and nonminority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Congested VMT is determined by analyzing the volume-to-capacity ratio on the roads within each TAZ. Those with a ratio of 0.75 or greater are considered congested.

CO = carbon monoxide. EJ = environmental justice. TAZ = transportation analysis zone. VMT = vehicle-miles traveled.

Source: Central Transportation Planning Staff.

2.4 Alternative 6

Alternative 6 would fully electrify the entire commuter rail system. Service improvements would include high-frequency service to most stations, with typical frequencies of 15 minutes, and the creation of a new connection between North and South Stations. In addition to the North–South Rail Link, other expansion projects would include the South Coast Rail (Full Build), service to Foxboro Station, and provision of shuttle service every 15 minutes on the Grand Junction Line. Benefits to riders would include faster and more frequent service and reduced emissions.

Access to Opportunities Metrics

Table 17 shows the results for the access to jobs metric. The number of jobs that are reachable within a 60-minute transit trip is projected to increase for the minority and low-income populations more so than for the nonminority and non-low-income populations, respectively, so there are no disproportionate benefits or burdens for either population.

The number of retail opportunities that are accessible within a 60-minute transit trip is projected to increase for both the minority and low-income populations more so than for their respective nonminority and non-low-income populations, so there are no disproportionate benefits or burdens for any population.

Access to higher education within a 60-minute transit trip is projected to increase more for the minority population than for the nonminority population, so there is

no disproportionate burden. Access to higher education is projected to increase for the low-income population, but the number is projected to be less than the increase for the low-income population, resulting in a disproportionate benefit with regards to access to higher education.

These results are likely due in large part to the construction in Alternative 6 of a North–South Rail Link that would increase the number of retail opportunities, jobs, and higher education opportunities for both EJ and non-EJ populations. They would also likely be a result of the increased service to urban rail stations and key stations near locations where high shares of minority and low-income populations live. However, service improvements will likely also benefit high shares of non-low-income populations that use commuter rail, resulting in this population benefiting more than the low-income population. Given these results, if Alternative 6 were pursued, additional work would need to be done to mitigate these disproportionate benefits.

**Table 17
Access to Opportunities Metric Results for Alternative 6**

Population	Access to Jobs by Transit		Access to Retail Opportunities by Transit		Access to Higher Education by Transit	
	Impact on EJ Population	Disproportionate Benefit or Burden?	Impact on EJ Population	Disproportionate Benefit or Burden?	Impact EJ Population	Disproportionate Benefit or Burden
Minority	Benefit	No	Benefit	No	Benefit	No
Nonminority						
Low-income	Benefit	No	Benefit	No	Benefit	Disproportionate
Non-low-income						Benefit

Note: The minority and nonminority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to jobs is calculated for those within a 60-minute transit trip and is reported in number of jobs. Access to retail opportunities is calculated for those within a 60-minute transit trip and is reported in number of retail jobs. Access to higher education is calculated for those within a 40-minute transit trip and is reported in number of students enrolled in two- and four-year institutes of higher education. EJ = environmental justice.

Source: Central Transportation Planning Staff.

Mobility Metrics

Tables 18 and 19 show the results for the transit and highway trip attraction and production metrics. The results show that the projected impacts for all four populations are within the forecasting error. Therefore, there are no disproportionate benefits or burdens for the minority or low-income populations across any of the metrics.

**Table 18
Mobility Metric Results for Transit Trips for Alternative 6**

	Average Transit Travel Time: Trip Attractions		Average Transit Travel Time: Trip Productions	
	Impact on EJ Population	Disproportionate Benefit or Burden?	Impact on EJ Population	Disproportionate Benefit or Burden?
Minority Nonminority	None	No	None	No
Low-income Non-low-income	None	No	None	No

Note: The minority and nonminority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

**Table 19
Mobility Metric Results for Highway Trips for Alternative 6**

	Average Highway Travel Time: Trip Attractions		Average Highway Travel Time: Trip Productions	
	Impact on EJ Population	Disproportionate Benefit or Burden?	Impact on EJ Population	Disproportionate Benefit or Burden?
Minority Nonminority	None	No	None	No
Low-income Non-low-income	None	No	None	No

Note: The minority and nonminority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Environmental Metrics

Table 20 shows the results for the congested VMT per square mile and CO emissions per square mile metrics. The results show that the projected impacts for all four populations are within the forecasting error. Therefore, there are no disproportionate benefits or burdens for the minority or low-income populations for either metric.

**Table 20
Environmental Metric Results for Alternative 6**

	Congested VMT		Carbon Monoxide	
	Impact on EJ Population	Disproportionate Benefit or Burden?	Impact on EJ Population	Disproportionate Benefit or Burden?
Minority Nonminority	None	No	None	No
Low-income Non-low-income	None	No	None	No

Note: The minority and non-minority populations are measured by number of people. The low-income and non-low-income populations are measured by number of households. The no-build and build scenarios are for the year 2040. Congested VMT is determined by analyzing the volume-to-capacity ratio on the roads within each TAZ. Those with a ratio of 0.75 or greater are considered congested.
 CO = carbon monoxide. EJ = environmental justice. VMT = vehicle-miles traveled.
 Source: Central Transportation Planning Staff.

3 CONCLUSION

The results for the six evaluated alternatives vary in regard to their projected impacts to EJ populations. Alternatives 1, 2, and 3 do not show any disproportionate benefits or burdens across any of the metrics for minority and low-income populations. This is likely because the changes to the commuter rail system in such a large study area produce impacts that are within the forecasting error. In addition, the planned improvements to service for Alternatives 2 and 3 are for key stations that are mostly outside of EJ communities, whereas Alternatives 5, 5B, and 6 include improvements to service for urban rail stations which are generally closer to EJ communities. Alternatives 4, 5, 5B, and 6 do show a benefit for one or more of the access to opportunity metrics, although none show benefits related to the mobility or environmental metrics.

Overall, EJ populations would likely receive the most benefits from Alternative 6, which would be expected to increase access to jobs, education, and retail opportunities. The exception relates to access to higher education, in which case the low-income population is projected to receive less of a benefit than the non-low-income population, although Alternative 6 would still have the greatest educational benefits across all of the alternatives. As a study, any actual planned improvements would go through another EJ analysis, and mitigation strategies would be identified for any projected disproportionate benefits or burdens.

Enclosures: Exhibit A

EXHIBIT A: RAIL VISION ENVIRONMENTAL JUSTICE ANALYSIS

Alternative 1

Table 1.1
EJ Analysis Results for Access to Jobs by Transit

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	3.3%	298,315	289,697 to 309,469	None	No
Nonminority	6.2%	139,065	131,209 to 148,554		
Low-income	3.7%	218,371	211,452 to 227,701	None	No
Non-low-income	5.0%	170,045	162,323 to 179,409		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to jobs is calculated for those within a 60-minute transit trip and is reported in number of jobs.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 1.2
EJ Analysis Results for Access to Retail Opportunities by Transit

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	9.1%	32,216	29,614 to 35,544	None	No
Nonminority	16.6%	15,288	12,939 to 18,089		
Low-income	10.2%	23,731	21,600 to 26,507	None	No
Non-low-income	13.7%	18,639	16,301 to 21,476		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to retail opportunities is calculated for those within a 60-minute transit trip and is reported in number of retail jobs.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 1.3
EJ Analysis Results for Access to Higher Education by Transit

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	3.5%	27,276	26,285 to 28,192	None	No
Nonminority	6.0%	13,528	12,709 to 14,331		
Low-income	3.4%	21,683	20,926 to 22,399	None	No
Non-low-income	4.6%	16,173	15,408 to 16,894		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to higher education is calculated for those within a 40-minute transit trip and is reported in number of students enrolled in two- and four-year institutes of higher education.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 1.4
EJ Analysis Results for Average Transit Travel Times: Trip Attractions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	14.5%	51	43 to 58	None	No
Nonminority	12.5%	48	42 to 54		
Low-income	13.0%	50	44 to 57	None	No
Non-low-income	12.2%	48	42 to 54		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 1.5
EJ Analysis Results for Average Transit Travel Times: Trip Productions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	17.3%	50	41 to 59	None	No
Nonminority	15.5%	48	40 to 55		
Low-income	16.1%	50	42 to 58	None	No
Non-low-income	15.7%	48	40 to 55		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 1.6
EJ Analysis Results for Average Highway Travel Times: Trip Attractions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	13.9%	18	16 to 21	None	No
Nonminority	13.1%	19	16 to 21		
Low-income	13.2%	18	16 to 21	None	No
Non-low-income	13.2%	19	16 to 21		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 1.7
EJ Analysis Results for Average Highway Travel Times: Trip Productions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	13.2%	19	16 to 21	None	No
Nonminority	13.2%	19	16 to 21		
Low-income	13.1%	18	16 to 21	None	No
Non-low-income	13.3%	19	16 to 21		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 1.8
EJ Analysis Results for Congested VMT

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	16.3%	80,902	65,348 to 90,800	None	No
Nonminority	22.6%	51,556	38,444 to 60,894		
Low-income	16.5%	66,715	53,673 to 74,885	None	No
Non-low-income	20.3%	60,007	45,953 to 69,361		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Congested VMT is determined by analyzing the volume-to-capacity ratio on the roads within each transportation analysis zone. Those with a ratio of 0.75 or greater are considered congested.

EJ = environmental justice. VMT = vehicle-miles traveled.

Source: Central Transportation Planning Staff.

**Table 1.9
EJ Analysis Results for CO Emissions**

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	11.9%	145	125 to 158	None	No
Nonminority	17.2%	93	75 to 107		
Low-income	12.6%	123	105 to 135	None	No
Non-low-income	15.4%	105	87 to 118		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. CO emissions are per square mile and are reported in kilograms.

CO = carbon monoxide. EJ = environmental justice.

Source: Central Transportation Planning Staff.

Alternative 2

Table 2.1
EJ Analysis Results for Access to Jobs by Transit

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	3.3%	298,315	289,773 to 309,551	None	No
Nonminority	6.2%	139,065	131,152 to 148,490		
Low-income	3.7%	218,371	211,806 to 228,081	None	No
Non-low-income	5.0%	170,045	162,487 to 179,591		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to jobs is calculated for those within a 60-minute transit trip and is reported in number of jobs.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 2.2
EJ Analysis Results for Access to Retail Opportunities by Transit

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	9.1%	32,216	29,680 to 35,623	None	No
Nonminority	16.6%	15,288	12,955 to 18,113		
Low-income	10.2%	23,731	21,653 to 26,572	None	No
Non-low-income	13.7%	18,639	16,347 to 21,537		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to retail opportunities is calculated for those within a 60-minute transit trip and is reported in number of retail jobs.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 2.3
EJ Analysis Results for Access to Higher Education by Transit

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	3.5%	27,276	26,212 to 28,113	None	No
Nonminority	6.0%	13,528	12,756 to 14,384		
Low-income	3.4%	21,683	20,950 to 22,425	None	No
Non-low-income	4.6%	16,173	15,458 to 16,948		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to higher education is calculated for those within a 40-minute transit trip and is reported in number of students enrolled in two- and four-year institutes of higher education.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 2.4
EJ Analysis Results for Average Transit Travel Times: Trip Attractions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	14.5%	51	43 to 58	None	No
Nonminority	12.5%	48	42 to 54		
Low-income	13.0%	50	43 to 56	None	No
Non-low-income	12.2%	48	42 to 54		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 2.5
EJ Analysis Results for Average Transit Travel Times: Trip Productions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	17.3%	50	41 to 59	None	No
Nonminority	15.5%	48	40 to 55		
Low-income	16.1%	50	42 to 58	None	No
Non-low-income	15.7%	48	40 to 55		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 2.6
EJ Analysis Results for Average Highway Travel Times: Trip Attractions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	13.9%	18	16 to 21	None	No
Nonminority	13.1%	19	16 to 21		
Low-income	13.2%	18	16 to 21	None	No
Non-low-income	13.2%	19	16 to 21		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 2.7
EJ Analysis Results for Average Highway Travel Times: Trip Productions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	13.2%	19	16 to 21	None	No
Nonminority	13.2%	19	16 to 21		
Low-income	13.1%	18	16 to 21	None	No
Non-low-income	13.3%	19	16 to 21		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 2.8
EJ Analysis Results for Congested VMT

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	16.3%	80,902	65,358 to 90,815	None	No
Nonminority	22.6%	51,556	38,412 to 60,844		
Low-income	16.5%	66,715	53,634 to 74,831	None	No
Non-low-income	20.3%	60,007	45,927 to 69,322		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Congested VMT is determined by analyzing the volume-to-capacity ratio on the roads within each transportation analysis zone. Those with a ratio of 0.75 or greater are considered congested.

EJ = environmental justice. VMT = vehicle-miles traveled.

Source: Central Transportation Planning Staff.

Table 2.9
EJ Analysis Results for CO Emissions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	11.9%	145	124 to 158	None	No
Nonminority	17.2%	93	75 to 106		
Low-income	12.6%	123	105 to 135	None	No
Non-low-income	15.4%	105	87 to 118		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. CO emissions are per square mile and are reported in kilograms.

CO = carbon monoxide. EJ = environmental justice.

Source: Central Transportation Planning Staff.

Alternative 3

**Table 3.1
EJ Analysis Results for Access to Jobs by Transit**

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	3.3%	298,315	294,945 to 315,076	None	No
Nonminority	6.2%	139,065	137,218 to 155,357		
Low-income	3.7%	218,371	217,823 to 234,561	None	No
Non-low-income	5.0%	170,045	168,585 to 186,331		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to jobs is calculated for those within a 60-minute transit trip and is reported in number of jobs.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

**Table 3.2
EJ Analysis Results for Access to Retail Opportunities by Transit**

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	9.1%	32,216	30,259 to 36,317	None	No
Nonminority	16.6%	15,288	13,526 to 18,910		
Low-income	10.2%	23,731	22,287 to 27,351	None	No
Non-low-income	13.7%	18,639	16,943 to 22,322		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to retail opportunities is calculated for those within a 60-minute transit trip and is reported in number of retail jobs.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 3.3
EJ Analysis Results for Access to Higher Education by Transit

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	3.5%	27,276	26,345 to 28,256	None	No
Nonminority	6.0%	13,528	12,846 to 14,485		
Low-income	3.4%	21,683	21,020 to 22,500	None	No
Non-low-income	4.6%	16,173	15,569 to 17,070		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to higher education is calculated for those within a 40-minute transit trip and is reported in number of students enrolled in two- and four-year institutes of higher education.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 3.4
EJ Analysis Results for Average Transit Travel Times: Trip Attractions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	14.5%	51	43 to 57	None	No
Nonminority	12.5%	48	41 to 53		
Low-income	13.0%	50	43 to 56	None	No
Non-low-income	12.2%	48	42 to 53		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 3.5
EJ Analysis Results for Average Transit Travel Times: Trip Productions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	17.3%	50	41 to 58	None	No
Nonminority	15.5%	48	40 to 54		
Low-income	16.1%	50	41 to 57	None	No
Non-low-income	15.7%	48	40 to 54		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 3.6
EJ Analysis Results for Average Highway Travel Times: Trip Attractions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	13.9%	18	16 to 21	None	No
Nonminority	13.1%	19	16 to 21		
Low-income	13.2%	18	16 to 21	None	No
Non-low-income	13.2%	19	16 to 21		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 3.7
EJ Analysis Results for Average Highway Travel Times: Trip Productions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	13.2%	19	16 to 21	None	No
Nonminority	13.2%	19	16 to 21		
Low-income	13.1%	18	16 to 21	None	No
Non-low-income	13.3%	19	16 to 21		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 3.8
EJ Analysis Results for Congested VMT

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Burden for EJ Population?
Minority	16.3%	80,902	65,238 to 90,648	None	No
Nonminority	22.6%	51,556	38,350 to 63,208		
Low-income	16.5%	66,715	53,562 to 74,731	None	No
Non-low-income	20.3%	60,007	45,866 to 69,230		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Congested VMT is determined by analyzing the volume-to-capacity ratio on the roads within each transportation analysis zone. Those with a ratio of 0.75 or greater are considered congested.

EJ = environmental justice. VMT = vehicle-miles traveled.

Source: Central Transportation Planning Staff.

**Table 3.9
EJ Analysis Results for CO Emissions**

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	11.9%	145	124 to 158	None	No
Nonminority	17.2%	93	75 to 106		
Low-income	12.6%	123	104 to 135	None	No
Non-low-income	15.4%	105	86 to 118		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. CO emissions are per square mile and are reported in kilograms.

CO = carbon monoxide. EJ = environmental justice.

Source: Central Transportation Planning Staff.

Alternative 4

Table 4.1
EJ Analysis Results for Access to Jobs by Transit

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	3.3%	298,315	307,330 to 328,306	Benefit	No
Nonminority	6.2%	139,065	142,329 to 161,144		
Low-income	3.7%	218,371	224,405 to 241,649	Benefit	Yes
Non-low-income	5.0%	170,045	175,860 to 194,372		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to jobs is calculated for those within a 60-minute transit trip and is reported in number of jobs.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 4.2
EJ Analysis Results for Access to Retail Opportunities by Transit

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	9.1%	32,216	31,643 to 37,979	None	No
Nonminority	16.6%	15,288	14,076 to 19,679		
Low-income	10.2%	23,731	23,070 to 28,311	None	No
Non-low-income	13.7%	18,639	17,717 to 23,343		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to retail opportunities is calculated for those within a 60-minute transit trip and is reported in number of retail jobs.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 4.3
EJ Analysis Results for Access to Higher Education by Transit

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	3.5%	27,276	27,010 to 28,969	None	No
Nonminority	6.0%	13,528	13,229 to 14,918		
Low-income	3.4%	21,683	21,495 to 23,008	None	No
Non-low-income	4.6%	16,173	16,043 to 17,590		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to higher education is calculated for those within a 40-minute transit trip and is reported in number of students enrolled in two- and four-year institutes of higher education.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 4.4
EJ Analysis Results for Average Transit Travel Times: Trip Attractions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	14.5%	51	43 to 57	None	No
Nonminority	12.5%	48	41 to 53		
Low-income	13.0%	50	43 to 56	None	No
Non-low-income	12.2%	48	42 to 53		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 4.5
EJ Analysis Results for Average Transit Travel Times: Trip Productions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	17.3%	50	41 to 58	None	No
Nonminority	15.5%	48	40 to 54		
Low-income	16.1%	50	41 to 57	None	No
Non-low-income	15.7%	48	40 to 54		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 4.6
EJ Analysis Results for Average Highway Travel Times: Trip Attractions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	13.9%	18	16 to 21	None	No
Nonminority	13.1%	19	16 to 21		
Low-income	13.2%	18	16 to 21	None	No
Non-low-income	13.2%	19	16 to 21		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 4.7
EJ Analysis Results for Average Highway Travel Times: Trip Productions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	13.2%	19	16 to 21	None	No
Nonminority	13.2%	19	16 to 21		
Low-income	13.1%	18	16 to 21	None	No
Non-low-income	13.3%	19	16 to 21		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Travel times are in minutes.
 EJ = environmental justice.
 Source: Central Transportation Planning Staff.

Table 4.8
EJ Analysis Results for Congested VMT

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	16.3%	80,902	65,336 to 90,783	None	No
Nonminority	22.6%	51,556	38,557 to 61,074		
Low-income	16.5%	66,715	53,678 to 74,892	None	No
Non-low-income	20.3%	60,007	46,091 to 69,570		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Congested VMT is determined by analyzing the volume-to-capacity ratio on the roads within each transportation analysis zone. Those with a ratio of 0.75 or greater are considered congested.
 EJ = environmental justice. VMT = vehicle-miles traveled.
 Source: Central Transportation Planning Staff.

**Table 4.9
EJ Analysis Results for CO Emissions**

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	11.9%	145	125 to 158	None	No
Nonminority	17.2%	93	75 to 107		
Low-income	12.6%	123	105 to 135	None	No
Non-low-income	15.4%	105	87 to 118		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. CO emissions are per square mile and are reported in kilograms.

CO = carbon monoxide. EJ = environmental justice.

Source: Central Transportation Planning Staff.

Alternative 5

Table 5.1
EJ Analysis Results for Access to Jobs by Transit

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	3.3%	298,315	309,665 to 330,801	Benefit	No
Nonminority	6.2%	139,065	143,854 to 162,870		
Low-income	3.7%	218,371	226,457 to 243,858	Benefit	Yes
Non-low-income	5.0%	170,045	177,558 to 196,249		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to jobs is calculated for those within a 60-minute transit trip and is reported in number of jobs.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 5.2
EJ Analysis Results for Access to Retail Opportunities by Transit

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Burden for EJ Population?
Minority	9.1%	32,216	31,946 to 38,342	None	No
Nonminority	16.6%	15,288	14,240 to 19,909		
Low-income	10.2%	23,731	23,313 to 28,609	None	No
Non-low-income	13.7%	18,639	17,910 to 23,596		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to retail opportunities is calculated for those within a 60-minute transit trip and is reported in number of retail jobs.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 5.3
EJ Analysis Results for Access to Higher Education by Transit

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	3.5%	27,276	27,073 to 29,037	None	No
Nonminority	6.0%	13,528	13,300 to 14,998		
Low-income	3.4%	21,683	21,539 to 23,055	None	No
Non-low-income	4.6%	16,173	16,132 to 17,688		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to higher education is calculated for those within a 40-minute transit trip and is reported in number of students enrolled in two- and four-year institutes of higher education.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 5.4
EJ Analysis Results for Average Transit Travel Times: Trip Attractions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	14.5%	51	42 to 57	None	No
Nonminority	12.5%	48	41 to 53		
Low-income	13.0%	50	43 to 56	None	No
Non-low-income	12.2%	48	41 to 53		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 5.5
EJ Analysis Results for Average Transit Travel Times: Trip Productions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	17.3%	50	41 to 58	None	No
Nonminority	15.5%	48	40 to 54		
Low-income	16.1%	50	41 to 57	None	No
Non-low-income	15.7%	48	40 to 54		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 5.6
EJ Analysis Results for Average Highway Travel Times: Trip Attractions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	13.9%	18	16 to 21	None	No
Nonminority	13.1%	19	16 to 21		
Low-income	13.2%	18	16 to 21	None	No
Non-low-income	13.2%	19	16 to 21		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 5.7
EJ Analysis Results for Average Highway Travel Times: Trip Productions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	13.2%	19	16 to 21	None	No
Nonminority	13.2%	19	16 to 21		
Low-income	13.1%	18	16 to 21	None	No
Non-low-income	13.3%	19	16 to 21		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 5.8
EJ Analysis Results for Congested VMT

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	16.3%	80,902	65,676 to 91,256	None	No
Nonminority	22.6%	51,556	38,609 to 61,155		
Low-income	16.5%	66,715	53,914 to 75,221	None	No
Non-low-income	20.3%	60,007	46,213 to 69,755		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Congested VMT is determined by analyzing the volume-to-capacity ratio on the roads within each transportation analysis zone. Those with a ratio of 0.75 or greater are considered congested.

EJ = environmental justice. VMT = vehicle-miles traveled.

Source: Central Transportation Planning Staff.

**Table 5.9
EJ Analysis Results for CO Emissions**

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	11.9%	145	125 to 159	None	No
Nonminority	17.2%	93	75 to 107		
Low-income	12.6%	123	105 to 135	None	No
Non-low-income	15.4%	105	87 to 119		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. CO emissions are per square mile and are reported in kilograms.

CO = carbon monoxide. EJ = environmental justice.

Source: Central Transportation Planning Staff.

Alternative 5B

Table 5B.1
EJ Analysis Results for Access to Jobs by Transit

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	3.3%	298,315	310,467 to 331,657	Benefit	No
Nonminority	6.2%	139,065	144,964 to 164,128		
Low-income	3.7%	218,371	227,306 to 244,773	Benefit	Yes
Non-low-income	5.0%	170,045	178,732 to 197,546		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to jobs is calculated for those within a 60-minute transit trip and is reported in number of jobs.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 5B.2
EJ Analysis Results for Access to Retail Opportunities by Transit

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	9.1%	32,216	32,050 to 38,467	Benefit	No
Nonminority	16.6%	15,288	14,351 to 20,065		
Low-income	10.2%	23,731	23,415 to 28,735	None	No
Non-low-income	13.7%	18,639	18,035 to 23,761		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to retail opportunities is calculated for those within a 60-minute transit trip and is reported in number of retail jobs.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

**Table 5B.3
EJ Analysis Results for Access to Higher Education by Transit**

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	3.5%	27,276	27,082 to 29,047	None	None
Nonminority	6.0%	13,528	13,319 to 15,019		
Low-income	3.4%	21,683	21,548 to 23,065	Burden	Yes
Non-low-income	4.6%	16,173	16,151 to 17,708		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to higher education is calculated for those within a 40-minute transit trip and is reported in number of students enrolled in two- and four-year institutes of higher education.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

**Table 5B.4
EJ Analysis Results for Average Transit Travel Times: Trip Attractions**

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	14.5%	51	43 to 57	None	No
Nonminority	12.5%	48	41 to 53		
Low-income	13.0%	50	43 to 56	None	No
Non-low-income	12.2%	48	41 to 53		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

**Table 5B.5
EJ Analysis Results for Average Transit Travel Times: Trip Productions**

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	17.3%	50	41 to 58	None	No
Nonminority	15.5%	48	40 to 54		
Low-income	16.1%	50	41 to 57	None	No
Non-low-income	15.7%	48	40 to 54		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

**Table 5B.6
EJ Analysis Results for Average Highway Travel Times: Trip Attractions**

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	13.9%	18	16 to 21	None	No
Nonminority	13.1%	19	16 to 21		
Low-income	13.2%	18	16 to 21	None	No
Non-low-income	13.2%	19	16 to 21		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 5B.7
EJ Analysis Results for Average Highway Travel Times: Trip Productions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	13.2%	19	16 to 21	None	No
Nonminority	13.2%	19	16 to 21		
Low-income	13.1%	18	16 to 21	None	No
Non-low-income	13.3%	19	16 to 21		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 5B.8
EJ Analysis Results for Congested VMT

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	16.3%	80,902	65,383 to 90,849	None	No
Nonminority	22.6%	51,556	38,520 to 61,014		
Low-income	16.5%	66,715	53,660 to 74,867	None	No
Non-low-income	20.3%	60,007	46,064 to 69,530		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Congested VMT is determined by analyzing the volume-to-capacity ratio on the roads within each transportation analysis zone. Those with a ratio of 0.75 or greater are considered congested.

EJ = environmental justice. VMT = vehicle-miles traveled.

Source: Central Transportation Planning Staff.

**Table 5B.9
EJ Analysis Results for CO Emissions**

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	11.9%	145	124 to 158	None	No
Nonminority	17.2%	93	75 to 107		
Low-income	12.6%	123	105 to 135	None	No
Non-low-income	15.4%	105	87 to 118		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. CO emissions are per square mile and are reported in kilograms.

CO = carbon monoxide. EJ = environmental justice.

Source: Central Transportation Planning Staff.

Alternative 6

Table 6.1
EJ Analysis Results for Access to Jobs by Transit

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	3.3%	298,315	320,625 to 342,509	Benefit	No
Nonminority	6.2%	139,065	149,540 to 169,309		
Low-income	3.7%	218,371	233,911 to 251,886	Benefit	No
Non-low-income	5.0%	170,045	184,508 to 203,930		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to jobs is calculated for those within a 60-minute transit trip and is reported in number of jobs.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 6.2
EJ Analysis Results for Access to Retail Opportunities by Transit

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	9.1%	32,216	33,202 to 39,849	Benefit	No
Nonminority	16.6%	15,288	14,913 to 20,849		
Low-income	10.2%	23,731	24,214 to 29,715	Benefit	No
Non-low-income	13.7%	18,639	18,734 to 24,682		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to retail opportunities is calculated for those within a 60-minute transit trip and is reported in number of retail jobs.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 6.3
EJ Analysis Results for Access to Higher Education by Transit

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	3.5%	27,276	27,471 to 29,464	Benefit	No
Nonminority	6.0%	13,528	13,320 to 15,021		
Low-income	3.4%	21,683	21,669 to 23,195	Benefit	Yes
Non-low-income	4.6%	16,173	16,202 to 17,765		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Access to higher education is calculated for those within a 40-minute transit trip and is reported in number of students enrolled in two- and four-year institutes of higher education.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 6.4
EJ Analysis Results for Average Transit Travel Times: Trip Attractions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	14.5%	51	42 to 56	None	No
Nonminority	12.5%	48	41 to 52		
Low-income	13.0%	50	42 to 55	None	No
Non-low-income	12.2%	48	41 to 52		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 6.5
EJ Analysis Results for Average Transit Travel Times: Trip Productions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	17.3%	50	40 to 57	None	No
Nonminority	15.5%	48	39 to 53		
Low-income	16.1%	50	41 to 56	None	No
Non-low-income	15.7%	48	39 to 53		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 6.6
EJ Analysis Results for Average Highway Travel Times: Trip Attractions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	13.9%	18	16 to 21	None	No
Nonminority	13.1%	19	16 to 21		
Low-income	13.2%	18	16 to 21	None	No
Non-low-income	13.2%	19	16 to 21		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040.

Travel times are in minutes.

EJ = environmental justice.

Source: Central Transportation Planning Staff.

Table 6.7
EJ Analysis Results for Average Highway Travel Times: Trip Productions

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	13.2%	19	16 to 21	None	No
Nonminority	13.2%	19	16 to 21		
Low-income	13.1%	18	16 to 21	None	No
Non-low-income	13.3%	19	16 to 21		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Travel times are in minutes.
 EJ = environmental justice.
 Source: Central Transportation Planning Staff.

Table 6.8
EJ Analysis Results for Congested VMT

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	16.3%	80,902	64,544 to 89,683	None	No
Nonminority	22.6%	51,556	37,895 to 60,025		
Low-income	16.5%	66,715	52,968 to 73,901	None	No
Non-low-income	20.3%	60,007	45,333 to 68,426		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. Congested VMT is determined by analyzing the volume-to-capacity ratio on the roads within each transportation analysis zone. Those with a ratio of 0.75 or greater are considered congested.
 EJ = environmental justice. VMT = vehicle-miles traveled.
 Source: Central Transportation Planning Staff.

**Table 6.9
EJ Analysis Results for CO Emissions**

Population	Forecasting Error	No-Build Scenario Results	Range of Expected Values for the Build Scenario	Benefit or Burden for EJ Population?	Disproportionate Benefit or Burden for EJ Population?
Minority	11.9%	145	123 to 156	None	No
Nonminority	17.2%	93	75 to 106		
Low-income	12.6%	123	104 to 134	None	No
Non-low-income	15.4%	105	86 to 117		

Notes: The minority and non-minority populations are measured in number of people. The low-income and non-low-income populations are measured in number of households. The no-build and build scenarios are for the year 2040. CO emissions are per square mile and are reported in kilograms.

CO = carbon monoxide. EJ = environmental justice.

Source: Central Transportation Planning Staff.