BOSTON REGION METROPOLITAN PLANNING ORGANIZATION

Stephanie Pollack, MassDOT Secretary and CEO and MPO Chair
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TECHNICAL MEMO

DATE: **November 5, 2020**
TO: **Boston Region Metropolitan Planning Organization**
FROM: **Betsy Harvey**
RE: **Disparate Impact Metrics Analysis Study**

1 PURPOSE OF THE STUDY

This memo describes the second and final phase of the Boston Region Metropolitan Planning Organization's (MPO) effort to develop a Disparate Impact and Disproportionate Burden (DI/DB) Policy for the MPO's Long-Range Transportation Plan (LRTP). The policy will be used to evaluate, in the aggregate, projects funded in the LRTP Recommended Plan for potential future disparate impacts and disproportionate burdens on minority and low-income populations, respectively. The DI/DB Policy responds to Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) requirements that recipients of federal funding identify and address potential future disparate impacts and disproportionate burdens.

Phase Two was undertaken through the MPO's Disparate Impact Metrics Analysis study. The goal of the study was to revise the thresholds that are used in the draft DI/DB Policy to identify disparate impacts and disproportionate burdens. This included reconvening the MPO's DI/DB Policy stakeholder working group that was first convened during Phase One. This memo describes a literature review conducted to help revise the thresholds, the outcomes of the working group, staff's recommendations for the final DI/DB Policy, and summary of the study results. The attached technical appendix gives more detail about the study metrics and thresholds.

2 BACKGROUND

The projects that are analyzed with the DI/DB Policy are those included in the LRTP Recommended Plan and that change the capacity of the transportation network. The Recommended Plan consists of regionally significant projects within the Boston MPO region that will be financed with federal funds. Regionally significant projects are defined as

Civil Rights, nondiscrimination, and accessibility information is on the last page.

- Highway projects
    - Projects that improve facilities that are important to regional travel, which include Interstate Highways; Principal Arterial Freeways and Expressways; or all sections of roadways classified as Principal Arterial “Other” that have fully or controlled access
    - Projects that cost $50 million or more
- Public transit projects
    - Projects that add new connections to or extend the rail or fixed-guideway public transit network or extend the bus rapid transit network
    - Projects that cost $50 million or more

Projects that do not change the capacity of the transportation network, including those funded through the MPO’s investment programs, are analyzed in the Transportation Improvement Program.

2.1 Federal Requirements

The MPO’s LRTP DI/DB Policy responds to two federal mandates: Title VI of the Civil Rights Act of 1964 and Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations, known as the Environmental Justice Executive Order (EJ EO).

Title VI prohibits intentional discrimination (disparate treatment) and unintentional discrimination (disparate impact) based on race, color, or national origin. Disparate treatment refers to actions that result in circumstances where similarly situated persons are intentionally treated differently because of their race, color, or national origin. Disparate impacts refer to a facially neutral policy or practice that disproportionately affects members of a group identified by their race, color, or national origin, where a funding recipient’s policy or practice lacks a substantial legitimate justification, and where there exists one or more alternatives that would serve the same legitimate objectives but with a less disproportionate effect.

Federal agencies enforce disparate impact compliance through Title VI, implementing regulations with which recipients of an agency’s funding must comply. As recipients of funding from FTA and FHWA, MPOs must comply with both of these agencies’ Title VI disparate impact regulations.

The EJ EO was issued in 1994 and made achieving EJ a mission of the executive branch. The EJ EO directs federal agencies to identify and address disproportionately high and adverse environmental and human health effects of

their activities, policies, and practices on minority populations and low-income populations. This obligation is passed to recipients of federal funding through executive branch agencies, including FTA and FHWA. For low-income populations, disproportionately high and adverse effects are referred to as disproportionate burdens.

FTA's most recent Title VI circular was issued in 2012. It requires MPOs to identify and address disparate impacts on minority populations that may result from projects programmed with state or federal funds in the aggregate. In 2015, FHWA issued combined Title VI and EJ guidance that similarly states that MPOs must assess the impacts on minority and low-income populations that may result from its activities. The DI/DB Policy addresses both FTA's and FHWA's requirements. These documents set guidelines for the following analyses:

- Projects must be analyzed as a group, not individually.
- Impacts on each population group must be assessed for the entire population in the MPO region, not by neighborhood or municipality.
- Disparate impacts refer to impacts that may result from proposed MPO activities, not inequities that are due to the existing transportation network.
- The analyses compare impacts to four population groups: impacts to the minority population are compared to those of the nonminority population, and impacts to the low-income population are compared to those of the non-low-income population
- The results for minority and low-income populations must be reported separately; they cannot be combined.[1]

2.2 Developing the Draft DI/DB Policy

In 2017, the Boston region MPO committed to developing a DI/DB Policy to use in subsequent LRTPs that would

- reflect the uncertainty inherent to the travel demand modeling process that is used to identify potential impacts to ensure that impacts that are identified are likely and not due to model "noise;"
- determine when potential impacts would be practically significant; and
- determine when these impacts would disproportionately affect minority and low-income populations.

[1] The minority population include people who identify as Black/African American; Asian; Hawaiian or other Pacific Islander; Alaskan Native or American Indian; and/or Hispanic. People are considered low income if they live in a family whose annual income is less than or equal to 200 percent of the national poverty level.

These changes would not only align the DI/DB Policy with federal guidance but would also ensure that the MPO allocates resources to address meaningful impacts. In addition, staff saw an opportunity to engage members of the public in the development of a new policy to ensure the policy reflected their interests.

MPO staff pursued a two-phased effort to develop the DI/DB Policy. The first phase took place in federal fiscal years (FFY) 2018 and 2019; the second phase took place in FFY 2020. For the first phase, during the spring and summer of 2018 staff began a public engagement process to solicit stakeholder and public input. Staff presented the results of this process to the MPO and solicited members' input on October 4, 2018.

Staff then synthesized public input to update the DI/DB analysis methodology, revise the metrics that would be analyzed, and quantify uncertainty in the travel demand modeling process. Staff developed a draft DI/DB Policy that incorporated all of this work. It was presented to the MPO on May 2, 2019, and the MPO approved its use in *Destination 2040*, the current LRTP. (Phase One is described in detail in the memo Development of the DI/DB Policy for the LRTP: Phase One.)

3 DEVELOPING THE DI/DB POLICY RECOMMENDATIONS

3.1 Metrics

The DI/DB Policy assesses the impacts of several metrics on four population groups—minority and low-income populations (protected populations) and nonminority and non-low-income populations (non-protected populations). During Phase One, MPO staff updated the metrics used in *Destination 2040*, which were used in this study to help develop the DI/DB Policy's thresholds.

- Accessibility Metrics
  - Jobs within a 60-minute public transit trip
  - Retail within a 60-minute public transit trip
  - Healthcare services within a 40-minute public transit trip
  - Two- and four-year institutions of higher education within a 40-minute public transit trip
- Mobility Metrics
  - Average travel times for public transit trips starting in the MPO
  - Average travel times for public transit trips ending in the MPO
  - Average highway travel times for auto trips starting in the MPO
  - Average highway travel times for auto trips ending in the MPO
- Environmental Metrics

- Carbon monoxide (CO)
- Vehicle-miles traveled (VMT)

3.2 Three-Test Investigation

The draft DI/DB Policy established the following guidelines to determine whether there would be disparate impacts and disproportionate burdens:

> [A]ny impact that is projected to adversely affect the protected population more than the non-protected population, and where the MPO can be confident that this is not due to model uncertainty, would indicate a potential future disparate impact or disproportionate burden.

Through this study, staff further refined this approach, proposing the use of three thresholds to identify disparate impacts and disproportionate burdens: the baseline uncertainty threshold, the practical impact threshold, and the disproportionality threshold. This approach clarifies how the MPO identifies disparate impacts and disproportionate burdens and aligns the policy with federal guidance as described in the Phase One memo. The DI/DB Policy must demonstrate that the impact is *caused* by the LRTP projects, that the impact is *significant*, and that it *disproportionately affects* the protected population compared to the non-protected population. The three thresholds address each of those requirements, and each metric must pass all three thresholds for there to be a finding of a disparate impact or disproportionate burden.

The first threshold is the baseline uncertainty threshold. It determines whether the predicted impact for each population group would likely occur or whether it would likely be due to the inherent uncertainty in the modeling process that is used to identify impacts.

The second threshold is the practical impact threshold. It determines whether the impact would be practically significant. (An impact that is practically significant is one that would have a demonstratable effect on people's quality of life. For example, an increase in carbon monoxide emissions that affects health outcomes.) The change between the no-build and build scenarios for each population group is compared to the practical impact threshold.

The third threshold is the disproportionality threshold. It determines whether the impact would adversely affect the protected population more than the non-protected population.

3.3 Development of the Practical Impact Threshold

In Phase One, staff identified the uncertainty associated with each of the 10 metrics that are used in the baseline uncertainty threshold. The purpose of Phase Two was to develop thresholds for the practical impact and disproportionality thresholds. In Phase One, stakeholders stated that they did not want the policy to allow any difference between the impacts to the protected and non-protected populations, unless there was evidence that a certain level of change rose to the level of being significant in terms of its effects on people's quality of life. Staff conducted a literature review to answer that question.

Identifying practical impact thresholds was a unique challenge because of the character of the distribution of the impacts analyzed in the DI/DB Policy. Because of the large geographic area covered by the analysis, transportation analysis zone (TAZ) values range, for example, from very low to very high travel times—yet the threshold is applied to the regional average. Using an absolute value (such as minutes of travel time) as the threshold would be useful for one part of the distribution (such as short travel times), but less useful for other parts. For that reason, staff sought to develop thresholds that were expressed as percentage changes. (See the Appendix for more details regarding analyses of the distribution of values across TAZs.)

Travel Time and Congested VMT Metrics

The goal for setting a practical impact threshold for travel time was to determine the magnitude of change in travel time that would be significant. (Because congested VMT can be understood as the amount of extra time a driver spends in traffic compared to an entire free flow trip, this metric was grouped with the travel time metrics.)

There is a large body of travel time literature on commute trips. Studies have shown that longer commutes lead to declines in mental and physical health, including headaches, high blood pressure, poor sleep, and high stress levels, among other symptoms. While every additional minute of commuting time affects well-being, that minute is a larger percentage of travel time for those with shorter commutes than it is for those with longer commutes. Therefore, a percentage change would be a more accurate way to express a threshold.[2,] Staff did not find any research, however, that suggested such a cutoff.

[2] Annette Schaefer, "Commuting Takes Its Toll," *Scientific American,* October 1, 2005, https://www.scientificamerican.com/article/commuting-takes-its-toll/; Office for National Statistics, "Commuting and Personal Well-being, 2014," The National Archives, February 12, 2014, https://webarchive.nationalarchives.gov.uk/20160105231823/http://www.ons.gov.uk/ons/rel/w

Staff also explored whether the value of travel time (VTT) could provide useful information for setting the threshold. Because cost is a variable in the travel demand model, travel time can be converted to monetary cost. VTT can be defined as the cost of time spent on traveling. It is most commonly expressed as a percentage of hourly wages. There are many variables that affect the VTT for a given traveler. These include

- trip purpose (for example, commute trips versus leisure trips);
- whether the trip is paid for by one's employer or paid by the traveler;
- traveler income;
- trip reliability;
- traveler preferences;
- the level of congestion (for auto or bus trips);
- trip mode;
- comfort level, such as amount of crowding on a bus; and
- whether the passenger is sitting or standing, wait time, and distance to/from the stops (for public transit trips).[3]

The model can produce metrics that break out travel times for some of these variables, such as mode, trip purpose, and congestion level, but for other variables, such as traveler preference, it would likely be impractical. Because of the number of factors that contribute to VTT, incorporating all of them into one metric would be impractical for the purposes of this analysis. Setting one value for an entire population would only incorporate a few of these variables and would exclude important differences in the variables that affect VTT. In addition, staff were unable to find any literature that suggested when a change in travel time is significant. Because of the many variables that go into measuring VTT, it did not prove to be a useful avenue through which to develop thresholds for travel time metrics.

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ellbeing/measuring-national-well-being/commuting-and-personal-well-being--2014/art-commuting-and-personal-well-being.html#tab-abstract.

[3] Victoria Transport Policy Institute, "Transportation and Travel Time Costs," in *Transportation Cost and Benefit Analysis: Techniques, Estimates, and Implications,* March 20, 2020, https://www.vtpi.org/tca/tca0502.pdf.

Carbon Monoxide

Breathing air with high levels of CO reduces the amount of oxygen available to critical organs, such as the heart and the brain. One major source of CO is vehicles. Because of the health effects of CO, especially for sensitive populations, it is prudent to think of air quality as meeting a certain standard developed to reflect health impacts. Staff explored using national and state CO standards as the practical impact threshold.

The MPO measures CO emissions in kilograms per square mile, which is based on the vehicle types, volumes, and trips made within each TAZ. To identify levels that are damaging to health, staff reviewed emission targets set by state and national agencies. Staff focused on primary targets, which provide public health protection, including for sensitive populations (such as people with asthma, children, and the elderly). The Environmental Protection Agency's (EPA) primary targets are 30 micrograms per meter cubed (mcg/m^3) (90 parts per million [PPM]) for one hour and 10 mcg/m^3 (9 ppm) for eight hours.[4] The Massachusetts Environmental Protection Agency (MEPA) standards are identical to EPA standards.[5]

Staff found several roadblocks that limited the usefulness of these standards. The standards pertain to data collected from point locations, whereas the impacts generated by the model reflect emissions in all MPO TAZs. In addition, the EPA and MEPA reports CO emissions standards as volumes (parts per million or microgram per meter), which cannot be meaningfully converted to kilograms. Because of these differences, EPA (and MEPA) thresholds for unhealthy levels of CO were not useable for the purposes of the DI/DB Policy.

Accessibility Metrics

The accessibility metrics measure access to land uses is critical to residents' quality of life. While much research analyzes access to these opportunities, as well as differences in access between protected and non-protected populations, nothing indicates how large a reduction in access would be harmful, perhaps suggesting that any decrease would be harmful.[6]

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[4] United States Environmental Protected Agency, NAAQS Table, last updated December 20, 2016, https://www.epa.gov/criteria-air-pollutants/naaqs-table.

[5] Ambient Air Quality Standards for the Commonwealth of Massachusetts, 310 C.M.R. 6.00 (2019), https://www.mass.gov/doc/310-cmr-600-ambient-air-quality-standards/download.

[6] Joseph Galaskiewicz, Kathryn Freeman Anderson, and Kendra Thompson-Dyck, "Minority-White Income Inequality across Metropolitan Areas: The Role of Racial/Ethnic Residential Segregation and Transportation Networks," *Journal of Urban Affairs* 0, no. 0 (October 31, 2019): 1–24. https://doi.org/10.1080/07352166.2019.1660581; Armin Jeddi Yeganeh, Ralph Hall, Annie Pearce, and Steve Hankey, "A Social Equity Analysis of the U.S. Public

Staff also explored how other MPOs analyze access to various opportunities, since these types of metrics are common to many MPOs. Staff found that there is no standard across MPOs, and many analyses are qualitative. For example

- How many (jobs, healthcare, etc.) could someone reach within X minutes using (insert transportation mode)?
- What percentage of people get to their destination within X minutes?
- How many (jobs, healthcare, etc.) are within X miles using (travel mode)?

Staff found that MPOs often qualitatively assess accessibility for protected populations, such as comparing EJ results to total for region without stating whether there's a DI or DB.[7] The San Diego Council of Governments uses a 20 percent threshold to identify disparate impacts and disproportionate burdens—for accessibility metrics as well as all of its metrics—but it is not related to the magnitude of actual impact on population groups.[8] The Metropolitan Transportation Commission (the San Francisco area MPO) uses statistical significance.[9] In light of this research, staff found there was no indication that suggested that any decrease in accessibility would not be harmful.

4 STAKEHOLDER WORKING GROUP

As part of this study, staff reconvened the same stakeholder working group that was previously gathered during Phase One. The purposes of the meeting were to (1) gather feedback from stakeholders on staff's threshold recommendations; (2) illustrate the benefits and drawbacks of using different thresholds through the DI/DB threshold application; and (3) show the role that the policy plays within the MPO's broader approach to equity.

The meeting took place on August 25, 2020. Stakeholders included Boston region MPO members, representatives from several advocacy groups, and

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Transportation System Based on Job Accessibility," *Journal of Transport and Land Use* 11, no. 1 (November 13, 2018), https://doi.org/10.5198/jtlu.2018.1370.

[7] Southern California Council of Governments, *Regional Transportation Plan: 2012-2035: Environmental Justice Appendix*, April 2012, http://rtpscs.scag.ca.gov/Documents/2012/final/SR/2012fRTP_EnvironmentalJustice.pdf.

[8] San Diego Association of Governments, *San Diego Forward: The 2019 Federal Regional Transportation Plan*, October 2019, https://sdforward.com/docs/default-source/2019federalrtp/draftfinal/app-h---social-equity-engagement-and-analysis.pdf?sfvrsn=247ff65_2.

[9] Metropolitan Transportation Commission, *Plan Bay Area 2040: Final Equity Analysis Report*, July 2017, http://2040.planbayarea.org/sites/default/files/2017-07/Equity_Report_PBA%202040%20_7-2017.pdf.

representatives of human service agencies, for a total of 12 participants. The meeting was also open to members of the public; there were 29 non-CTPS staff attendees, including stakeholders. Although the first three stakeholder working group meetings were convened in person, this meeting was conducted via the Zoom online meeting platform because the COVID-19 pandemic prohibited in-person meetings. The first half of the meeting was dedicated to reminding attendees the role of the DI/DB Policy and showing them the proposed revisions to the draft policy, and the second half consisted of guided discussions in small and large groups to gather reactions from stakeholders.

Stakeholders were overall supportive of the proposed changes. Stakeholders provided the following comments:

- Moderate uncertainty is a fair baseline in the uncertainty threshold—it recognizes that modeling is not perfect.
- Stakeholders felt staff incorporated their feedback from previous meetings.
- It is acceptable to err on the side of false positives (where a disparate impact or disproportionate burden is identified that likely would not actually exist).
- The MPO needs to balance disparate impact and disproportionate burden findings with the fact that projects often also do a lot of good as well.
- Some attendees suggested that staff consider moving the baseline uncertainty threshold to after the practical impact threshold. This would prevent cutting off analysis before seeing the projected impacts of those metrics whose impacts fall within the baseline uncertainty threshold. While this alternative approach would not change the result of the analysis, it would give the MPO more information about the impact. The proposed order of the thresholds reflects the process of identifying disparate impacts espoused by federal guidance, but with the DI/DB threshold application, each step is separately analyzed so staff can provide this information to the MPO.

Stakeholders also provided the following recommendations for future MPO work:

- Conduct a sensitivity analysis of the projects being analyzed to see if or when projects start to show impacts.
- Address existing inequities through the MPO's other equity work.
- Provide more information on what the MPO would do if a disparate impact or disproportionate burden is found—this is explained in the final version of the DI/DB Policy.

5 THRESHOLD RECOMMENDATIONS

Staff developed the following threshold recommendations for the DI/DB Policy, which were proposed to the stakeholder working group. They are incorporated into the final DI/DB Policy.

- **Baseline Uncertainty Threshold: moderate uncertainty.** Staff considered three possible threshold values: low, moderate, and high uncertainty. Moderate uncertainty reflects the uncertainty that can be expected from the model and the metrics that are analyzed. (For ease of analysis, MPO staff divided possible baseline uncertainty thresholds into three categories: low, moderate, and high. A low threshold would mean staff are very confident that the model accurately represents future travel conditions. High uncertainty would mean staff are less confident that the model does so.)
- **Practical Impact Threshold: 0 percent.** Based on the literature review findings described above, staff did not find a compelling reason to set the threshold above zero for any of the metrics for a large group of people. Without being able to identify instances where impacts are significant for each of the metrics, staff felt that an instance of any impact should be considered significant, especially since any changes for several metrics can be harmful to human health. Setting the practical impact threshold to 0 percent also accounts for the uneven distribution of impacts across the region and for different populations.
- **Disproportionality Threshold: 0 percent.** Stakeholders recommended that the policy not allow protected populations to be disproportionately affected by MPO investments to prevent exacerbation of existing inequities between protected and non-protected populations. MPO staff agreed with this conclusion, including it in the draft DI/DB Policy. Staff retained this threshold in the final version of the DI/DB Policy.

6 NEXT STEPS AND CONCLUSION

In the fall of 2020, staff will seek the MPO's endorsement of a final DI/DB Policy, which will incorporate the revisions described in this memo. Prior to the next LRTP, staff will also update existing metrics and add new ones that are analyzed for disparate impacts and disproportionate burdens. The MPO will use both the metrics and the final DI/DB Policy in the next LRTP.

The Boston Region Metropolitan Planning Organization (MPO) operates its programs, services, and activities in compliance with federal nondiscrimination laws including Title VI of the Civil Rights Act of 1964 (Title VI), the Civil Rights Restoration Act of 1987, and related statutes and regulations. Title VI prohibits discrimination in federally assisted programs and requires that no person in the United States of America shall, on the grounds of race, color, or national origin (including limited English proficiency), be excluded from participation in, denied the benefits of, or be otherwise subjected to discrimination under any program or activity that receives federal assistance. Related federal nondiscrimination laws administered by the Federal Highway Administration, Federal Transit Administration, or both, prohibit discrimination on the basis of age, sex, and disability. The Boston Region MPO considers these protected populations in its Title VI Programs, consistent with federal interpretation and administration. In addition, the Boston Region MPO provides meaningful access to its programs, services, and activities to individuals with limited English proficiency, in compliance with U.S. Department of Transportation policy and guidance on federal Executive Order 13166.

The Boston Region MPO also complies with the Massachusetts Public Accommodation Law, M.G.L. c 272 sections 92a, 98, 98a, which prohibits making any distinction, discrimination, or restriction in admission to, or treatment in a place of public accommodation based on race, color, religious creed, national origin, sex, sexual orientation, disability, or ancestry. Likewise, the Boston Region MPO complies with the Governor's Executive Order 526, section 4, which requires that all programs, activities, and services provided, performed, licensed, chartered, funded, regulated, or contracted for by the state shall be conducted without unlawful discrimination based on race, color, age, gender, ethnicity, sexual orientation, gender identity or expression, religion, creed, ancestry, national origin, disability, veteran's status (including Vietnam-era veterans), or background.

A complaint form and additional information can be obtained by contacting the MPO or at http://www.bostonmpo.org/mpo_non_discrimination. To request this information in a different language or in an accessible format, please contact

Title VI Specialist
Boston Region MPO
10 Park Plaza, Suite 2150
Boston, MA 02116
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DISPARATE IMPACT METRICS STUDY APPENDIX

This technical appendix describes how metrics analyzed for disparate impacts and disproportionate burdens (DI/DB) as part of this study were defined, and how the thresholds are applied to the metric impacts that are identified. In addition, the appendix discusses an analysis of the distribution of impacts by transportation analysis zone (TAZ).

1 METRICS ANALYZED FOR DISPARATE IMPACTS AND DISPROPORTIONATE BURDENS

The DI/DB analysis assesses the impacts of several metrics that are projected to occur in the outer year of the Long-Range Transportation Plan (LRTP) (2040 in the case of the most recent LRTP, *Destination 2040*). Using a travel demand model, impacts are analyzed for each TAZ in the Metropolitan Planning Organization (MPO) region, which are then aggregated for the entire region.[1]

1.1 Accessibility Metrics

Accessibility metrics determine the number of various types of destinations that are reachable within a given travel time by public transit. The metrics were

- jobs within a 60-minute public transit trip;
- retail within a 60-minute public transit trip;
- healthcare services within a 40-minute public transit trip; and
- two- and four-year institutions of higher education within a 40-minute public transit trip.

The average number of destinations was calculated for each of the four population groups, based on their respective share of the population within each TAZ. Access to jobs was determined by calculating the total number of jobs accessible by public transit. Access to retail opportunities was determined by calculating the total number retail jobs accessible by public transit. Access to higher education was determined by calculating the total available student seats (based on current student enrollment) accessible by public transit. Access to

[1] 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 as small as city blocks or buildings in (more densely developed) central business districts. The MPO region is divided into 1,901 TAZs.

healthcare was determined by calculating the total number of hospital beds accessible by public transit.

1.2 Mobility Metrics

The mobility metrics evaluate the door-to-door travel time for trips starting or ending in MPO TAZs. The mobility metrics were

- average travel times for public transit trips starting in the MPO;
- average travel times for public transit trips ending in the MPO;
- average highway travel times for auto trips starting in the MPO; and
- average highway travel times for auto trips ending in the MPO.[2]

Average travel times were calculated for each of the population groups, based on their respective share of the population within each TAZ. Trips that end in TAZs were those generated by non-household land uses (such as retail, employment, health care, and education) within the MPO region. They originate either from households within or from outside of the region.[3] Trips that start in TAZs were those trips generated by households. The trips end either within another TAZ within or outside of the region.

1.3 Environmental Metrics

The two environmental metrics were congested vehicle-miles traveled (VMT) and carbon monoxide (CO) emissions. While the other metrics evaluated the impacts affecting users of the roadway or public transit system, these metrics assessed the VMT and CO impacts on residents in each TAZ. Both were calculated using highway trips only. The CO metric assessed the kilograms of CO emissions per square mile within each TAZ. The congested VMT metric assessed the volume-to-capacity ratio on the roads within or adjacent to each TAZ; those with a ratio of 0.75 or greater were considered congested.

2 APPLYING THRESHOLDS

The DI/DB Policy will consist of a three-test investigation that uses three thresholds to identify disparate impacts and disproportionate burden: (1) baseline uncertainty threshold, (2) practical impact threshold, and (3) disproportionality threshold.

[2] Highway trips consist of automobile and truck trips taken on any road in the MPO region. It does not include bus trips.

[3] Trips ending or originating outside of the MPO region are only those within the modeled area, which includes all of Massachusetts and Rhode Island, as well as southern New Hampshire. Only surface transportation trips are included—air travel is not.

2.1 Baseline Uncertainty Threshold

The baseline uncertainty threshold sets the sensitivity for detecting if a change between the no-build and build scenarios would likely exist, or whether it would likely be due to the inherent uncertainty in the modeling process.[4] It is applied to the no-build and build scenarios for each population group in a pair—minority/nonminority populations and low-income/non-low-income populations. A zero percent threshold indicates confidence that the impacts produced by the model would occur. A higher threshold indicates greater uncertainty about whether the impact would occur.

For a metric to pass the baseline uncertainty test and therefore be identified as an impact, it must exceed the threshold for one or more population groups in each pair. If neither population group is likely to experience an impact, then it would indicate that there would be no disparate impact or disproportionate burden, and no further analysis would be needed.

2.2 Practical Impact Threshold

The practical impact threshold is applied to the difference (or impact) between the no-build and build scenarios for each of the four population groups. The change between the no-build and build scenarios for each population group is compared to the practical impact threshold, calculated as a percent change:

$$\%\,\boldsymbol{change} = \frac{(\boldsymbol{build} - \boldsymbol{nobuild})}{\boldsymbol{nobuild}} \times \mathbf{100}$$

A positive percent change indicates a benefit when an increase results in a beneficial impact, as is the case for the accessibility metrics. For the environmental and mobility metrics, a positive percent change is considered a burden, as an increase would be harmful.

This calculation does not account for the baseline uncertainty from the first step. It uses the build and no-build scenario results regardless of the uncertainty associated with them. A percent change of zero indicates there would be no difference between the build and no-build scenarios. To pass the practical impact test, the impact must exceed the threshold for at least one population group in a pair.[5] If neither of the population groups exceeds the threshold, there would be

[4] The no-build scenario is where the projects under analysis are not included in the travel scenario that is analyzed for impacts; the build-scenario is where the projects under analysis are included in the travel scenario that is analyzed.

[5] There are two cases in which a disparate impact or disproportionate burden is identified by the practical impact threshold without having to use the disproportionality threshold: when the

no disparate impact or disproportionate burden and no further analysis would be needed.

2.3 Disproportionality Threshold

Disproportionality is calculated as a ratio comparing the absolute value of the percent change for the protected population to the absolute value of the percent change for the non-low-income population. For example,

$$\boldsymbol{ratio} = \frac{|\%\ \boldsymbol{change}_{\boldsymbol{minority}}|}{|\%\ \boldsymbol{change}_{\boldsymbol{nonminority}}|}$$

When the ratio equals one, the impacts to the two populations are projected to change at the same rate. At a ratio greater than one, the protected population changes more than the non-protected population. At a ratio less than one, the protected population changes less than the non-protected population. The threshold allows for a percentage range surrounding a ratio of one such that within this range, it does not indicate a potential disparate impact or disproportionate burden. For example, a disproportionality threshold of 10 percent would mean that ratios between 0.90 to 1.10 would not be flagged as a disparate impact or disproportionate burden. For the accessibility metrics, ratios above that range would be flagged. For the mobility and environmental metrics, ratios below that range would be flagged.

3 ANALYSIS OF THE DISTRIBUTION OF IMPACTS BY TAZ

Staff developed an application to facilitate the exploration of how different thresholds would affect the identification of disparate impacts and disproportionate burdens. Using the results from the 10 metrics analyzed in *Destination 2040,* users can vary each of the three thresholds to visualize the effect on the identification of disparate impacts and disproportionate burdens.

The application is modeled after the three-step investigation described above: would there be an impact; if so, would the impact be significant; and if it would be significant, would the protected population be more disproportionately affected than the non-protected population? Users can adjust the threshold that accompanies each step, allowing them to sort through potential DI/DB outcomes to help decide which thresholds should be used in the DI/DB Policy.

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protected population burdens are beyond the threshold and the non-protected population benefits are either beyond the threshold or within the threshold.

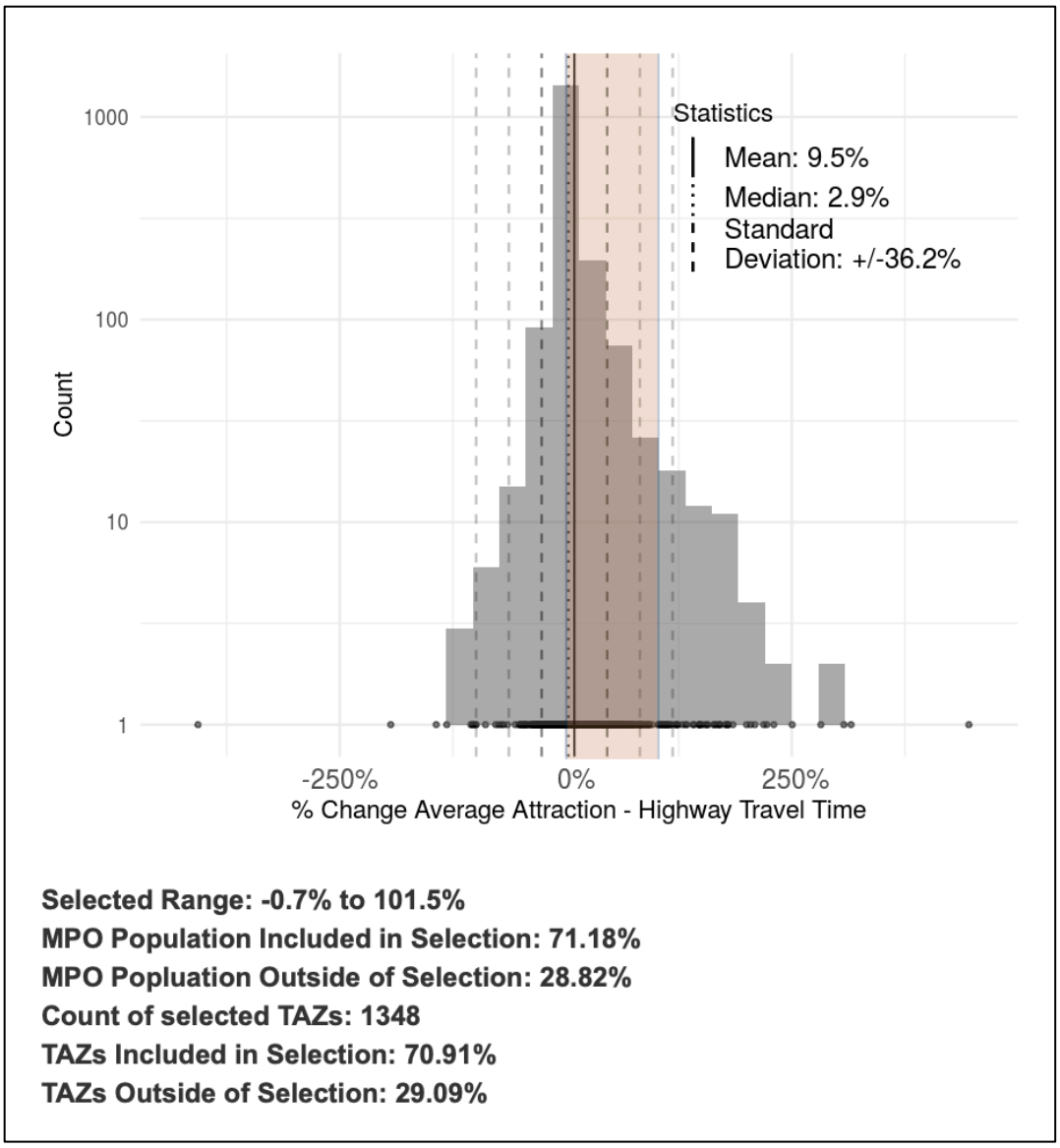
The application also allowed staff to explore other options for the practical impact threshold. The practical impact threshold described above uses weighted averages for the MPO region. Using the application, staff explored if there was an alternative method for setting an impact threshold by analyzing the distribution of the model results for each TAZ in the MPO region. Instead of using the regionwide averages for each population, staff used the model results for each TAZ.

Staff investigated the distribution of the impact for each metric by TAZ to determine whether there appeared to be a logical point in the distribution at which impacts changed significantly. To do so, staff used the same percent change formula as described above for the practical impact threshold.

Figure 1 shows the results, produced with the DI/DB threshold application, using the percent change for the average attraction for highway travel time metric. The Y axis shows the count of TAZs, represented by each bar in the histogram, on a logarithmic scale.[6] The dots below the histogram represent the percent change for each individual TAZ. To characterize the spread of the change across MPO TAZs, the summary statistics for each metric are reported as well. The user can select a range values on the histogram; the histogram reports the population included in the selection, the count of selected TAZs, and the number of TAZs included in the selection. The orange selection box represents the range associated with the selected percent change.

Figure 1
Distribution of the Percent Change in Average Attraction Highway Travel Times, by MPO TAZ

[6] A logarithmic scale is a way of displaying data over a wide range of values. Instead of each number on the scale being equally spaced, each is 10 times that of the preceding number.



MPO = metropolitan planning organization. TAZ = transportation analysis zone.

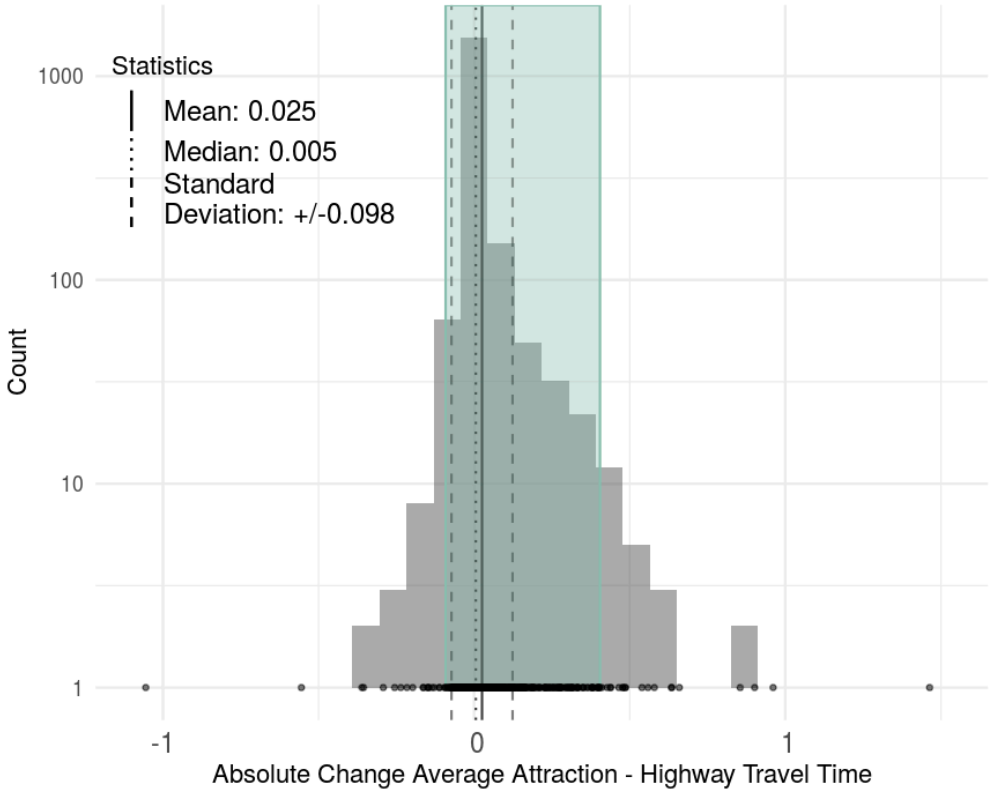
Staff also explored setting thresholds based on the absolute change between the build and no-build scenarios for every TAZ, exploring deriving threshold values based on the median change in a metric's value for a certain percentage of TAZs. For each TAZ, staff calculated the absolute change:

$$absolute\ change\ =\ build - nobuild$$

For example, the range that resulted from identifying the middle 50 percent of TAZs was calculated by finding the absolute change associated with the 25th percentile of TAZs and the 75th percentile of TAZs. Similarly, the middle 98 percent of TAZs was calculated by finding the absolute change associated with the first percentile and the 99th percentile. Figure 2 shows the absolute change

for all TAZs in the MPO region for the average attraction highway travel time metric using the DI/DB threshold application. The green selection box represents the range of absolute change derived from the middle percentile of TAZs associated with the selected radio button (98 percent). Below the histogram is a summary of statistics associated with the selection within the highlighted percentile.

Figure 2
Distribution of the Absolute Change in Average Attraction Highway Travel Times, by MPO TAZ



Selected Range: -0.092 to 0.405
MPO Population Included in Selection: 98.48%
MPO Popluation Outside of Selection: 1.52%
Count of selected TAZs: 1863
TAZs Included in Selection: 98%
TAZs Outside of Selection: 2%
Note: Selected range is inclusive.

MPO = metropolitan planning organization. TAZ = transportation analysis zone.

The distribution of the changes in travel time—both the absolute values and percent changes—was fairly widely distributed around the mean, while for the

environmental and accessibility metrics the values were much more tightly gathered around the mean. Staff also found that analyzing the distribution of changes by TAZ—both absolute values and percent change—identifies outliers rather than a point along the distribution that indicates a significantly larger impact. For metrics where the impacts are clustered around the mean, there simply was not a big enough variation to identify such a break point. For those metrics with more variation, if most of the TAZs had large changes, the metric would not move past the practical impact test regardless of the magnitude of the impacts. This approach would just show that most of the TAZs had similar impacts rather than identify meaningful changes.