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CONTRIBUTORS

ICF Hannah Twaddell and ICF Beth Zgoda; Transit Cooperative Research Program; Transportation Research Board; National Academies of Sciences, Engineering, and Medicine

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TRANSIT COOPERATIVE RESEARCH PROGRAM

TCRP RESEARCH REPORT 214

**Equity Analysis in
Regional Transportation
Planning Processes**

Volume 1: Guide

Hannah Twaddell

ICF
Charlottesville, VA

AND

Beth Zgoda

ICF
Washington, DC

Subject Areas

Public Transportation • Planning and Forecasting • Policy

Research sponsored by the Federal Transit Administration in cooperation with the Transit Development Corporation

The National Academies of
SCIENCES • ENGINEERING • MEDICINE



TRANSPORTATION RESEARCH BOARD

2020

TRANSIT COOPERATIVE RESEARCH PROGRAM

The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands. Research is necessary to solve operating problems, adapt appropriate new technologies from other industries, and introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

The need for TCRP was originally identified in *TRB Special Report 213—Research for Public Transit: New Directions*, published in 1987 and based on a study sponsored by the Urban Mass Transportation Administration—now the Federal Transit Administration (FTA). A report by the American Public Transportation Association (APTA), *Transportation 2000*, also recognized the need for local, problem-solving research. TCRP, modeled after the successful National Cooperative Highway Research Program (NCHRP), undertakes research and other technical activities in response to the needs of transit service providers. The scope of TCRP includes various transit research fields including planning, service configuration, equipment, facilities, operations, human resources, maintenance, policy, and administrative practices.

TCRP was established under FTA sponsorship in July 1992. Proposed by the U.S. Department of Transportation, TCRP was authorized as part of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). On May 13, 1992, a memorandum agreement outlining TCRP operating procedures was executed by the three cooperating organizations: FTA; the National Academies of Sciences, Engineering, and Medicine, acting through the Transportation Research Board (TRB); and the Transit Development Corporation, Inc. (TDC), a nonprofit educational and research organization established by APTA. TDC is responsible for forming the independent governing board, designated as the TCRP Oversight and Project Selection (TOPS) Commission.

Research problem statements for TCRP are solicited periodically but may be submitted to TRB by anyone at any time. It is the responsibility of the TOPS Commission to formulate the research program by identifying the highest priority projects. As part of the evaluation, the TOPS Commission defines funding levels and expected products.

Once selected, each project is assigned to an expert panel appointed by TRB. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, TCRP project panels serve voluntarily without compensation.

Because research cannot have the desired effect if products fail to reach the intended audience, special emphasis is placed on disseminating TCRP results to the intended users of the research: transit agencies, service providers, and suppliers. TRB provides a series of research reports, syntheses of transit practice, and other supporting material developed by TCRP research. APTA will arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by urban and rural transit industry practitioners.

TCRP provides a forum where transit agencies can cooperatively address common operational problems. TCRP results support and complement other ongoing transit research and training programs.

TCRP RESEARCH REPORT 214, VOLUME 1

Project H-54
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In Memoriam Statement of Appreciation to TCRP H-54 Panel Member Nikki Tishler (Deceased March 25, 2018)

Nikki Tishler was a transportation planner and Title VI strategist with the Office of Transportation Planning of the Massachusetts Department of Transportation, supporting capital planning and civil rights compliance activities at the agency. With a background in community organizing, Nikki was passionate about promoting civic engagement and improving public participation processes so that public-sector activities would reflect the needs and wants of the public. In her role as Title VI strategist, Nikki saw the consideration of civil rights and transportation equity as an opportunity to improve the customer experience for the diverse constituencies served by the Massachusetts Department of Transportation. Nikki held a joint Master of Public Policy and Master of Arts in Women's and Gender Studies from Brandeis University's Heller School for Social Policy and Management and a Bachelor of Arts in Civic Engagement and the Politics of Representation from the University of Massachusetts–Amherst.

On April 9, 2018, the Senate of the Commonwealth of Massachusetts approved a motion to adjourn in honor of Nikki. The text of the motion reads as follows:

The Commonwealth of Massachusetts
JOURNAL OF THE SENATE
Adjourn In Memory of Nikki Tishler

The Senator from Norfolk and Plymouth, Mr. Keenan, moved that when the Senate adjourns today it adjourn in memory of Nikki Tishler. Nikki Tishler passed away after a brief illness on March 25, 2018 at the age of 29 with her father Gary by her side. The loss to her family, friends, colleagues, and the whole MassDOT community is a deep one. Nikki was raised in Easton and most recently lived in Quincy. Her work at MassDOT focused on issues of inclusion and social equity in the transportation planning process, and much of her time was spent on strengthening implementation of Title VI of the Civil Rights Act. She was also the Coordinator of MassDOT's Safe Routes to Schools program and a liaison to three of the Commonwealth's Metropolitan Planning Organizations. Nikki had recently been recognized for her work by the Boston chapter of the Women in Transportation Seminar, which had selected her to be a 2018 Emerging Professional. Nikki was a member of the Fontbonne Academy Class of 2007, earned her Bachelor of Arts from the University of Massachusetts Amherst College of Humanities & Fine Arts, with a concentration in the Women, Gender, and Sexuality Studies program, and went on to receive a Master's degree from the Heller School for Social Policy and Management at Brandeis University. Prior to joining MassDOT, Nikki was a Federal Policy and Communications Fellow at the Sexuality Information and Education Council of the United States and the Director of Operations for Lucky Horse Equine Rescue. She was also a Teaching Fellow at Brandeis and a Research Assistant at UMass. Nikki's devotion to service and her passion to help others was inspirational. She was a fierce advocate for social justice; a good and loyal friend; a volunteer for a suicide prevention hotline; a warm and thoughtful person; a lover of candy, yoga, adventurous travel, and dancing; and an observer of her Jewish faith. As one of her colleagues described her, 'Nikki had the innate ability to promote social wellness, which she was a living example of. Her closest colleagues benefited both professionally and personally from her contagious positivity.' The world will miss her. Accordingly, as a mark of respect in memory of Nikki Tishler, at twenty-six minutes past eleven o'clock A.M., on motion of Mr. Tar, the Senate adjourned to meet again on Wednesday next at eleven o'clock A.M.

The National Academies of **SCIENCES • ENGINEERING • MEDICINE**

The **National Academy of Sciences** was established in 1863 by an Act of Congress, signed by President Lincoln, as a private, non-governmental institution to advise the nation on issues related to science and technology. Members are elected by their peers for outstanding contributions to research. Dr. Marcia McNutt is president.

The **National Academy of Engineering** was established in 1964 under the charter of the National Academy of Sciences to bring the practices of engineering to advising the nation. Members are elected by their peers for extraordinary contributions to engineering. Dr. John L. Anderson is president.

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The three Academies work together as the **National Academies of Sciences, Engineering, and Medicine** to provide independent, objective analysis and advice to the nation and conduct other activities to solve complex problems and inform public policy decisions. The National Academies also encourage education and research, recognize outstanding contributions to knowledge, and increase public understanding in matters of science, engineering, and medicine.

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The **Transportation Research Board** is one of seven major programs of the National Academies of Sciences, Engineering, and Medicine. The mission of the Transportation Research Board is to provide leadership in transportation improvements and innovation through trusted, timely, impartial, and evidence-based information exchange, research, and advice regarding all modes of transportation. The Board's varied activities annually engage about 8,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation.

Learn more about the Transportation Research Board at www.TRB.org.

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CRP STAFF FOR TCRP RESEARCH REPORT 214

Christopher J. Hedges, *Director, Cooperative Research Programs*
Lori L. Sundstrom, *Deputy Director, Cooperative Research Programs*
Gwen Chisholm Smith, *Manager, Transit Cooperative Research Program*
Emily Griswold, *Program Coordinator*
Eileen P. Delaney, *Director of Publications*
Natalie Barnes, *Associate Director of Publications*
Sharon Lamberton, *Editor*

TCRP PROJECT H-54 PANEL **Field of Policy and Planning**

Lee L. Davis, *Lee L. Davis & Associates, Palmdale, CA* (Chair)
Ashley B. Burns, *Burns Innovation Group, New Orleans, LA*
Aida Copic, *Transit Authority of River City, Louisville, KY*
Kayla Marie Ferguson, *RPM Transportation Consultants, LLC, Nashville, TN*
Kristin M. Haldeman, *Arlington Public Schools, Arlington, VA*
Austin Lee, *AC Transit, Oakland, CA*
Heidi Schallberg, *Metropolitan Council, Saint Paul, MN*
Nicole Tishler, *Massachusetts Department of Transportation, Boston, MA* (Deceased)
Ken Zatarain, *WSP, Portland, OR*
Wesley Blount, *FHWA Liaison*
Ken Cervenka, *FTA Liaison*
Christopher E. Zeilinger, *CTAA Liaison*

AUTHOR ACKNOWLEDGMENTS

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FOREWORD

By **Gwen Chisholm Smith**

Staff Officer

Transportation Research Board

TCRP Research Report 214: Equity Analysis in Regional Transportation Planning Processes, Volume 1: Guide documents a five-step equity analysis framework for regional transportation plans and programs. The opening chapters provide a high-level overview of relevant requirements and the analysis framework; quick-reference charts of activities, resources, and guidebook sections that apply particularly to planners, policy makers, analysts, and modelers; and approaches for laying a strong foundation of public and stakeholder engagement to support the entire analysis process. Subsequent chapters provide step-by-step descriptions of methods, examples, and resources to help agencies develop and implement equity analyses that reflect varying regional contexts and agency capabilities. Volume 1 concludes with descriptions of brief pilot projects conducted with four metropolitan planning organizations (MPOs) to test different aspects of the equity analysis framework.

A separate *Research Overview*, published as *TCRP Research Report 214, Volume 2*, describes the results of the research effort conducted to identify ways in which equity in public transportation can be analyzed through an integrated participatory and quantitative approach that is adaptable to plans and programs developed by MPOs in partnership with transit agencies and that relates to environmental justice analysis and Title VI procedures, implementation, and reporting compliance.

The products of this research will be useful to transportation professionals engaged in the process of planning and programming federal transportation funds at MPOs and transit agencies. The reports provide information about methods, tools, and resources that agencies can use to support plans and programs that are compliant with equity-related federal requirements. The guidance and information provided in the reports do not constitute any standard, specification, or regulation.

In metropolitan regions, public services such as transportation, parks, libraries, health services, law enforcement, and affordable housing are often not provided in such a way that all segments of the population have equal access to these services. Barriers can include the physical and socio-economic segregations between population groups that receive greater benefits and/or experience fewer burdens associated with transportation investments, and those that receive fewer benefits or experience higher burdens. Research has shown historic patterns of biased service delivery associated with income, race, color, and national origin, often in relation to urban location. A review of planning documents and reports from over 50 large MPOs shows that a wide variety of approaches have been used in the process with no clear standards, methodologies, metrics, or reporting formats by which plans can be easily evaluated or compared.

This report was prepared by ICF consultants under TCRP Project H-54. The primary objective of this research was to develop a reference guide that identifies and describes how equity in public transportation can be analyzed through an integrated participatory and quantitative approach that is adaptable to planning and development at local and regional levels.

To accomplish these objectives, a focused review of literature, research in progress, and current practices related to equity in transportation plans and programs was conducted. In addition, pilot testing of best practices and technical assistance was completed with four MPOs. Lessons learned through this research were compiled in this reference guide, which leads MPOs through a five-step equity analysis process that integrates quantitative and qualitative approaches.



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Introduction

Transportation agencies that manage federally funded programs and projects are responsible for ensuring that their plans, programs, policies, services, and investments benefit everyone in their jurisdictions equitably. Historically, certain individuals and communities, including those from minority, low-income, and limited English proficiency (LEP) populations, have not benefited equitably from transportation investments and programs. Understanding the impacts of transportation investments on these individuals and communities and taking steps to address inequities are critical functions of transportation agencies.

This guide describes a five-step framework for conducting an equity analysis for regional transportation plans and programs developed by metropolitan planning organizations (MPOs). Each step includes detailed methods and examples to help an agency develop and implement equity analyses that best meet the unique context of a community. After the fifth step, the guide provides a list of the major elements of each step and resources that can assist with that step.

Purpose and Target Audience

This reference guide is designed to help MPOs to analyze and address equity effectively in long-range, regional, multimodal transportation planning and programming processes. Equity analyses should be designed to support the legal requirements of Title VI of the 1964 Civil Rights Act (Title VI) as elucidated by the 1994 Executive Order 12898 on Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (hereafter referred to as E.O. 12898). Equity analyses should also include related assessments and engagement activities required for MPOs to comply with the 2000 Executive Order 13166 on Improving Access to Services for Persons with Limited English Proficiency (LEP) (hereafter, E.O. 13166). In accordance with the requirements set forth in Title VI and elucidated by the two executive orders, MPOs must conduct analyses of the Metropolitan Transportation Plan (MTP), the Transportation Improvement Program (TIP), and other plans and projects to ensure equitable access to their services and decision-making processes, and an equitable distribution of the benefits and burdens generated by transportation investments. In this report, Volume 1 (the guide) provides quantitative and qualitative options for equity analyses, whereas Volume 2 (the technical report) summarizes the research process and policy considerations.

Many of the approaches and concepts presented in this guide also can be applied to project-level assessments conducted by transit agencies, state departments of transportation (DOTs), local public works departments, and other transportation agencies. It is important to note, however, that project-level equity analyses are subject to detailed requirements that are not addressed deeply in this report. The focus of this guide is on the broader regional planning and decision-making processes that typically precede detailed project studies.

2 Equity Analysis in Regional Transportation Planning Processes

MPOs are responsible for long-term transportation planning and for programming federal transportation funds in U.S. urban regions where 50,000 or more people occupy two or more jurisdictions. Every 4 years, each MPO adopts an MTP that outlines a 20-year (or longer) vision for the transportation system, accounting for all of the current and proposed transportation investments to be supported by estimated funds from federal, state, and local sources. To implement the MTP, the MPO adopts and regularly updates a short-term TIP that lists and designates funding for all regionally significant transportation projects to be moved forward during a period of 4 or more years.

What Does Equity Mean for Transportation Planners?

The following excerpts from materials published by the U.S. DOT, FTA, and FHWA discuss some key terms and concepts associated with equity, including *environmental justice* (EJ), *Title VI, non-discrimination*, and *equity*.

According to the U.S. DOT's Environmental Justice Strategy document (dated November 15, 2016),

[e]nvironmental justice is the fair treatment and meaningful engagement of all people, regardless of race, ethnicity, income, national origin, or educational level with respect to the development, implementation and enforcement of environmental laws, regulations and policies.

. . . Fair treatment means that no population, due to policy or economic disempowerment, is forced to bear a disproportionate burden of the adverse human health and environmental impacts, including social and economic effects, resulting from transportation decisions, programs and policies made, implemented and enforced at the Federal, State, local or tribal level.

The FTA's Circular 4703.1 (dated August 15, 2012) comments on the agency's commitment to EJ, specifically that the agency seeks to make EJ

. . . part of our mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of our programs, policies, and activities on minority populations and/or low-income populations (collectively, 'EJ populations'). Environmental justice at

What is *Equity* in Transportation?

Equity in transportation seeks fairness in mobility and accessibility to meet the needs of all community members. A central goal of transportation equity is to facilitate social and economic opportunities by providing equitable levels of access to affordable and reliable transportation options based on the needs of the populations being served, particularly populations that are traditionally underserved. This population group includes low income individuals, minority individuals, elderly persons, children, people with LEP, and/or persons with disabilities.

An equitable transportation plan considers the circumstances that impact a community's mobility and connectivity needs, and this information is used to determine the measures needed to develop an equitable transportation network. To attain an equitable transportation network, all components of Title VI, EJ, and non-discrimination must be considered.

Source: FHWA EJ program website (www.fhwa.dot.gov/environment/environmental_justice/equity)

FTA includes incorporating environmental justice and non-discrimination principles into transportation planning and decision-making processes as well as project-specific environmental reviews.

As federal financial recipients, MPOs are responsible for managing their programs in accordance with federal requirements, and FTA is responsible for ensuring that recipients follow federal statutory and administrative requirements.

Further, the FHWA's *Environmental Justice Reference Guide* (dated April 1, 2015) states,

EJ at FHWA means identifying and addressing disproportionately high and adverse effects of the agency's programs, policies, and activities on minority populations and low-income populations to achieve an equitable distribution of benefits and burdens. This also includes the full and fair participation by all potentially affected communities in the transportation decision-making process.

Why Conduct Equity Analyses?

A strong transportation system provides all community residents with equitable access to economic opportunities, such as jobs or schools, and to destinations that are vital to health and livability such as grocery stores and healthcare. However, transportation projects can also have adverse effects on the quality of life, such as increasing pollution or bisecting communities. Historically, the benefits and costs of transportation investments have often been distributed inequitably, with underserved persons bearing a higher share of the burdens of the transportation system and a lower share of the benefits. Recognizing these patterns of inequity in transportation decision making, federal policies were implemented that have required regional agencies to consider equity impacts in their planning processes.

A comprehensive regional equity analysis can support (but not replace) an MPO's Title VI plan, LEP, and/or EJ documentation. That said, this report is not intended to provide detailed guidance on meeting federal requirements. Rather, it focuses more broadly on approaches and methods for using equity analyses to support regional plans and initiatives that strive to address the current and anticipated needs of underserved persons, and to correct decision-making patterns that have generated unbalanced benefits or burdens in the past.

By conducting robust equity analyses and addressing identified inequities within the transportation system, an MPO can improve its ability to make transportation investments that contribute to the health, prosperity, and quality of life for all persons and communities in a region.

"Since the landmark civil rights legislation of the 1960s, government has primarily used a color-blind approach to combat racial discrimination and establish a race-blind standard. This approach is founded on the well-intended idea of equality, which means that everyone receives the same treatment. Unfortunately, equality assumes sameness—that everyone faces the same barriers. Equality does not take into account historical or current forms of discrimination that are present in our public institutions and structures, such as redlining, which prevented many people of color from owning property and accruing wealth, or predatory lending practices targeting communities of color. As a result, color-blind policies have not reversed racial inequity. People of color continue to experience the worst outcomes."

Source: Oregon Metro Strategic Plan to Advance Racial Equity, Diversity and Inclusion (Oregon Metro 2016)

What Requirements Are Relevant to Equity Analyses?

Three important equity-focused federal laws and directives merit discussion at the outset:

- Title VI of the Civil Rights Act of 1964 (42 U.S.C. § 2000d et seq.);
- E.O. 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (Exec. Order No. 12898, 59 FR 7629 [February 16, 1994]); and
- E.O. 13166, Improving Access to Services for Persons with Limited English Proficiency (Exec. Order 13166, 65 FR 159 [August 16, 2000]).

Title VI prohibits discrimination on the basis of race, color, and national origin in programs receiving federal assistance.

Transportation agencies are legally required to comply with Title VI, and FTA and FHWA monitor their compliance. E.O. 12898 protects low-income persons and minority persons and directs federal agencies to develop an agency-wide EJ strategy to address disproportionately high and adverse effects of their programs, policies, and activities. E.O. 13166 requires federal agencies to identify any need for services to LEP persons and to develop and implement a system to provide language services to LEP persons so that they can have meaningful access to information.

Title VI requires agencies to ensure there is not discrimination based on race, color, and national origin, which involves (1) analyzing whether design, construction, or future changes in service delivery for transportation projects have a disparate impact on those populations, and (2) if disparate impacts are found, either demonstrating that these impacts are unavoidable or identifying ways to mitigate them.

EJ analysis is similar in nature, but focuses on a determination of whether minority and low-income individuals experience disproportionately high and adverse effects at all phases of planning, design, construction, and future changes for a project. Equity analysis for transit planning in the Title VI context usually refers to (1) a siting or locating equity analysis (discussed in FTA Title VI Circular 4702.1B, Chapter 3, Section 13); (2) a service equity analysis (discussed in the Circular in Chapter 4, Section 7.a); or (3) a fare equity analysis (discussed in the Circular in Chapter 4, Section 7.b). In practice, the analysis that would arise specifically for MPOs is discussed in the Circular in Chapter 6, Section 2.a(5) and is folded into review of the demographic maps required by Chapter 6, Section 2.a(4).

The requirements of the Title VI statute and E.O. 12898 are distinct, but, there is overlap between the two, and transportation agencies often conduct regional equity analyses that address Title VI, EJ, and other non-discrimination regulations.

E.O. 13166 requires agencies to make federally funded services, programs, and activities accessible to persons with a limited ability to read, write, speak, or understand English. This executive order does not require an analysis of potentially disparate benefits and burdens of transportation investments on LEP populations; however, consideration of LEP needs and concerns can complement an equity analysis. Guidance issued by the U.S. Department of Justice (DOJ) in 2002 notes that failure to ensure that LEP persons can effectively participate in or benefit from federally assisted programs and activities may violate the Title VI prohibition against national origin discrimination.

To support compliance with both the Title VI statute and E.O. 12898, transportation agencies must identify required populations. For Title VI analyses, agencies must analyze whether proposed plans or projects have a disparate impact on protected population groups. The EJ analysis process involves analyzing whether proposed plans or projects could generate disproportionately high and adverse effects on one or more covered groups. The authorities and requirements associated with these federal policies differ—compliance with one does not necessarily indicate

compliance with the other. It is helpful, however, to consider the implications of both when evaluating the impacts of a proposed plan or project, as noted in the following example:

For example, while a bus rehabilitation project may not impose disproportionately high AND adverse effects on EJ populations, the use of those buses subsequent to the rehabilitation may be subject to a Title VI analysis to ensure that vehicles assigned to a particular area do not result in a disparate impact on the basis of race, color, or national origin. In addition, if there are substantive changes to the service levels in the future for which the rehabilitated or other buses will be used, i.e., the vehicles are deployed in such a way that the nature and quantity of service in a particular area is changed, then a service equity analysis must be conducted under Title VI to determine whether this change results in a disparate impact on the basis of race, color, or national origin (FTA Circular 4702.1B).

“Because many planning documents and processes require joint review from FHWA and the Federal Transit Administration (FTA), Division Office planners should coordinate with FTA regional staff to ensure that recipients meet the EJ requirements of both agencies. The agencies’ approaches are similar, since FHWA and FTA are both governed by joint planning regulations and the TMA [Transportation Management Area] planning certification process. However, coordination is important because they each have different EJ policies that respond to the uniqueness of their programs. The FTA EJ Circular 4703.1 provides information specific to transit. FHWA and FTA are jointly responsible for providing oversight of the transportation planning process, including TMA certification reviews, the statewide planning finding, and planning documents such as the statewide long-range transportation plan (LRTP), metropolitan transportation plan (MTP), statewide transportation improvement program (STIP), transportation improvement program (TIP), unified planning work program (UPWP), and participation plan.”

Source: Federal Highway Administration Environmental Justice Guide (FHWA 2015)

Fundamental Principles of EJ

The essence of effective EJ practice, distilled into three fundamental principles, has been summarized in U.S. DOT and FHWA guidance:

- Avoid, minimize, or mitigate disproportionately high and adverse human health and environmental effects, including social and economic effects, on minority populations and low-income populations;
- Ensure the full and fair participation by all potentially affected communities in the transportation decision-making process; and
- Prevent the denial of, reduction in, or significant delay in the receipt of benefits by minority and low-income populations.

Source: Federal Highway Administration Overview of Transportation and Environmental Justice (released May 2000).

Table 1 broadly summarizes the key elements in Title VI, E.O. 12898, and E.O. 13166 that relate to transportation planning.

Table 1. Key elements in Title VI, E.O. 12898, and E.O. 13166.

	Title VI	Environmental Justice (EJ)	Limited English Proficiency (LEP)
Authorizing Directive	Civil Rights Act of 1964 (42 U.S.C. § 2000d et seq.)	E.O. 12898 (1994)	E.O. 13166 (2000)
Required Populations	Race, color, and national origin	Minority persons and low-income persons	Individuals with a limited ability to read, write, speak, or understand English
Applicable Agencies/ Programs	Programs receiving federal assistance	Federal agencies and recipients of federal financial assistance	Federally funded programs and activities
Guidance	23 CFR Parts 200 and 450; FTA Title VI Circular 4702.1B (2012)	FTA EJ Circular 4703.1 (2012)	U.S. DOJ Guidance to Federal Financial Assistance Recipients Regarding Title VI Prohibition Against National Origin Discrimination Affecting Limited English Proficient Persons (2000)

Terms Used in This Guide

Researchers and practitioners use a wide variety of terms to describe the populations specified in federal laws, directives, and requirements. This guide uses the following terms:

- **Required populations** or **required population groups** will refer to the population groups for which analyses are required for an MPO to comply with federal laws and guidance relating to Title VI, E.O. 12898, and E.O. 13166 (the EJ and LEP executive orders). These include minority and non-minority racial/ethnic populations, low-income and non-low-income populations, and LEP and non-LEP populations. Beyond these required populations, MPOs can and should consider and address the needs of other populations in their regions that may face disproportionate transportation-related burdens or inequities.
- **Underserved persons** will refer more broadly to any person of a population group that an MPO might want to consider for inclusion in an equity analysis. This term includes persons of the required population groups as well as members of other groups that may face disproportionate transportation-related burdens or inequities, such as older adults or persons with disabilities.
- **Underserved communities** will refer to geographic areas or neighborhoods in which underserved persons live, and includes areas that agencies have designated as high-priority areas for any given population of underserved persons.
- **Transportation disadvantaged** will refer to those persons who, because of physical or mental disability, income status, or age, are unable to transport themselves or to purchase transportation and who are, therefore, dependent on others to obtain access to health care, employment, education, shopping, social activities, or other life-sustaining activities.

Many MPOs also identify other persons or communities within the region who may be underserved by the transportation network or by the transportation decision-making process, such as persons with disabilities, older adults, or children and youth. These regionally defined persons or groups are sometimes combined with required populations for the purpose of conducting plan analyses and designing public engagement campaigns, and identified as “vulnerable populations,” or “communities of concern.” These regionally defined broader designations of persons or communities are generally referred to as “underserved” throughout this guidebook.

Organization of This Guide

This guide begins with a chapter that emphasizes the importance of a strong foundation of public engagement. Subsequent chapters detail the five steps of the equity analysis process. A diagram appears at the beginning of each chapter to reinforce the importance of continuing to integrate public engagement throughout the five steps (Figure 1).

Chapter 2 is titled “Lay the Foundation with Public Engagement.” This chapter describes the important role of public engagement and describes elements of inclusive public engagement, which is critical to the success of each step in the equity analysis process.

Chapter 3 is titled “Step 1: Identify Populations for Analysis.” This chapter describes methods for defining and identifying populations of underserved persons and communities for which equity analyses will be conducted.

Chapter 4 is titled “Step 2: Identify Needs and Concerns.” This chapter describes how public engagement and data analysis can be used to identify the needs and concerns of selected populations to help focus and measure the equity impacts.

Chapter 5 is titled “Step 3: Measure Impacts of Proposed Agency Activity.” This chapter describes options for selecting appropriate equity indicators and technical methodologies to assess the benefits, burdens, and relative impacts of transportation plans and projects. The analyses of plans and programs will determine whether the benefits and burdens they are expected to generate will be equitably distributed among underserved and non-underserved persons and communities.

Chapter 6 is titled “Step 4: Determine Whether Impacts Are Disparate or Have DHAE.” This chapter describes methodologies for determining whether identified differences in the impacts generated by transportation plans and programs on underserved persons versus non-underserved persons are disparate or have disproportionately high and adverse effects (DHAE).

Chapter 7 is titled “Step 5: Develop Strategies to Avoid or Mitigate Inequities.” This chapter describes approaches for addressing and mitigating equity issues identified in the analysis. Meaningful equity analyses, even ones that do not find disparate impacts or DHAE, often spur broader actions to address systemic disparities and needs of underserved persons, such as institutional changes in decision-making processes (such as equity-related project-selection criteria and robust public engagement).

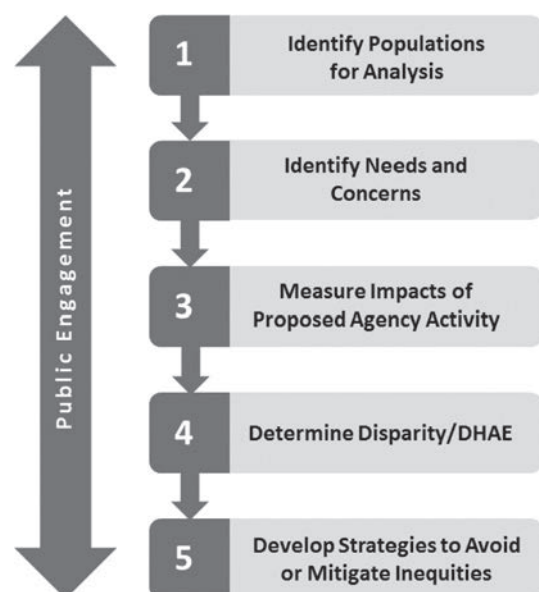


Figure 1. Organization of this guide.

8 Equity Analysis in Regional Transportation Planning Processes

The guide concludes with an appendix detailing the *Pilot Case Studies*. The appendix describes the experiences of four MPOs that tested elements of the five-step equity analysis framework. The chapters in this guide provide an overview of key points to remember, discuss key actions and resources for conducting each step of a meaningful equity analysis, and provide case-study examples based on testing of the process. When using the five steps, it is important to remember that public engagement is a continuous and iterative process; thus, even as each step is completed, ongoing monitoring, assessments, and other activities will likely continue. Published separately, Volume 2 of *TCRP Research Report 214* provides an overview of the research conducted in TCRP Project H-54 to identify ways equity in public transportation can be analyzed through an integrated participatory and quantitative approach that (1) is adaptable to plans and programs developed by MPOs in partnership with transit agencies and (2) relates to environmental justice analysis and Title VI procedures, implementation, and reporting compliance.

Quick References for Planners, Policy Makers, Analysts, and Modelers

Planners, policy makers, data analysts, and modeling staff play complementary roles throughout an equity analysis. Table 2 summarizes the key responsibilities of these players that are associated with each step of the process. For quick reference, the tasks in the table are keyed to the relevant chapters and subsections in this guide.

Table 2. Tasks involving planners/policy makers and analysts/modelers, keyed to chapter sections in this guide.

Chapters	Tasks Involving Planners/Policy Makers—Chapter Section(s)	Tasks Involving Data Analysts/Modelers—Chapter Section(s)
Lay the Foundation with Public Engagement (Chapter 2)	<ul style="list-style-type: none"> Develop an Inclusive Public Engagement Plan 	<ul style="list-style-type: none"> Evaluate Progress
Step 1: Identify Populations for Analysis (Chapter 3)	<ul style="list-style-type: none"> Define Population Groups for Analysis Identify High-Priority Areas Understand Demographic Change 	<ul style="list-style-type: none"> Define Population Groups for Analysis Identify High-Priority Areas Identify Regional Distribution of Underserved Persons
Step 2: Identify Needs and Concerns (Chapter 4)	<ul style="list-style-type: none"> Validate Results 	<ul style="list-style-type: none"> Identify Needs at the Regional Level Identify Needs at the Neighborhood Level Document Findings for Use in Other Steps
Step 3: Measure Impacts of Proposed Agency Activity (Chapter 5)	<ul style="list-style-type: none"> Select Indicators Differentiate Project Types for Evaluation 	<ul style="list-style-type: none"> Measure Outputs Measure Outcomes Document Measurements for Use in Next Steps
Step 4: Determine Whether Impacts Are Disparate or Have DHAЕ (Chapter 6)	<ul style="list-style-type: none"> Validate Findings with Qualitative Methods and Stakeholder Engagement Explore Causes and Mitigation Options (If disparate or disproportionately high and adverse impacts are found, diagnose why.) 	<ul style="list-style-type: none"> Review Data to Identify Differences Among Population Groups Screen for Disparate Impacts Using Quantitative Methods
Step 5: Develop Strategies to Avoid or Mitigate Inequities (Chapter 7)	<ul style="list-style-type: none"> Invest in Projects That Advance Equity Address Equity in all Phases of Planning and Decision Making 	<ul style="list-style-type: none"> Evaluate and Measure Progress

Equity Analysis Elements and Resources

Several key elements should be considered when initiating a successful equity process. First, identify and engage members of underserved populations to make sure the process is fully informed by their input. Next, make sure to clearly articulate their needs and concerns before attempting to assess the benefits and costs of plans and programs. No matter how well-intentioned the effort, a planning agency can fail to meaningfully address equity issues by neglecting to involve the appropriate stakeholders.

Because each region has a unique set of communities and challenges, identify approaches and resources for each step that reflect the local context. This guide includes case studies of equity analyses conducted by a variety of MPOs that may help agencies identify applicable solutions.

Regardless of the local context, and the agency's capacity for analysis and engagement, strive to bring the planning process closer to assessing and addressing equity concerns fully. Resources, including this guide, identify many practices that MPOs of any size can implement to take additional steps toward equitable decision making. The resources listed in Table 3 can help agencies to assess their current equity analysis activities and to consider resources, methods, and strategies to address equity more fully. Citations and URLs for specific resources also appear in the resource lists that follow each chapter and in the references section of this guide.

Table 3. Equity analysis elements, resources, methods, and strategies.

Lay the Foundation with Public Engagement	Resources
<ul style="list-style-type: none"> Develop an inclusive Public Engagement Plan: connect, educate, and sustain 	<ul style="list-style-type: none"> FTA EJ Circular 4703.1 (2012); FTA Title VI Circular 4702.1B (2012); FTA 5310 Program Circular 9070.1G Enhanced Mobility of Seniors and Individuals with Disabilities Program Guidance (2014) FHWA public involvement website NHI/NTI EJ and public involvement courses
<ul style="list-style-type: none"> Develop a performance-based approach to conducting tailored engagement Establish goals and metrics; evaluate progress 	<ul style="list-style-type: none"> FHWA public involvement website NHI/NTI EJ and public involvement courses FHWA <i>Performance-Based Planning and Programming Guidebook</i>
<ul style="list-style-type: none"> Collect data to measure the effectiveness of outreach and engagement efforts 	<ul style="list-style-type: none"> Outreach: number and distribution diversity of emails, social media posts, and "snail-mail" postcards or newsletters; number and diversity of media releases; number and locations of posted flyers Engagement: number and diversity of participants engaged (home and work zip codes, household demographics, etc.) compared to regional demographic characteristics; participant evaluations of workshops, surveys, or focus groups; numbers and diversity of persons engaging in multiple ways
Step 1: Identify Populations for Analysis	Analysis Methods/Resources
<ul style="list-style-type: none"> Low-income households 	<ul style="list-style-type: none"> U.S. Department of Health and Human Services poverty guidelines U.S. Census Bureau
<ul style="list-style-type: none"> Ethnic and cultural minority households (e.g., Black, Hispanic/Latino, Asian American, American Indian, Native Hawaiian) 	<ul style="list-style-type: none"> U.S. Census Bureau
<ul style="list-style-type: none"> Persons with LEP 	<ul style="list-style-type: none"> U.S. Census Bureau Local adult literacy programs or English as a second language programs

(continued on next page)

Table 3. (Continued).

Step 1: Identify Populations for Analysis	Analysis Methods/Resources
<ul style="list-style-type: none"> Other underserved persons relevant to the region 	<ul style="list-style-type: none"> Stakeholder input
<ul style="list-style-type: none"> Create heat maps and dot-density maps to show how the numbers and concentrations of each population group vary across the region 	<ul style="list-style-type: none"> GIS Demographic data
<ul style="list-style-type: none"> Add demographic information to the travel-demand model's traffic analysis zones (TAZs) to support assessments of relative benefits to various populations 	<ul style="list-style-type: none"> Travel-demand model Equivalency tables to match census data to TAZs
<ul style="list-style-type: none"> Identify high-priority areas for each required population 	<ul style="list-style-type: none"> Heat maps and dot-density maps Stakeholder input
Step 2: Identify Needs and Concerns	Analysis Methods/Resources
<ul style="list-style-type: none"> Gather qualitative data on needs of underserved persons 	<ul style="list-style-type: none"> Stakeholder input Survey the public on their needs. Include questions on demographics to ensure the demographics of the respondents reflect the demographics of the region; if not, conduct targeted surveys to reach the missing population groups
<ul style="list-style-type: none"> Assess environmental health and safety conditions 	<ul style="list-style-type: none"> Guidance and resources relating to EJ Analyze relative exposure to mobile source emissions (regional emissions models) and fatal crashes (Fatality Analysis Reporting System [FARS] data) Walk/bike audits and other field research supplemented by public input
<ul style="list-style-type: none"> Analyze access to transit and to destinations 	<ul style="list-style-type: none"> Travel-demand model Census journey to work data Transit rider surveys and ridership statistics Safe Routes to School program data Stakeholder input
<ul style="list-style-type: none"> Conduct neighborhood-level analysis to hone in on issues identified at the regional level 	<ul style="list-style-type: none"> GIS-based analyses Stakeholder input Neighborhood-level audits (e.g., conducting a walkability audit in a neighborhood that has a high number of pedestrian fatalities)
Step 3: Measure Impacts of Proposed Agency Activity	Analysis Methods/Resources
<ul style="list-style-type: none"> Assess transportation-related environmental impacts on underserved communities (e.g., air quality, noise, vibration, stormwater runoff) 	<ul style="list-style-type: none"> Air quality or noise exposure analysis (using travel-demand model outputs) GIS overlays Stakeholder input
<ul style="list-style-type: none"> Consider destruction or disruption of community cohesion, economic vitality, use of public facilities and services, or potential displacement of persons or businesses 	<ul style="list-style-type: none"> GIS analysis to identify potential physical barriers, land use impacts, or other disruptions introduced by new projects Travel-demand model analyses
<ul style="list-style-type: none"> Identify potential denial of, reduction in, or significant delay in the receipt of, benefits of transportation programs, policies, or activities 	<ul style="list-style-type: none"> Travel-demand model analyses to compare forecast outcomes Transit analysis to identify potential reductions/improvements in services Comparative analyses of levels and types of transportation investments to improve safety, accessibility, and/or to address other needs identified

Table 3. (Continued).

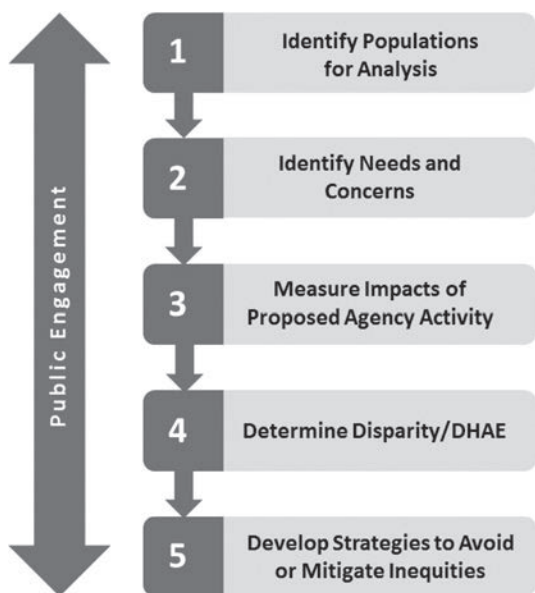
Step 4: Determine Whether Impacts Are Disparate or Have DHAЕ	Analysis Methods/Resources
<ul style="list-style-type: none"> Apply quantitative screening methods to evaluate levels of difference 	<ul style="list-style-type: none"> Benchmarks Statistical significance Location quotients (LQs)
<ul style="list-style-type: none"> Validate assessments using qualitative methods 	<ul style="list-style-type: none"> Existing studies, surveys, and other supplementary information Stakeholder input
<ul style="list-style-type: none"> If disparate impacts are found, determine why to help develop mitigation options 	<ul style="list-style-type: none"> Ask “why?” . . . then “why?” . . . then “why?” Eventually, answers will point toward actions the agency can take Stakeholder input
Step 5: Develop Strategies to Avoid or Mitigate Inequities	Example Strategies
<ul style="list-style-type: none"> Implement institutional changes in decision making to address systemic disparities or needs 	<ul style="list-style-type: none"> Equity goals, objectives, and targets to adopt a performance-based planning and programming approach to equity Equity criteria in project evaluation criteria Improve engagement with underserved persons Examine decision-making structures for opportunities to give more organizational power to underserved communities Examine how any modal funding targets address equity considerations
<ul style="list-style-type: none"> Apply roadway design and vehicle technology strategies to improve air quality 	<ul style="list-style-type: none"> Retrofitted buses with increased emission control technologies Vegetated buffers along the highway to trap particulates Considering air quality when siting high-density housing
<ul style="list-style-type: none"> Apply infrastructure design strategies to improve multimodal safety and accessibility 	<ul style="list-style-type: none"> Complete Streets policies that promote multimodal roadway design Strategic application of safety countermeasures in communities most at risk Road diets (e.g., reducing roadway lane widths to create safe spaces for cyclists and pedestrians) for existing or proposed facilities
<ul style="list-style-type: none"> Implement transit and ridesharing program improvements to support increased accessibility 	<ul style="list-style-type: none"> Increased transit service frequencies, headways, hours of service for underserved communities Improved pedestrian and bicycle access to transit for underserved communities Public-private transit and ride-hailing service programs to fill gaps and improve access to transit services
<ul style="list-style-type: none"> Develop strategies to reduce transportation-related household costs 	<ul style="list-style-type: none"> Transit fare discounts and free services Highway toll discounts and vouchers Coordinated housing affordability programs in transit-accessible locations



CHAPTER 2

Lay the Foundation with Public Engagement

Why Is Public Engagement Important?



Meaningful public engagement is an essential component to equity analyses. Federal planning regulations and equity-related directives require the engagement of underserved populations in transportation decision making. Public participation plans (PPPs) and language assistance plans are vital to public engagement; MPOs are required to report them to FTA as part of their overall Title VI plans. In addition to complying with requirements, however, agencies can use public engagement techniques to gain critical insights that are difficult or impossible to discern from quantitative analyses, and to effectively address unique concerns and values.

Develop an Inclusive Public Engagement Plan

The meaningful engagement of underserved persons is a core component of equitable transportation decision making. Inclusion is the bridge between diversity and equity. For engagement to be meaningful, it is not enough simply to inform a diverse array of individuals and communities about a transportation planning or decision-making process. It is important

that MPOs actively foster inclusive engagement that is designed to invite underserved persons to express their needs, concerns, and ideas, and—perhaps most importantly—to trust that their input will be considered. Some underserved persons may live in communities that have a history of being effectively shut out of transportation investment decisions that generated significant impacts on their neighborhoods, such as bisection, isolation, or widespread demolition. Others may be part of immigrant groups that are wary of engaging in public discourse due to prior experiences in their countries of origin or because they are afraid of deportation. MPOs are advised to consider the potential for these kinds of barriers to participation in a region and employ sensitive, tailored communication techniques to make sure all voices are heard.

Meaningful engagement requires one to acknowledge the diversity that exists within a region and uses tailored engagement strategies designed to help everyone feel comfortable in conveying their needs and desires for consideration in the transportation decision-making process. MPOs will do this by (1) connecting with underserved persons to encourage them to participate; (2) educating all stakeholders about transportation decision making so they can be well-informed, effective participants; and (3) sustaining equitable participation through long-lasting relationships and partnerships.

Connect

For inclusive public engagement, it is critical to identify and understand underserved persons in the region, from the languages they speak to the places they live, work, and play. An analysis to identify underserved persons (Step 1) will help gather this information by combining quantitative mapping and data-gathering with personal engagement with individuals and organizations that represent or work with underserved persons (sometimes called “equity stakeholders”).

Connection involves working to develop collaborative, long-term relationships with community-based organizations and leaders that are widely trusted within underserved communities. These partners can help serve as ambassadors or liaisons between the MPO and a variety of underserved persons, helping to facilitate diversity and inclusion in the public engagement process.

Community engagement starts with awareness, being transparent about the MPO’s goals, and realizing the barriers hindering participation. Identifying community demographics helps ensure the engagement strategies are specifically tailored for underserved persons and create a comfortable space where their input and perspectives are welcomed, recognized, and valued—a message that helps address the disengagement and disenfranchisement these communities experienced in the past.

Organizations that represent or work with underserved persons can play a critical role in an inclusive public engagement process by helping with engagement or serving as stakeholders to provide the perspective of their constituents. Such organizations may include community-based groups, schools or youth groups, faith-based institutions, businesses, universities, and so forth.

In summary, MPOs can use the Step 1 analysis to (1) identify high-priority areas for reaching and engaging underserved persons and (2) conduct targeted engagement within those areas to identify preferred communication methods and meeting locations. Understanding these characteristics and needs will help the agency develop a range of effective outreach strategies such as social media campaigns, traditional mailing lists, bilingual flyers, and radio announcements, as well as engagement techniques, such as focus groups, interviews, and hands-on gaming exercises. When planning public engagement activities, it is important to make sure to identify the needs and preferences of underserved groups about where and when to conduct face-to-face meetings. Many low-income people work multiple jobs or shifts and/or are raising children alone, which makes it hard to attend traditional evening events. A trip to a downtown city hall may take much longer on public transit than by private car, posing an engagement barrier to people who cannot drive.

Educate

When a community feels confident about understanding the transportation decision-making process, the people of that community may be more inclined to participate effectively and to take ownership of their role in the process. A sense of ownership can foster sustained participation and can inspire participants to strive for, and serve in, community leadership roles. Agencies that effectively educate stakeholders, including people from traditionally underserved communities, play an important part in equipping those stakeholders to make meaningful contributions to civic decisions, whether they participate as individuals, speak on behalf of local organizations, or represent constituents as elected officials.

Education is a two-way street when it comes to equitable engagement. Agency staff must be prepared to hear and convey insights from community representatives about issues and needs

the agency may not have considered before, ranging from new perspectives on local concerns to considerations of equitable representation on agency boards.

It is critical to clearly communicate the decision-making process to all stakeholders, to demonstrate accountability, and to manage expectations. Few things can erode trust faster than the disappointment and confusion caused by inflated expectations or unclear communications. For example, a critical element of working with a liaison or advisory group is the clear definition of participants' roles within the decision-making process. Make the role of the advisory group clear in relation to the decision-making authority of the MPO policy board. If some of the advisors' recommendations are changed or dropped in the final version of a policy or plan, make sure the advisory group has every opportunity to weigh in, and that they understand how and why the changes were made. Educate the MPO board, as well, about the importance of ongoing self-evaluation to make sure the interests of all stakeholders are fairly represented in the decision-making process and in the membership of the board and its committees.

Examples in Practice: Educating the Community

In Tennessee, the **Memphis Urban Area MPO** developed a series of videos to educate the public about transportation decision making in the region. The videos cover topics such as livability and mobility, and the process for developing the TIP. The videos feature mayors from jurisdictions around the region and include subtitles in Spanish—appealing to a diverse audience. The videos are played at public meetings and are also available on the MPO's YouTube channel (Memphis Urban Area MPO 2016). At the time of the writing of this report, the YouTube Channel is available at the following address: <https://www.youtube.com/user/memphismpo>.

In Colorado, the **Denver Regional Council of Governments (DRCOG)** PPP states that partnerships are a critical strategy to engaging underserved persons. From 1998–2017, Transit Alliance, a local non-profit, was particularly effective in encouraging members of the public, including underserved persons, to participate in the transportation decision-making process. With the closure of Transit Alliance, DRCOG has committed to take on its Citizens Academy, a seven-week program that equips participants to become involved in regional transportation issues, with a focus on multimodal transportation, mobility, infrastructure investments, and community development. At the conclusion of the program, participants are encouraged to develop a personal action plan to address a transportation need or issue in their communities. Over the years, approximately one-third of the program graduates have later served in the region in a volunteer or elected capacity, including the DRCOG board (DRCOG 2010).

Sustain

Public engagement is an ongoing process. Inclusive public engagement aims to continually assess and refine the approach to engaging underserved persons. MPOs can create an environment that encourages residents to provide feedback, offer comments, and provide input through a variety of outlets, including simple in-person, paper, or online surveys. MPOs also can provide access to information about events, upcoming projects, and meetings to the public. For example, a website or an automated phone line would offer 24/7 access to information.

Partner with community organizations or establish advisory committees to build trust between the agency and the communities in need of engagement. Partnerships encourage MPO staff and decision makers to deepen their sensitivity toward the needs and concerns of underserved persons and to pursue creative joint initiatives. Effective partnerships can be formed with a broad range of organizations, and are not necessarily limited to partners within a region. The key to success is identifying organizations whose missions are in sync with the goals the agency is trying to achieve.

An MPO can benefit greatly from developing relationships with local residents who are well regarded and trusted by members of the communities with which they want to engage. Informal community leaders can advise on how best to approach community advocates, to help recruit local “ambassadors” for a planning process, and to educate residents on transportation issues and decision-making processes. They can help to anticipate and address controversies, and to develop and share conflict resolution strategies.

Examples in Practice: Partnering with Community-Based Organizations

In Georgia, the **Atlanta Regional Commission (ARC)** entered into a formal partnership with the Partnership for Southern Equity (a local social justice organization and trusted community voice) to host a four-part “Building Opportunity” workshop series that gathered input from community leaders and equity groups on policy areas including transportation access, community development, economic opportunity, and livability. The Partnership for Southern Equity developed content for the workshop and managed engagement throughout the development of Atlanta’s Regional Plan (ARC 2018). Effective partnership can be formed with a broad range of organizations, and MPOs are not necessarily limited to working with partners in their own regions. When identifying potential partners, seek organizations with similar values (e.g., equity) but otherwise be open to both traditional and unconventional partners.

In Washington State, the **Puget Sound Regional Council (PSRC)** leveraged its partnerships with community-based organizations by participating in the organizations’ existing meetings and/or events to broaden its engagement efforts. The PSRC made presentations, distributed questionnaires, and used “dot exercises” to let participants prioritize topics on large posters using dot stickers. The dot exercise was specifically used for engagement with special needs groups to understand their needs, gaps, and prioritized strategies for the Coordinated Transit-Human Services Transportation Plan (PSRC 2018).

Commit Resources

Tailored engagement strategies require staff time and financial resources. MPOs should be prepared to spend time researching the media outlets and communication preferences that are effective with different communities and populations. Some populations may prefer face-to-face interactions, but others may prefer virtual ones (e.g., online meetings or telephone town halls). It may be important to schedule public events during the evening or on weekends in some areas. Follow-up also is needed to document, share, and post the input collected at public events so that people in each community know their voices are being heard.

Meeting activities that involve direct expenses can range from renting a venue, purchasing refreshments, and printing materials (perhaps in multiple languages), to arranging free transit passes and/or rides, providing translators, and hiring professional child-care providers. Large projects might require establishing a satellite office in the community.

Agencies also can allocate public involvement funds (from ongoing Unified Planning Work Program monies or from special studies such as regional planning grants and project environmental impact assessments) directly to community groups or liaisons in order to foster meaningful, hands-on engagement. In Minnesota during the early 2000s, the **Metropolitan Council of Minneapolis–Saint Paul (Met Council)** initiated a community engagement team outreach grant program for the council’s “Corridors of Opportunity” planning process (Met Council 2015). The grant program was funded by a federal Sustainable Communities Planning grant, and the council maintained the program for several years after the original corridors plan was completed, issuing grants to local nonprofits and civic organizations to help boost participation in transit planning studies among people of color, low-income communities, and people with disabilities.

Evaluate Progress

A fundamental way to ensure long-term commitment to inclusive engagement is to build in ongoing measurement and evaluation of a process. An MPO already evaluates transportation system performance toward goals such as mobility and accessibility. Using a similar approach, the MPO can set goals and objectives, choose performance metrics, identify and implement strategies, collect relevant data, evaluate progress, and update plans for public engagement.

Set goals and objectives that convey a tangible commitment to an equitable, inclusive engagement approach that encourages all stakeholders to contribute to transportation planning and decision making. Collect data and evaluate progress to better understand how engagement methods resonate with different populations and how to improve or restructure methods to engage underserved persons, including low-income persons, minority persons, and those with LEP. Quick surveys or polls conducted at meetings or online, for example, can provide basic data about the numbers and demographics of participants. Answers from open-ended questions posed on paper or in person can help an MPO to discern why individuals participated, what they thought of the outreach materials or the venue, and ways in which the engagement process could be improved.

To determine the level of performance or achievement that occurred because of the public engagement activities or services, it is important to measure not only the outputs (e.g., numbers of meetings conducted, numbers of surveys distributed), but also the outcomes (e.g., socio-economic diversity of participants, level of response to surveys) of outreach efforts. One important outcome to measure is whether the engagement effort has reached the intended recipients. To address this question, data collected about outputs could include the number of emails sent, number of email recipients, number of news releases, locations of public comment materials, number and locations of flyer distributions, and the numbers of attendees at specific events. By also collecting data from respondents and participants, such as home zip codes and household demographics, agencies can determine whether the groups of respondents and participants—the people being reached through the agency’s efforts—are representative of the general population. The outcomes of public involvement efforts are measured by collecting and comparing data that is gathered both before and after the activities or services provided by the agency.

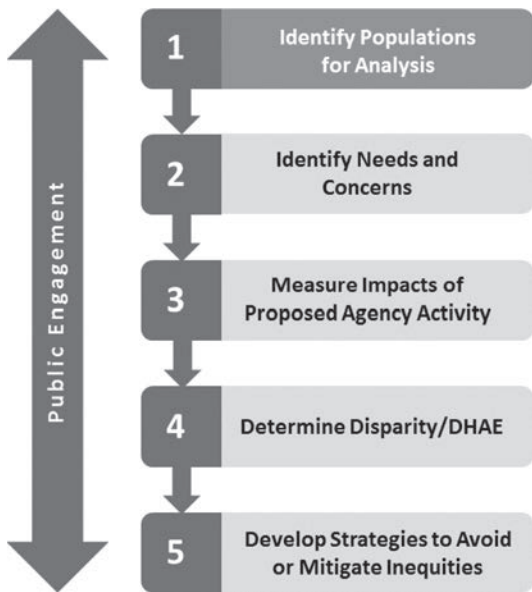
Resources

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CHAPTER 3

Step 1: Identify Populations for Analysis



An equity analysis begins by identifying populations for analysis using a combination of demographic methods and public engagement techniques. In addition to identifying the populations specified in federal requirements, agencies may identify unique communities or combinations of groups that present specific needs and concerns.

Analysis techniques discussed in this chapter include the following:

- Developing heat maps based on population concentrations;
- Developing dot-density maps based on numbers; and
- Adding demographic information to the data used for the travel-demand model's TAZs.

It is helpful to use more than one analysis method to identify the populations of importance to a region. The data can tell a different story depending on how it is collected, grouped, and depicted. For example, it may be hard to pinpoint small pockets of low-income households from a thematic map that clusters income levels into just a few broadly defined ranges or assigns the characteristics to relatively large geographic areas such as TAZs or census tracts. Using a more fine-grained geographic scale or a more detailed set of themes may produce a map that is hard to read at a regional scale; in this case, it might be appropriate to generate a broader snapshot of the region as well as subarea maps and narrative reports.

Developing a thoughtful, well documented assessment of the characteristics of the regional population at the outset of the planning process can not only inform the development of long-range plans and programs (which is the focus of this guide), but also provide valuable contextual data for subsequent project-level studies or processes. As noted numerous times in the Promising Practices report by the Federal Interagency Working Group on Environmental Justice and NEPA (the National Environmental Policy Act of 1970), the detailed analyses conducted for a meaningful NEPA assessment can be enriched by considering or comparing the characteristics of the affected environment to those of the region as a whole (Federal Interagency Working Group 2016).

Define Population Groups for Analysis

This guide focuses on *required populations*—that is, populations that are required to be included in federally compliant Title VI and EJ analyses. MPOs may also identify other underserved persons or communities unique to their regions. This section clarifies the required and optional population groups to define for analyses.

- **Required populations** or **required population groups** are terms that refer to the population groups for which analyses are required for an MPO to comply with federal laws and guidance relating to Title VI and EJ. These include minority and non-minority racial/ethnic populations, low-income and non-low-income populations, and LEP and non-LEP populations.
- **Underserved persons** refers more broadly to any person of a population group that an MPO might want to consider for inclusion in an equity analysis. This term includes persons of the required population groups but may also include members of other populations of interest, such as older adults or persons with disabilities.
- **Underserved communities** refers to geographic areas or neighborhoods in which underserved persons live and includes areas that the MPO may have designated as high-priority areas in relation to particular populations of underserved persons.

Each required population must have its own analysis and is likely to have different needs and burdens. For example, the Memphis Urban Area MPO found that minority individuals are likely to commute by carpool or rapid transit, but low-income persons are more likely to walk, rideshare, or use a bus (Memphis Urban Area MPO 2016).

Define Required Populations

Title VI prohibits discrimination on the basis of race, color, and national origin. Agencies that do not comply with Title VI risk lawsuits, termination of current federal grants, and loss of eligibility for future grants. E.O. 12898 includes minority populations and low-income individuals on the list of required populations. Failure to comply with EJ guidance can lead to the loss of federal funding or failure to pass certification reviews.

All of the required population groups associated with EJ and Title VI requirements represent important demographic characteristics for MPOs to identify. Characteristics associated with Title VI include race, color, and national origin (which is often linked to LEP). The Title VI groups are required populations even when they are not low-income and even when the impacts are not disproportionately high and adverse, and they apply to all future actions carried out by transportation agencies, such as changes in service. The EJ groups (low-income populations and minority populations) are required only if there is a disproportionately high and adverse impact.

Language for describing a person's race, color, and national origin is continually evolving. Table 4 summarizes definitions of required populations listed in FTA Title VI Circular 4702.1B.

Identify Appropriate Data Sources

Most agencies use U.S. Census Bureau data to identify and map required populations. As the decennial census is updated once every 10 years, many agencies refer to the annual American Community Survey (ACS) for more current data (<https://www.census.gov/programs-surveys/acs>). The ACS includes data on limited English-speaking households, household income, and racial and ethnic populations (see also U.S. Census Bureau 2009).

Additional tools and data sources are available. For example, the EPA's online *EJSCREEN* mapping and screening tool (<https://www.epa.gov/ejscreen>) provides demographic and environmental information that has helped many MPOs, such as the **Puget Sound Regional Council (PSRC)** in Washington State, identify underserved communities as well as their exposure to environmental risks (PSRC 2018).

Table 4. Defining required populations.

Required Populations	Definition
Persons with LEP (Title VI)	Persons for whom English is not their primary language and who have a limited ability to read, write, speak, or understand English. This group includes people who reported to the U.S. Census Bureau that they speak English less than very well, not well, or not at all.
Low-income persons (EJ)	<p>Any person whose median household income is at or below the United States Department of Health and Human Services (HHS) poverty guidelines. Find the current HHS poverty guidelines at https://aspe.hhs.gov/poverty-guidelines. The term <i>low-income population</i> refers to any readily identifiable group of low-income persons who live in geographic proximity, and, if circumstances warrant, to geographically dispersed/transient persons (such as migrant workers or Native Americans) who will be similarly affected by a proposed FTA program, policy, or activity.</p> <p>Note that FTA encourages agencies to use a locally developed threshold, such as the definition found in 49 U.S.C. 5302 as amended by MAP-21, which “refers to an individual whose family income is at or below 150% of the poverty line (as that term is defined in Section 673(2) of the Community Services Block Grant Act (42 U.S.C. 9902(2)), including any revision required by that section) for a family of the size involved” or another threshold, provided that the threshold is at least as inclusive as the HHS poverty guidelines.</p>
Minority persons (Title VI and EJ)	<p>Non-white persons, specifically American Indian and Alaska Native; Asian; Black or African American; Hispanic or Latino; and Native Hawaiian or Other Pacific Islander. <i>Minority population</i> means any readily identifiable group of minority persons who live in geographic proximity and, if circumstances warrant, geographically dispersed/transient populations (such as migrant workers or Native Americans) who will be similarly affected by a proposed DOT program, policy, or activity.</p> <p>FTA’s EJ Circular notes the importance of not conflating low-income and minority populations, stating “there are minority populations of all income levels, whereas low-income populations may be minority, non-minority, or a mix in a given area” (FTA Circular 4703.1, 2012).</p>

Define Optional Population Groups

Many MPOs analyze additional socio-economic characteristics in order to identify population groups that may be underserved in their region. Generally, supplemental approaches to identifying populations tend to take two forms:

- Modifying the national definition of *low-income* to reflect regional characteristics, or
- Identifying unique population groups—beyond the required underserved groups—whose transportation needs may differ from those of the general population.

Stakeholders engaged through an equitable public participation process can provide valuable insights about the issues of most importance to underserved populations. For example, the **Mid-Ohio Regional Planning Commission (MORPC)** analyzes the impacts of its activities on racial and ethnic subgroups, persons with disabilities, older adults, low-income households, and zero-vehicle households. Based on feedback from stakeholders, however, the analysis accompanying their latest TIP focused on minority persons and low-income households rather than also providing analyses of impacts on additional underserved populations (MORPC 2017).

Modify the Definition of Low-Income

A complete equity analysis ensures an adequate examination of potential disparate impacts/DHAE that may be experienced by those with the lowest incomes. The U.S. DOT’s EJ guidance

recommends using the HHS poverty guidelines, but regional differences in the cost of living can mean that the national guidelines might not capture all persons with financial burdens in a region.

Some agencies with high regional costs of living have chosen more inclusive definitions, such as using 200% of the federal poverty guideline. For example, the San Francisco Bay Area **Metropolitan Transportation Commission (MTC)** formed a Regional Equity Working Group to consider conditions specific to the Bay Area when defining what qualifies as low-income. In consideration of the high cost of living in the region compared to the national average, the agency defined low-income populations as those with income at approximately 200% of the federal poverty guideline (MTC 2015).

Add Optional Underserved Populations

In addition to the required populations, there may be other underserved populations to include in an analysis. These might be populations that have unique needs related to communications, public engagement, or transportation choices. These populations might include members of federally recognized tribes, older adults, persons with disabilities, or zero-car households. Work with the equity stakeholders in a region to identify the most appropriate populations to include. An MPO will need to balance the desire to be inclusive with the risk of becoming overwhelmed with data.

Identify Regional Distribution of Underserved Persons

Rather than identifying a limited number of geographic areas with significant concentrations of underserved persons, this guide recommends first developing an understanding of the overall distribution of these persons throughout the region. Developing this regional understanding can reveal new insights that could be missed if an MPO focuses solely on areas with high concentrations of underserved persons, and it ensures compliance with Title VI and EJ guidance to consider the members of the required populations even when they do not live in underserved communities.

This section of the chapter provides three approaches to identifying the regional distribution of the populations analyzed: (1) heat maps of concentrations; (2) dot-density maps of numbers; and (3) matching demographic characteristics to TAZs.

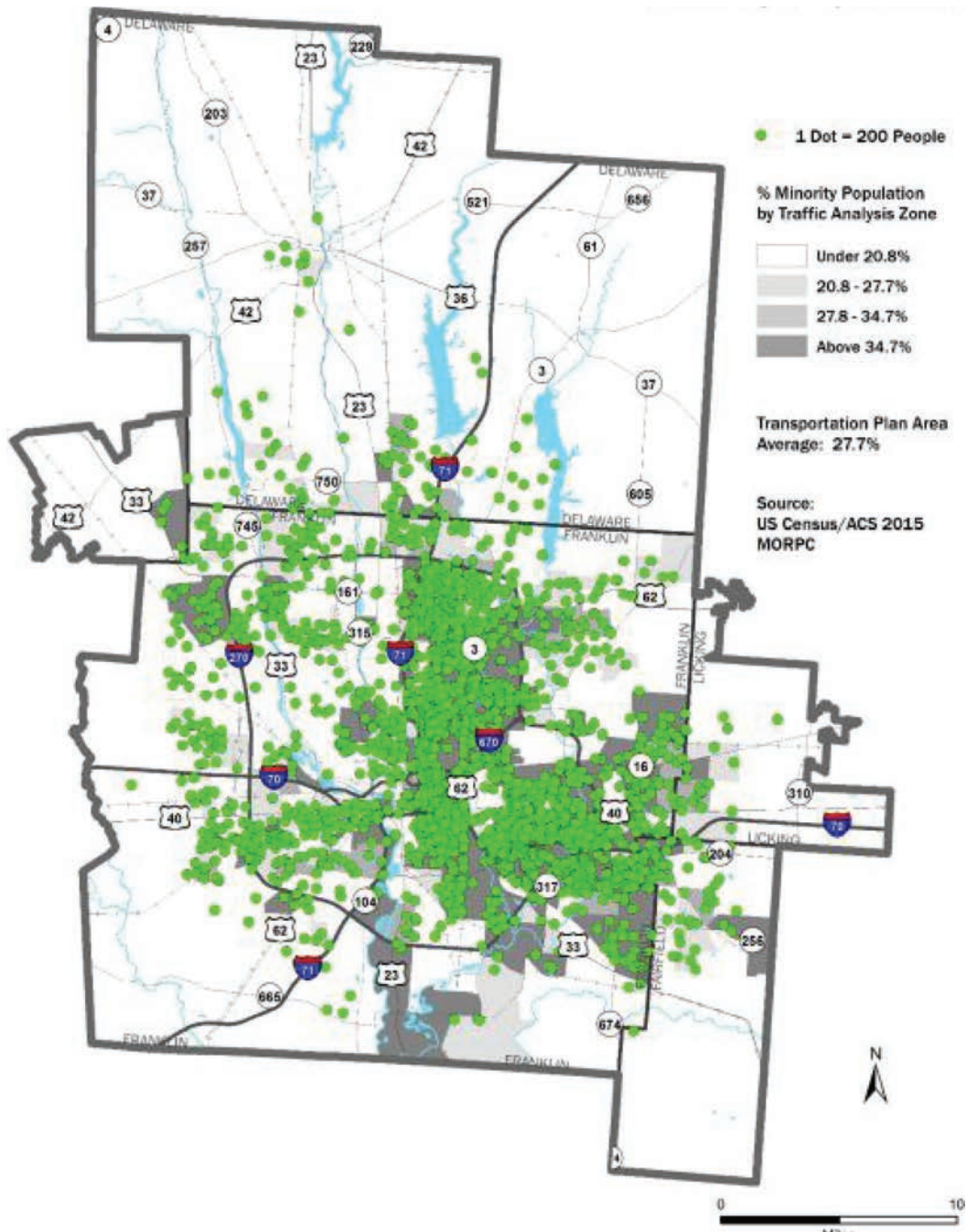
Figure 2 shows how the MORPC used these three approaches in one map, showing the relative concentration of minority persons at the TAZ level using a heat map to show four gradations of concentrations and one dot to represent 200 minority persons.

Heat Maps

Heat maps use color gradations for a geographic area (such as census tracts) in proportion to the concentration of the population being analyzed. To be useful for comparison purposes, these maps should have at least three gradations. To develop such a map, select the desired geographic scale and download the relevant data from U.S. Census Bureau products such as the ACS. When creating a heat map, consider the following:

- Collect data for the relevant populations by geographic unit and calculate the concentration of the analysis population for each geographic unit. For example, divide the number of minority persons in each TAZ by the total population in that TAZ. This can be calculated and then loaded in a GIS software package for analysis, or it can be calculated within most GIS programs.

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Source: MORPC (2017), 2017 Metropolitan Transportation Plan, Appendix D, "Environmental Justice"

Figure 2. Dot-density map of the minority population in the MORPC area.

- Group the data into ranges of values (bins). The cutoff values used to define the bins can be set in a number of ways. The analyst could choose thresholds that align with the agency metrics. For example, the agency may define underserved communities to be any TAZ with a concentration of minority persons over the regional average by at least one standard deviation. The analyst also could group values into concentrations by standard deviation—that is into concentrations at the regional average, and concentration bands below and above the average. Alternatively, the analyst could use the distribution of the values to establish the bins. For example, the analyst could group the TAZ minority concentrations into the bottom third, middle third, and top third.
- Assign each bin a color to distinguish each geographic unit by its population concentration. If a dot-density map will be overlaid on top of a heat map, be sure to select colors for the bins that can be distinguished from the dots.

Dot-Density Maps

A dot-density map displays dots representing the presence of persons or households throughout a selected geographic area (see Figure 2). The visual clustering depicts relative population densities, provides a visual representation of the absolute number of persons in an area, and complements heat maps that display the relative concentrations of a given population.

A dot-density map can illustrate the locations and densities where low-income and/or minority populations reside. Dot-density maps overlaid on heat maps are particularly effective in conveying both absolute numbers and relative concentrations of populations.

Most agencies with GIS capabilities can create dot-density maps with relative ease. When creating a dot-density map, agencies should consider the following steps:

- Use a GIS software package to map relevant population groups in the analysis area. After loading the population data into the GIS application, adjust the symbology properties of the appropriate layer to use dot-density and specify the number of individuals that each dot represents and the size of the dot. The analyst may need to experiment with these settings to generate a map that conveys density without obscuring other information.
- Consider map legibility when choosing to represent multiple populations on the same dot-density map. Zoomed inset maps may help viewers decipher dot locations within areas with high concentrations of underserved persons.
- To minimize concerns regarding the subjectivity of dot-density maps, ensure that the number of persons represented per dot (i.e., one dot = X persons) does not overly exaggerate or minimize the population present in a given area.

In Figure 2, each dot represents 200 people identified as minority, and the dots are overlaid on a heat map showing TAZs that have been shaded by the percentage of minority residents. Combining the dot-density map with the heat map allows an MPO to see which TAZs have many minority people, even within areas that may not have high concentrations of minority people. Conversely, the method can reveal sparsely-populated places with higher concentrations of minority people. Overall, the visualization contributes to a more robust discussion of regional spatial patterns of segregation, integration, and isolation.

Add Demographics to the Travel-Demand Model at the TAZ Level

Agencies frequently convey the benefits of their plans and programs using performance measures from the regional travel-demand model. By matching demographic information to TAZs, an agency can use these same measures to conduct equity analyses, enabling the analyses to reveal whether the agency's plans or programs are forecast to benefit underserved populations

in the same ways that they benefit other populations. This will enable the MPO to model the forecast outcomes (such as average travel time to work) for each demographic group being analyzed. (In this guide, the process of forecasting outcomes is described in more detail in Chapter 5, “Step 3: Measure Impacts of Proposed Agency Activity.”)

To match demographics to TAZs, agencies can follow the steps listed below. These steps describe the process as used by the **MORPC** and test-piloted by the **Mid-America Regional Council (MARC)**, which serves Kansas and Missouri (MARC 2015):

1. Download demographic data from the ACS (<https://www.census.gov/programs-surveys/acs>), or from a locally developed source.
2. Create an equivalency table to convert demographic data to TAZs. For data through 2018, existing equivalency tables (available through the U.S. Census Bureau’s Transportation Planning Products [CTPP] program) also can be used. These equivalency tables automatically match census demographic data to TAZ boundaries. (The CTPP program tools have traditionally been used for this purpose, but CTPPs released in 2019 and beyond will no longer include TAZ-level information.)
3. Develop forecasts for each demographic subgroup within each TAZ by changing its future numbers to match the overall TAZ growth rate that had been generated previously in accordance with regional land use forecasts. Assumptions for the first round are:
 - a. Hold the regional population count steady.
 - b. Hold the population count for each TAZ steady.
 - c. Hold the demographic makeup (percentage of each demographic group) steady for each TAZ. (See the section titled “Understand Demographic Change” for a discussion of the flaws of this assumption. All uses of the model rely on imperfect assumptions.)
 - d. Hold the demographic makeup steady for the region (or allow it to fluctuate if changes are anticipated).
4. Conduct a quality control review: Did the regional population totals for each demographic group hold steady or change in a way that reflects the anticipated changes in the region’s demographics? Or did the demographics for the region change in a way that was contrary to what is expected? In the MORPC exercise, the initial forecast produced a total percentage of underserved persons that was smaller than that of the base year, which was not consistent with what was expected in the region.
5. If something unexpected is found, ask why. The MORPC staff realized that the model assumed that most of the region’s population growth would occur in TAZs that currently had low percentages of underserved persons. The MORPC had held the demographic makeup of their TAZs constant (matching the present-day data), which meant that the model showed more of an increase in the population of non-underserved persons and less of an increase in the population of underserved persons than would be expected.
6. Refine the assumptions to correct any quality control issues identified. The problem that the MORPC found is likely to occur. Here is how to fix it:
 - a. Identify the demographic makeup (percentage of each group) expected in the regional forecast. For example, socio-economic and cultural trends analyses may indicate that the future proportion of low-income households may be higher in some neighborhoods and lower than others.
 - b. Slightly revise the demographic proportions within each TAZ to correct the assumptions while holding constant the number of people in each TAZ and at the regional level, and while holding constant each TAZ’s relative share of the population group for which the adjustment is made. For example, if the forecast number of low-income households needs to be increased by 10,000, then the agency can distribute an additional 10,000 among the TAZs based on each TAZ’s current share of the region’s low-income persons. In other

words, the TAZs that have 1% of the region's low-income households today should also have 1% of the region's low-income households in the forecast year. Make these adjustments to the TAZs' demographics while continuing to hold constant the total population numbers of each TAZ and at the regional level. For example, 200 low-income persons may have just been added to a TAZ; to maintain that TAZ's control total, reduce the non-low-income persons in that TAZ by 200. This should bring it back to a regional demographic profile that matches those of the base year.

The resulting datasets of base-year and forecast demographic profiles enabled the MORPC to run numerous impact analyses using its travel-demand model and spreadsheet tools, as documented within the MORPC's equity appendix to plans and programs. Smaller agencies without the in-house or contractor resources to add travel demographics to travel-demand models can use free, web-based demographic forecasting tools such as the U.S. Census Bureau's free Subnational Projections Toolkit Software, available at <https://www.census.gov/data/software/sp-toolkit.html>. Chapter 5 in this guide describes Step 3 and provides additional information about these resources.

Identify High-Priority Areas

Knowing the regional distribution of required populations is valuable, but an agency that wants to apply targeted activities to address equity will need to know which areas to prioritize for these efforts. Also, reviewers for federal certification programs often require an agency to identify areas that are high-priority areas under Title VI or EJ.

This section begins by describing how to identify high-priority areas for each population group being analyzed by using heat maps and dot-density maps. The section next describes an optional approach that creates an index to identify areas that have multiple types of underserved populations.

Identify Areas with High Numbers and Concentrations of Each Required Population

This chapter previously described how to generate heat maps to show the relative concentrations of various populations and dot-density maps to show where high numbers of underserved populations live. These concentrations and population values can be used to identify which areas have the highest concentrations and which areas have the highest numbers of each population group included in the analysis.

Many agencies currently identify *high-priority equity areas* as areas that have a concentration of underserved populations that exceeds a selected threshold concentration, often the regional average. Although easy to apply, this approach has many potential drawbacks:

- Agencies are required to identify disparate impacts and DHAE on required populations regardless of where they live. When an agency limits its equity analysis to only the geographic areas (such as census tracts) that meet a predetermined threshold, then the equity analysis will overlook the experiences of underserved persons that live in other areas.
- When the thresholds are based on the concentration of underserved populations, the analysis risks overlooking areas that have high numbers of underserved populations in favor of focusing on the underserved community's share of the overall population.
- An analysis based on high-priority equity areas might wash out dissimilarities that exist between areas that have larger differences in their concentrations.

- Using the regional average as a threshold could result in most of the region counting as an equity area, which is not very helpful to an agency that is trying to identify areas to prioritize.
- If an agency does not document its rationale for selecting a threshold, the selection can appear arbitrary to constituents, which may reduce equity stakeholders' willingness to engage in the process.

Acknowledging the drawbacks to this approach, agencies can consider applying the following techniques to improve their equity analyses:

- Seek input and feedback from equity stakeholders. What thresholds would be appropriate to use as indicators of high-priority areas? Are the identified areas the appropriate areas to prioritize for equity analysis?
- Use standard deviations to set the thresholds that categorize areas into three groupings. Areas that exceed one standard deviation above the regional number for underserved populations would be classified as high-priority equity areas. Areas that fall below one standard deviation below the regional for underserved populations would be the control group. Areas that fall within one standard deviation to either side of the regional number would be considered neutral areas that might not contribute meaningfully to the comparative analysis. (Additional discussion of control groups is provided in Chapter 6 under the heading, "Use Statistical Significance to Screen for Disparity.")
- Use a combination approach that identifies areas that have high numbers and areas that have high concentrations of underserved populations. By identifying both types of areas, the analysis will hedge against the weaknesses of either approach.

Optional: Use Indices to Identify Areas with Multiple Underserved Populations

To assist with prioritizing, agencies can use indices to help identify areas that have multiple categories of underserved persons. To create an index, start by identifying high-priority areas for each population group being studied, as described in the previous section. Then, overlay these maps to identify which areas qualify as high-priority areas for more than one population of underserved persons. For example, a census tract that is a high-priority area because of a high number of minority individuals might also be a high-priority area because of a high number of persons with disabilities. An index approach captures these overlapping vulnerabilities and ranks areas based on the degree of potential disadvantage.

MPOs that are using these index approaches include the **Atlanta Regional Commission (ARC)**, the **Delaware Valley Regional Planning Commission (DVRPC)**, and the **San Francisco Bay Area's MTC**. The MTC identifies high-priority areas for eight different population groups that are at risk of disadvantages: minority populations, low-income populations, LEP populations, zero-vehicle households, adults over 75 years of age, persons with a disability, single-parent families, and rent-burdened households. By overlapping these indicators into an index, the MTC can identify areas that may be at risk due to multiple types of potential disadvantages, which can help the agency prioritize areas that may need additional attention or efforts (MTC 2015). Figure 3 illustrates the equitable target area index approach used by the ARC.

Indices of multiple characteristics can be useful prioritization tools to support agency decision making and can supplement an equity analysis, but it is critical to have an approach that focuses specifically on the required populations. Relying solely on an index risks mixing the analysis for required populations with analyses of other populations that are not federally required.

ETA Index Categories		
Poverty Category	Race Category	ETA Index
1	1	Very High
	2	High
	3	
2	1	Medium
	2	
	3	
3	1	Non-ETA
	2	

Source: 2016 Atlanta Region's Plan, Appendix J: Equitable Target Area Methodology

Figure 3. ARC equitable target area index categories.

Understand Demographic Change

An area's demographic makeup is always changing. Many urban areas are grappling with gentrification caused by neighborhood redevelopment and housing price trends. Meanwhile, numerous regions throughout the country have undergone rapid rises or falls in numbers of different demographic groups and/or economic conditions. It is difficult to accurately forecast future population composition and distribution based on jagged historic trend lines. For example, during the 25-year span of a typical long-range transportation plan, a downtown neighborhood that begins with a high concentration of low-income populations could easily transform into an upscale community of expensive homes and, during the same period, a homogeneous suburb could become an ethnically diverse community. In rapidly evolving communities, it may not make sense, to consider the potential equity impacts of long-range transportation plan investments and outcomes using maps and statistics of present-day underserved communities.

Some MPOs, including the **Oregon Metro**, the San Francisco **MTC**, the **PSRC**, and the **Southern California Association of Governments (SCAG)** have begun to quantitatively analyze gentrification and displacement risk in their equity analyses. In response to stakeholder group concerns about the ability to accurately forecast the locations and concentrations of underserved persons over the long-range transportation planning horizon in the Portland, Oregon region, Metro has begun conducting a 10-year interim analysis of long-range transportation planning investment scenario transportation system performance outcomes (as opposed to only looking at the longer-term forecast). Innovative approaches such as these are helping to address uncertainties stemming from changing demographics (Oregon Metro 2016).

Resources

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CHAPTER 4

Step 2: Identify Needs and Concerns

Following the identification of the populations for analysis, use public engagement and data analysis techniques to identify the existing needs and concerns of these individuals and groups. Agencies can make informed decisions about how to improve equity only if they first understand the perceived and actual inequities that are unique to the underserved individuals of their region.

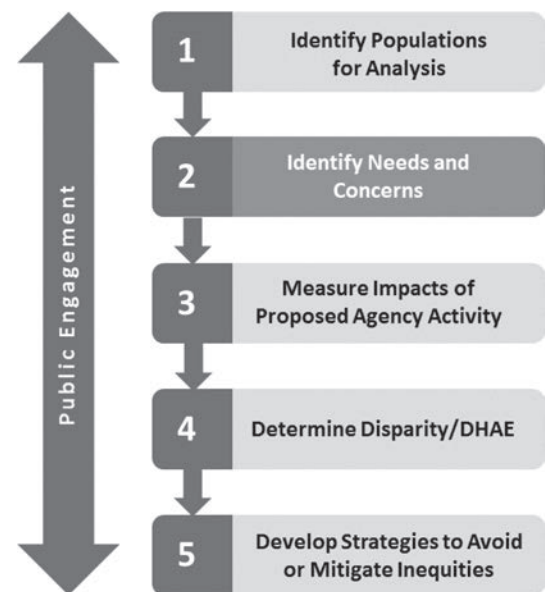
This step focuses on understanding current conditions, which are to some degree a product of past agency actions. Step 3, which will be discussed in Chapter 5, will describe how to apply knowledge of current conditions to understand the impacts of the agency's proposed actions (such as investment decisions in the TIP).

Current conditions and needs will bear examination at both the regional and neighborhood level. This guide recommends developing an understanding of existing needs at a regional level before analyzing more granular disparate impacts/DHAE within specific neighborhoods. By starting at the regional level, an agency can understand the most common concerns throughout its jurisdiction and identify locations indicating disparate impacts/DHAE with regard to key concerns such as health, safety, and mobility. This “big-picture” view and understanding can help the agency prioritize neighborhoods in which to conduct additional investigation. With the priority neighborhoods identified, the agency can repeat the process to evaluate conditions and identify needs at the neighborhood level. The essential elements of the needs analysis are essentially the same, but some units of measurement may differ between the regional and neighborhood scale. The elements of the analysis are:

- Identify and prioritize needs and concerns through stakeholder input,
- Assess environmental health and safety conditions,
- Assess gaps in access and mobility,
- Validate results through stakeholder engagement, and
- Document the findings for use in later steps.

When assessing needs of underserved persons, it is important to consider three general categories of needs: (1) potential adverse effects to environmental health and safety; (2) potential delays or reductions in the receipt of transportation benefits such as access and mobility; and (3) any other high-priority needs and concerns that have been identified through direct engagement with underserved persons.

After successfully identifying the needs of underserved persons at the regional level (and to the extent possible, at the neighborhood level), the agency documents the findings in preparation



for subsequent steps discussed in this guide (Step 3, which involves measuring and assessing impacts, and Step 4, which involves understanding and assessing disparateness). In Step 3, the agency uses the understanding of existing needs and concerns to select appropriate measures for understanding the impacts of agency actions. In Step 4, the agency evaluates the data gathered in Step 2 and Step 3 to understand whether any differences in existing or forecast conditions are disparate or pose DHAE. Where disparate distribution of benefits or burdens or DHAE are found, Step 5 is then used to develop practical mitigation strategies for implementation.

Identify Needs at the Regional Level

This guide recommends that agencies use the following process for understanding the existing needs and concerns of underserved persons at the regional scale:

1. Gather input from underserved persons about the appropriate issues to analyze;
2. Assess exposure to the burdens of the transportation system, such as environmental health and safety conditions;
3. Assess access to the benefits of the transportation system, especially access to jobs and services via transit; and
4. Validate findings with stakeholder input.

Gather Input from Underserved Persons About the Appropriate Issues to Analyze

MPOs are advised to spend time reaching out to underserved persons to identify the most pressing issues before going into any technical analysis or modeling of existing environmental health, safety, and transit access conditions. By providing an opportunity for communities to share their needs and concerns, agencies ground their analyses in local priorities, thus ensuring that these analyses are meaningful to the communities they are intended to benefit.

Chapter 2 of this guide provided details and ideas to help agencies lay the foundation for public engagement. Focusing more narrowly, this section recommends using one of two different approaches, both of which can make good use of surveys and other methods for collecting input. The first and easier approach is to incorporate engagement of underserved persons into existing public participation efforts, such as those used for development of the MPO's Long-Range Transportation Plan or TIP. The second approach is to conduct a special study focused just on the needs and concerns of underserved persons in the region.

An MPO can fairly easily incorporate equity considerations into existing public participation processes for plans, programs, and other activities. Options the agency should consider include:

- When collecting information (via surveys or public forums) from the public at large, ask for demographic information, and analyze the results to confirm that the respondents represent the full diversity of a region.
- For surveys, oversample in areas with high numbers of underserved populations. Oversampling helps ensure that the respondent demographics of the survey match those of the region.
- When organizing open houses, roundtables, or focus groups on particular topics, be sure to hold some in venues that are accessible to the previously identified high-priority underserved communities, and include some events that focus specifically on the needs of underserved persons.

- Consider conducting a special study that specifically focuses on identifying the needs of underserved persons. Identify organizations in the region (such as churches and community centers) that serve underserved persons, and ask these organizations to assist with gathering data. Staff at the organizations can serve on focus groups to provide information about their clients' needs. Ask if the organization could help distribute and collect surveys in which their clients identify transportation barriers or other concerns.

It is important to acknowledge that not all community perspectives may be captured in a single engagement effort. For example, a retired person in an underserved community may have more time to attend community meetings or participate in community events than a working single parent. To supplement any gaps in identifying needs at the regional level, bolster the insights extracted from community engagement efforts with quantitative analysis (described in the subsequent sections, “Assess Environmental Health and Safety Conditions” and “Assess Gaps in Transit Access and Mobility”).

Additionally, each community will have a variety of needs related to transportation. Measures such as “commute time to work” or “number of severe crashes” speak to potentially important issues but do not paint the whole picture of needs and concerns within a community. Some issues may be compounded by planned changes that would otherwise bring benefits. For example, a planned measure may be intended to increase transit access; however, if an increase in transit fares accompanies the increase in transit access, underserved persons might not be able to participate in the benefits provided by the increased access.

Example in Practice: Conducting a Needs Assessment

Oregon's **Rogue Valley MPO** conducted a special study, titled *Transportation Needs Assessment for Traditionally Underserved Populations*, that involved partnering with 22 organizations to distribute and gather information. The study identified that lack of access to public transportation was a major impediment and that it would be necessary to expand transit service both geographically and temporally (RVMPO 2016).

Assess Environmental Health and Safety Conditions

For transportation agencies, assessing environmental risks generally means analyzing exposure to mobile source emissions and to vehicle crashes (especially crashes involving non-motorized roadway users) to determine whether the transportation system burdens underserved persons more than it burdens other population groups.

To assess and ultimately remedy the largest health and safety risks related to exposure to environmental hazards, an agency needs to first determine the predominant locations of these risks. A variety of online tools exist to facilitate this, including the U.S. EPA's web-based *EJSCREEN* tool, which overlays map layers of demographic data and environmental risk data (such as exposure to high levels of various roadway emissions). A user can run reports about the demographics and environmental conditions of a user-defined area to discover relationships between these variables. The various “heat maps” generated from *EJSCREEN* can be used to identify areas that are most at risk for environmental hazards. *EJSCREEN* is a quick method for identifying environmental hazards such as air pollution risks (and requires minimal training

to use), but the tool has some limitations; for example, it only allows users to compare the environmental conditions of a selected geographic region to the state or national average (rather than the MPO regional average).

In addition to air pollution risks, assess the frequency and distribution of high-crash locations to determine whether these crashes occur more frequently in underserved communities. Data on numbers of crashes involving fatalities are available from the federal Fatality Analysis Reporting System (FARS), but state DOTs (e.g., in Florida) or other agencies in the area might collect more detailed data. Some MPOs, such as SCAG, are starting to develop their own databases of severe crash data, including the locations of crashes and the demographic characteristics of the persons involved.

Assess Gaps in Transit Access and Mobility

Several approaches exist for assessing the existing gaps in transit access and mobility across a region's various demographic groups, and similar approaches can be used to assess access to other benefits of the transportation system. With any of these approaches, it is important that agencies:

- **Understand mode preferences.** Through the use of travel surveys, determine the modal preferences of different population groups.
- **Understand access to transit.** Understand disparate impacts/DHAE among differing demographic groups with regard to access/proximity to transit stations (with proximity generally defined as a walkable distance of no more than a ¼-mile to ½-mile distance from a transit stop). The information that is gathered and assessed should answer the question, “Is transit available to underserved persons?” It is important to consider access in terms of contextual factors that affect trip speed and cost. Low-income persons may not benefit equitably from the travel-time savings offered by a new bus rapid transit or commuter rail service if the fares for the new service are significantly higher than those charged for slower, local buses.
- **Understand access to destinations by transit.** Understand disparate impacts/DHAE among differing demographic groups with regard to their ability to use existing transportation infrastructure to access opportunities for jobs, education, health care, retail, services, and other essential daily activities. The information and analysis should answer the question, “How many opportunities can underserved persons reach within a reasonable travel time?” Transit mobility can be analyzed through general transit feed specification (GTFS) mapping, through travel shed analyses, and through travel-demand models.

This guide recommends that, to the extent possible, agencies incorporate each of these approaches (described in more detail in the next sections of this chapter) in their analyses of identifying the needs of underserved persons at the regional level.

Understand Travel Mode Preferences

A variety of data sources are available for understanding mode choice. Federal data sources include the U.S. Census Bureau's ACS and the FHWA's National Household Travel Survey (NHTS), which can be used to identify mode split and other equity indicators such as the presence of zero-vehicle households.

Consider whether to conduct a local travel survey for a region, which many MPOs do to develop more detail than is available from national data. Although these surveys can be resource-intensive, the effort can be achieved at reasonable cost by developing partnerships with other organizations that have an interest in the data, such as transit providers, the state DOT, universities, nonprofits, and advocacy organizations.

Example in Practice: Enriching Travel Survey Data

To supplement the NHTS data, which often lacks sufficient sampling for reliable use at the neighborhood level, the **Madison Area Transportation Planning Board (MATPB)**—the Madison, Wisconsin, MPO—contracted with the University of Wisconsin Survey Center (UWSC). The UWSC conducted a survey that oversampled in areas with significant numbers of minority persons, households in poverty with children, or older adults, to ensure that these underserved persons were adequately represented in the survey’s responses. Using this travel survey data, the MATPB conducted a mode split and travel-time analysis for the various population groups, finding differences as high as 30% when comparing rates of travel to work alone among different population groups (MATPB 2017).

Understand Access to Transit and Other Community Assets

To determine how many people have access to a transit facility, agencies with basic GIS tools can perform a simple “buffer analysis” of the numbers of households and jobs within proximity of transit stops. If the agency can gather data from local municipalities on sidewalk infrastructure, it can use GIS tools to conduct a more robust network analysis such as route directness or level of quality around transit stops. Regardless of the level of detail, the agency can conduct a comparative analysis between population groups to determine if different populations have equal access to the system; if overlaid with maps of high-priority underserved areas, these approaches can also help identify gaps in service that transportation agencies could work to fill. Agencies also can consider using this approach to determine access to other community assets, such as full-service grocery stores or medical facilities.

Start by using GIS to draw distance buffers (e.g., ¼-mile or ½-mile radius areas) around transit stops to determine how many people (of each population group being analyzed) reside within a certain geographical distance of transit service. A PSRC assessment of low-income individuals and people of color within ¼-mile walking distance of frequent transit provides a useful example (see the text box, “Examples in Practice: Network Analysis and Mapping Walk Sheds”).

Drawing buffers is a quick analysis that provides a rough idea of how many people live near transit facilities, but it does not account for the geography of roadway and sidewalks. For example, although a transit stop may be within ¼ mile of a home from a birds-eye-view, the actual walking distance to the transit stop is likely longer because the available pedestrian network rarely forms a straight line between the home and the transit stop. Recommendations to assess sidewalk coverage only apply to places that have already conducted a sidewalk inventory.

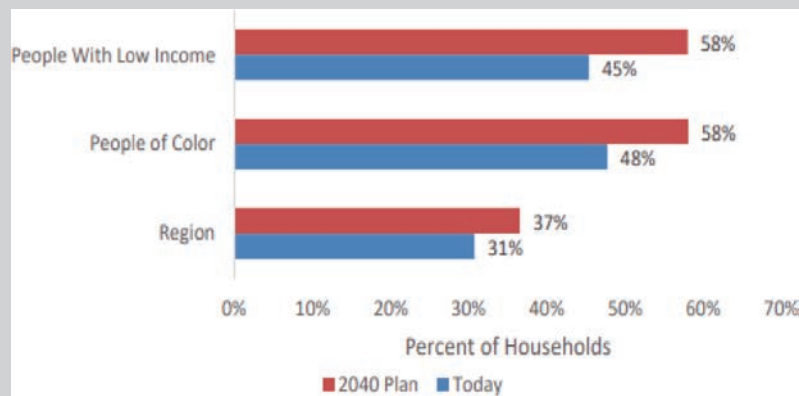
To provide a more accurate insight into transit access, consider improving the analysis by using a network distance buffer that captures the actual walking distance to the transit facility. Using GIS of the available pedestrian network, mark out the distance buffers using the pedestrian routes.

Either approach—buffer or network analysis—can be used to analyze populations that live within walking distance of important community services, not just transit. Consider conducting the same analysis to understand access to schools, multi-use paths, full-service grocery stores, medical facilities, or other opportunities that are important to the equity stakeholders in a community.

Examples in Practice: Network Analysis and Mapping Walk Sheds

Network Analysis

The PSRC performed a network analysis by mapping a ¼-mile walking distance (via the available network) to frequent transit, which they defined as routes with headways of 15 minutes or less. The PSRC then analyzed the demographics of the people residing within these areas under today's conditions and under the forecast conditions for their 2040 Long-Range Transportation Plan. They found that 31% of the region's population currently resided within the ¼-mile walking distance to frequent transit, including nearly 50% of low-income persons and of minority persons. With the 2040 plan improvements, the MPO forecast that 37% of the region's population would be within the ¼-mile walking distance of frequent transit, including 60% of both low-income persons and minority persons (see figure) (PSRC 2018).



Source: PSRC. 2018. Regional Transportation Plan, Appendix B: Equity Analysis Report

Low-income individuals and people of color within ¼-mile walking distance of frequent transit.

Mapping Walk Sheds

The Rogue Valley MPO mapped a ¼-mile walking network distance around each transit route, sidewalk, bike lane, multi-use path, public school, and grocery store in the region's high-priority areas. Although the analysis did not support comparisons among different population groups, it did offer important insights about the degree to which underserved persons have access to these community assets (RVMPO 2016).

Understand the Access Transit Provides to Destinations

To understand how useful the transit system is, consider measuring how many destinations a person can travel to from a specific location within a given time frame. In addition to comparing access for different population groups, consider comparing differences in travel time for transit relative to driving if transit is a mode that is highly used by underserved persons in a region. This guide provides two approaches for understanding access to destinations. One approach uses the region's travel demand model and the other uses GTFS and GIS data.

GTFS is a standardized, open-source data source that enables transit agencies to share and continually update their network data, including route geographies, stops, fares, and schedules. By introducing the time components from schedules, the GTFS data can be used to develop maps of high-frequency transit and of the areas or opportunities that are accessible within a given transit travel time. An example of this approach is provided by the MATPB (see the text box titled “Examples in Practice: Travel-Demand Modeling and Using GTFS”).

By combining GTFS and GIS data, an MPO can develop a variety of maps that respond to the interests and needs expressed by equity stakeholders. Such maps may show the following:

- How much of the region is accessible via a 45-minute transit trip from high-priority underserved communities;
- A 30-minute transit trip (or “travel shed”) to full-service grocery stores, which can then be overlaid with a map of high-priority underserved communities to identify communities in which grocery access could be improved; or
- The travel sheds to other essential destinations, such as educational institutions, medical facilities, and major employment centers.

The regional travel model is another useful tool for examining the current access by transit to destinations by various population groups. The travel model is also used to forecast regional outcomes, and Chapter 5, covering Step 3, provides guidance on how to conduct this analysis.

Validate Results

Quantitative analyses often overlook important contextual information. Ask equity stakeholders to review and critique or validate the assumptions and results of any quantitative analysis.

Example in Practice: Engaging Stakeholders to Refine Assumptions

After equity stakeholders criticized the **Oregon Metro’s** equity analysis, the MPO sought more proactive approaches to engage equity stakeholders and underserved persons in refining the assumptions and approaches for conducting equity analyses and addressing concerns (Oregon Metro 2016).

Identify Needs at the Neighborhood Level

After conducting a regional needs assessment, an agency might find some gaps where underserved persons or communities may not be equitably benefiting from the transportation system, or may even be disproportionately burdened. The regional-level analysis may not provide sufficient actionable information for the agency to identify and support next steps. A neighborhood-level assessment can help the agency gain a better understanding of the conditions in those neighborhoods.

Just as in the regional-level analysis, use public engagement and quantitative approaches to identify and understand needs at the neighborhood level. Some or all of the following techniques may be appropriate:

- Use results of the regional analysis to identify areas to prioritize for in-depth study;
- Conduct additional quantitative analysis at a smaller geographic scale;
- Gather more input from underserved persons in specific, high-priority neighborhoods; and
- Conduct on-the-ground audits, if necessary.

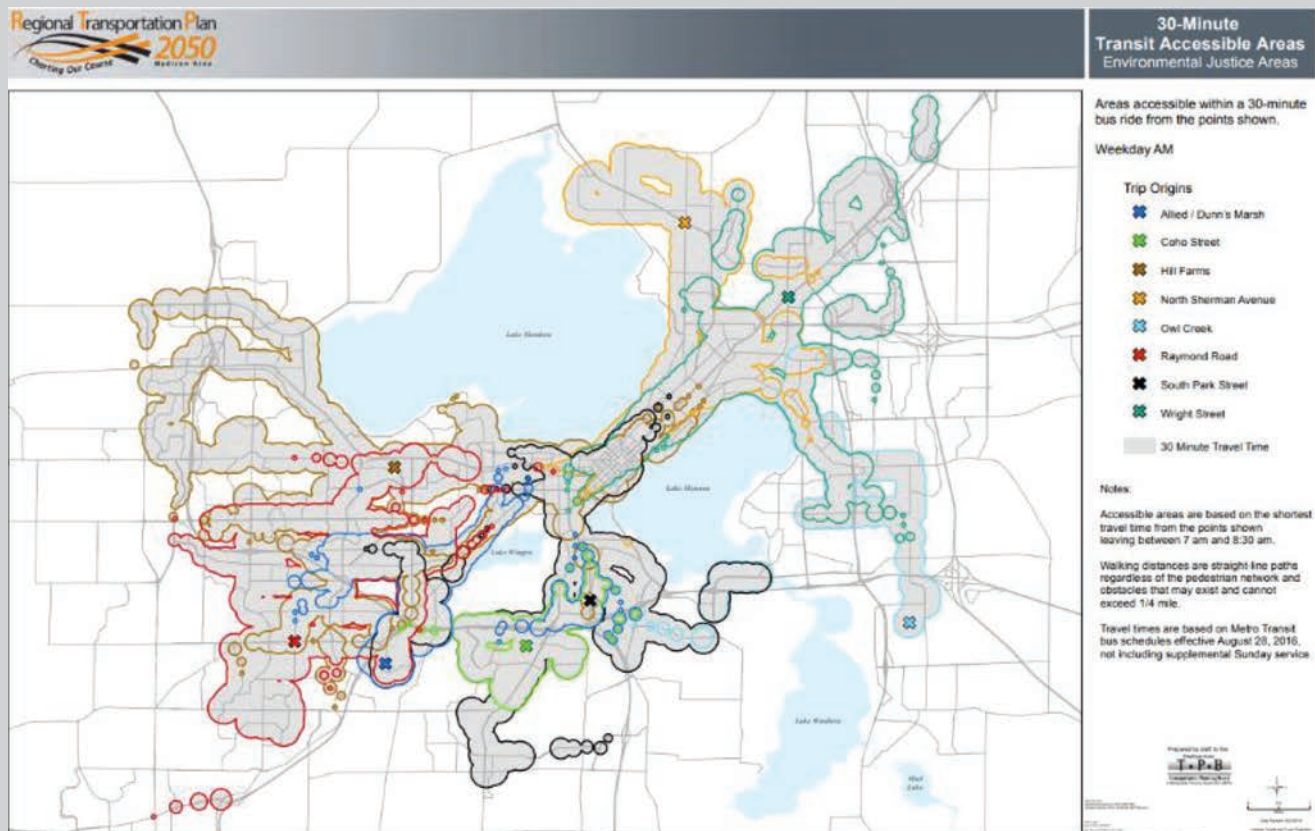
Examples in Practice: Travel-Demand Modeling and Using GTFS

Travel-Demand Modeling:

The MORPC used a population-weighted approach in its regional travel-demand model to build demographic profiles of each TAZ and to assess underserved persons' accessibility issues such as access to destinations (jobs, shopping, and non-shopping opportunities) within a 20-minute auto trip or a 40-minute transit trip. The agency also calculated average travel times for trips (for work/school, shopping, other purposes, all purposes, and to the central business district) and the percentage of population with close access to a college, hospital, major retail destination, or central business district (MORPC 2017).

Using GTFS:

- The ARC overlaid the locations of various underserved communities with transit travel sheds for 60-minute trips to destinations like schools, jobs, and hospitals, and 30-minute trips to grocery stores. The ARC focused on transit sheds of underserved communities to better understand service gaps and found that most underserved persons were not able to access entry-level jobs within a 60-minute transit trip. This analysis highlighted where underserved communities experienced gaps in transit service, which could be used in guiding transit planning (ARC 2018).
- The MATPB developed maps to approximate how far a person can travel by public transit within a given timeframe from a specific origin, such as from the center of a high-priority underserved area. The MATPB also looked at 15-minute bus access to full-service grocery stores. This measure was used to evaluate access from underserved communities to affordable and healthy food, which is essential for maintaining physical health and financial independence (MATPB 2017).



Source: MATPB (2017), Regional Transportation Plan, Appendix B, "Environmental Justice Analysis"

Access by a 30-minute bus ride from high-priority communities during weekday morning peak period.

This guide does not go into further detail on the first technique listed. Basically, this step simply implies that a neighborhood-level analysis is meant to supplement an already-conducted regional analysis. After the preliminary analysis sheds light on certain neighborhoods in the region, the agency can apply the same approaches to assess existing conditions on a more granular level.

A regional planning agency may not have the bandwidth or capability to engage in frequent or comprehensive neighborhood-level analyses. This level of detail can be reserved for instances when an agency and its equity stakeholders believe that a regionwide analysis of equity-related needs and concerns does not adequately uncover the local context. An MPO can use resources such as Unified Planning Work Program (UPWP) funds to partner with a municipality to collect essential data and conduct studies on local accessibility indicators such as pedestrian and bicycle network completeness and quality.

Conduct Additional Quantitative Analysis

After quantifying the health and safety risks across its jurisdiction and identifying high-risk areas, consider conducting a more in-depth analysis of high-risk areas. Once an initial regional analysis has been conducted, the use of GTFS data, GIS tools, buffer mapping, travel shed mapping, and other previously mentioned software can simply be reiterated (though it may involve slightly different techniques) for a smaller subregion within an agency's jurisdiction. To further improve the agency's understanding, more complex approaches also can be developed given that the analysis need only cover a smaller portion of the region.

If the regional-level transit needs gap analysis revealed the need for further investigation, consider using the travel model to gain additional understanding. A simple yet effective approach (used by the **Memphis Urban Area MPO** in Tennessee) is to use the model to assess a limited set of origin-destination pairs that are important to underserved persons, following these steps (Memphis Urban Area MPO 2016):

- a. Identify a subset of origin-destination pairs of importance to underserved persons in the region. Select origins corresponding to the region's high-priority underserved communities. Select important destinations such as major employers (such as area airports and hospitals). Consider any other origins or destinations based on the findings of a regional assessment of transit accessibility.
- b. For those origin-destination pairs, pull the transit travel time and the automobile travel time from the model.
- c. For each pair, calculate the difference between the transit and automobile travel times.
- d. Identify which pairs had the most significant differences between transit and automobile travel times. Focus transit improvement efforts on improving those transit links.

Another effective approach is to conduct a neighborhood-level travel shed analysis for specific areas of interest within an agency's jurisdiction. This approach was successfully piloted by the **MORPC**. With the overarching goal of bridging first-mile/last-mile gaps and improving lives through increased access to transit, the agency assessed the characteristics and completeness of bicycle, pedestrian, and road networks in selected "mobility hubs" (e.g., in underserved areas) by obtaining answers to the following questions (MORPC 2017):

- From an equity standpoint, what minority populations and low-income populations are currently served by the selected mobility hubs, and how do the numbers compare?
- What are the numbers of jobs accessible within each of these mobility hubs by a given mode?
- Where are the gaps or opportunity areas in the current networks?
- What minority populations and low-income populations could potentially be served by strategic bike and sidewalk infrastructure?

To address these issues, the following steps are recommended (MORPC 2017):

1. Assemble various geographic datasets (such as sidewalk and crosswalk inventory, bicyclist “level of comfort” data for each roadway, Open StreetMap highway network data);
2. Gather demographic datasets (such as U.S. Census Bureau surveys, Longitudinal Employer-Household Dynamics, Origin-Destination Employment Statistics);
3. Intersect/overlay #1 and #2 above;
4. Calculate the current and potential number of minority residents and low-income residents and jobs within specific travel sheds based on #3;
5. Identify which measures to implement to connect the greatest number of underserved persons with the benefits of transportation infrastructure; and
6. Through a public engagement effort, ask the people who live in those areas to validate the findings.

Gather Input from Underserved Persons in Specific, High-Priority Neighborhoods

Supplement analytical work with targeted engagement of underserved persons and within underserved communities, especially if the regional needs assessment identified communities that may be seeing a lot of burdens and/or not a lot of benefits from the transportation system. This effort may include conducting a survey that is tailored to staff and clients of local organizations, circulating questionnaires within a particular school, or engaging in meet-and-greets around local business to ask people how they typically commute. Examples can be seen in the Rogue Valley MPO’s Transportation Needs Assessment for Traditionally Underserved Populations from 2016 (RVMPO 2016), and the public engagement activities that were conducted by the Polk County Transportation Planning Organization (TPO) as part of its neighborhood-level audits (Polk 2015).

Neighborhood-Level Audits

Site-specific analyses of specific neighborhoods or blocks may be conducted where additional investigation is warranted. One such assessment is a walkability audit. AARP offers a free online toolkit for hosting a walkability workshop and conducting a community walkability audit (AARP 2018). Neighborhood-level approaches like this enable an agency to engage the public in gathering qualitative and quantitative data to uncover nuanced transportation needs and concerns that would not have been detected by analyses conducted from a distance. For walkability audits, agency staff and neighborhood volunteers catalog and map a variety of characteristics relating to pedestrian mobility and safety, such as whether pedestrian crossing signals at busy intersections offer sufficient time for pedestrians to cross safely.

Document Findings for Use in Other Steps

If they are sufficiently documented, the findings from these regional and neighborhood needs assessments can be used to inform agency decision making, including decisions about the other steps in the agency’s equity analysis. Moreover, the needs and concerns of underserved populations can be tracked over time to assess the effectiveness of an agency’s actions over time and to hold an agency or regional decision makers accountable for efforts at mitigation. Following are some ideas for making the most of the information and findings documented from the needs assessments conducted in Step 2 of the equity analysis:

- In Step 3 of the equity analysis (detailed in Chapter 5 of this guide), the agency must select indicators for measuring its impacts. The findings from the needs assessments can help the agency identify or create meaningful indicators to measure the impacts of proposed

agency activity. For example, if the needs assessment reveals that underserved persons in the neighborhood or region rely heavily on transit, then the impact indicators chosen by the agency might include investments in transit or forecast improvements in transit access. These meaningful indicators can be used to rank projects or in other decision-making activities.

- In Step 4 of the equity analysis (discussed in Chapter 6), the agency must determine whether any population groups experience disparate impacts or DHAE. These impacts or effects might occur under current conditions, or they may result from the agency's proposed actions (as will be discussed in Chapter 5). In either case, the findings from any needs assessments that involved comparative assessments among population groups should be included in an agency's Step 4 activities. For example, if the assessment of exposure to mobile source emissions or vehicle crashes revealed differences in impacts between an underserved population and another population group, the agency can look to Step 4 for guidance on determining whether those differences are disparate or have DHAE.
- In Step 5 of the equity analysis (discussed in Chapter 7), an agency develops strategies to avoid or mitigate inequalities. This step involves identifying and implementing mitigation of potential inequities. The findings of the needs assessments conducted in Step 2 can help the agency develop appropriate mitigation approaches. For example, these needs assessments can help the agency identify the most appropriate places to improve transit stops or service.

Example in Practice: Extending Needs Assessments Throughout the Equity Analysis Process

The **Mid-America Regional Council (MARC)** in Kansas/Missouri mapped its crash data and learned that most bicycle and pedestrian fatalities were occurring in the region's underserved communities. This new knowledge led the MARC to analyze the geographic distribution of its safety funding (an output indicator—see Chapter 5) as part of its equity analysis. When the MARC found that the safety funding was primarily going toward suburban communities that had a higher capacity to apply for the grants, the agency began developing safety countermeasures and related engagement with the underserved communities that were experiencing the high crash rates. Additional details from this example are provided in Chapter 7 under "Revise Project Evaluation Criteria" (MARC 2015).

Resources

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- U.S. Census Bureau. n.d. American Community Survey. Available at: <https://www.census.gov/programs-surveys/acs/>.
- U.S. DOT National Highway Traffic Safety Administration *Fatality Analysis Reporting System (FARS)*. Available at: <https://www.nhtsa.gov/research-data/fatality-analysis-reporting-system-fars>.
- U.S. EPA. n.d. *Environmental Justice Screening and Mapping Tool (EJSCREEN)*. Available at: <https://www.epa.gov/ejscreen>.

CHAPTER 5

Step 3: Measure Impacts of Proposed Agency Activity

By identifying underserved persons in Step 1 and determining their needs in Step 2, an agency begins to know what benefits underserved persons need or which burdens they want to avoid. The next step in conducting an equity analysis is to assess the impacts of the agency's proposed actions (such as plans, programs, or projects) on underserved persons and their respective control groups (such as minority, non-minority; low-income, non-low-income; and LEP, non-LEP). This chapter guides an agency through selecting and then measuring indicators of agency outputs and forecast outcomes.

The sections provide separate guidance for measuring outputs versus outcomes; measurement techniques tend to be similar within the two categories, but they tend to differ from one category to another.

Step 3 involves five broad tasks, and each broad task involves subsets of actions to consider or perform. The broad tasks, as discussed in this chapter, are:

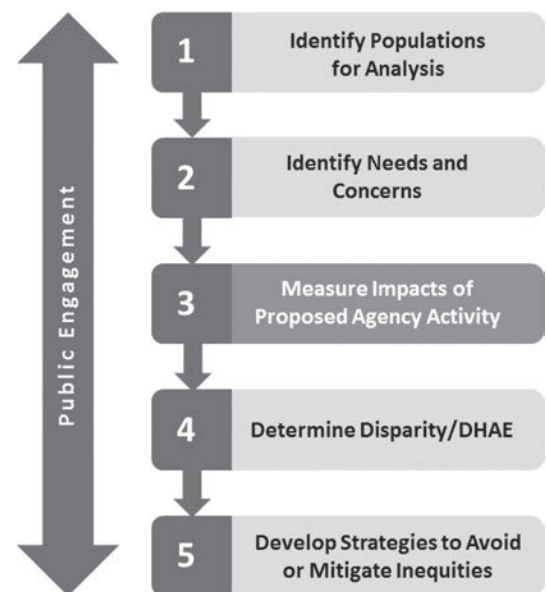
- Select indicators,
- Differentiate project types for evaluation,
- Measure outputs,
- Measure outcomes, and
- Document the task, outputs, and outcomes for use in subsequent steps.

Step 4 (addressed in Chapter 6) will discuss how to compare the results found in Step 3 to determine whether any differences constitute disparate impacts or have DHAE.

Select Indicators

The first task in Step 3 is to select indicators to measure the impacts, benefits, and burdens of the agency's actions. As with recommended practices in performance-based planning and programming, a comprehensive equity analysis considers indicators of agency *outputs* and indicators of potential *outcomes*:

- *Outputs* can be described as the “quantity of activity delivered through a project or program” (FHWA 2016). A transportation agency has direct control over output indicators, based on the agency's decisions regarding inputs and investments. Outputs can demonstrate quantitatively how an agency is responding to disparate impacts/DHAE identified in their needs assessment or prior analyses, as required for Title VI and EJ analyses. Examples of outputs



include the amount of money spent on transit projects, the miles of sidewalk constructed, and the number of safety countermeasures projects.

- *Outcomes* are the “results or impacts of a particular activity that are of most interest to system users” because the outcomes measure the system users’ experience (FHWA 2016). A transportation agency has indirect control over outcome indicators. Examples of outcomes include the decrease in average travel times, the increase in the number of jobs accessible within the region’s average commute time, and the decrease in exposure to poor air quality.

To measure congestion reduction, an agency might select indicators that measure the amount of money spent on projects to increase system efficiency (the output) and the travel-time savings resulting from those outputs (the forecast outcome).

Meaningful equity analyses should examine both the benefits and the burdens of transportation investments, rather than looking solely at where those investments are allocated. Federal regulations do not prescribe which burdens or benefits to assess, nor which indicators to use. Rather, MPOs can work with underserved persons and communities to determine which items to analyze. The converse of many of the benefits could be burdens, and vice versa. For example, bodily harm as measured by an increase in the number of traffic injuries and fatalities is a burden, but a decrease in injuries and fatalities is a benefit.

How to Select Indicators

Guidance on how to select indicators is detailed in the following actions:

1. Inventory the indicators the agency currently measures.
2. Create a list of the indicators the transportation agency already measures (such as bicycle network coverage, accessibility to jobs, or average travel time by mode). Any of these indicators likely can be tailored to an assessment of impacts on underserved persons without incurring significant additional work for the agency. Distinguish which indicators measure outputs and which measure outcomes.
3. Of the indicators the agency is already measuring, determine which indicators can be tailored to address the needs and concerns of underserved persons.
4. Review the inventory of indicators and identify those that relate to the needs and concerns of underserved persons, as identified in Step 2 of the equity analysis. For example, if underserved persons want to increase the amount of time their children spend playing outside, look for measures of the availability and quality of sidewalks, bicycle routes, and access to local parks, with an eye toward developing infrastructure and services that would complement public health, community development, and law enforcement programs. If underserved persons expressed a need for reliable transit, look for indicators of transit hours of service, frequency, and coverage.
5. Determine if the agency needs to add new indicators for a meaningful equity analysis.
6. Identify whether any of the needs identified are lacking relevant indicators and determine what new indicators the agency could begin to measure, either for the current analysis effort or as part of ongoing research activities. If the new indicators would be highly meaningful but would require too high a level of effort to develop at this time, consider including their development as part of the agency’s work plan for the upcoming year.

In practice these indicators translate into definitions of benefits and burdens. Table 5 lists benefits and burdens discussed in federal guidance, along with possible indicators for measuring them. The inventory created by any given agency might resemble this table, but it should reflect the specific needs and concerns of underserved persons in the region, as discovered through public engagement.

Table 5. Sample indicators of benefits and burdens.

Benefits	Sample Output Indicators	Sample Outcome Indicators
Travel-time reductions	Dollars invested in projects to improve system efficiency	Average commute travel times Number of jobs accessible in 30-minute commute
Congestion reductions	Dollars invested in projects to improve system efficiency	Vehicle/person-hours of delay Congested lane-miles Passenger/freight throughput
Safety improvements	Dollars invested in countermeasures Numbers of countermeasure projects	Decreases in injuries and fatalities
Travel option improvements	Transit hours of service and service frequencies Sidewalk network coverage Bike lane network coverage	Number of jobs accessible in 30-minute transit commute
Infrastructure condition	Dollars invested in maintenance	Roadway and sidewalk condition
Burdens	Sample Output Indicators	Sample Outcome Indicators
A denial of, reduction in, or delay in the receipt of benefits	See the indicators listed in the benefit rows	See the indicators listed in the benefit rows
Air or water pollution	Number of CMAQ-funded projects	Exposure to mobile source air emissions
Displacement of persons or businesses	Number of households and businesses within or adjacent to proposed roadway expansion corridors	Number of households or businesses displaced or rendered less accessible (usually not known until project design but can be estimated prior to that)
Loss of access to transit	Number of transit stops removed Reduced frequency or coverage of transit routes	Number of households with no access to transit
Destruction/disruption of community resources, cohesion, or economic vitality, including access to key destinations	Density of walkable intersections Pedestrian network connectivity index Ratio of high- to low-stress streets (using a pedestrian level-of-traffic-stress index tool)	Increased travel times to access key destinations by mode

CMAQ = The FHWA's Congestion Mitigation and Air Quality Improvement program (<https://www.fhwa.dot.gov/fastact/factsheets/cmaqfs.cfm>).

Example in Practice: Develop a List of Potential Measures

The MORPC developed a table of potential measures, each of which described the relevant mode, the type of portrayal (population, geographic, or visual), the tool needed to measure it, and the availability of data for immediate use. The list helped the agency to quickly narrow down an initial list of indicators that could be developed fairly quickly, and potential indicators to develop in the future (MORPC 2017).

Document Rationale

Explain the rationale behind choosing the indicators in the table, and how the agency considers each to be a benefit or a burden. Carefully lay out the rationale for each decision to draw

on this reasoning for future analyses and when communicating the decisions to the public, stakeholders, and agency decision makers. Be aware of indicators studied and involved in developing solutions to address any identified disparate impacts/DHAE and, in general, the needs and concerns of underserved persons.

Differentiate Project Types for Evaluation

Some projects benefit adjacent communities, whereas other projects can place adjacent communities at risk for adverse impacts such as increased noise, pollution, or physical isolation. To distinguish between projects that will benefit communities and projects that might burden communities, MPOs can begin by categorizing projects by their type (such as safety countermeasures, bicycle and pedestrian, highway expansion). Table 6 describes some of the options for breaking out projects and lists example MPO analyses that appear in this guide.

Measure Outputs

Transportation agencies typically measure output indicators by comparing the distributions of funding between underserved communities and the remainder of the region. Many indicators also can be expressed in terms of their occurrence or usefulness relative to the study population. This section outlines two approaches of measuring outputs: allocating investments by

Table 6. Types of projects to consider breaking out for separate analyses.

Reason to Break Out	Examples: Projects to Examine	Examples: MPO Analyses	Literature Review, Pilot, and Case-Study Information		
			Volume 1 Appendix	Volume 2 App. A	Volume 2 App. B
Projects tending to have net benefit to adjacent communities	<ul style="list-style-type: none"> Transit, if it stops in the community Maintenance and preservation projects Bicycle and pedestrian facilities Highway modernization Safety countermeasures 	<ul style="list-style-type: none"> DRCOG Memphis Urban Area MPO ** MARC Wichita Area MPO (WAMPO) ** 	<ul style="list-style-type: none"> ✓ ✓ ✓ 	<ul style="list-style-type: none"> ✓ ✓ ✓ ✓ 	<ul style="list-style-type: none"> ✓ ✓ ✓ ✓
Projects that may generate a net burden to adjacent communities (e.g., risks of displacement or pollution) *	<ul style="list-style-type: none"> Highway expansions that could fragment a neighborhood or speed up traffic in a pedestrian area Express transit lines that bifurcate the community without adding access 	<ul style="list-style-type: none"> DRCOG Madison Area Transportation Planning Board (MATPB) ** 	<ul style="list-style-type: none"> ✓ 	<ul style="list-style-type: none"> ✓ ✓ 	<ul style="list-style-type: none"> ✓ ✓
Modes favored by underserved persons	<ul style="list-style-type: none"> Transit Bicycle and pedestrian facilities 	<ul style="list-style-type: none"> DRCOG MATPB ** WAMPO ** 	<ul style="list-style-type: none"> ✓ 	<ul style="list-style-type: none"> ✓ ✓ ✓ 	<ul style="list-style-type: none"> ✓ ✓ ✓

* Supports a planning and environmental linkages (PEL) approach: identifying potential impacts during planning prepares for them to be addressed during project design, thereby streamlining the NEPA and environmental review process.

** References to the Memphis Urban Area MPO in Volume 1 appear in the Examples in Practice text box, “Educating the Community”; in chapter text under the headings, “Define Population Groups for Analysis” and “Conduct Additional Quantitative Analysis,” and in Appendix Table A-2, with additional information provided in Volume 2. References to the MATPB in Volume 1 appear in two “Example in Practice” text boxes: “Enriching Travel Survey Data” and “Using GTFS,” with case study information provided in Volume 2. The WAMPO case study information is provided in Volume 2.

geographic area and allocating investments by users. Both approaches not only fulfill federal requirements but also encourage agencies to conduct a meaningful equity analysis. MPOs can work with equity stakeholders in a region to determine which approach would be most meaningful.

Allocate Investments by Geographic Area

The FTA requires that project maps be overlaid on maps of underserved communities to determine where investments are being allocated. The overlaid maps can help an agency to compare the distributions of investment dollars in areas with required populations to distributions in other areas. To look more closely at the comparisons, some agencies further stratify the data into modal categories and/or calculate relative per capita spending levels. For example, if an agency has learned that underserved persons are heavily reliant on transit for access to employment, then it would want to be able to evaluate its per capita investments in transit.

This type of analysis can be conducted by performing the following actions:

- 1. Create map layers for each project category or funding source, overlaid on the maps created in Step 1 of the equity analysis.** Given that the ultimate purpose of an equity analysis is to determine whether required populations are at risk of bearing higher burdens or receiving fewer benefits than other populations, it is best to create separate map layers of the project categories that were just developed. For each project category, overlay the map layer on the base maps of high-priority areas for each population being analyzed, which were created in Step 1.
- 2. Attribute investments to the adjacent communities.** Divide the funding for each project among the communities the project touches. For example, if a highway expansion project touches six census tracts (or whatever unit of geography is being used for analysis), then assign one-sixth of the project's funding to each tract. Sum the investments in underserved communities and in the control population groups for each project type and population group. Track this information in a table (comparable to Table 7) for use in making comparisons.

Table 7. Sample per capita spending per category of underserved persons.

Measure	Population Group	Total Investment (\$million)	Population Size	Per Capita Allocation (\$)
Bicycle/Pedestrian	Minority Communities	\$12	1,000,000	\$ 12.00
	Non-Minority Areas	\$8	1,000,000	\$ 8.00
Total Investment: \$20 Million	LEP Communities	\$1	100,000	\$ 10.00
	Non-LEP Areas	\$19	1,900,000	\$ 10.00
	Low-Income Communities	\$14	600,000	\$ 11.18
	Non-Low-Income Areas	\$6	1,400,000	\$ 4.29
Highway Expansion	Minority Communities	\$450	1,000,000	\$ 450.00
	Non-Minority Areas	\$550	1,000,000	\$ 468.42
Total Investment: \$1 Billion	LEP Communities	\$110	100,000	\$2550.00
	Non-LEP Areas	\$890	1,900,000	\$ 272.00
	Low-Income Communities	\$400	500,000	\$ 667.00
	Non-Low-Income Areas	\$600	1,500,000	\$ 429.00

If additional underserved population groups are being considered in the equity analysis, be sure to include each population and its control group as a row for each measure.

3. **Determine the per capita funding distribution.** Add two columns to the table, labeled “Population Size” and “Per Capita Allocation.” Divide the total planned investments per project type by the actual population sizes to determine the per capita allocation, as shown in Table 7.

If the analysis stops at Action 2 and only takes into account the total investment amounts, there would appear to be a lower level of investment in bicycle and pedestrian projects in LEP communities. Calculating the data on a per capita basis (Action 3) enables the agency to examine the investments based on relative population sizes, which shows a proportionate distribution between LEP and non-LEP populations.

Allocate Investments by Usage by Different Population Groups

A use-based analysis assigns spending amounts for a project to populations based on their use of that type of project rather than on the project’s proximity to a high-priority area for that population. This approach may more accurately allocate the spending among different population groups than does the geographic-based approach. The basic actions to be performed are:

1. Categorize investments as transit, roadway, or non-motorized (or other modal splits as appropriate to a region and the available data).
2. For each mode, calculate the *share* (percentage) of vehicle-miles traveled (VMT) or trips made by each population group on that mode under current conditions. This data can come from the travel model, transit agency data, household travel survey data, or census data. For example, the share of trips taken by low-income individuals equals the number of transit trips taken by low-income individuals divided by the total number of transit trips.
3. Allocate the investments in each mode to the population groups based on the share of trips that are taken by each population group (as calculated in Action 2). For example, the share of investment in transit that benefits low-income individuals equals the total transit investment multiplied by the share (percentage) of transit trips taken by low-income individuals.
4. For each mode, compare the total investments allocated to each population group to that population group’s usage of the mode.

Table 8 shows a hypothetical use-based comparison. In this example, the agency is adequately investing in minority communities reliant on transit (i.e., 64% of the agency’s transit investments are directed toward the 62% of the minority population that uses transit); however, the investment may inadequately meet the needs of low-income persons who depend on transit (only 51% of the transit investments are directed toward the low-income population, which makes up 58% of those who use transit). Further analysis would be needed to address whether this under-investment is a disparate impact. It is important to note that projects with

Table 8. Sample investment allocation by usage.

Share of People	Share of Trips			Share of Investments			
	Transit and Roadway	Transit	Roadway	Transit and Roadway	Transit	Roadway	
Low-Income	30%	31%	58%	28%	40%	51%	28%
Non-Low-Income	70%	69%	42%	72%	60%	49%	72%
Minority	61%	54%	62%	55%	57%	64%	52%
Non-Minority	39%	46%	38%	45%	43%	36%	48%

lower levels of usage may reflect lower investment, and that low usage does not preclude the potential use of a future investment. This is a common occurrence with bicycle and pedestrian projects, for which agencies must first invest in a safe and connected network of facilities before cyclists and pedestrians feel comfortable using those facilities.

Example in Practice: Use-Based Approach

The San Francisco MTC used the use-based approach to allocate spending by project use or mode, looking at indicators such as number of trips on a transit route or VMT on a roadway. The MTC broke the usage down by different populations to determine if investments were proportional to the travel decisions made by residents (MTC 2015).

Measure Outcomes

MPOs use regional travel-demand models to forecast the impacts of an investment or policy on transportation system performance. These analyses may occur at the corridor level or at the regional scale and typically employ TAZs as the geographic unit of comparison. The primary model-based outcomes are accessibility measures, which may include measures of average highway or transit travel time to job centers or other major destinations. Many MPOs already compare the forecast outcomes of their plans and programs to current conditions or to alternative future scenarios using the results of travel-demand models and off-model estimations. For some measures, the model results need to be postprocessed using custom programming scripts to obtain the results at a required format or level of aggregation.

This section of the guide describes a *population-weighted* approach to using those same forecast measures in an equity analysis by weighting each TAZ's results according to the percentage of the region's population that resides within that TAZ. (Some agencies that use this approach may call it a *population-based* approach.) The population-weighted approach contrasts with the geographic-based approach, in which only the outcomes forecast for high-priority TAZs are considered. An analysis based on the geographic approach will likely omit underserved persons who do not live in those high-priority TAZs, whereas an analysis based on the population-weighted approach is likely to include them.

Determine the Demographic Makeup for Each TAZ

See “Step 1: Identify Populations for Analysis” (Chapter 3) for instructions. For each TAZ, also determine what percentage that TAZ contains of each of the regional populations for each population group being analyzed. For example, if TAZ A has one minority individual and the region has 100 minority individuals, then TAZ A has 1% of the region's minority population. When calculating the regional outcomes for minority persons, TAZ A will be weighted at 1% as the TAZs are summed to develop the full regional outcome.

Develop the Scripts for the Selected Outcomes

Most indicators for outcomes are based on the model's estimation of auto and transit travel times from each TAZ to every other TAZ, which is known as the *travel time skim*. Model scripts

can build off the trip characteristics (such as travel times) to assess accessibility. A relatively simple script can calculate the number of trips originating in each TAZ. Then, for each TAZ, the script can divide the trips among that TAZ's identified demographic groups. For purposes of equity analysis, demographic groups to parse out for each TAZ must encompass the populations required under Title VI, E.O. 12898, and E.O. 13166:

- Minority persons and non-minority persons,
- LEP persons and non-LEP persons, and
- Low-income households and non-low-income households.

By attributing a share of each TAZ's trips to the six population groups listed above, the scripts can calculate trip-based indicators for individual population groups throughout the region by summing the outcomes for each TAZ.

The population-weighted approach can be applied to four-step models, trip-based models, tour-based models, or activity-based models. The same approach of weighting the TAZ results by their relative share of the regional population can be applied to any measure the agency forecasts using the model's travel-time skims. The following sections describe the process for three common types of outcomes.

Average Travel Time for a Given Trip Purpose

Travel models produce travel times for a variety of trip purposes. Although models differ in their defined trip types, a model might include mandatory trips (i.e., trips to work or school), trips for shopping, trips for other purposes, and trips for all purposes. The actions listed in this section of the guide demonstrate how to calculate the average travel time for work trips, but the same method would be used for other trip purposes:

1. Match the travel-time skim with the regional work-trip table.
2. Determine the number of work trips from each TAZ, and apportion them among the various populations for analysis based on each TAZ's demographic makeup.
3. When summing the TAZ results into the regional totals for each population group, use the regional percentage of each population group within each TAZ to calculate the weighted average work travel times for that population group.

Average Number of Destinations Accessible Within a Given Travel Time

Travel models also are used to measure the number of destinations that can be reached within a given travel time by transit or by driving. Destination types could include job opportunities, shopping opportunities, or other opportunities (depending on what is available in the model). Agencies can perform the following actions to calculate the average number of jobs nearby, and the same method can be used for other destination types.

1. Select the appropriate travel-time thresholds and whether the transit trip times will include only in-vehicle time or also time spent walking, waiting, or transferring. (If the agency also produces forecasts of the number of jobs nearby, then the agency can use their existing approach. Many agencies use the region's average travel time for work trips. This demonstration uses a 20-minute drive threshold and a 40-minute transit threshold.)
2. Run the model to generate the travel-time skims.
3. Calculate the number of jobs accessible within a 20-minute drive and a 40-minute transit trip from each TAZ.
4. When summing the TAZs into the regional totals for each population group, weight the average number of jobs accessible from each TAZ by that TAZ's share of the regional population of each population group.

Percentage of Population with Reasonable Access to Important Destinations

The agency may want to understand how many people (and how many of each population group) live within a reasonable travel time of major destinations such as colleges, hospitals, grocery stores, or major retail destinations. These numbers are measures of accessibility. The actions listed in this section describe an approach for measuring accessibility to grocery stores using a traditional four-step travel-demand model. The same approach could be used for any destination of interest to the agency and the equity stakeholders in its region.

1. Determine which TAZs have grocery stores that qualify for inclusion in the assessment.
2. Select a travel-time threshold that is appropriate for trips to grocery stores (such as 20 minutes), and use the travel-time skims to determine which TAZs contain grocery stores within the selected travel-time threshold.
3. For the TAZs that contain grocery stores within the selected travel-time threshold, sum the results by each population group.
4. For each population group, divide the number of persons who can reach the grocery stores (as calculated in Action 2) by the number of persons who cannot, and multiply by 100 to calculate the percentage.

Example in Practice: Population-Weighted Approach

The **MORPC** uses this population-weighted approach and has documented the approach well in the equity analysis appendices to its plans and programs (MORPC 2017). The **MARC** piloted the approach as part of the development of this guide (MARC 2015). Following its initial research, the project team also identified the **Northwestern Indiana Regional Planning Commission (NIRPC 2011)** and the **Licking County (Ohio) Area Transportation Study (LCATS 2016)** as additional examples of the population-weighted approach.

Run the Scripts and Collect the Data

Once the population-based scripts have been written for selected indicators, the next step is to run the scripts for the current conditions and the forecast conditions. It is important to compile the script results into a table that compares results across population groups, such as the example shown in Table 9.

Table 9. Sample format for organizing data.

Performance Measure	Population Group	Current Conditions	Forecast Conditions
Commute Travel Times	Minority		
	Non-Minority		
	LEP		
	Non-LEP		
	Low-Income		
	Non-Low-Income		
	Regionwide		

Current conditions are included to help fulfill FHWA EJ guidance that the analysis consider “the cumulative effect of a decision *in combination with past actions* and all other reasonably foreseeable future actions” (FHWA 2015). Therefore, the analysis needs to describe whether minority persons and low-income persons are *currently* experiencing disproportionate benefits/burdens as well as the distribution of benefits and burdens in the forecast year.

Apply the Data Collected to Any Postprocessing or Other Forecasting Efforts

Once the model results are available, use the model data to forecast other outcomes, such as exposure to mobile source emissions. Use the region’s air dispersion model to analyze mobile source emissions to determine the degree to which underserved persons and their relative control populations are exposed to roadway emissions. If the region also has a noise and vibration analysis approach, use that to measure the burdens experienced by different populations.

Limitations

Limitations apply to any exercise that relies on the travel-demand model, including those described in this section. For example, many models are not good at capturing travel by walking or bicycling. Transit travel times might not be well represented and may not include time spent walking, waiting, or transferring. Measures of access to jobs often do not consider differences in education levels and the appropriateness of jobs. Also, rapid changes in transportation technology are leading some researchers to question the validity of some traditional models.

Document Measurements for Use in Next Steps

Fully document the rationale and assumptions made during the analysis process. This documentation will enable an MPO to dig into the data more deeply if disparate impacts/DHAE are found, and it will assist in communicating the findings and perspective to the public, equity stakeholders, and agency decision makers.

The data collected in this chapter will likely reveal some differences in impacts or effects among the various population groups. Chapter 6 (covering Step 4) will assist in determining whether those differences are disparate or disproportionately high and adverse, and Chapter 7 (covering Step 5) will provide some ideas for mitigating identified disparate impacts/DHAE.

Resources

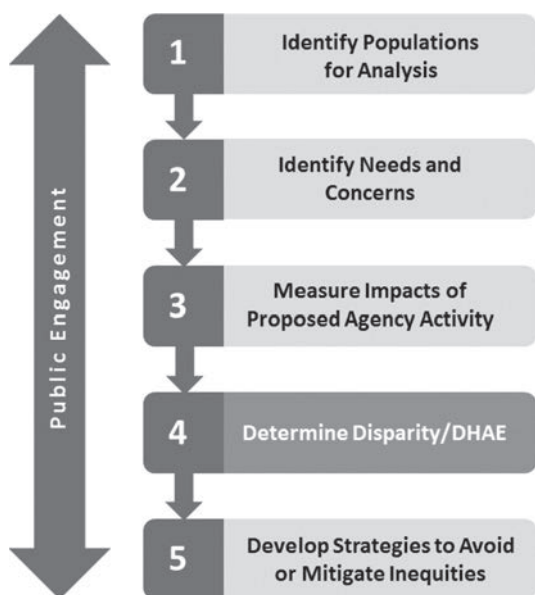
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CHAPTER 6

Step 4: Determine Whether Impacts Are Disparate or Have DHAE



After assessing the impacts of plans, programs, and projects on traditionally underserved persons, determine whether the levels of impacts are disparate and/or whether any impacts are disproportionately experienced among differing population groups. It is important to remember that the assessment should consider not only proposed future investments but also the present needs and concerns of underserved populations.

The laws and regulations relating to Title VI and E.O. 12898 require agencies responsible for federally funded programs and activities to assess and address potential disparate impacts and DHAE generated by their activities. The FTA's Title VI Circular 4702.1 defines terms related to disparity as follows (FTA 2012):

- f. Disparate impact refers to a facially neutral policy or practice that disproportionately affects members of a group identified by race, color, or national origin, where the 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 less disproportionate effect on the basis of race, color, or national origin.
- g. Disproportionate burden refers to a neutral policy or practice that disproportionately affects low-income populations more than non-low-income populations. A finding of disproportionate burden requires the recipient to evaluate alternatives and mitigate burdens where practicable.
- h. Disparate treatment refers to actions that result in circumstances where similarly situated persons are intentionally treated differently (i.e., less favorably) than others because of their race, color, or national origin.

DHAE include individual and cumulative impacts as well as "the denial of, reduction in, or significant delay in the receipt of, benefits." FTA's EJ Circular 4703.1 provides step-by-step guidance on determining DHAE consistent with the requirements of the U.S. DOT Order 5610.2(a) (U.S. DOT 2012), which defines a DHAE as one that:

- (1) is predominately borne by a minority population and/or a low-income population, or
- (2) will be suffered by the minority population and/or low-income population and is appreciably more severe or greater in magnitude than the adverse effect that will be suffered by the non-minority population and/or non-low-income population.

MPOs must assess the potential for disparate impacts and DHAE on underserved persons that may result from any activities involving federal funds. To support this evaluation, this chapter guides MPOs in identifying whether underserved persons are disproportionately adversely affected by burdens or by benefits that have been denied, reduced, or significantly delayed.

In Step 4, MPOs review the data collected in Step 2 and Step 3 to analyze the distribution of existing benefits and burdens, agency actions, and forecast outcomes, using both quantitative

and qualitative methods. Quantitative methods serve as preliminary screening tools for potentially disparate impacts. Then, incorporating qualitative information through supplemental sources and public engagement allows MPOs to validate findings and better understand how underserved persons experience the benefits and burdens associated with transportation decisions. Robust evaluation of disparate impacts is an iterative process: new insights from qualitative analysis may warrant that MPOs adjust and rerun quantitative screening tools used initially. Step 4 ends with guiding questions to explore causes and potential mitigation options for disparate impacts that have been identified. This diagnosis process leads into the final phase of equity analysis, mitigating issues in Step 5.

Review Data to Identify Differences Among Population Groups

Through the actions taken under Step 2 and Step 3, MPOs can produce data tables of indicators that summarize the differing experiences of various population groups in relation to agency outputs (such as agency investments) and existing and forecast outcomes relating to accessibility, safety, environmental quality, and health risks. Outputs and outcomes are the major categories of measures of agency impact. This section provides guidance on using the data gathered previously to identify whether any population group is experiencing different impacts. Later sections of this chapter will provide guidance for discerning whether those different impacts are disproportionate.

Outputs

Outputs such as funding distributions are an important piece of an equity analysis, though they are insufficient on their own for determining disparate impacts. Investment amounts do not capture the full range of benefits or burdens conferred by investments, and funding distribution assessments often inaccurately assume that the transportation investment provides net benefits only to the adjacent areas and no effects to other areas.

Building on the example results calculated in previous steps, Table 10 illustrates a hypothetical equity analysis that uses the approach in previous steps to assess per capita spending on adjacent projects and total regional spending for minority, LEP, and low-income populations and for the control populations for each group. The example analysis shows that people residing in minority communities receive \$3,000 in per capita investments, which is 25% less than the \$4,000 per capita

Table 10. Sample of per capita spending by geographic areas.

Measure	Population Group	Population Size	Per Capita Spending	Difference Underserved Persons/Other
Per Capita Spending on Adjacent Projects	Minority Communities	1,000,000	\$3,000	25% less than non-minority areas
	Non-Minority Areas	1,000,000	\$4,000	
	LEP Communities	200,000	\$5,000	80% more than non-LEP areas
Regional Total: \$3,000 per capita (\$6 billion/2 million people)	Non-LEP Areas	1,800,000	\$2,778	
	Low-Income Communities	600,000	\$5,000	117% more than non-low-income areas
	Non-Low-Income Areas	1,300,000	\$2,308	

Table 11. Sample commute travel times.

Performance Measure	Population Group	Current Conditions	Plan Forecast	Percent Reduction
Commute Travel Times (in minutes) and Time Savings	Minority	50	48	4%
	Non-Minority	40	38	5%
	LEP	45	44	2%
	Non-LEP	40	38	5%
	Low-Income	60	50	17%
	Non-Low-Income	35	34	3%
	Regionwide	45	42	7%

investments in non-minority areas. By comparison, per capita spending for LEP communities and low-income communities is higher than for their counterpart populations.

Outcomes (Existing and Forecast)

To evaluate outcomes, gather data from Step 2 and Step 3 to compare how different population groups fare under current conditions, the forecast year, and the percentage change over time. To comply with federal EJ guidance, equity analyses need to consider “the cumulative effect of a decision *in combination with past actions* [emphasis added] and all other reasonably foreseeable future actions” (FHWA 2015). Therefore, the analysis also needs to assess whether minority persons and low-income persons are currently receiving fewer benefits of the transportation system. If they are currently receiving a disproportionately smaller benefit, then the improvements offered by the plan should narrow that gap. Seek to evaluate and remedy existing inequities, not just ensure that the current activities do not create additional disparate impacts. Do no harm going forward and remedy past harms.

The sample case illustrated in Table 11 shows that travel times improve for all groups, but not as much for minorities and LEP as for their counterpart populations. Travel times for the low-income population improve far more than those for the non-low-income group. However, given that travel times for the low-income population are far higher than for any other group under the current condition, this disproportionately large improvement is appropriate to remedy the current disparity. Line graphs are an effective way to visualize these differences, as shown in Figure 4. These graphs can make the data easier for the agency staff to review and easier to communicate the results with the public, equity stakeholders, and agency decision makers.

Screen for Disparate Impacts Using Quantitative Methods

Quantitative methods such as benchmarking, statistical significance, and location quotients (LQs) are helpful for screening for potential disparate impacts to identify impacts that may warrant additional investigation. For equity analyses of the required populations, compare the demographics and impacts on an affected population with a more general population, such as the population of the county or MPO planning area (*Crenshaw Subway Coalition v. LACMTA*). The LQ method applies this standard. MPOs will need to follow their quantitative screening with qualitative analysis to validate the findings and to obtain input as to why the disproportionate impacts are occurring; the next section in this chapter presents some qualitative approaches.

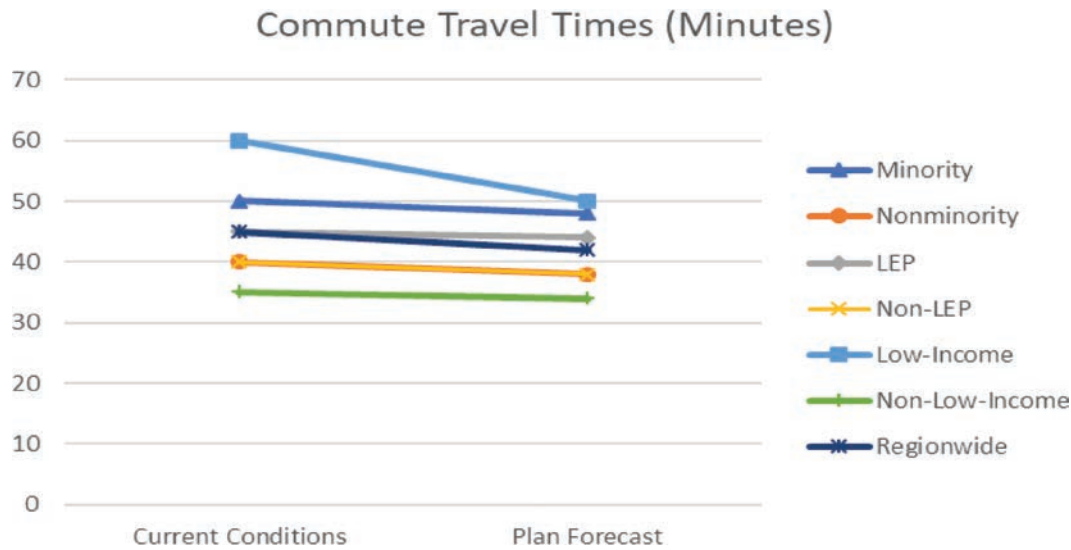


Figure 4. Change in sample commute travel times.

Establish Benchmarks to Flag Differences

Establish benchmarks for percentage differences in indicator values between population groups to flag potentially disparate impacts for further investigation. Justify benchmark values with relevant contextual and historical information for each indicator. Comparison to existing conditions could be useful in establishing benchmarks. Consultation with equity stakeholders can help the agency develop appropriate benchmarks that can be used to flag when an impact needs further attention. For example, the MPO might work with equity stakeholders to determine that a current difference of 25% in commute times for minority populations compared to non-minority populations is disparate and should be reduced. If the assessment of future conditions demonstrates little improvement—or worse, a growing disparity—consider mitigation strategies to reduce the percentage more significantly.

Use Statistical Significance to Screen for Disparity

Guidance from the U.S. EPA on EJ impacts recommends using statistical significance, which is a statistical method for confirming that an identified variation is not occurring by chance (U.S. EPA 2004). Statistical significance is particularly important for studies that use sample sizes that are much smaller than the full population.

In an equity analysis, the population groups evaluated for statistically significant differences include *test groups* (each required population group) and *control groups* (non-required population groups that serve as benchmarks for comparison to the test groups). A t-test can be used to determine if the means of the indicators of interest (such as average travel times) for each group are statistically different.

For data derived from the census and related data products, the U.S. Census Bureau makes available the Excel-based ACS Statistical Testing Tool (<https://www.census.gov/programs-surveys/acs/guidance/statistical-testing-tool.html>). A worksheet in the tool, “Statistical Testing for Multiple Estimates,” offers testing at the 10%, 5%, or 1% significance levels (U.S. Census Bureau 2018). The 5% significance level is most commonly used to identify statistically significant differences. If the agency is using U.S. Census Bureau data without the Excel tool, refer to the publication *A Compass for Understanding and Using American Community Survey Data: What*

Researchers Need to Know, which provides guidance and instructions for manually calculating statistical significance, including adapting an indicator’s margin of error according to significance level and geography (U.S. Census Bureau 2009).

A finding of statistical significance indicates that an observed difference was unlikely to have occurred by chance. However, this finding provides limited information about potential disparate impacts on the test group, as it does not convey the magnitude of the difference and its meaning for the everyday lives of underserved persons. A statistically significant difference may not be particularly meaningful or relevant to the issues being considered, whereas an observed difference that is not statistically significant might be quite important. For example, the rate of pedestrian injuries within a region’s low-income population may not differ enough from the region’s overall rate of pedestrian injuries to be statistically significant. Nonetheless, if the low-income population primarily relies on walking as its main mode of transport, whereas other people in the region usually choose other options, the higher urgency of the low-income population’s need for pedestrian safety is important to take into account.

An assessment of statistical significance only serves as a preliminary screening tool to flag potential concerns or issues, and should be considered in light of other information such as the expressed concerns of underserved populations. It should not be used as the sole indicator of disparate impacts. U.S. DOT guidance uses terms and phrases such as *disproportionately*, *predominantly*, and *appreciably more severe or greater in magnitude* to describe differences that would warrant a finding of disproportionate impact regardless of whether they are statistically significant. FTA’s EJ Circular 4703.1 recommends considering the “totality of the circumstances.” The qualitative methods described later in this chapter can help MPOs to determine whether an identified impact is meaningful and warrants mitigation.

Apply LQs

LQs screen for potentially disparate impacts of indicators that are associated with particular geographic areas. LQs compare the concentration of underserved persons in an affected geographic area to see if the demographics of the affected population closely resemble the demographic makeup of the regional population (as discussed in *Crenshaw Subway Coalition v. LACMTA*). Examples of geographic areas for which population demographics could be compared include:

- Populations living within walking distance of transit compared to the regional population,
- Populations living outside a 20-minute car or bus trip to a full-service grocery store compared to the regional population, and
- Populations living in close proximity to high-volume roadways with elevated air and noise pollution as compared to the regional population.

Calculating LQs will be straightforward for MPOs with access to population data that can be apportioned according to areas impacted by the existing transportation system or forecast changes. To calculate the LQ, consider the area of impact as the *study area* and the broader region as the *reference area* to apply the following formula:

$$\text{Location quotient} = \frac{\left[\frac{\text{Underserved population in the study area}}{\text{Total population in the study area}} \right]}{\left[\frac{\text{Underserved population in reference area}}{\text{Total population in reference area}} \right]}$$

If the LQ equals one (LQ = 1), it indicates that the population within the study area is the same as that of the broader region (i.e., there are equal proportions of underserved persons

in the study area and the reference area). If the LQ is greater than one ($LQ > 1$), it indicates that underserved persons are concentrated in the study area relative to the reference area. If the study area represents a burden (such as risk exposure), then $LQ > 1$ signifies a disproportionate adverse impact. If the LQ is less than one ($LQ < 1$), it indicates that there are fewer underserved persons in the study area relative to the reference area. If the study area represents a benefit (such as transit access), then $LQ < 1$ signifies a potentially disproportionate denial of receipt of benefits.

By comparing the proportion of underserved populations in an impacted area to the proportion of the underserved population in the overall region, an agency can identify if underserved populations are disproportionately exposed to benefits or burdens. For an example, an agency could compare the proportion of low-income individuals living in TAZs with high crash rates to the regionwide proportion of low-income individuals. If the “high-crash TAZs” population is 1,000, of which 250 are low-income persons, and the total population is 100,000, of which 25,000 are low-income persons, the LQ will equal one, and would be calculated as follows:

$$LQ = [250/1,000] / [25,000/100,000] = 0.25/0.25 = 1.$$

In this example, $LQ = 1$ would indicate that low-income persons are not over-represented in high-crash zones. However, if the number of low-income persons in the high-crash zones is much higher, say 500, the LQ would double, as follows:

$$LQ = [500/1,000] / [25,000/100,000] = 0.5/0.25 = 2.$$

In the revised example, the value $LQ = 2$ could serve as a “red flag” prompting the MPO to examine why low-income persons were over-represented in high-crash zones.

The Rhode Island DOT and its MPO used LQs to identify disproportionate exposure of EJ populations to pollution and asthma risk (see “Example in Practice: LQs” text box).

Limitations of Quantitative Analysis

Each of the quantitative analyses described previously is limited in its ability to determine disparate impacts. The values used for benchmarks are subjective choices set by stakeholders or determined by policies; communities that experience small impacts relative to the benchmark could still be experiencing disproportionate impacts that are not captured or revealed by quantitative analyses alone.

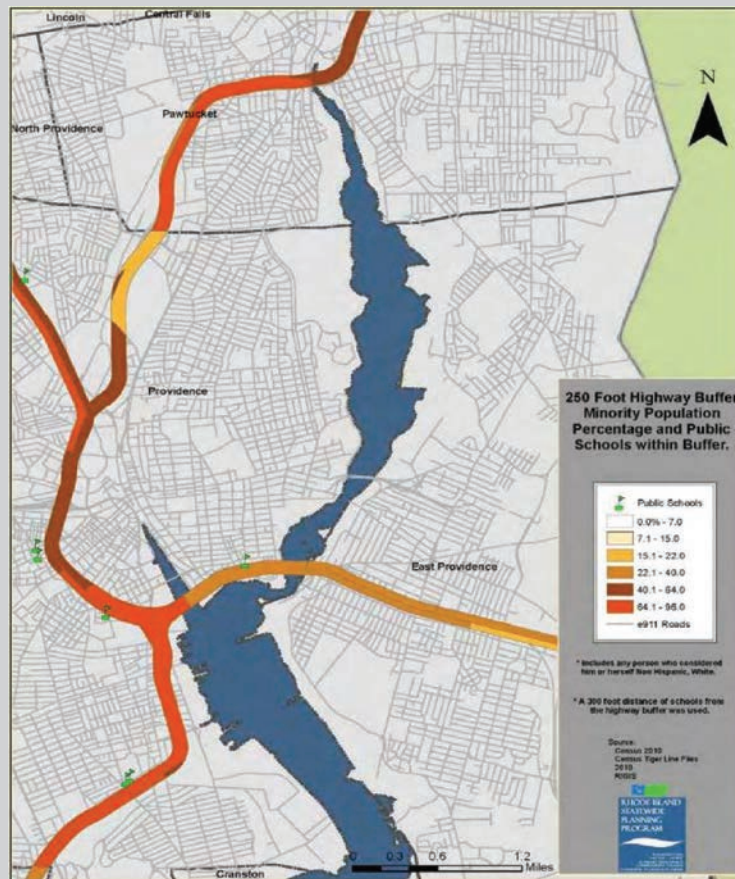
Tests of statistical significance depend heavily on sample sizes and only describe the likelihood of differences between populations. As sample sizes near the full population, any differences in the results are likely to be statistically significant. Therefore, it is important for MPOs to determine whether a difference is *meaningfully* disproportionate, regardless of its statistical significance. Due to inevitable lack of precision in demographic data reported by geography (such as census tracts), LQs should be considered as estimates for potentially disparate impacts. Although LQs may be useful for identifying areas that may experience disparate impacts for further investigation, they cannot be used to conclude that impacts are not disproportionate. Consider other impacts in the equity analysis before making this determination.

The quantitative analyses described in this section should only be used to screen potentially disparate impacts for further investigation, and should not be used as adequate evidence that no disparate impacts exist. Supplementing quantitative analyses with qualitative methods incorporating existing supplemental information and public engagement is critical to fully understand the full range of meaningfully disproportionate impacts on underserved persons.

Example in Practice: LQs

The **State Planning Council in Rhode Island** defined the study area as 250 feet around limited access roadways, based on academic research, and then determined the demographic makeup of the study area compared to the statewide demographics (see highway buffer map). The agency chose not to include other arterials because of the perceived offsetting benefits of providing access to transit and destinations (Rhode Island State Planning Council 2017).

Using data obtained from the 2010 Census (see table), the agency calculated LQs for the minority population (1.68) and for the population below the poverty level (1.48). The agency concluded that there was a disproportionate impact.



Source: Rhode Island State Planning Council (2017)

Population-based LQ calculation, proximity to Interstate Highways. *

	Study Area		Reference Area		LQs (A/B)/(C/D)
	Targeted Underserved (A)	Total Population (B)	Targeted Underserved (C)	Total Population (D)	
Minority	7,691	20,367	248,882	1,052,567	1.68
Population below poverty level	3,538	20,367	123,396	1,052,567	1.48

* Population numbers based on 2010 Census.

Data Source: Rhode Island State Planning Council (2012)

Validate Findings with Qualitative Methods and Stakeholder Engagement

Qualitative methods inform analysis of disparate impacts with the values, attitudes, knowledge, and preferences of underserved persons. Qualitative methods should be used to determine which impacts are considered as benefits or burdens, and how significantly they are felt within the community. This section guides MPOs in gathering supplemental information from existing sources before filling in knowledge gaps with additional input from equity stakeholders.

At this stage in an equity analysis, the scope of stakeholder engagement will likely be limited to using the ongoing activities listed in the agency's Public Engagement Plan or existing equity advisory committees. As described in Chapter 2, the methods used to lay the foundation with public engagement are particularly helpful for understanding what is important to various groups. Findings from qualitative analysis may lead MPOs to revisit and adjust assumptions underlying tests for statistical significance, LQs, and other quantitative screening tools as previously discussed.

Gather Supplemental Information

Collect supplemental information to determine the priorities of the stakeholders and the context of potential planning decisions. This can include, for example, guidance from an equity advisory committee, previous studies, stakeholder interviews, public input gathered during prior engagement efforts, or public opinion about similar projects as documented in the media. It is also helpful to assess related indicators to see if the discrepancies are consistent across the board; if not, there may be issues with the data or calculation for the outlying indicator.

Supplemental information provides MPOs with a better understanding of the burdens and benefits resulting from a plan or program on different population groups. For example, without understanding the priorities of a community, a finding that most of the region's roadway investments were located outside of underserved communities could easily be interpreted in two distinct ways: a person could conclude that (1) the agency was not investing enough in the underserved community, or (2) the agency was protecting the cohesion of underserved communities by not disrupting them with construction or new facilities.

Guiding Questions for Supplemental Information

Guiding questions for supplemental information are outlined below to help determine whether differences are meaningful.

- Are other positive benefits or actions in place to counteract or mitigate disparate impacts/DHAE? For example, current conditions may seem to generate disparate impacts, but the MPO's outputs may include additional funds to remedy those disparities. If the current transit commute times are poor for a given underserved community but the MPO is investing heavily in transit service for those communities, then the MPO is probably already working to mitigate the disparity.
- Do some of the indicators push in different directions? For example, extending transit from lower-income central city neighborhoods to affluent suburbs might appear to be generating a disproportionate benefit to higher-income populations. If, however, these transit connections provide new access to jobs for lower-income persons, then this benefit could outweigh the apparent disparity.
- Is an existing disparity worse under the plan scenario? For example, if minority populations currently experience 55-minute commute times compared to 40-minute times for non-minority populations, then any activities that generate longer commute times for minorities

(compared to the change in commute times for non-minorities) will make an already disproportionate indicator even worse. Remember that impacts can include a denial of benefits or a reduction in benefits.

- Do the underserved persons in affected areas think the impact is disproportionate? For example, individuals in areas with high levels of zero-car households may be much more concerned than the general regional population with transit funding allocations or sidewalk quality indicators. Previous engagement efforts may have captured relevant input. If the relevant information is not available, additional stakeholder engagement may be needed to address this question.

Use Public Engagement to Fill Gaps in Understanding

Where there is a lack of existing qualitative information on impacts to different population groups, MPOs can fill gaps in understanding through additional public engagement. At the planning and programming level for MTPs and TIPs, consulting an advisory panel is likely sufficient to gather stakeholder input. At the project level, more intensive, targeted engagement is needed to involve affected underserved persons in the environmental review and project development process.

Get Input from Equity Stakeholders

Gathering input from equity stakeholders can strengthen relationships and streamline project development by offering the opportunity to identify and resolve issues long before the project goes into development. Develop a network of equity stakeholders with whom to consult iteratively throughout the planning and decision-making process, from the earliest stages of long-range visioning through design, deployment, construction, and ongoing maintenance.

Guiding Questions for Public Engagement

- How do underserved persons believe they will be impacted? What one community perceives as a burden, another community may perceive as a benefit. It is also possible that, within the same community, the same action may be perceived by various segments as both a burden and a benefit. Therefore, MPOs are advised to work with underserved populations through a transparent engagement process that fosters mutual understanding of the benefits and burdens of proposed projects.
- What outcomes are most important? By understanding what outcomes are most important to underserved populations, agencies can focus their efforts on those outcomes, related outputs, and potential mitigation.
- How well do the indicators and analysis methods reflect the experiences of underserved persons? Stakeholders should have the opportunity to provide input on any indicators that are being screened for potentially disparate impacts through quantitative methods, especially indicators with observed differences that were statistically significant or with LQs that can be interpreted as identifying disproportionate burdens or reduced benefits to underserved persons.
- Do the expected outcomes align with the experiences of underserved persons? Many agencies justify planning decisions based on modeled or previous experiences, but these expected outcomes may not match the experiences of the underserved persons. For example, an agency may justify making investments to extend transit in wealthy suburban areas on the basis that the additional routes will provide underserved persons in the urban core access to job opportunities in the suburbs. It is important, however, to verify that the investment truly provides underserved persons greater access to the available jobs. If, despite the transit investment, the underserved population cannot access the jobs (due to scheduling

problems or barriers related to the skills or education that may be required for those jobs), the expected outcomes clearly do not align with the experiences of underserved persons.

Explore Causes and Mitigation Options

If an MPO identifies disparate impacts or DHAE in its plans or programs, the next actions to be taken are (1) to diagnose the factors contributing to the existing or forecast disparity/DHAE, and (2) to ensure that future actions mitigate and remedy those impacts or effects. As stated in the FHWA *EJ Reference Guide* (FHWA 2015):

If the recipient determines that a program causes disproportionately high and adverse impacts to a given population group relative to other population group(s), then the recipient must analyze the disparate impact. The analysis should seek to demonstrate that the disparate impact is nondiscriminatory in nature and that less discriminatory alternatives were not available.

This section provides some tips for diagnosing the reasons behind disparate impacts/DHAE so that the agency can develop and implement appropriate mitigations in Step 5.

A meaningful equity analysis includes a concerted effort by the MPO (and partner transportation agencies) to account for, mitigate, and remedy systemic disparities faced by underserved persons. If an indicator for any population group diverges greatly from that of its control group and/or the regional average, seek to understand reasons for the discrepancy. The public engagement process is an important source of supplemental information and feedback from the affected communities to correctly diagnose disparate impacts. An accurate diagnosis of disparate impacts/DHAE often points to opportunities to mitigate them.

Guiding Questions for Exploring Causes and Mitigation Options

- How do existing conditions contribute to disparate impacts/DHAE? Where disparities/DHAE already exist, the agency can take immediate action to ensure that its investment decisions are strategically targeted toward remedial activities.
- How do agency outputs and investments interact with existing conditions? Investments should counteract existing conditions that contribute to disparate impacts/DHAE while avoiding the creation of new problems.
- Do multiple disparate impacts/DHAE stem from the same cause(s)? Disparate impacts/DHAE that have been identified across several different outcome indicators may share the same causal factors. For example, roadway expansion and traffic growth within underserved communities may cause disproportionate exposure to air pollution, noise pollution, and safety risk.
- What capacity exists within underserved communities to contribute toward solutions, such as applying for grants to build needed infrastructure? Lack of investment in underserved communities with respect to a specific program area, such as pedestrian and bicycle facilities, may result from insufficient staff or volunteer capacity to successfully advocate for their needs or to deploy strategies such as applying for competitive grants.
- How is the funding process structured? An MPO could set aside a portion of funding for a safety countermeasure program to reduce traffic fatalities in underserved communities that experience disparate safety impacts/DHAE. This strategy can also help to ensure that the MPO achieves safety targets set under federally required performance management standards. If the program requires communities to proactively apply for funds, however, the agency could unintentionally favor neighborhoods whose residents have the time and know-how to navigate the bureaucracy.

It is important to work with public engagement staff and consultants to integrate discussions of both the potential causes of disparity and mitigation options throughout the planning and decision-making process. These insights inform quantitative screening, qualitative validation, and diagnosis. The next chapter, which covers Step 5, provides detailed guidance on mitigating disparate impacts.

Resources

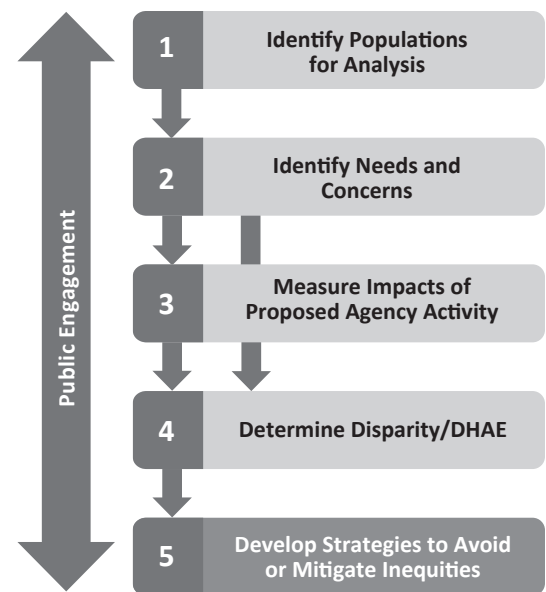
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CHAPTER 7

Step 5: Develop Strategies to Avoid or Mitigate Inequities

By conducting a thorough study of needs and concerns, the impacts of existing programs and policies, and the likely impacts of proposed transportation investments and actions, an MPO will have determined whether disparate impacts exist. This determination should be based on a thoughtful and robust study, starting with a clear understanding of the needs and concerns of underserved individuals and communities in the region. Mitigation strategies should directly address identified disparate impacts/DHAE related to the needs and concerns that were identified in Step 2, as well as the impacts of proposed plans determined in Step 3.

If, in Step 4, the agency found disproportionate impacts/DHAE within existing conditions or in the forecast outcomes of planning or programming activities, the next step is to develop strategies that avoid or mitigate the inequities. By addressing these existing and potential equity concerns “up front” in the planning and programming process, an agency is laying the groundwork for more equitable and effective project delivery in later stages such as NEPA analyses and construction. Toward this end, this chapter describes two broad tasks the agency can undertake: (1) invest in projects that advance equity, and (2) address equity in all phases of planning and decision making. Each broad task contains subsets of actions to consider or perform.



Invest in Projects That Advance Equity

Revise Project Evaluation Criteria

Agencies can use project prioritization methods to support investments in underserved communities and that address the needs identified by underserved persons. Although it may be tempting for an MPO and its project sponsors to assume that simply locating a project adjacent to an underserved community will improve accessibility, this is not necessarily true. Points may be awarded only for projects with verifiable benefits. The agency also may deduct points from projects that pose some level of burden to underserved communities.

MPOs are encouraged to develop equity-based project evaluation criteria for an efficient and wide-reaching practice to advance equity and to address identified needs and imbalances in the region. Now that all the effort has been put into conducting a meaningful equity analysis, the agency can use what was learned to modify the project evaluation criteria. Establishing project evaluation criteria at early stages of the planning process can set expectations for equitable planning and help ensure that underserved persons benefit equitably from transportation investment.

Various options exist for project evaluation criteria (see Table 12), but the most effective options require that the project sponsor describe verifiable benefits to underserved persons and estimate potential adverse impacts. For some ideas, review both the “Examples in Practice: Project Evaluation” and the “Example in Practice: LQs.” If the population-based approach is adopted, an agency can ask project sponsors to forecast the demographics of the project’s opening-day users. For bicycle and pedestrian projects, which are not well represented in models, use the demographics within the mile around the project, or use another scale for which data is available. Once the demographics have been captured, the agency can ask questions such as the following:

- Do those demographics match that of the region?
- When taken together with the other projects being considered, does the scenario or project portfolio benefit a group of people that has demographics matching that of the region?
- Did the needs assessment identify needs of underserved communities? If so, do the projects proposed in those areas address those needs?
- Does the process for developing project proposals or applying for grant funding pose barriers to underserved communities?
- Did the impact assessment show any disparities? What kinds of investments are needed to address those disparities?
- Were modal funding targets considered? MPOs may use targets for the percentages of funding given to each mode in competitive processes they manage. For example, 30% may be targeted to transit, 50% to roads, and 20% to bicycles and pedestrians. This funding distribution also can involve equity issues that won’t be addressed in individual project evaluation criteria.

Fund Activities That Remedy Disparate Impacts/DHAE

Although equity analyses can be used to score or respond to proposed projects and programs, an MPO also can take proactive steps to address disparate impacts/DHAE, such as proposing projects to help mitigate these impacts/effects or projects that are otherwise beneficial to underserved populations. Examples of mitigation strategies that can be considered include transit and rideshare projects and strategies designed to improve household transportation costs, air quality, and safety.

Table 12. Selected MPO MTP and TIP project evaluation criteria.

Project Evaluation Criteria	MPO
Reduce the score of a roadway project in the MTP if it adds vehicle lanes in an underserved area	Charlotte County-Punta Gorda
Award points for MTP transit system expansion projects serving an underserved community, and for TIP projects that benefit census tracts with high indicators of “Potential Disadvantage” communities	DVRPC
Award points depending on the degree to which a TIP project in an underserved community improves access to opportunities	East-West Gateway Council of Governments
Add or subtract points for TIP projects adjacent to underserved communities depending on net positive or adverse impacts to the adjacent communities (e.g., add points for transit improvements, safety enhancements, bicycle/pedestrian improvements, subtract points for displacement of residents or creating barriers)	Memphis Urban Area MPO
Award points to TIPs for projects that improve multimodal accessibility in EJ areas, and to projects that benefit public health (particularly in areas with health outcome disparities) by improving safety, providing community/social space, and/or improving access to parks/open space, health care, healthy foods, and opportunities for physical activity	MATPB

Examples in Practice: Project Evaluation

- As part of its 2017 regional transportation plan, Oregon's **Rogue Valley MPO** conducted a formal needs assessment study to understand the needs of underserved persons in the region. The agency then revised their project evaluation criteria to reward projects that would address the needs identified in the study (Rogue Valley MPO 2017).
- The **MORPC** examines its project portfolio in relation to the region's demographics to assess how the projects and scenarios benefit people with demographics matching that of the region (MORPC 2017).
- In Missouri, the **MARC** identified that bicycle and pedestrian fatalities were disproportionately occurring in underserved communities in the urban core. They studied the distribution of safety funding (to see how well they were addressing the need), and realized that most of the safety funding was going to suburban communities. The agency investigated the reason for this pattern and learned that the grant-based safety funding was only awarded to communities that had the capacity to write government funding proposals. The MARC then began developing safety countermeasures to apply in the underserved communities that were experiencing the disparate impact (MARC 2015).
- The **PSRC** in Washington State uses a performance matrix for equity for projects in consideration for its TIP (PSRC 2017). A project's ability to improve access to "opportunity" for minorities, low-income households, older adults, people with disabilities, and members of zero-car households can earn up to 10 points out of an overall total of 90 points. "Opportunity" is defined by 20 indicators related to education, economic health, housing and neighborhood quality, transportation/mobility, and health and environment.

Transit and Rideshare

In many areas, a high percentage of underserved households do not have access to a vehicle; therefore, the members of those households rely on transit. Gaps in mobility can be addressed by focusing investments in areas with high concentrations of low-income or zero-vehicle households. Examples of transit and ridesharing programs improvements to implement include:

- Increased transit service frequencies, headways, hours of service for underserved communities;
- Improved pedestrian and bicycle access to transit for underserved communities; and
- Public-private transit and ride-hailing service programs to fill gaps and improve access to transit services.

Household Transportation Costs

Underserved households often spend a greater share of their income on transportation. An agency can implement efforts to help reduce the cost of transportation for these households in several ways. Examples include:

- Transit fare discounts and free services,
- Highway toll discounts and vouchers, and
- Coordinated housing affordability programs in transit-accessible locations.

Air Quality

Air pollution is often an issue for underserved populations that live in close proximity to highways. To address disproportionate impacts from air pollution, options include:

- Retrofitted buses with increased emissions-control technologies,
- Vegetated buffers along the highway to trap particulates, and
- Considering air quality when siting high-density housing.

Safety

Safety is also often a concern that disproportionately impacts underserved communities. Options for MPOs include roadway design strategies that improve multimodal safety and accessibility, such as:

- Complete Streets policies that promote multimodal roadway design,
- Strategic application of safety countermeasures in communities most at risk, and
- Road diets (e.g., reducing roadway lane widths to create safe spaces for cyclists and pedestrians) for existing or proposed facilities.

Safety considerations involve broader issues than just protection from cars. For example, transportation-related policing concerns also are common among communities of color and low-income populations. The **Met Council's** long-range transportation plan, *Thrive MSP 2040*, includes safety strategies that address policing concerns by identifying best practices and recommendations for policing practices and building public trust (Met Council 2018).

Address Equity in All Phases of Planning and Decision Making

The first part of this chapter dealt with mitigation strategies focused on specific identified impacts. To advance equity over the long term, however, it is important to institutionalize concepts and processes in order to make equity analysis standard during all steps of the planning and decision-making process. Including research and other initiatives in work plans will generate data or information that can be used in tangible follow-up activities. Such follow-up activities could include:

- Level-of-traffic-stress bikeway network analyses to identify gaps in the low-stress network serving underserved communities;
- Studying potential disparate impacts/DHAE in preservation/maintenance spending, in transportation infrastructure condition, and in safety outcomes; or
- Setting objectives such as having 100% sidewalk coverage within 1 mile of all schools and grocery stores.

Improve Underserved Persons' Engagement in Planning Processes

A theme stressed throughout this guide has been the critical importance of public engagement during each stage of the planning process. Under 23 CFR 450.316, MPOs are required to develop strategies and desired outcomes that are articulated through a participation plan. As stipulated in 23 CFR 450.316:

- (a) The MPO shall develop and use a documented participation plan that defines a process for providing . . . representatives of users of public transportation, representatives of users of pedestrian walkways and bicycle transportation facilities, representatives of the disabled, and other interested parties with reasonable opportunities to be involved in the metropolitan transportation planning process.

(1) The MPO shall develop the participation plan in consultation with all interested parties and shall, at a minimum, describe explicit procedures, strategies, and desired outcomes for:

...

(vii) Seeking out and considering the needs of those traditionally underserved by existing transportation systems, such as low-income and minority households, who may face challenges accessing employment and other services. . . .

Beyond the legal mandates, effective engagement helps to ensure that the end product of the planning process is meaningful to the communities it is intended to benefit. Take a holistic approach focused on including underserved persons throughout the transportation decision-making process, especially when actions could impact their well-being. Inclusion strategies are discussed in more detail in Chapter 2 on public engagement, and include techniques for improving public involvement such as ensuring that advisory committees and decision-making bodies have diverse representation and that their role as advisors rather than decision makers is clearly defined.

Adopt Equity Goals in Plans and Policies

Agency plans and policies can incorporate policy goals to promote equity and access for underserved persons. Equity goals can be integrated at various levels. For example,

- High level policy goals can be useful for explaining to constituents why equity should be improved in the region.

Example in Practice: Using Community Input to Develop and Refine a Technical Approach

Following an equity assessment, the **Oregon Metro** received criticism from underserved persons during public engagement efforts. The criticism reflected the fact that the agency's methodology had failed to evaluate the outcomes and impacts that mattered most to this population. To remedy this failure, Metro convened the Transportation Equity Assessment Working Group for the development of its 2018–2021 MTIP Transportation Equity Assessment. The process was to be led by representatives of underserved groups who had identified accessibility, affordability, safety, and public health as key areas of concern. These themes were translated into system evaluation measures that could be applied to the analytical framework developed in consultation with this group. This assessment took the form of an equity-based scenario planning analysis that will compare base-year conditions and anticipated conditions resulting from the short-term investment program (Oregon Metro 2016).

The Oregon Metro's Data and Research Department then developed a suite of tools for this effort that could support the modeling of changes in economic, demographic, land use, and transportation activity. As developed, the tools also use GIS and the region's travel-demand model to assess connectivity, safety, and other outcomes of the investment program on underserved communities. The Oregon Metro's effort to involve underserved persons early and throughout the duration of its equity assessment will help to ensure that (1) the perspectives of underserved persons are well represented, and (2) the outcomes of these efforts will be meaningful to the populations they are designed to serve.

- Specific goals can be created that relate to equity issues that have been identified in the region, such as avoiding displacement or reductions in transportation access. These specific goals usually focus on either reducing burdens or improving access to benefits for underserved populations.
- Equity goals also can be incorporated into other work. For example, the pedestrian element of a plan could include a goal to improve pedestrian infrastructure in neighborhoods with high numbers of underserved residents.

Evaluate and Measure Progress

Mitigation efforts, such as adopting policies or increasing participation of underserved populations in the planning process, need to be accompanied by efforts to evaluate progress and ensure that the measures undertaken have a positive impact on underserved persons. As with any performance-based planning and programming approach, it is important to **define performance measures, set targets, and measure progress**. Measuring progress helps the planning process be more transparent and holds the agency accountable for actions.

Equity performance measures can provide quantifiable ways to measure progress and increase the transparency and accountability of equity-focused planning activities. Likewise, a performance-based approach can be used to incorporate quantifiable equity considerations into project prioritization in MPOs' TIPs. These performance measures can be shared with the public using online dashboards (such as those powered by Tableau and Highcharts), which allow visitors to intuitively engage with the performance data. The San Francisco MTC's Vital Signs dashboard is one example.

Select measurable goals, targets, and other metrics to reflect the priorities of the region and underserved persons within the region. Examples of measurable goals include (but are not limited to) minimizing disparate impacts/DHAE in transportation costs, commute times, bicycle and pedestrian infrastructure, safety, and asset conditions, and/or accessibility to jobs, services, schools, recreation, retail, and other important destinations.

While taking steps to address identified disparate impacts/DHAE, continue to involve underserved persons to ensure that the agency's strategies are in line with their needs and concerns. Continuing to track progress and conduct meaningful public engagement throughout all stages of the planning process will help prioritize equity goals and anticipate challenges faced by underserved persons.

Include Equity Initiatives in UPWPs

Include research and other initiatives in work plans in order to generate data or information that can be used in a tangible follow-up activity. Such initiatives can include activities such as level-of-traffic-stress bikeway network analyses to identify gaps in the low-stress network serving underserved communities; studying potential disparate impacts/DHAE in preservation/maintenance spending, in transportation infrastructure condition, and in safety outcomes; or setting objectives such as having 100% sidewalk and ADA-compliant curb ramp coverage within 1 mile of all schools and grocery stores.

Resources

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APPENDIX

Pilot Case Studies

The outcome of the research conducted for TCRP Project H-54 is a succinct, readable resource guide that focuses on the key questions transportation agencies face when conducting equity analyses. During the early phases of the research, the team reviewed hundreds of online documents published by a nationwide sample of MPOs, followed by in-depth interviews with 10 agencies. Working with the advisory panel, the team selected four agencies with which to conduct pilot studies that would refine and enrich the contents of the guide:

- Metro (Portland, Oregon): Developing key messages and communication vehicles for conveying results of an equity analysis to stakeholders and decision makers;
- Denver Regional Council of Governments (Denver, Colorado): Testing the “population-weighted” approach for identifying populations to consider in equity analysis;
- Mid-America Regional Council (Kansas City, Missouri/Kansas): Developing a strategic plan to engage a new regional equity network (REN) in the upcoming long-range transportation plan update, and (like Denver) testing the “population-weighted” approach for identifying populations to consider in equity analysis; and
- Mid-Ohio Regional Planning Commission (Columbus, Ohio): Conducting GIS analysis to identify potential positive and negative impacts of new “smart city” transit investments.

The objectives of the pilot project task were to ensure that the reference guide is a useful resource for practitioners and to benefit the agencies that are offering their time to help with pilot testing. Some of the pilot agencies are well-resourced, but we shaped the testing approach and documentation of each pilot to make the case studies useful to agencies with a wide array of capabilities, ideally allowing for replicability in many settings.

The consultant project team considered issues and opportunities for implementing a few selected method(s) with each pilot agency and embedded those insights into the case studies as well as reflecting them in the main body of the guide. We strove to ensure that each pilot project case study was useful as an illustration of a given equity analysis method or approach, and that the tested method was contextualized within the broader planning and decision-making framework.

Pilot Case Study Development Process

1. **Initial discussions and assessments** with staff. We identified key considerations and analysis methods for the agency to test and apply to its planning and decision-making process. For pilot testing to provide useful feedback, we applied the guidance to actual planning decisions.
2. **Technical assistance** from the project team over a period of several weeks, during which we continued reaching out to staff to offer help as needed. Some projects involved peer exchange conference calls and/or site visits to discuss methods and processes in depth. The content of the technical assistance varied based on the needs of each MPO, but primarily covered issues such as:
 - a. Defining populations for analysis,
 - b. Developing plans to engage key communities or stakeholders,
 - c. Defining and identifying data sources for equity indicators,
 - d. Conducting GIS analysis of indicators for different populations, and
 - e. Facilitating meetings with stakeholders.
3. **Case studies** summarizing the interaction with each pilot tester agency.

Metro (Portland, Oregon, MPO)

Agency Context

Metro, the MPO for the region surrounding Portland, Oregon, is a progressive organization which has taken many steps over the years to improve equity within transportation planning. The agency maintains an “Equity Dashboard” which tracks the racial and gender diversity of its workforce, and works closely with its Committee on Racial Equity, which is charged with overseeing and implementing a strategic plan to “remove barriers for people of color and improving equity outcomes for these communities by improving how Metro works internally and with partners around the Portland region.”

In prior years, Metro conducted equity assessments primarily based on the amount of funding spent in underserved communities compared to other communities. For its 2018 Regional Transportation Plan, Metro tested new methods to assess the impacts of planned transportation investments in a more targeted and sophisticated manner and adjust their plan based on the assessment.

Pilot at a Glance

Region: Portland, Oregon

MPO Service Population:
~1,500,000

Phase: Long-Range Transportation Planning, Programming

Focus of Technical Assistance:
Assess Relative Impacts

Overview of Technical Assistance

Metro staff discussed their outcomes-based approach to equity analyses on conference calls and one in-person meeting with the project team in order to inform the project team of their process in the context of this guide and to identify options for communicating both the process and the results of the process.

The objective of this pilot was to observe and discuss Metro’s outcomes-based assessment of transportation investments, which measured how projects would impact underserved persons in a meaningful and understandable way. The project team provided technical assistance to identify key messages and an appropriate communication vehicle to describe the results of the assessment. Messages would be suitable for elected officials, interest groups, and the general public.

Method

Metro conducted an equity evaluation of proposed transportation projects using a set of measures indicating a variety of impacts on underserved persons. Underserved communities were defined as communities meeting threshold percentages of persons of color, persons in poverty, persons with Limited English Proficiency (LEP), older adults, and young people.

The following measures were selected as representing priorities for the Regional Transportation Plan (RTP) identified during the public input process:

- **Access to jobs:** Number of low/medium/high wage jobs accessible by a “reasonable” commute time via walking, bicycling, transit, and driving. Commute times defined as 20 minutes by walking, 30 minutes by bicycling, 45 minutes by transit, and 30 minutes by automobile.
Data used: Geospatial project information for proposed transportation projects provided by project sponsors; forecast employment/jobs determined by Metro’s Metroscope Model.
- **Access to community places:** Number of community places, such as schools, religious organizations, libraries, health services, and so forth, accessible by a “reasonable” commute

time via walking, bicycling, transit, and driving.

Data used: Geospatial project information for proposed transportation projects from project sponsors; U.S. Bureau of Labor Statistics – Quarterly Census of Employment and Wages (2013); and North American Industry Classification System (NAICS) codes.

- **Share of safety projects:** Number and percentage of transportation safety projects compared to total RTP investment packages; percentage of total cost of investment strategies; percentage of transportation safety investments per capita regionwide, in underserved communities, and on high injury corridors.

Data used: Geospatial project information for the investment strategies from project sponsors; location of high injury corridors identified by Metro, the Oregon Department of Transportation (DOT) Pedestrian and Bicycle Safety Implementation Plan, state/city/county safety plans, high injury intersections, and areas with one or more severe crashes in the previous 5 years.

- **Exposure to severe crash risk:** Change in non-freeway average vehicle-miles traveled.
- **High value habitat impact:** Percentage of transportation projects intersecting identified resource habitats.

Data used: Geospatial project information for the investment strategies from project sponsors; geospatial resource conservation information from Metro-identified resource and conservation habitat areas.

The measures were estimated for a constrained scenario (2040), strategic scenario (2040), short-term constrained scenario (2027), and no-build scenarios for both 2027 and 2040.

After conducting the equity analysis for submitted project list, Metro published the results and called for a second round of project submissions from its local partners, providing an opportunity to revise their list of projects to better serve underserved communities. After receiving the second list of projects from partners, Metro conducted another equity analysis. The second analysis used the same measures, but an improved methodology. The two-round call for projects was a new process for the 2018 RTP.

At this stage, Metro planned to communicate the results of the equity analysis to elected officials, partners, stakeholders, and the general public, both to describe the efforts undertaken to analyze the impacts of transportation investment on the region as a whole as well as specifically on underserved communities, and also to illustrate the work still required to address discrepancies between underserved persons and other populations. Figure A-1 summarizes underserved communities defined in Metro's 2018 RTP Transportation Equity Evaluation.

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Community	Definition	Geography Threshold	Data Source
People of Color	Persons who identify as non-white.	Census tracts above the regional rate (26.5%) for people of color.	2010 Decennial Census
People in Poverty	Households with incomes equal to or less than 200% of the Federal Poverty Level (2016); adjusted for household size	Census tracts above the regional rate (31.1%) for Household with Lower-Income	American Community Survey, 2011-2015
People with Limited English Proficiency	Persons who identify as unable "to speak English very well."	Census tracts above the regional rate (8.5%) for Limited English Proficiency (all languages combined).	Oregon Education Department School Enrollment Data (LEP only)
Older Adults	Persons 65 years of age and older	Census tracts above the regional rate for Older Adults (11%) AND Young People (22.8%)	2010 Decennial Census
Young People	Persons 17 years of age and younger		

Figure A-1. Underserved communities, defined in the Portland [Oregon] Metro 2018 RTP Transportation Equity Evaluation.

Results

After discussions during the pilot, Metro decided to focus communication efforts on the access to jobs measure. The ability to access jobs within a reasonable commute is a clear and common objective for many people and can highlight the relevance of transportation planning on the everyday lives of Metro's citizens.

The proposed transportation investments were shown to increase access to jobs across all wage levels for all communities in the region, however, underserved communities were predicted to have a smaller increase than other communities.

Among all modes, transit improvements were the most substantial. For all communities, the percent increase in access to jobs via transit was over four times the percent increase in access to jobs by any other mode. As underserved communities may be more reliant on transit than the general population (related to income discrepancies or abilities), this demonstrated investment in transit may be interpreted as a positive strategy for the RTP.

There are other potential explanations for the discrepancy in increased access to jobs, other than an imbalance in transportation investment. For example, increased traffic congestion or changes in land use may impact commute times, decreasing the number of jobs accessible within the model parameters of a "reasonable commute." Despite other possible explanations, the results of the analysis indicate that Metro as a region should make strategic investments to support transportation for persons living in underserved communities.

The project team drafted simple infographics (Figure A-2) illustrating the results of the measure, showing that while all people living in the region will have access to more jobs, those living in underserved communities will have a smaller percentage increase than others.

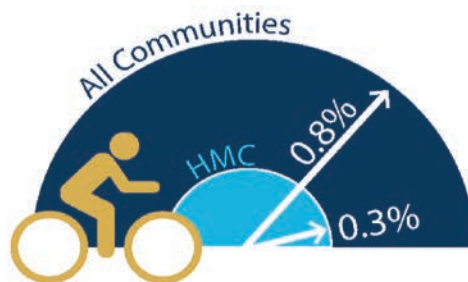


Metro residents on average will have access to 6% more jobs by automobile in 2027, however, persons living in Historically Marginalized Communities will only see a 6% increase in access to jobs.

All communities in the Portland Metro will be able to access more jobs across all modes, however, Historically Marginalized Communities will have a smaller percent increase in access across every mode.

The Regional Transportation Plan has made strong investments in transit which has the highest percent increase in access to jobs across all communities.

Despite investing in transportation options that will provide access to jobs for everyone in the Portland Metro, Historically Marginalized Communities overall see a smaller percent increase.



Source: Metro, 2018 Regional Transportation Plan, Transportation Equity Evaluation Appendix.

Figure A-2. Draft infographics illustrating discrepancies in access to jobs by mode between historically marginalized communities and non-historically marginalized communities.

Lessons Learned: Implications for the Equity Guide

Metro's equity analysis assesses specific impacts to underserved communities in a way that is understandable and meaningful. Stakeholders can understand how the investment will make a difference in how the transportation system will connect them to jobs, key destinations, and help improve safety on the streets.

Offering a second call for projects to local partners after conducting an initial equity analysis provides an opportunity for partners to reflect and re-evaluate their project lists. As the analysis methods evolved over the development of the 2018 RTP, Metro was unable to compare the change in equity impacts between the two rounds. Ideally, the methodology for the analysis would be identical between the two rounds in order to compare potential improvements.

Illustrating the discrepancies in job access is an important step in addressing inequalities. This discrepancy can be seen as a call to action for local partners in focusing a greater share of their transportation investment on projects that will help underserved persons access jobs and other destinations.

Resources

- Metro. 2018. Regional Transportation Plan, Transportation Equity Evaluation Appendix. Retrieved from: https://www.oregonmetro.gov/sites/default/files/2018/06/29/RTP-Appendix_E_2018_RTP_Transportation_Equity_Evaluation_with_attachments.pdf.

Denver Regional Council of Governments (DRCOG)

Agency Context

The DRCOG is a large MPO serving the Denver metropolitan region, which includes adjacent cities and rural areas in Colorado. DRCOG was included in the research for this guide because the agency has a strong working relationship with the area's transit agency (Regional Transit District) and is often held up as an example of good practices for public engagement and equity analyses. The literature review and subsequent interviews revealed that DRCOG is also one of relatively few MPOs that have used their travel-demand models as part of their equity analyses.

On reaching out for this study, the research team learned that DRCOG has been dissatisfied by the approaches for designating certain areas as equity areas on the basis of some threshold concentration levels of underserved persons. DRCOG staff have been looking for options for expanding their equity analyses beyond solely comparing geographic areas that meet the thresholds to areas that do not meet the thresholds.

During the course of the technical assistance and pilot, DRCOG and the technical support team discussed alternative approaches to the process of identifying equity areas, and the agency experimented with the population-weighted approaches used by the Mid-Ohio Regional Planning Commission (MORPC). The pilot also briefly covered options for getting equity focus groups to weigh in on impacts and options for evaluating whether TIP projects improve equity; given the timeframe of the pilot, DRCOG opted not to further explore these options at this time.

Overview of Technical Assistance

The objective of this pilot was to identify how the approaches suggested in the draft guide could help DRCOG refine its approach to equity analyses to avoid issues that DRCOG had identified with its current process, in which it identified areas as equity or non-equity areas on the basis of the area's percentage of underserved persons. Two issues in particular with the all-or-nothing approach to defining an "environmental justice zone" (EJ zone) were as follows:

- More than half of the region's population lives in an EJ zone. DRCOG would like to improve its ability to focus strategically on high-priority zones.
- Significant numbers of underserved persons live outside the designated EJ zones. DRCOG would like to ensure that its analyses capture impacts to those underserved persons.

DRCOG also would like to develop quantitative methods to improve their current qualitative approaches for assessing whether projects in their plans or programs have a disproportionate adverse effect on EJ populations.

Method Tested

DRCOG and the technical support team held a series of calls to discuss potential approaches. Each discussion built on prior calls to further refine the mutual understanding of the challenges

Pilot at a Glance

Region: Denver, Colorado

MPO Service Population:
2,827,082

Phase: Long-Range Transportation Planning, Programming

Focus of Technical Assistance:

- Identifying Populations,
- Measuring Impacts,
- Population-Weighted Analysis

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with thresholds-based approaches and to explore the population-weighted approach as an alternative. DRCOG staff reviewed the population-weighted approach described in the draft guide, and the technical support team answered questions DRCOG had about implementing the approach.

The technical support team organized and facilitated a peer-to-peer web-enabled call with staff from MORPC, in which DRCOG (and MARC) staff asked questions they had about the approach.

- **Identifying populations for analysis:** Rather than using a threshold approach, MORPC uses a combination of heat maps showing relative percentages and a dot-density map showing density numbers.
- **Determining disproportionate adverse effect:** MORPC uses line graphs showing how the modeled benefits (such as travel-time savings) vary by population group for the current/base year, the no-build in the forecast year, and the plan/program's projects in the forecast year. These line graphs enable MORPC staff to identify gaps and to see how improvements might vary for different populations.
- **Long-term applicability of Census Transportation Planning Products (CTPP):** The CTPP will be phasing out TAZs in favor of block groups, which diminishes the usefulness of the CTPP. MORPC used census products early on but has since created their own population synthesizer (using Urban Sim population data) to calculate population demographics of TAZs. Other agencies could start with the CTPP and then develop their own approaches in later years. DRCOG already has the demographic data for their TAZs but had previously only used that data for comparisons between EJ zones and non-EJ zones; the same data can be used to develop a population-weighted approach.

Results

DRCOG staff tested the use of the population-weighted approach in the fall of 2018 as the agency prepared for its long-range transportation plan update. The test asked the following questions:

- What MORPC EJ measures are replicable in the Denver region?
- What EJ measures should be added for the Denver region?
- What data are necessary for the analysis; is that data available in the Denver region?
- How capable is DRCOG of replicating the analysis from start to finish?

Analyses were conducted on four selected measures:

1. Target/Non-Target by Zones,
2. Average Number of Employers Close (within 20 minutes for auto and 40 minutes for transit),
3. Average Travel Time for All Purposes, and
4. Average Travel Time to CBD [Central Business District].

The test proved that it was possible for DRCOG to replicate some measures of the MORPC EJ technical analysis. Next steps include combining and weighting the information by population group. It may also be necessary for the DRCOG transportation team and information systems team to brainstorm several more measures before finalizing this work.

Analysis Process

Identification of Replicable Measures

EJ measures “. . . compare the relative treatment of the target populations and non-target populations in the planning process.” The MORPC methodology covered the following measures:

- Target/Non-Target by Zones,
- Average Number of Job Opportunities Close,
- Average Number of Shopping Opportunities Close,
- Average Number of Non-Shopping Opportunities Close,
- Percent of Population Close to a College,
- Percent of Population Close to a Hospital,
- Percent of Population Close to a Major Retail Destination,
- Average Travel Time for Mandatory Purposes,
- Average Travel Time for Shopping Purposes,
- Average Travel Time for Other Purposes,
- Average Travel Time for All Purposes,
- Average Travel Time to CBD,
- Transit Access to CBD,
- Congested Vehicle-Miles of Travel during Peak Hours,
- Transportation Investments, and
- Displacements from Highway Projects.

Of these 16 MORPC measures, DRCOG identified the following eight as immediately replicable based on current data in the Denver region (strikeouts indicate where DRCOG data varies slightly from MORPC data):

- Target/Non-Target by Zones,
- Average number of ~~[Job Opportunities]~~ Employers Close,
- Percent of Population Close to a College,
- Percent of Population Close to a Hospital,
- Average Travel Time for ~~[Mandatory]~~ Job Purposes,
- Average Travel Time for All Purposes,
- Average Travel Time to CBD, and
- Transit Access to CBD.

Additional Measures Identified

During the preliminary assessment of EJ measures used by MORPC, DRCOG identified the following additional measures as potential for study in the Denver region:

- Average number of Grocery Stores Close,
- Average travel time to VA Medical Facilities,
- Average travel time to Public Recreation Centers, and
- Transit Access to all Regional Employment Centers.

More measures may be created or identified if a full DRCOG EJ technical analysis moves forward.

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Data Required for Methodology

Most of the measures described by MORPC in their analysis rely on Census ACS data (see Figure A-3). The Census ACS data provides information on target populations—Disabled, Hispanic or Latino, In Poverty, Minority, Over 65, Zero-Car Households—by block group and tract.

Many measures also rely on the DRCOG travel forecasting model process. The travel forecasting model process takes land use and transportation information and estimates travel times, patterns, and volumes on the transportation system. The most current transportation modeling data for DRCOG is 2015, and DRCOG also

creates future horizon-year estimates including data for the year 2040. In the MORPC analysis, data for two different 2040 forecast scenarios were presented for each measure (first, forecast travel assuming no growth in transportation system, second, forecast travel with growth in the transportation system). DRCOG represents data for only one 2040 scenario, using projections that assume growth in the transportation system.

Travel model data is aggregated at TAZs for off-peak times and peak times, and for automobiles and transit. This results in eight total scenarios used from the travel model—Off-Peak Automobile 2015, Off-Peak Transit 2015, Peak Automobile 2015, Peak Transit 2015, Off-Peak Automobile 2040, Off-Peak Transit 2040, Peak Automobile 2040, and Peak Transit 2040.

Measurements Identified for Test

In the interest of time, this test application of the MORPC methodology addressed only the following measures:

- Target/Non-Target by Zones,
- Average Number of Employers Close,
- Average Travel Time for All Purposes, and
- Average Travel Time to CBD.

Test Measurement Methodology

Data analysis occurred for the four test measures identified. The following sections describe the technical details of analysis by measure.

Target/Non-Target by Zones

As stated in the MORPC analysis, “In order to create the population-based measures, it is necessary to estimate the target and non-target population within each TAZ. However . . . only

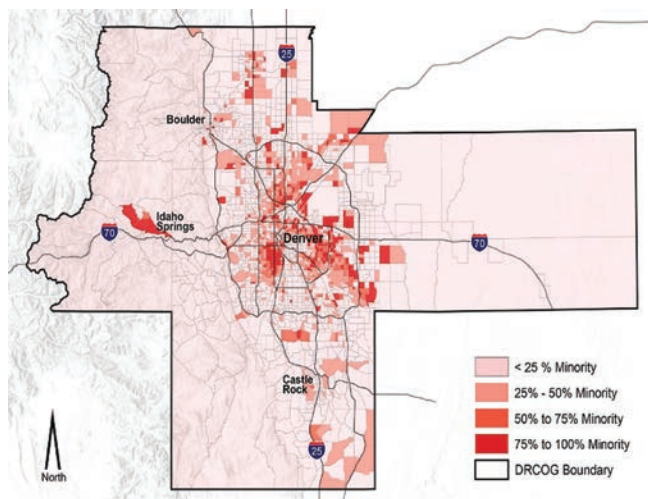


Figure A-3. Example illustration of ACS 2016 5-year data: percentage minority for TAZs in the Denver region.

total population by TAZ is developed.” At DRCOG, target and non-target population information from 2016 Census ACS data is summarized by census block group and census tract and distributed publicly as a “Vulnerable Populations” dataset. (Despite the 1-year difference from travel model work, this data was used for the purposes of this methodology test. It is also significant to note that because of this data source, this test only covers the DRCOG planning region rather than the entire transportation modeling region.)

In order to apply target population information to TAZ geographies it was first necessary to create a Tract-to-TAZ equivalency table and a Block-Group-to-TAZ equivalency table using weighted percentages based on population and housing. To build the equivalency tables, DRCOG used census block centerpoints to determine approximately what percentage of each Tract and Block Group population or housing stock fall inside of each TAZ. Census/TAZ overlap geometries were defined as new polygon “equivalency” layers.

Using this join method for every census/TAZ overlap, the total population of blocks within each “equivalency” overlap polygon was determined. This number was then compared to the Tract or Block Group population total to define the approximate percentage of each block group or tract that is represented within each TAZ (see Figure A-4). In Figure A-4, TAZs are represented by black lines, and block groups are represented by red lines. Block centerpoints are then used to create an equivalency layer (shown in blue in Figure A-4). Block totals were also compared to Tract and Block-Group totals to quality check the block information.

Using the equivalency layer percentages, target population data from 2016 Census ACS data was added to TAZ geographies. Then, another group of percentages was calculated to weight forecast 2040 populations by assuming the same percentage totals. The resulting data thus includes target population information by zone for both different scenarios—2015 and 2040—and

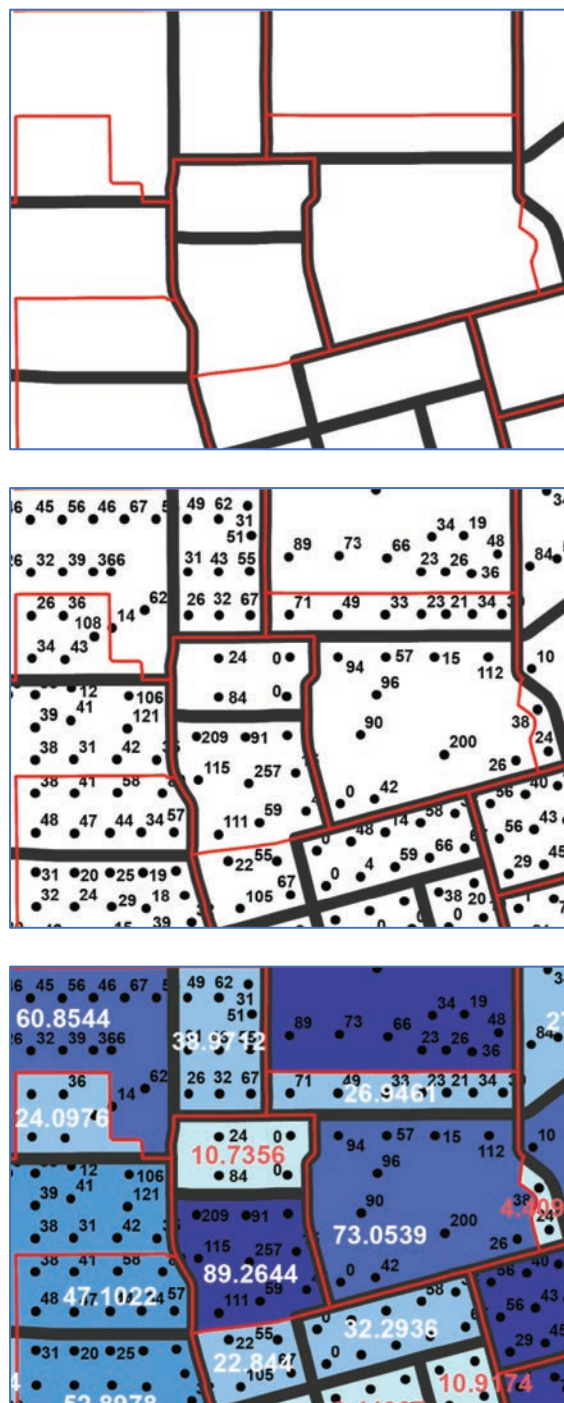


Figure A-4. Illustration of block group-to-TAZ equivalency.

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for all six target populations (Disabled, Hispanic or Latino, In Poverty, Minority, Over 65, Zero-Car Households).

From MORPC, “In estimating the target populations by traffic zone, it was assumed that [in 2040] the total regional percentage for each population would be the same percentage as the 2015 percentage. For example, the regional percentage in poverty in 2015 was 13.9%. Thus, for the forecast 2040 populations, it was assumed that the regional poverty percentage would remain at 13.9%.”

Average Number of Employers Close

This measure nearly replicates the MORPC measure “Average Number of Job Opportunities Close” using the DRCOG’s master employment dataset. The measure estimates the average number of employers within a specified travel time from each zone.

- The raw number of employers by TAZ was first calculated using a simple spatial join.
- Next, information from the DRCOG travel model was used to estimate peak and non-peak period auto and transit travel times from each TAZ to every other TAZ (a travel-time skim).
- For each TAZ based on the skim, the total number of employers located in TAZs within 20 minutes by auto (see Figure A-5) and 40 minutes by transit were calculated.
- A weighted average of the number of employers can be calculated based on the number of each target population group within each TAZ.

In Figure A-5 (next page), the top map shows the number of employers within 20 minutes for 2015 non-peak skims, and the bottom map shows the number of employers within 20 minutes for 2040 peak skims.

Average Travel Time for All Purposes

As described in the MORPC documentation, “through the modeling process, different tour purposes are defined The previous measures were accessibility measures. This measure, however, is a travel estimate measure.” To calculate average travel times for all purposes from each TAZ, the TAZ-to-TAZ baseline totals were summed by the originating TAZ and an average travel time was calculated (see Figure A-6). In Figure A-6, the top map shows average travel times for 2015 non-peak skims, and the bottom map shows average travel times for 2040 peak skims. As the MORPC points out, “exact population groups using the different modes is unknown. Thus, when calculating the measure for a particular mode, the weighted average is based on the proportion to the target and non-target population in the origin zone” Next, the weighted average of travel time by population group can be calculated.

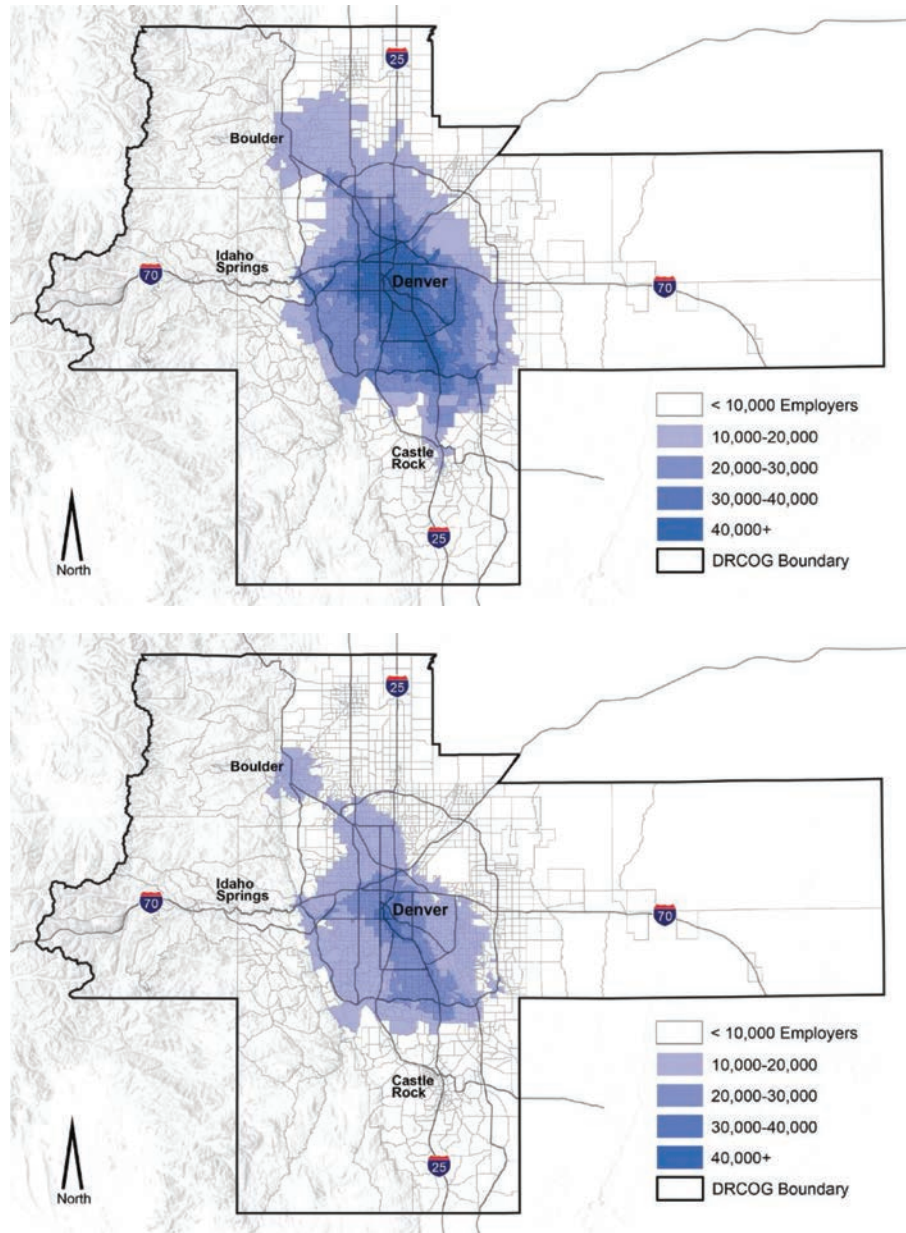


Figure A-5. Example illustration of employers within 20 minutes for auto skims.

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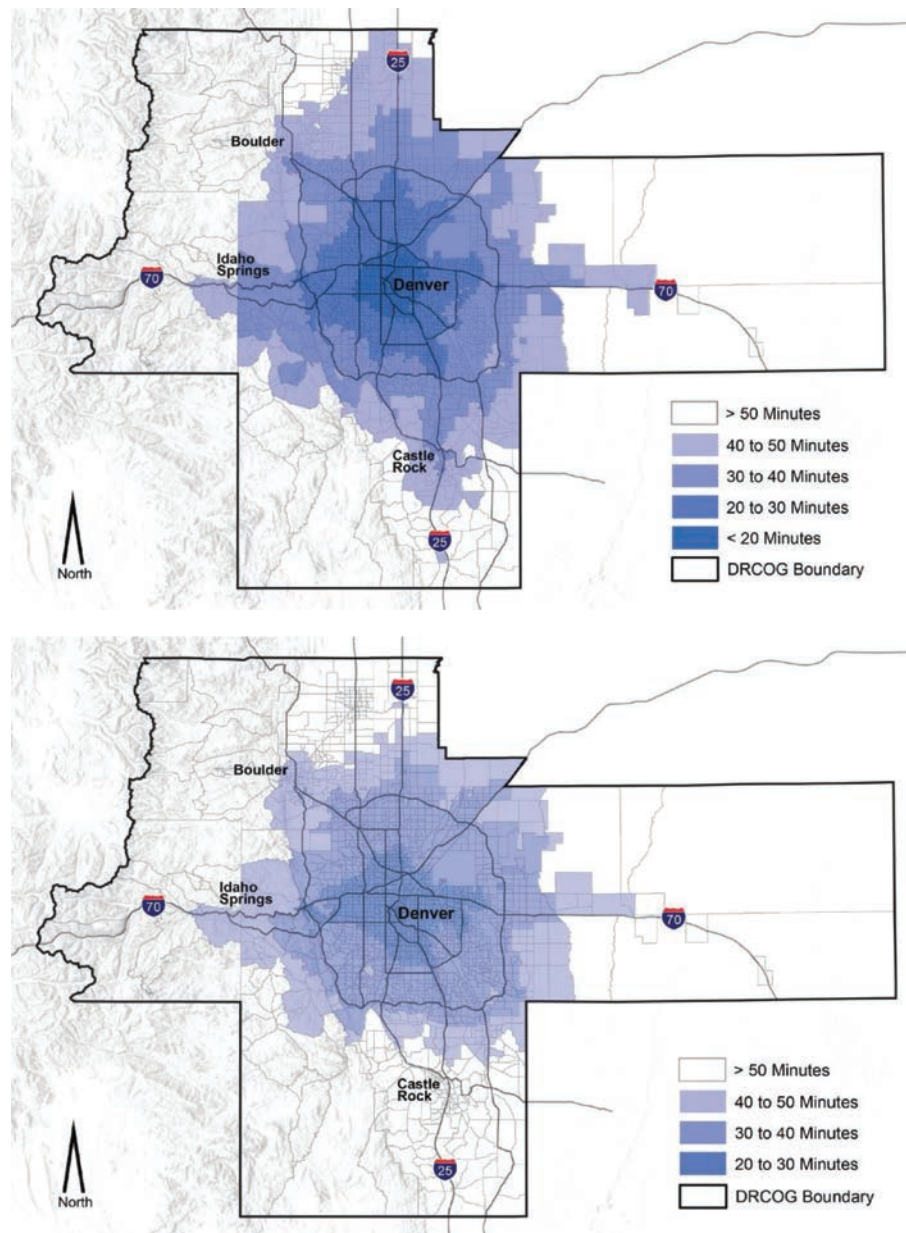


Figure A-6. Example illustration of travel times to all TAZs for auto skims.

Average Travel Time to CBD

At DRCOG, significant urban centers are named and distributed publicly as an “Urban Centers” dataset that helps guide planning efforts. This measure pulled the average travel time from each TAZ in the region to the single TAZ containing the DRCOG “Central Business District” urban center centroid. Next, the weighted average travel time by population group can be calculated.

In Figure A-7, the top map shows average travel times to CBD for 2015 non-peak skims, and the bottom map shows average travel times to CBD for 2040 peak skims.

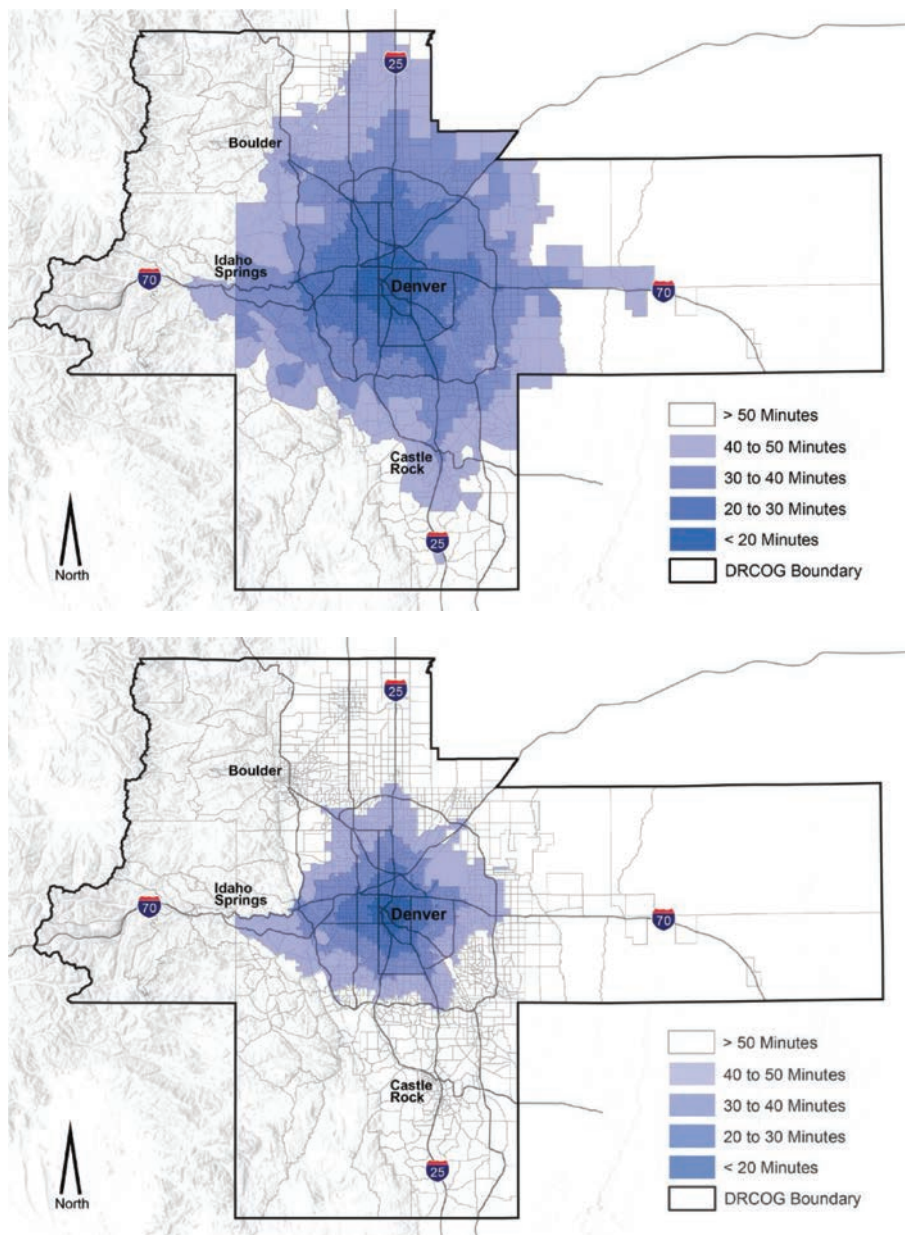


Figure A-7. Example illustration of travel times to CBD for auto skims.

Lessons Learned: Implications for the Equity Guide

Based on the questions posed by DRCOG and the conversation held during the peer-to-peer call, the technical support team revised the relevant sections of this guide to provide additional clarity and explanation.

Resources

- DRCOG. Equity Atlas. Available at: <http://www.denverregionalequityatlas.org>.
- DRCOG. 2017. 2040 Metro Vision Regional Transportation Plan. Retrieved from: <https://drcog.org/sites/default/files/resources/FINAL%20-%202040%20MVRTP%20w%20APPENDICES%20-%20April%202017.pdf>.
- DRCOG. 2010 Public Participation Plan. Retrieved from: <https://drcog.org/sites/drcog/files/resources/FINAL%20DRCOG%20Public%20Involvement%20in%20Regional%20Transportation%20Planning%20Adopted%20April%202010.pdf>.

Mid-America Regional Council (MARC)

Agency Context

The Mid-America Regional Council (MARC) serves as the MPO for the Kansas City region. The MPO spans nine counties in two states.

MARC is committed to advancing racial and economic equity. In 2010, MARC established the Creating Sustainable Places Initiative, with funding from the U.S. Department of Housing and Urban Development. The initiative set out to create a regional vision for sustainable development, with a focus on green, healthy, and vibrant places offering a range of housing options, amenities, and services, that are well connected by multiple transportation options. The Creating Sustainable Places Initiative established equity as a core principle for regional planning and decision making. MARC also developed an equity lens to facilitate a multi-dimensional consideration of equity that addresses education, public engagement, EJ, housing choices, transportation, health, and reinvestment.

Pilot at a Glance

Region: *Kansas City, Kansas/ Missouri*

MPO Service Population:
2,086,771

Phase: *Long-Range Transportation Planning*

Focus of Technical Assistance:

- *Public Engagement,*
- *Use of Population-Weighted Approach for Assessing Relative Impacts*

Overview of Technical Assistance

MARC received technical assistance related to public engagement and assessing relative impacts for the development of its long-range Regional Transportation Plan 2050. Specifically, the technical assistance included (1) guidance on conducting a population-based equity analysis, and (2) the development of an engagement plan to involve the existing REN (a partnership of local organizations formed to support the Creating Sustainable Places Initiative) in the public engagement process.

Method

Population-Based Analysis Method Guidance

MARC piloted the draft guide's instructions for conducting a population-weighted equity analysis, which forecasts the outcomes of transportation investments on minority persons and low-income persons throughout the region. A population-based approach to an equity analysis helps reveal impacts to all underserved populations, not just those living in high-priority underserved communities. The population-based equity analysis could replace the geographic-based analysis used in previous regional transportation plans.

To support the implementation of this new approach, MARC received a draft version of the reference guide that documents the population-based approach used by the MORPC. MARC successfully used the approach by following the draft guide's instructions but found that the agency's regional travel-demand model did not forecast transit-based measures as accurately as they would like. The technical support team organized and facilitated a peer-to-peer webconference with staff from MORPC, in which MARC (and DRCOG) staff asked questions they had about the approach.

- **Defining populations for analysis:** MORPC always conducts separate analyses for each population group, rather than combining minority populations with low-income populations. MORPC always includes a control group to enable comparative analyses of the results; for example, when they analyze minority populations, they also analyze non-minority populations.
- **Identifying populations for analysis:** MARC staff had questions about developing the forecast year's population figures.
 - MORPC explained that they needed to hold three things constant: (1) the regional demographics held constant with the base year's; (2) the regional overall population number for the forecast year; and (3) the total population of each TAZ in the forecast year.
 - To successfully hold those three things constant while accommodating the different growth rates forecast for different TAZs, they had to redistribute slightly at the TAZ level but maintained each TAZ's relative share of the regional population for each population group being analyzed.
 - They identified which population groups had declined at the regional level and how far they were off. Then they adjusted TAZs based on each TAZ's current share of the region's population of that population group. For example, if they needed to add 10,000 more low-income persons to the region, then they would distribute an additional 10,000 low-income persons to the TAZs based on the current proportions of low-income persons in each TAZ, and then reduce each TAZ's non-low-income numbers by the same amount to hold the TAZs' total population constant.
- **Identifying high-priority areas:** MORPC uses a combination of heat maps showing which TAZs have high concentrations of each population group and dot-density maps showing where high numbers of each population group live.
- **Determining disparate impacts and/or disproportionately high and adverse effects (DHAE):** MORPC uses line graphs showing how the modeled benefits (e.g., travel-time savings) vary by population group for the current/base year, the no-build in the forecast year, and the plan/program's projects in the forecast year. These line graphs enable MORPC staff to identify gaps and to see how improvements might vary for different populations.
- **Identifying mitigation strategies:** Although MORPC did not identify disparate impacts or DHAE, MARC was interested in how the use of this approach influenced decision making at the agency. MORPC then described its approach of requiring project sponsors to forecast the opening-day users of proposed projects, which MORPC compares to the region's demographics to ensure that they are adequately funding projects that benefit a representative sample of the region.

REN Engagement Plan

The REN Engagement Plan identifies opportunities for targeted engagement of the REN members in the development of the long-range transportation plan. Currently, the REN participates in MARC's transportation committee and provides input to transportation planners in one-on-one meetings. The engagement plan helps to cultivate dual roles for the REN member organizations to (1) serve as a focus group to provide input on the transportation needs, concerns, and ideas from the perspective of underserved persons; and (2) serve as engagement ambassadors to support MARC's efforts to effectively engage with underserved persons.

The purpose of the plan is to identify opportunities for MARC to meaningfully engage members of the REN in the development of the long-range Regional Transportation Plan 2050. Engaging REN members will support the understanding and consideration of transportation needs, concerns and ideas from the perspective of underserved populations, helping to ensure that regional transportation planning is more inclusive and equitable.

About the REN

In 2010, MARC received a Sustainable Communities Planning Grant from the U.S. Department of Housing and Urban Development. With the grant, MARC established the Creating Sustainable Places Initiative to make the region more “vibrant, connected, and green.” A set of guiding principles were developed, which included the following definition of equity (MARC):

Residents of all races, economic means, and abilities are welcome and equipped to participate in all aspects of community life. A region is most likely to be sustainable, and nationally and globally competitive, if all its residents are active participants in its economy, community, and public life.

As part of the initiative, an “equity lens” was developed that identifies potential strategies, programs, and policies to address equity. The lens provides a multi-dimensional consideration of equity that addresses education, public engagement, EJ, housing choices, transportation, health, and reinvestment. One of the first applications of the equity lens was the evaluation of six corridor-planning demonstration projects (MARC).

To support the Creating Sustainable Places Initiative, local organizations formed the REN to advance the consideration of equity. The group’s mission is to “ensure that all planning processes and policy decisions take social equity priorities into account” (MARC).

REN Members

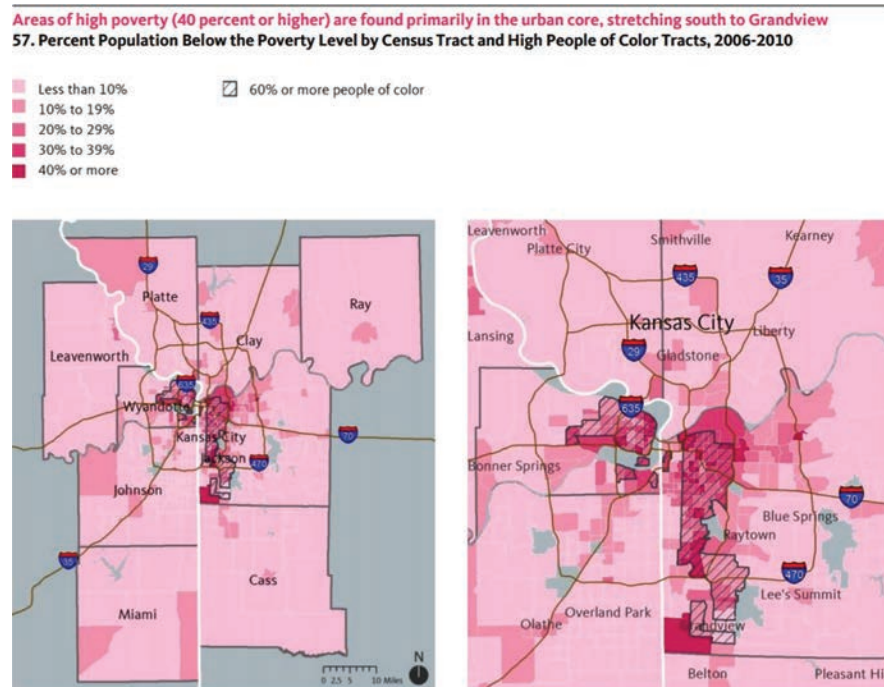
- Ad Hoc Group Against Crime,
- Blue Hills Housing Development Corporation,
- Communities Creating Opportunities,
- Greater Kansas City Local Initiative Support Corporation,
- Health Department of the City of Kansas City,
- Ivanhoe Neighborhood Council,
- Latino Civic Engagement Collaborative,
- MORE2 (Metro Organization for Racial and Economic Equity),
- MARC,
- Neighborhood Housing Services Department, City of Kansas City,
- Northland Neighborhoods, Inc.,
- University of Missouri Kansas City, Urban Planning Department,
- Upper Room,
- Urban League,
- William Jewell College, and
- Westside Housing community leaders, stakeholders, and individual members.

Regional Equity Profile

The REN’s first major activity was to develop a Regional Equity Profile to better understand the state of social equity in the nine-county area served by MARC. REN worked with PolicyLink and

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the Program for Environmental and Regional Equity at the University of Southern California on an analysis of the composition and spatial distribution of minority populations and low-income residents in the region (Figure A-8).



Source: PolicyLink and U.S.C. Program for Environmental & Regional Equity (2013), Equity Profile of the Kansas City Region

Figure A-8. Concentrations of households in poverty and people of color.

The profile presented an equity indicators framework with a focus on four key areas: demographics, economic vitality, economic readiness, and connectedness to regional assets and opportunities. The measures were developed using data from a regional equity database as well as public and private data sources. The analysis found growing inequalities related to employment, income, and education despite steady regional economic growth.

The Regional Equity Profile recommends that, “given the region’s rapid demographic shifts, public-sector leaders need to take steps to ensure active and accessible public engagement by all of its racial and ethnic communities in local and regional planning processes” (<http://www.marc.org/Regional-Planning/Creating-Sustainable-Places/Plans/Social-Equity>). The REN Engagement Plan helps accomplish this objective by identifying concrete strategies for meaningful engagement from communities of color and low-income residents in the update of the RTP. Specific insights gleaned from the profile that were considered in the development of the REN Engagement Plan are summarized in Table A-1.

Table A-1. Equity profile insights for REN Engagement Plan.

Regional Equity Profile Findings	Insights for REN Engagement Plan
The Kansas City region is rapidly diversifying in the urban core and suburbs. Communities of color have contributed to most of the region's recent population growth, particularly among youth. The Latino community is almost evenly comprised of U.S.-born and foreign-born individuals. The Asian community is very diverse, representing people with roots in nations such as China, Taiwan, Viet Nam, the Philippines, and Korea.	<ul style="list-style-type: none"> Identify strategies to encourage participation of both U.S.-born and immigrant Latinos, which may include addressing the language barrier. Acknowledge the diversity of the Asian community and seek out participation from the various cultural groups. Make concerted efforts to engage people of color throughout the region.
Communities of color, especially youth, face educational gaps and health challenges. Black and Latino communities lack the education and training demanded by employers and job forecasts. Also, the prevalence of disease, such as obesity, diabetes, and asthma is higher, in part due to lack of access to medical care.	<ul style="list-style-type: none"> Make concerted efforts to engage youth within communities of color. Consider how transportation decision making impacts health (e.g., access to medical care and opportunities for walking and biking).
Although residential segregation is decreasing overall, areas of concentrated poverty present a growing challenge and people of color are more likely to reside in these areas.	<ul style="list-style-type: none"> Consider the compounding impact of multiple layers of disadvantage. Conduct targeted engagement in areas with intersecting high concentrations of poverty and of people of color.

Regional Transportation Plan 2050 Timeline and Engagement

The development of the Regional Transportation Plan 2050 is a six-step process (Figure A-9). MARC completed the first two phases of the process prior to the pilot study: **Discovery and Needs Assessment** and **Storytelling and Policy Framework**. The next phase, **Investment Scenarios**, was slated to begin in the fall of 2018.



Figure A-9. MARC Regional Transportation Plan 2050 development schedule.

Public and stakeholder engagement is a critical component of MARC's planning process. The Regional Transportation Plan 2050: Public & Stakeholder Engagement Plan details the underlying principles and strategies for the public engagement process:

- Active and continuous process:** MARC is committed to fostering a public participation process that provides equal access to engagement opportunities. MARC strives to facilitate

meaningful public engagement, in which members of the public understand how their input influences transportation decision making.

- **Inclusive engagement:** Efforts to address equity include the participation of the REN in the RTP steering workgroup to provide guidance on the planning process and to encourage engagement among advocacy and faith-based organizations. Social service agencies serve as a voice for transportation-disadvantaged populations such as older adults, youth, persons with disabilities, persons with LEP, ethnic and racial minority community members, and low-income households. These groups participate in MARC’s transportation committee and provide input during one-on-one meetings. To effectively engage this group, MARC will provide education about the decision-making process and facilitate dialogues with members of low-income and minority communities and their representatives. Furthermore, MARC will document input from transportation-disadvantaged groups for review and consideration by decision makers, and communicate back to these groups about how their feedback is being addressed in the plan.
- **Broad communications and engagement strategies:** MARC uses a wide range of strategies and tools to communicate, educate, and engage, including a website, social media, press releases, newsletters, videos, story maps, presentations, targeted engagement, one-on-one meetings, “piggyback” presentations, public meetings, open houses, pop-up meetings, online surveys, workshops, contests, youth-focused engagement, participation in regional events, and advertisements in print, online, and radio media.
- **Evaluation:** The plan states that MARC will use evaluation metrics (quantitative and qualitative) to measure the effectiveness of engagement techniques. These may include, for example, numbers of participants, completed surveys, geographic distribution and demographics of participants (age, income, gender, race, ethnicity, and so forth), and web analytics.

Action Strategies for REN Engagement

The REN Engagement Plan makes recommendations to MARC on how to meaningfully engage REN member organizations in the update of the RTP. There are two key roles that REN members can serve in the public engagement process:

1. Serve as a focus group to convey to planners the transportation needs, concerns and ideas from the perspective of transportation-disadvantaged groups in the region and provide technical expertise; and
2. Serve as engagement ambassadors to support MARC’s efforts to meaningfully and effectively engage with transportation-disadvantaged groups.

Due to the timing of the pilot project, the recommendations in this plan identify preliminary activities that would enable REN members to provide input on completed phases, as well as strategies for expanding REN engagement in the remaining phases.

Preliminary Activities

The first two phases of the plan development process gather information about big-picture needs in the region and shape the story of transportation in the region—present and future. These steps create the foundation on which the remaining phases—and ultimately the long-range plan—will be built. Therefore, it is important that the narrative and policy framework developed during these phases depict an accurate picture of the current transportation system and envision a more equitable

future. The following preliminary activities are recommended to enable REN members to validate the outcomes of the previous steps and to set the stage for meaningful engagement throughout the remainder of the process.

- Examine the current REN roster and suggest additional members to ensure that it reflects the diversity of the region found in the Regional Equity Profile. Specifically, REN should also include groups that work on behalf of youth, both U.S.- and foreign-born Latino immigrants, and the various Asian cultures found in the region.
- Convene REN members to review and provide feedback on the needs assessment, regional story narrative, and policy framework developed in the earlier phases. REN members can confirm whether the needs of low-income populations and communities of color have been accurately identified.
- Work with REN members to develop measures of effectiveness for communication, education, and engagement strategies that foster an inclusive public and stakeholder engagement (such as participants' demographic information). Consider evaluation goals and targets, as well as methods for documenting, tracking, and responding to evaluation results.
- Seek input from REN members on which public engagement techniques might be most effective for reaching various audiences (such as interactive games, group discussions, one-on-one interviews, and surveys). Also ask them to identify places to hold workshops and other activities and distribute meeting advertisements for targeted engagement to underserved communities.
- Provide materials for REN members to share the story map and policy framework through social media, agency websites and “piggyback presentations.” This can help set the stage for targeted engagement of transportation-disadvantaged populations in subsequent phases.

Action Strategies for Remaining Phases of Plan Development

These preliminary activities will lay the foundation for the REN members to serve as both technical consultants and engagement partners in the subsequent phases to begin in the fall of 2018. Table A-2 lists suggested strategies for REN engagement in each of the remaining plan development phases. These recommendations include a broad array of activities that MARC can use to engage REN members in the long-range planning process, with varying levels of time, resource, and capacity requirements. As a first step toward implementing these or other ideas, MARC will gauge REN members' interest in these potential strategies, which could lead to the development of alternative and/or additional activities

Lessons Learned: Implications for the Equity Guide

- **Public engagement:** Involve local stakeholder groups early in the planning process, and develop strategies to leverage their availability and capacity most effectively, especially given time and resource constraints of stakeholders operating as nonprofits.
- **Population-based method:** Conducting a population-based equity analysis is an effective tool in understanding impacts on underserved individuals throughout a region. The technical analysis is not significantly more labor intensive than a geographic-based approach. By using a population-based analysis, project sponsors can be required to include projected numbers or percentages of a project's users, broken down by demographics. Projects serving higher

percentages or numbers of individuals from underserved groups can be prioritized in project programming. Guidance on how to analyze transit travel-time trends would be helpful.

Table A-2. Potential strategies for REN engagement in Regional Transportation Plan 2050.

Phase: Investment Scenarios
Objective: Develop alternative scenarios for regional transportation investments.
REN Role: Help shape scenarios that address the needs of transportation-disadvantaged populations.
<p>Potential Action Strategies:</p> <ul style="list-style-type: none"> • Educate REN members about scenario planning, particularly because this is the first time scenario planning is being used to develop the long-range transportation plan. • Produce a brief video featuring REN members to educate the public—particularly transportation-disadvantaged groups—about scenario planning and transportation decision making to increase interest in public engagement activities. The video could be shared online and played at public engagement events. <i>Example: Memphis MPO YouTube Channel video https://www.youtube.com/user/memphismpo.</i> • Create opportunities for REN members to serve as engagement ambassadors to draw transportation-disadvantaged groups to participate in regional stakeholder workshops and online survey/poll. Focus on areas with high concentrations of low-income residents and minority populations. • Seek input from REN members on quantifiable indicators to incorporate the equity lens to the selection of the preferred scenario. Work with REN members to determine measures of effectiveness for policies included in the policy framework. Establish guiding principles for the scenario analysis such that the preferred scenario should not harm low-income communities and communities of color. • Leverage REN interest in housing to consider the linkages between housing and transportation. Utilize the Housing + Transportation Index and other data on housing availability and affordability to enrich scenarios to consider land use impacts as well. Also consider data on health to address how scenarios might help address health disparities identified in the Regional Equity Profile. • Ask REN member organizations to invite MARC to existing community events/meetings to present on the planning process and capture input and ideas for consideration. • Provide training to REN members to facilitate activities during public workshops and meetings. • Hold activities to specifically involve youth. For example, hold charrettes for teenagers, use schools as public meeting spaces, or partner with youth organizations (e.g., Boys and Girls Club or youth organizations in Latino or Asian communities). Engaging youth can also be an effective strategy for involving their parents/guardians in the public engagement process. • Ask REN member organizations to consider contributing culturally-appropriate incentives to encourage participation from underserved groups (e.g., catering, translation services, raffle prizes, and transit passes).
Phase: Project Selection
Objective: Identify list of projects to accomplish transportation vision.
REN Role: Support engagement of transportation-disadvantaged in the selection of projects that address transportation equity.
<p>Potential Action Strategies:</p> <ul style="list-style-type: none"> • Seek input from REN members on the project selection criteria to incorporate the equity lens. Equity-related criteria might include, for example, access to jobs and services, transportation choices, and household transportation costs. Connect project selection criteria back to the preferred scenario. • Ask REN for input on projects with a higher potential for burdens and benefits impacting underserved populations. • Develop specific opportunities for REN members to serve as engagement ambassadors (time and resources permitting) during regional workshops and open houses. For example, train them to be discussion facilitators, activity leads, greeters, and scribes. • Develop communications resources (e.g., sample messages, boilerplate text, images, and graphics) for REN members to share opportunities for public comment on individual projects through their social media, newsletters, websites, and other outlets.

(continued on next page)

Table A-2. (Continued).

Phase: Plan Development
Objective: Prepare long-range transportation plan.
REN Role: Support engagement of transportation-disadvantaged in the selection of strategies that address transportation equity.
Potential Action Strategies: <ul style="list-style-type: none"> • Leverage the expertise of REN members and seek their input on draft strategies and plan narrative. • Work with REN members to identify and address any equity-related impacts (positive and negative) of plan recommendations. • Develop communications resources (e.g., sample messages, boilerplate text, images, and graphics) for REN members to share opportunities for public comment on the draft plan through their social media, newsletters, websites, and other outlets. • Develop specific opportunities for REN members to serve as engagement ambassadors (time and resources permitting) during regional workshops, pop-ups, and open houses. For example, train them to be discussion facilitators, activity leads, greeters, and scribes. • Coordinate with REN members to hold engagement activities in areas with high concentrations of low-income residents and minority populations. • Communicate to REN members how their input—as well as input from low-income communities and minority populations—is being considered in the plan. • Collaborate with REN members to identify opportunities for alignment between plan recommendations and agency programs and initiatives. Leveraging transportation investments with REN activities helps to maximize benefits, promote integrated planning, and advance smart investments.
Phase: Plan Adoption
Objective: Adopt final long-range transportation plan.
REN Role: Help communicate to transportation-disadvantaged groups how their feedback was considered and addressed in the final plan, and encourage their continued engagement.
Potential Action Strategies: <ul style="list-style-type: none"> • Develop communications resources (e.g., sample messages, boilerplate text, images, and graphics) for REN members to share opportunities to encourage participation in the 30-day public comment period through social media, newsletters, websites, and other outlets. • Develop communications resources (e.g., sample messages, boilerplate text, images, and graphics) for REN members to share the final plan and to thank the community for participating in the process. • Solicit and document feedback from REN members on the effectiveness of the engagement of low-income residents and minority populations throughout the process. • Identify lessons learned for application to future transportation planning and decision-making processes.

Resources

- PolicyLink and USC Program for Environmental & Regional Equity. 2013. An Equity Profile of the Kansas City Region. http://www.marc.org/Regional-Planning/Creating-Sustainable-Places/assets/Kansas-City_Profile_23August2013.aspx.
- MARC. Creating Sustainable Places: Equity Lens. <http://www.marc.org/Regional-Planning/Creating-Sustainable-Places/assets/InitialEquityStrategiesforCorridors.aspx>.

Mid-Ohio Regional Planning Commission (MORPC)

Agency Context

The Mid-Ohio Regional Planning Commission (MORPC), which is the MPO for the Columbus, Ohio, region, has emerged as a national leader in transportation equity practice. The agency’s population-based approach to equity analysis, which uses travel-demand model outputs to analyze aggregate impacts of transportation actions on different demographic groups, provides a valuable alternative to the prevailing threshold-based approach. However, the agency’s equity practice has remained largely unchanged over the past decade. As MORPC looks ahead to its forthcoming 2020–2050 MTP cycle, agency staff are considering new and innovative ways to address the region’s equity issues. For example, Columbus has a relatively low unemployment rate, yet workplace access remains an issue for the region’s low-income populations and minority populations.

In 2016, the City of Columbus won the U.S. DOT Smart City Challenge and was awarded \$40 million to develop a “smart” transportation system that leverages technology and data to improve the movement of goods and people. As part of this initiative, the city is developing a multimodal trip planning application that provides a robust set of transit options and alternative travel options as well as routes, schedules, and dispatching availability. Use of this app will be supported by free public Wi-Fi access on buses and at transit stations. The city is also developing a common fare payment system that provides unbanked customers with access to bike and car sharing systems.

To extend service for patrons who lack access to the trip planning app, Columbus will install multimodal trip-planning kiosks at select transit stations along the city’s recently launched bus rapid transit (BRT) corridor. Further, the city is developing an autonomous shuttle service in an area near the BRT corridor. (At some point in the future, this shuttle service could develop into a driverless ride-hailing program to better connect the city’s transit users to their destinations.) These projects are scheduled to launch in 2019 and 2020, and will be deployed first in neighborhoods with high concentrations of low-income populations or minority populations. The city’s overarching goal with these initiatives is to bridge first-mile/last-mile gaps and improve underserved persons’ lives through increased access to opportunity.

Overview of Technical Assistance

Columbus’s Smart City initiatives (<http://smart.columbus.gov>) will provide the city’s transit users with enhanced connectivity between travel modes, yet physical connectivity barriers surrounding these smart mobility hubs may hinder their full potential. Recognizing that safe and convenient interconnected bicycle and pedestrian networks are key to addressing first-mile/last-mile gaps, MORPC has been interested in testing promising peer agency techniques in multimodal network connectivity analysis. These types of analyses assess the characteristics and completeness of the bicycle, pedestrian, and highway networks in order to understand how they may impact travel behavior and route choice. The findings of these analyses can aid in identifying network connectivity gaps and understanding disparate levels of multimodal network connectivity between

Pilot at a Glance

Region: Columbus, Ohio

MPO Service Population:
1,426,183

Phase: Long-Range Transportation Planning, Programming, Project Development

Focus of Technical Assistance:
Identify Needs and Concerns

population groups and neighborhoods across a region. Validation and refinement of these findings through public engagement can be used alongside quantitative factors like residential density and job density to prioritize improvements to the multimodal network and improve regional equity outcomes.

For the pilot, MORPC selected three points along the Cleveland Avenue BRT corridor that may become smart mobility hubs. These three points include the Linden Transit Center, the Northern Lights Transit Center and Columbus State Community College. These three points are either adjacent to low-income communities and minority communities along the BRT corridor or important travel destinations for these populations. The pilot assistance included analysis of walking potential within a half-mile of these three points; bicycling potential within 2 miles of these three points; and driving potential within 4 miles of these three points. The half-mile walk-shed distance and 2-mile bike-shed distance were chosen by MORPC under the assumption that transit patrons in these areas are willing to travel these distances on foot or by bike, respectively, to connect to a BRT station. (The distances also comport with travel-shed distances for these modes used in other studies on first-mile/last-mile accessibility.) The 4-mile drive-shed analysis served two purposes:

1. It demonstrated the number of residents or workers who could be served by a ride-hailing service or shuttle service within a given travel shed, and
2. It served as a proxy for the total multimodal network connectivity potential of the highway network, assuming all streets in a given travel shed included sidewalks and comfortable bicycling facilities.

This provided the ratio of *current* bikeable or walkable streets to *potential* bikeable or walkable streets for a given travel shed. (For example, through this calculation one might find that 54% of streets within a half-mile driving distance from a given smart mobility hub include sidewalks).

Method

Broadly, this pilot sought to answer the following questions:

1. From an equity standpoint, what minority populations and low-income populations are *currently* served by the three mobility hubs, and how do the numbers compare?
2. What are the numbers of jobs accessible within each of these mobility hubs by a given mode?
3. Where are the gaps or opportunity areas in the current networks?
4. What minority populations and low-income populations could potentially be served by strategic bike and sidewalk infrastructure?

In addition to the three mobility hubs along the BRT corridor, several different datasets were used to construct the transportation networks for this analysis:

- The Sidewalk Inventory layer compiled by MORPC and available through the Open Data website (<https://public-morpc.opendata.arcgis.com/datasets/>) contains a comprehensive inventory of existing sidewalks and crosswalks.
- The Bike Level of Comfort layer provided on MORPC's Open Data website provides an indication of suitability for cyclists based on non-rush hour travel conditions and feedback from Columbus-area residents.
- Open StreetMap (OSM) highway network data was obtained from Geofabrik (<http://download.geofabrik.de/north-america/us/ohio.html>), a firm specializing in OSM services. The road layer was used to supplement gaps or provide additional features (such as off-roadway paths) to the travel networks.

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- U.S. Census Bureau ACS 5-year data (2012–2016) at the block-group level was used to identify locations of households under the federal poverty level and current population counts of the minority population.
- U.S. Census Bureau Decennial 2010 data at the block level was used to identify the minority population counts at a finer scale than is provided by block-group data from the ACS.
- Longitudinal Employer-Household Dynamics (LEHD) Origin-Destination Employment Statistics (LODES) data Workplace Area Characteristics (WAC) from 2016 at the block-group level was used to identify the type of jobs available in a block.

Using the Network Analyst extension with ArcGIS software, the three smart mobility hubs and three different mode networks were analyzed to create travel sheds using the corresponding travel distances for each mode. To calculate both the current and potential number of minority residents and low-income residents and jobs served by the various mode network travel sheds, these sheds were intersected with the census data described above. The demographic and job data were then apportioned based on the area within the various travel sheds. For example, if 50% of a given census block was enclosed within a half-mile walk shed, then half of the minority residents and low-income residents of that particular block would be considered to fall within the walk shed; this would be repeated for all other block groups that intersected the walk shed, and those demographic groups would be aggregated and compared to the control population within the same area.

To identify the opportunity areas based on the potential surrounding a mobility hub, the number of low-income residents and minority residents that could be serviced by the road network—a proxy for the maximum possible potential of the multimodal network, excluding off-street paths—were compared to the bike sheds and walk sheds. Figure A-10 (next page) provides an example of the difference between an existing network and a potential network. The potential 2-mile bike shed represents a scenario wherein all existing roads are considered to be at least moderately comfortable for bicycle travel.

Results

Based on the findings of this analysis, both the Northern Lights and Linden Transit Centers have the potential to better connect over 500 minorities and over 300 low-income residents to the stations by expanding adjacent sidewalk infrastructure. Columbus State has the opportunity to connect to more jobs, but to much fewer residents. Likewise, the analysis finds that both the Northern Lights and Linden Transit Centers appear to have the opportunity to connect to neighborhoods with substantial minority populations and low-income populations with expanded bike infrastructure. Additionally, Linden has the most opportunity to connect Columbus residents to more jobs, with Columbus State close behind. Table A-3 depicts the potential bike-shed opportunity for low-income residents and minority residents and jobs for each of the three pilot study areas.

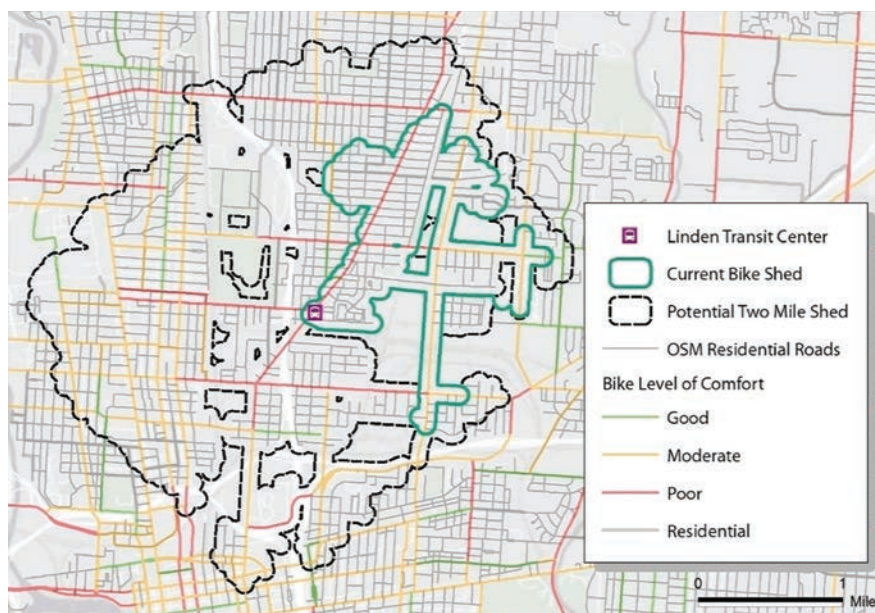


Figure A-10. Current 2-mile bike shed compared to the potential 2-mile bike shed for the Linden Transit Center.

Table A-3. Potential bike-shed opportunity by demographic groups for three mobility hubs.

Mobility Hub	Additional Minority Population	Additional Low-Income Population	Additional Total Population	Additional Jobs
Northern Lights	13,049	6,492	17,809	4,745
Linden	15,424	18,508	45,620	17,765
Columbus State	3,621	2,607	9,987	14,064

Lessons Learned: Implications for the Equity Guide

Network data should be compared to on-the-ground conditions before making any conclusions. Key connections that currently exist may be missed for various reasons in the network layer. For example, if a half-mile walk shed and 2-mile bike shed terminate at the same point, this may represent a barrier such as a river or train tracks. However, this could also represent an inaccuracy in the network or a short break in pedestrian or bike network that would not represent a considerable barrier in reality (for the purpose of this analysis MORPC opted to take a conservative approach to defining the bicycle level of comfort network). Engaging affected populations to learn about experience in the field is a key step to ground-truthing and refining these findings.

Resources

- City of Columbus, Ohio. *Smart Columbus*. <https://smart.columbus.gov/>
- FHWA. 2018a. *Guidebook for Measuring Multimodal Network Connectivity*. https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/multimodal_connectivity/.
- FHWA. 2018b. *Guidebook for Measuring Multimodal Network Connectivity, Appendix: Case Studies*. https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/multimodal_connectivity/appendix.cfm.

Technical Addendum to MORPC Pilot Study

This addendum provides a detailed discussion of the methods, results, level of effort, and limitations of the MORPC multimodal network connectivity pilot case study featured in the guidebook.

Analysis Context

Columbus's forthcoming Smart City initiatives (<http://smart.columbus.gov>) seek to provide the city's transit users with enhanced connectivity between travel modes. Yet physical connectivity barriers surrounding these smart mobility hubs may hinder their full potential. Multimodal network connectivity analyses assess the characteristics and completeness of the bicycle, pedestrian, and highway networks in order to understand how these factors may impact travel behavior and route choice. The findings of these analyses can aid in identifying network connectivity gaps and understanding disparate levels of multimodal network connectivity between population groups and neighborhoods across a region.

For the pilot, MORPC selected three points along the Cleveland Avenue BRT corridor that may become smart mobility hubs (Figure A-11). These three points include the Linden Transit Center, the Northern Lights Transit Center and Columbus State Community College. The points are either adjacent to underserved communities (neighborhoods with higher percentages of minority individuals and/or individuals with low incomes) along the BRT corridor or important travel destinations for these populations. The pilot assistance included analysis of walking potential within a half-mile of these three points; bicycling potential within 2 miles of these three points; and driving potential within 4 miles of these three points.

Analysis Process

Data Assembly

Several different datasets were used to construct the transportation networks for this analysis:

- MORPC staff provided the locations of three mobility hubs along the BRT corridor.
- The Sidewalk Inventory layer compiled by MORPC and available through the Open Data website contains a comprehensive inventory of existing sidewalks and crosswalks.
- The Bike Level of Comfort layer provided on the Open Data website provides an indication of suitability for bicyclists based on non-rush hour travel conditions and feedback from Columbus-area residents.
- OSM data is available through a variety of sources. For this pilot study, the road layer for Ohio was obtained from Geofabrik, a firm specializing in OSM services. The road layer was used to supplement gaps or provide additional features (such as off-roadway paths) to the travel networks.

Technical Analysis at a Glance

Focus: Multimodal First-Mile/Last-Mile Connectivity Analysis

Context of Study Area: Urban

Scale of Study Area: Three Pilot Mobility Hubs

Tools & Models: GIS

Application: Long-Range Planning, Programming, Project Development

Equity Analysis Step: Identify Needs and Concerns

- U.S. Census Bureau ACS 5-year data (2012–2016) at the block-group level was used to identify locations of households under the federal poverty level and current population counts of the minority population.
- U.S. Census Bureau Decennial 2010 data at the block level was used to identify the minority population counts at a finer scale than is provided by block-group data from the ACS.
- LEHD Origin-Destination Employment Statistics (LODES) data WAC from 2016 at the block level was used to identify the types of jobs available in a block.
- OSM road data, the sidewalk inventory, and the bike level of comfort inventory were used to compile networks for each of the three modes: walking, biking, and driving. Each mode required a different set of considerations.

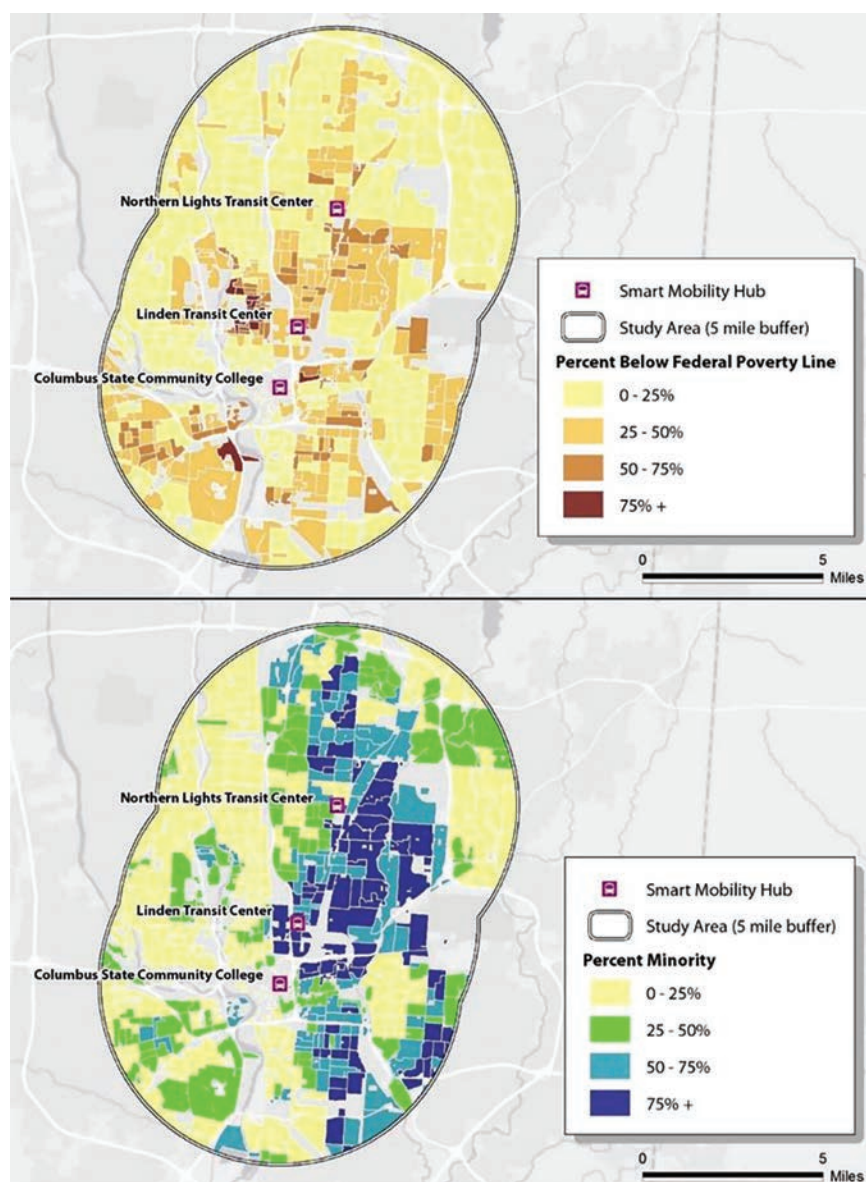


Figure A-11. MORPC study area, underserved communities and mobility hubs.

Table A-4. MORPC pilot study GIS layers.

Mode	Layers Used	Feature Types
Walk	<ul style="list-style-type: none"> MORPC Sidewalk inventory OSM roads 	<ul style="list-style-type: none"> All sidewalk types excluding “X” or no sidewalks OSM <i>fclass</i> types of <i>footway</i>, <i>path</i>, <i>pedestrian</i>, <i>steps</i>, and <i>service</i>
Bike	<ul style="list-style-type: none"> MORPC bike level of stress OSM roads 	<ul style="list-style-type: none"> <i>Good</i>, <i>Moderate</i>, and <i>Residential</i> types OSM <i>fclass</i> types of <i>residential</i>, <i>cycleway</i>, and <i>path</i>
Drive (Ride Hail)	<ul style="list-style-type: none"> OSM roads 	<ul style="list-style-type: none"> All roads excluding <i>motorway</i> and <i>motorway_link</i>, <i>path</i>, <i>pedestrian</i>, <i>track</i>, <i>track_grade1</i>, <i>track_grad2</i>, <i>steps</i>, <i>footway</i>, and <i>cycleway</i>

- Walking:** The pedestrian network was compiled using the sidewalk inventory excluding locations where no sidewalks are present, and the OSM road layer (see Table A-4). The sidewalk inventory was supplemented with OSM data to provide additional off-roadway features. The rationale for including these features is that they provide key links through parks, campuses, and other areas. These features were relevant to include in this particular study area; however, when moving to other study areas the data will need to be reviewed to ensure the selection aligns with ground conditions.
- Biking:** The biking network was compiled using the bike level of comfort and the OSM road layers. The level of comfort rating was completed on major roadways and contains ratings of residential, good, moderate, and poor. Residential, good, and moderate roadways were selected for the analysis, and supplemented by OSM residential road data in order to capture all potential comfortable bike routes.
- Driving:** The ride-hailing network was compiled using the OSM road data and excluded pedestrian features and motorways. The rationale for excluding motorways is that this study aims to assess first- and last-mile transit connections and not travel from a substantial distance away on grade-separated highways.

Analyzing Travel Sheds

Using the Network Analyst extension with ArcGIS software, the mobility hubs and three different mode networks were analyzed to create travel sheds for the various travel distances selected by MORPC. These travel sheds can be viewed in Figure A-12 through Figure A-15.

- Walking:** A half-mile walk shed (about a 10-minute walk assuming an average walking speed of 3.1 mph),
- Biking:** A 2-mile bikeshare travel shed, and
- Driving (ride-hailing):** A 4-mile drive shed.

To create the travel sheds, connected networks were buffered by 100 meters—the agreed-on distance for comfortably accessing a network route. This does present a limitation to the analysis, because often paths for accessing locations off the road network (such as through an apartment building courtyard) are not adequately mapped in inventory datasets, resulting in missed populations during the overlay analysis.

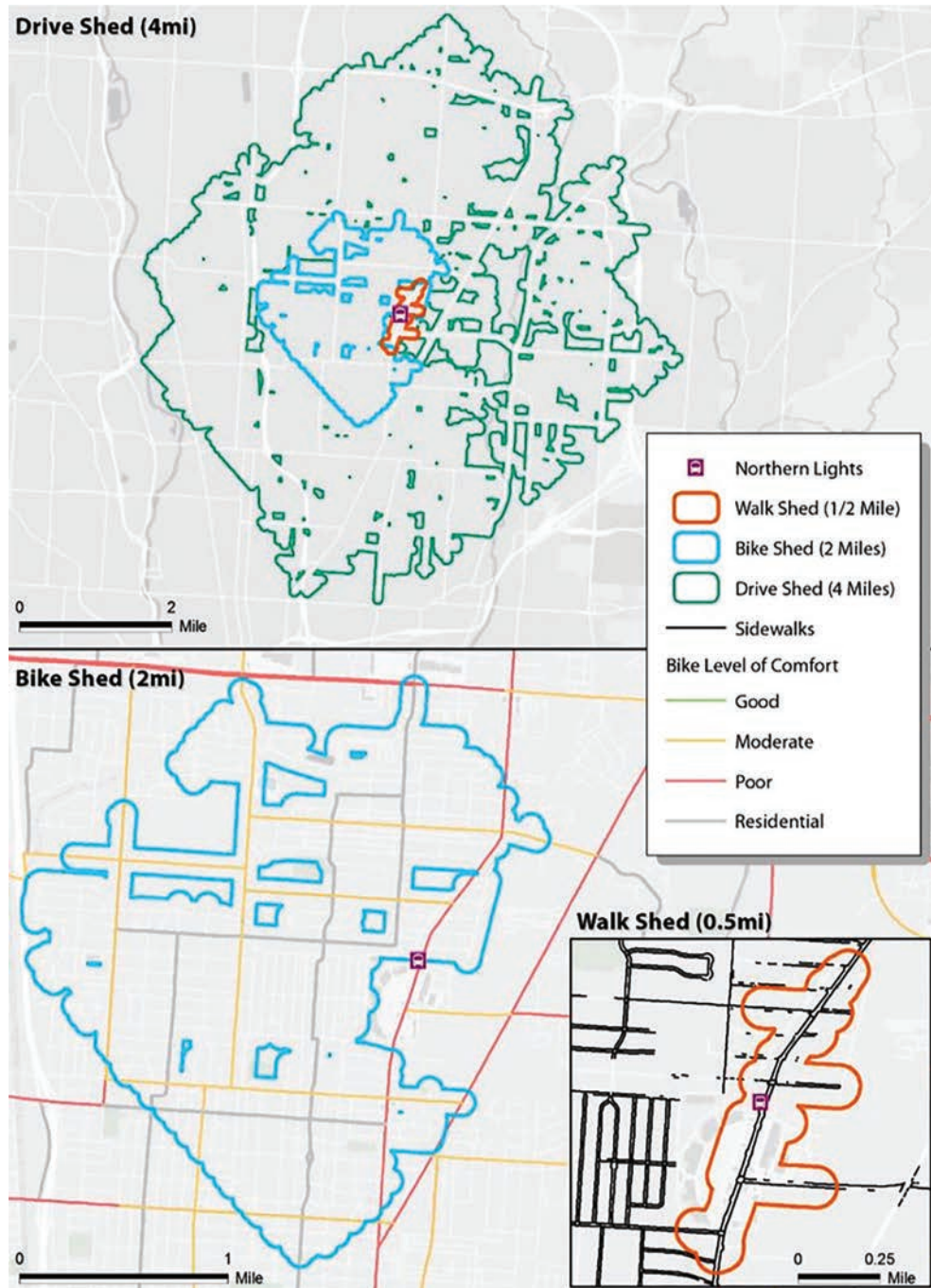


Figure A-12. Northern Lights Transit Center current drive, bike, and walk sheds.

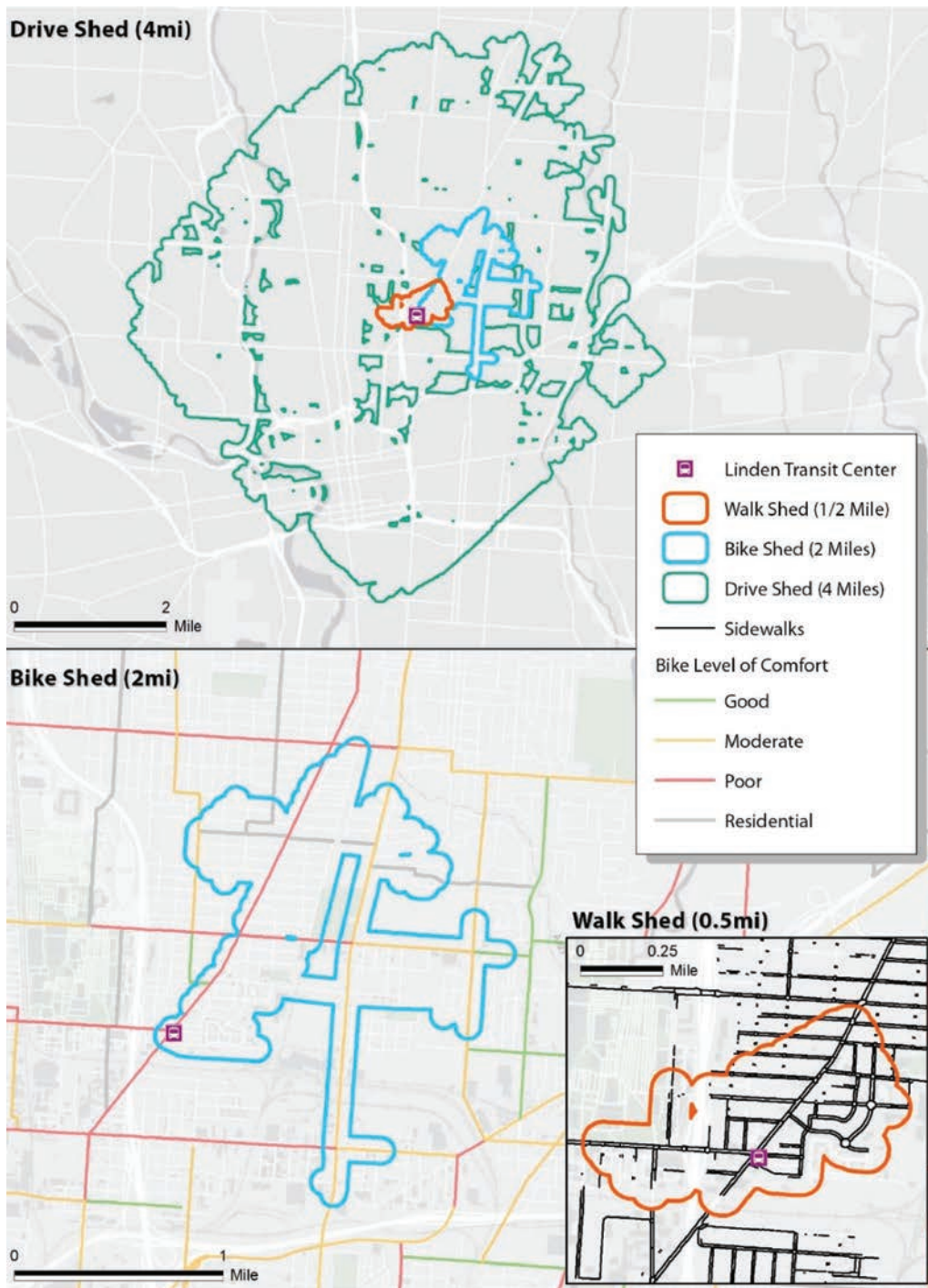


Figure A-13. Linden Transit Center current drive, bike, and walk sheds.

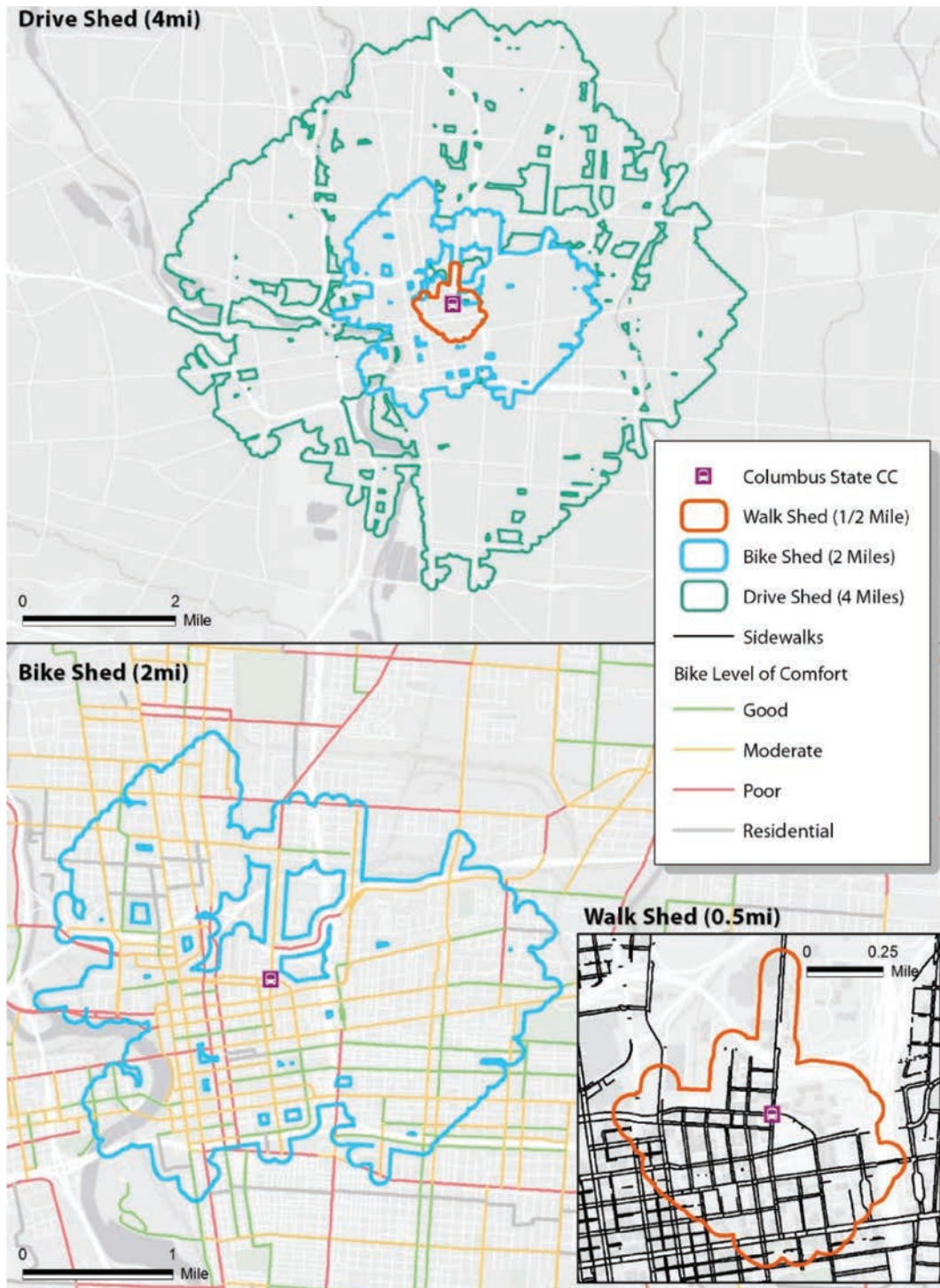


Figure A-14. Columbus State Community College Transit Center current drive, bike, and walk sheds.

Purpose

The generated travel sheds are used to answer two key questions in this study:

1. From an equity standpoint, what percentage of residents *currently* served by the three mobility hubs are considered minority or low-income individuals, and how do the numbers compare to non-minority/mid- or high-income?
2. Where are the gaps or opportunity areas in the current networks? What minority and low-income populations in the study area could be served by strategic bike and sidewalk infrastructure?

In addition to underserved communities, the estimated number of jobs within the travel sheds were calculated using the LODDES data to assess the demand for people to travel to the mobility hub, rather than from the hub. This metric is important to consider alongside residential characteristics.

To answer the second question and identify the opportunity areas based on the potential surrounding a mobility hub, two additional travel sheds were created to represent the *potential* walking and biking network. These were created from the road network rather than using a straight distance measure. The road network was seen as a good indication of all potential sidewalk and bike lanes that could exist on the existing network. It is worth noting that the bike and pedestrian network may potentially “beat” the road network in certain areas if there is a path unavailable for car use, so including these existing features in the potential network should be considered. An example of the difference between an existing network and a potential network can be seen in Figure A-15, which shows the current 2-mile bike shed and a potential 2-mile bike shed for the Linden Transit Center. In Figure A-15, the potential bike shed represents conditions wherein all existing roads are considered comfortable for bike travel.

To calculate both the current and potential number of minority and low-income residents (and also jobs) within the travel sheds, the various travel sheds were *intersected* with the best available census data. This varied depending on the metric. Minority and low-income populations were assessed at the block-group level. To further refine the distribution of the populations within the block groups, census blocks with zero population were *erased* from the block group data. Jobs data was available at the block level. The block-group and block totals were apportioned based on the area within the various travel sheds.

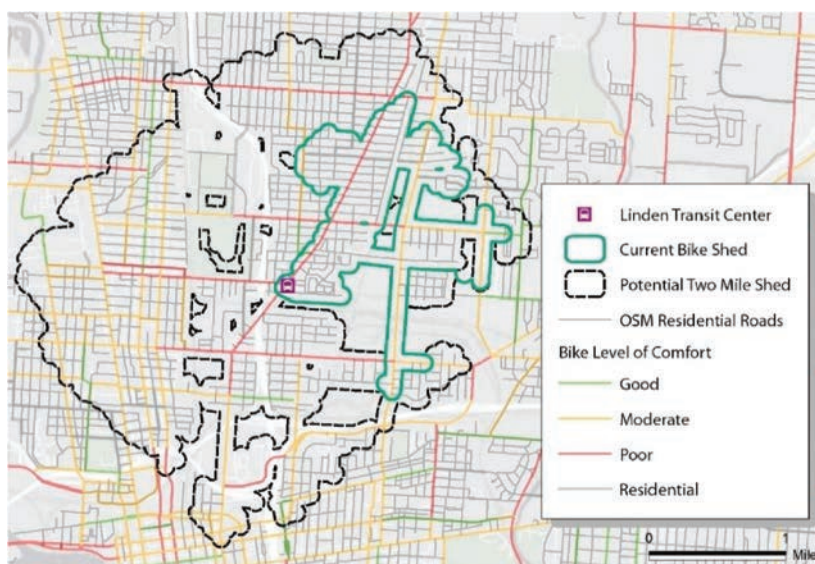


Figure A-15. Current 2-mile bike shed compared to the 2-mile bike shed for the Linden Transit Center.

Results: Mobility Hub Comparison

The results of the analysis aimed to compare the three hubs and answer the first of the two key questions of this analysis: *How many residents currently served by the existing networks are considered minority or low-income?*

Minority Communities

- **Walking:** Of the three study hubs, the Linden Transit Center’s current walk shed serves the highest minority population, total population, and minority percentage. The Columbus State Transit Center’s current walk shed, with 279 total minority residents, serves the lowest population in all three categories (Table A-5).

Table A-5. Walk sheds—minority populations.

Mobility Hub	Minority Population	Total Population	Percentage Minority
Northern Lights	529	1,161	46%
Linden	1,223	1,734	71%
Columbus State	279	824	34%

- **Biking:** The Columbus State Community College Transit Center bike shed has the lowest minority percentage but serves the highest number of minority people, whereas the Linden Transit Center serves the least number of overall people but the highest minority percentage (Table A-6). This may indicate a potential opportunity to better serve minority communities, which will be explored in the next section.

Table A-6. Bike sheds—minority populations.

Mobility Hub	Minority Population	Total Population	Percentage Minority
Northern Lights	9,394	21,410	44%
Linden	5,466	6,637	82%
Columbus State	11,733	30,315	39%

- **Driving (ride-hailing):** The Northern Lights Transit Hub serves the highest minority population within a 4-mile ride-hailing shed, both in total people and percentage (Table A-7). Linden and Columbus State serve a higher total population overall.

Table A-7. Drive (ride-hailing) sheds—minority populations.

Mobility Hub	Minority Population	Total Population	Percentage Minority
Northern Lights	77,066	150,320	51%
Linden	60,056	165,618	36%
Columbus State	60,227	170,467	35%

Low-Income Communities

- **Walking:** Of the three study hubs, the Linden Transit Center current walk shed serves the highest low-income population, total population, and low-income percentage (Table A-8).

Table A-8. Walk sheds—low-income populations.

Mobility Hub	Low-income Population	Total Population	Percentage Low-income
Northern Lights	478	1,161	41%
Linden	1,040	1,734	60%
Columbus State	254	824	31%

- **Biking:** The Columbus State Community College Transit Center bike shed serves the highest number of low-income and total population, whereas the Linden Transit Center serves the least number of overall people but the highest low-income percentage (Table A-9).

Table A-9. Bike sheds—low-income populations.

Mobility Hub	Low-income Population	Total Population	Percentage Low-income
Northern Lights	5,525	21,410	26%
Linden	3,173	6,637	48%
Columbus State	8,389	30,315	28%

- **Driving (ride-hailing):** The sheds show modest differences across population totals, with Northern Lights serving fewer low-income residents (Table A-10).

Table A-10. Drive (ride-hailing) sheds—low-income populations.

Mobility Hub	Low-income Population	Total Population	Percentage Low-income
Northern Lights	37,459	150,320	25%
Linden	47,512	165,618	29%
Columbus State	52,044	170,467	31%

Jobs

Jobs are an important indicator of what might draw people to a particular mobility hub and complete a “last-mile” trip, rather than residents completing a first-mile trip. Stations such as Columbus State Community College provide access to more employment opportunities for residents of the broader region than to residents nearby. Table A-11 compares the numbers of jobs within proximity to each hub, which varies depending on the mode shed.

Table A-11. Jobs within travel sheds of stations.

Mobility Hub	Walk Shed	Bike Shed	Ride Shed
Northern Lights	697	2,749	60,792
Linden	841	1,294	188,494
Columbus State	10,339	109,170	200,380

Results: Potential Opportunities

Table A-12 and Table A-13 aim to answer the second key question of this analysis by providing the totals for *additional* residents who could be served. These are the numbers of individuals living within the optimal potential sheds for the respective mode distances. Higher numbers indicate opportunity areas for connecting more people to the transit hub with expanded walking or biking infrastructure. It is important to note that network data should be compared to on-the-ground conditions before making any conclusions. Key connections that exist currently may be missed due to various reasons in the network layer, which will be discussed in the section titled “Limitations.”

- **Walking:** Both the Northern Lights and Linden Transit Centers appear to have the opportunity to better connect over 500 minorities and over 300 low-income residents to the stations with expanded sidewalk infrastructure, with Northern Lights connecting a larger total population. Columbus State has the opportunity to connect to more jobs, but much fewer residents. Figure A-16 depicts both the current and potential walk sheds for Northern Lights overlaid on block-group minority populations. Sidewalk gaps along many of the streets prevent the shed from extending to the northeast. As seen in Figure A-16, block groups in all directions may potentially benefit from further completion of sidewalks.

Table A-12. Potential walk-shed opportunities.

Mobility Hub	Additional Minority Population	Additional Low-income Population	Additional Total Population	Additional Jobs
Northern Lights	586	415	1,269	429
Linden	578	307	807	557
Columbus State	136	119	407	3,526

- **Biking:** Both the Northern Lights and Linden Transit Centers appear to have the opportunity to connect a large minority population with expanded bike infrastructure, with Linden adding a substantial increase to both the low-income population (by more than 18,000 people) and total population (by more than 45,000 people). Additionally, Linden has the most opportunity to connect workers with more jobs, with Columbus State close behind. Figure A-17 depicts both the current and potential bike sheds for Linden Transit Center overlaid on block-group minority populations. Poor level of comfort streets traveling north, east, and south of the station appear to prevent a large number of people from having comfortable bike access to the station. Block groups to the west and south of the existing bike network contain a high percentage of minorities; however, as seen in Figure A-17, these groups appear to have a tough time connecting to the current bike network.

Table A-13. Potential bike-shed opportunities.

Mobility Hub	Additional Minority Population	Additional Low-income Population	Additional Total Population	Additional Jobs
Northern Lights	13,049	6,492	17,809	4,745
Linden	15,424	18,508	45,620	17,765
Columbus State	3,621	2,607	9,987	14,064

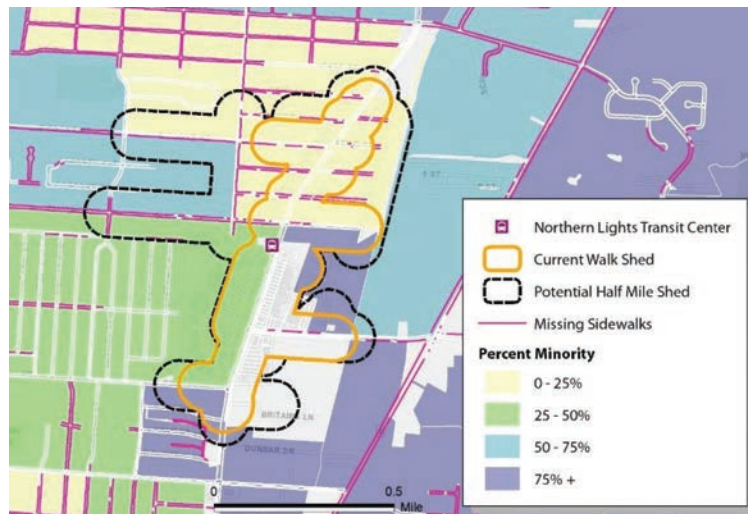


Figure A-16. Potential opportunity areas for greater connection of minority communities to the Northern Lights Transit Center walking network.

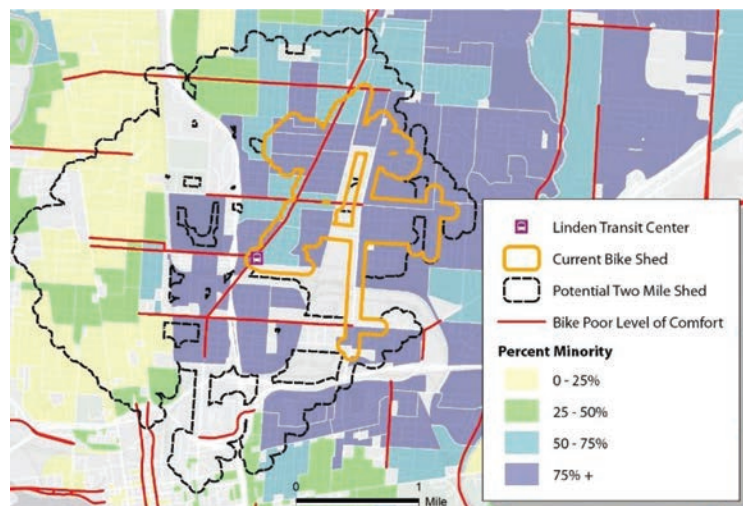


Figure A-17. Potential opportunity areas for greater connection of minority communities to the Linden Transit Center bike network.

Methodology

The steps below outline the specific steps to perform this analysis. One of the key aims of this study was to derive a methodology that is both repeatable and scalable across many mobility hubs, or different focal locations (e.g., hospitals). All existing network data (OSM, sidewalk inventory, bike level of comfort) and mobility hub locations were loaded into a single GIS map. ESRI ArcGIS software was selected for this analysis because of its Network Analyst extension and its familiarity to GIS analysts at most agencies.

The travel networks for walking, biking, and driving were prepared using the following steps:

1. Clip to the study area, defined as a 5-mile buffer around the mobility hubs for this analysis. This distance encompasses the maximum of 4 miles for the drive shed, while still depicting what is present just beyond the study distances.
2. Select the appropriate features using queries.
3. Merge the data obtained from MORPC's open data portal with supplemental OSM data. The MORPC inventories were completed for a certain purpose (such as identifying a level of stress on major streets only), making it necessary to supplement the data to build a more complete network.
4. The Feature to Line tool was then used to "fix" any topography errors resulting from the merge, such as lines not being split when crossed by another line. If this step is not taken, when creating the travel shed turns will not be modeled appropriately. This tool will automatically add nodes at all intersecting lines.
5. The Split Lines at Vertices tool should then be used to ensure that nodes are placed where a line touches but does not cross another line. The Feature to Line tool will take care of four-way intersections, whereas the Split Lines at Vertices tool will take care of three-way intersections.

After the line layers for the three modes were built following the previous steps, a network dataset can be built and "solved" using the Network Analyst extension. This is the process taken to create the various travel sheds.

1. Create a new geodatabase, and then add a new feature dataset for each of the different modes being analyzed. Separate feature datasets are required because only one network dataset is allowed within a single feature dataset. Take note of the unit of measurement with the selected coordinate system (use feet or meters).
2. Add each of the base network layers described in the Preparing Data section to its respective feature dataset created in Step 1.
3. Right click on the Feature Dataset name when in the Catalog and select New >> Network Dataset. Use Length as the cost, allow for global turns, and build a regional index. One-way streets were not modeled in the analysis.
4. It is important to note that if changes are made to the network at a later time, the network dataset will need to be recreated. The Build Network tool can be used to reconstruct an existing network.

The following steps outline how to create the travel-shed polygon layers using the network datasets created in Step 3. It is highly recommended that the following steps be done in the ArcGIS ModelBuilder environment so that all selected parameters and input datasets can be documented. Additionally, travel sheds are rarely perfect the first time, and viewing them can draw attention to obvious flaws in the underlying network. Using the ModelBuilder environment makes for quick

repeatability of steps after the input dataset has been fixed. Once built, the model can also be copied for analyzing additional mode networks.

1. Use the Make Service Area Layer tool with the network dataset created in Step 3 as the input. There are other ways of building travel sheds, however, this was the approach selected for this particular analysis.
2. A number of options need to be set within the tool. The first is the Impedance Attribute, which should be set to Length. Travel From or To Facility is important when modeling one-way features and looking into differentiating between residential characteristics (travel to) or opportunity and job characteristics (travel from), however, for this particular analysis this setting was not used. Only one shed was generated per mode not modeling one-way streets.
3. Default Break Values allow the assessment of multiple travel distances at one time. Ensure that the units selected are the same as the feature dataset coordinate system.
4. For this analysis, lines were selected for the travel shed instead of polygons and then buffered by 100 m to create consistent polygons. This was the distance determined to be reasonable to walk or bike to get on a comfortable network.
5. The next step is to Add Locations to the service area. These are the mobility hub centers that are being assessed. A search tolerance may need to be set so that the point is able to “get on” the network. Note that during repeat runs of the model, this step would often throw an error. To get past this, simply remove and re-add the step to the model.
6. Next, use the Solve tool to create a temporary solution in memory to the service area based on the input locations. The Select Data tool can then capture individual components of the solution, such as lines and polygons. This selection is only in memory for the time being. A final use of the Select tool can save the output for use in the overlay analysis with the census areas.

After the generated travel sheds have been reviewed for accuracy and determined to be sufficient, these polygons can be overlaid with population or employment data to estimate who is being serviced by the current network. The steps below provide a general outline of how this was done.

1. Census and LODES data was joined with block group or blocks depending on the resolution available. Some data that is sensitive (e.g., income) is not available at the block level; however, general population estimates are.
2. Blocks determined to have zero population were erased from the block-group level data. This helped to further refine the distribution of populations at the block-group level by eliminating certain areas (e.g., transportation corridors, parks, industrial areas).
3. The block groups were then intersected with the travel sheds to obtain minority and low-income population estimates, and blocks intersected to provide number of jobs estimates.
4. The block-group totals were apportioned based on the area within the travel shed. For example, if the block group is 50% within a shed, only 50% of the population was counted.

Level of Effort

Table A-14 outlines high-level steps, basic assumptions, estimated hours (by mode, if applicable), and level of skill required. This analysis does require experience working with Network Analyst, complex network datasets, and census data. If the analyst does not have this experience, more time should be expected to complete a similar study. More time also should be added if studying many locations at a time for reviewing data and compiling results.

Table A-14. Level of effort for MORPC GIS analysis.

Step	Assumptions	Estimated Hours	Skill Required
Compile multiple network datasets into a single layer to depict the network available by mode	<ul style="list-style-type: none"> Data are readily available and do not require editing Network criteria are pre-established 	~5 hours per mode; more to establish and quality control criteria	Low (moderate if criteria are not pre-established)
Acquire and set up census and LEHD data	<ul style="list-style-type: none"> Data are not readily available and need to be obtained Analyst has general familiarity with census data fields, equity characteristics, and joining tabular data to spatial units 	~10 hours	Moderate
Build network datasets using Network Analyst and solving them to define routes and travel sheds	<ul style="list-style-type: none"> Access to Network Analyst extension Familiarity with network dataset characteristics and limitations Experience with ArcGIS ModelBuilder environment 	~10 hours per mode	Moderate to advanced
Check outputs, identify and resolve issues, and rerun analysis steps	Steps have been built in a model environment	~5 hours per mode	Moderate to advanced
Overlay analysis with residential and employment data, apportion and compile data to shed		~5 hours per mode	Moderate to advanced

Limitations

This study was based off of existing network data and did not set out to “fix” any network issues that may have produced erroneous results. This was intentional for a few reasons. The first goal was to assess how readily usable existing data can be to performing this type of analysis and the second goal was to highlight potential limitations of the data that may help guide how future inventories are compiled.

A-44 Equity Analysis in Regional Transportation Planning Processes

A few of the main limitations identified in this analysis are as follows:

- Data from different sources may not always align. For routing analyses to work correctly, data needs to be connected; otherwise, the break will be a barrier to further travel. Snapping datasets together may be one potential fix to this issue.
- Often network datasets do not accurately capture all available routes to all modes, with preference often given to roads for car use. Obvious paths for pedestrians and bicyclists may be missing, such as connections to apartment buildings, around campuses, or through parks. This can greatly reduce the walk and bike sheds compared to on-the-ground conditions. Sidewalk and bike level of comfort inventories should aim to contain all available routes, not just those along existing road networks.
- The 100 m distance from routes selected for this analysis may not accurately depict the distance that people are willing to travel to get on a network and may drastically undercut populations that are disconnected due to the previous limitation. For example, if a path traveling to a group of apartments is not in the network, this block group may be erroneously severed from the shed.
- Data at the block-group level could be further refined to provide a more accurate distribution of where individuals from minority and low-income populations reside. This could be done by using parcel level data rather than distributing individuals evenly across block groups.
- Road crossings are not accurately depicted. In Figure A-18, Cleveland Avenue is identified as having a poor level of comfort rating for bicyclists. The neighboring residential streets, however, are likely quite comfortable. Because of how the network data is set up, the line is not traveling through the intersection, and bicyclists will not be able to cross Cleveland Avenue in the routing analysis. One potential solution to this issue is to supplement the bike network with crosswalk data, which may help bridge some of these gaps. This does, however, require the crosswalks to be attributed separately from sidewalks so that they are easy to extract from a sidewalk inventory.

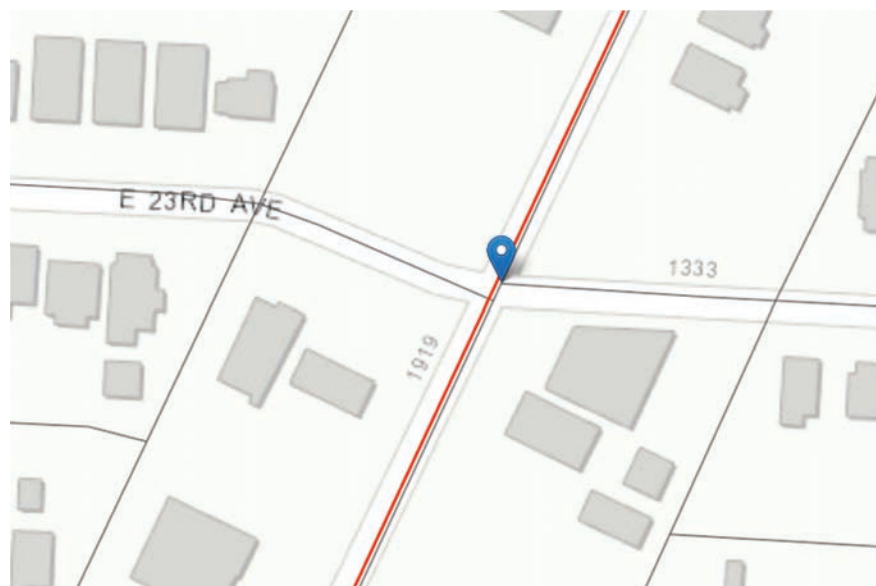


Figure A-18. *Inaccurate depiction of road crossing resulting in a poor level-of-comfort rating for bicyclists.*

Abbreviations and acronyms used without definitions in TRB publications:

A4A	Airlines for America
AAAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI-NA	Airports Council International-North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FAST	Fixing America's Surface Transportation Act (2015)
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TDC	Transit Development Corporation
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S. DOT	United States Department of Transportation

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