ACTIVATE

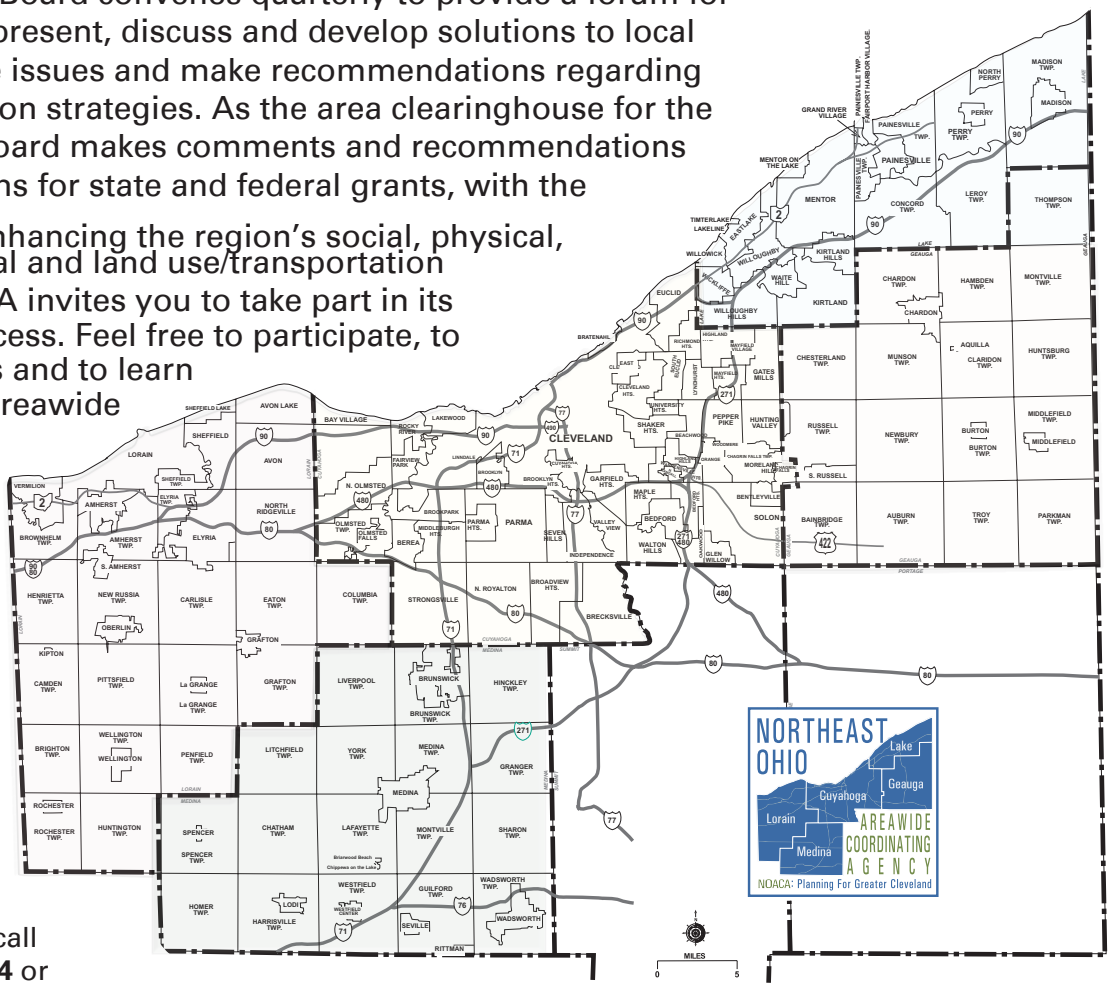
Technical Guidelines for Nonmotorized Transportation Planning

Northeast Ohio Areawide Coordinating Agency

The Northeast Ohio Areawide Coordinating Agency (NOACA) is a public organization serving the counties of and municipalities and townships within Cuyahoga, Geauga, Lake, Lorain and Medina (covering an area with 2.1 million people). NOACA is the agency designated or recognized to perform the following functions:

- Serve as the Metropolitan Planning Organization (MPO), with responsibility for comprehensive, cooperative and continuous planning for highways, public transit, and bikeways, as defined in the current transportation law.
- Perform continuous water quality, transportation-related air quality and other environmental planning functions.
- Administer the area clearinghouse function, which includes providing local government with the opportunity to review a wide variety of local or state applications for federal funds.
- Conduct transportation and environmental planning and related demographic, economic and land use research.
- Serve as an information center for transportation and environmental and related planning.
- As directed by the Board, provide transportation and environmental planning assistance to the 172 units of local, general purpose government.

NOACA's Board of Directors is composed of 48 local public officials. The Board convenes quarterly to provide a forum for members to present, discuss and develop solutions to local and areawide issues and make recommendations regarding implementation strategies. As the area clearinghouse for the region, the Board makes comments and recommendations on applications for state and federal grants, with the purpose of enhancing the region's social, physical, environmental and land use/transportation fabric. NOACA invites you to take part in its planning process. Feel free to participate, to ask questions and to learn more about areawide planning.



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12) Abstracts The fields of bicycle and pedestrian transportation planning are evolving rapidly in the United States, especially within the last decade. New designs and planning initiatives are emerging that increase the comfort and safety of those who bike and walk, often at minimal additional cost in transportation projects. Emerging projects of increasing popularity across the country include conventional and separated bike lanes, protected cycle tracks, road diets, neighborhood traffic calming, and crosswalk enhancements. One of the goals in the NOACA vision statement is building a sustainable multimodal transportation system and such a system should include nonmotorized modes of travel, typically walking and biking. To fulfill this vision, the NOACA ACTIVATE plan provides GUIDELINES for practitioners, planners (transportation/urban/community), and decision makers to EXPAND AND IMPROVE the existing bikeways and walkways in order to INCREASE the travel share of nonmotorized modes safely and USE the street network more equitably. The main goals of this plan are: Ensure fair use of streets; Develop a truly multimodal transportation system; Facilitate and encourage short trips by nonmotorized modes; Influence transportation and land-use policies; Improve the safety of biking and walking; Create complete transit connectivity; and Reduce transportation carbon footprints locally and regionally.	
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Technical Guidelines for Nonmotorized Transportation Planning

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EXECUTIVE SUMMARY

The following vision statement received approval from the NOACA Board of Directors at its January 2014 meeting:

> NOACA will STRENGTHEN regional cohesion, PRESERVE existing infrastructure, and BUILD a sustainable multimodal transportation system to SUPPORT economic development and ENHANCE quality of life in Northeast Ohio.

One of the goals in the NOACA vision statement is building a sustainable multimodal transportation system. Such a system should include nonmotorized modes of travel, typically walking and biking. To fulfill this goal, the NOACA ACTIVATE Plan provides ***GUIDELINES*** for practitioners, planners (transportation/urban/community), and decision makers to ***EXPAND AND IMPROVE*** the existing bikeways and walkways in order to ***INCREASE*** the travel share of nonmotorized modes safely and ***USE*** the street network more equitably.

This planning document discusses the proposed guidelines in eight chapters with following titles:

1. Purpose, Vision & Goals
2. Previous Plans, Definitions, Challenges & Opportunities
3. Public Engagement
4. Nonmotorized Infrastructure Data
5. Pedestrian & Cyclist Safety
6. Current Volumes & Future Demand
7. Planning & Prioritizing Nonmotorized Facility Investments
8. Estimated Benefits of Investments In Nonmotorized Facilities

The primary vision of the NOACA ACTIVATE Plan is to activate streets, communities, programs, and ultimately people to try biking and walking, and thus reap the physical, economic, and social benefits of active transportation.

The main goals of the NOACA ACTIVATE Plan are:

- **Fair Use of Streets:** Planning for fair use of the existing and future street networks
- **Multimodal:** Developing a true multimodal transportation system
- **Trip Length:** Facilitating and encouraging short trips by nonmotorized modes
- **Policy:** Influencing transportation and land-use policies on the community and regional levels
- **Safety:** Improving the safety of biking and walking
- **Connectivity:** Creating complete transit connectivity by developing the “first-mile” and “last-mile” connections to existing and future transit networks
- **Emissions:** Reducing transportation carbon footprints locally and regionally

Achieving these goals will result in equity in the NOACA transportation system.

1. PURPOSE, VISION & GOALS

1.1 Purpose

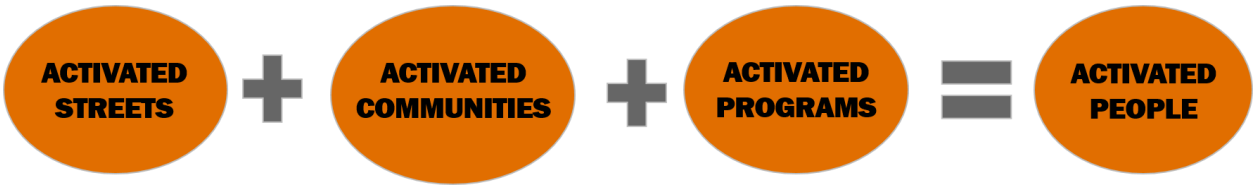
The purpose of the NOACA ACTIVATE Plan is to provide ***guidelines*** for

- Practitioners
- Planners (transportation/urban/community)
- Decision makers

to ***expand and improve*** the existing bikeways and walkways in order to ***increase*** the travel share of nonmotorized modes safely and ***use*** the street network more equitably.

1.2 Vision: ACTIVATE

Nonmotorized modes of travel (also known as active or human-powered transportation) are not used extensively as a means of transportation in the NOACA region today. The verb "ACTIVATE" means to make something active or to convert an immobile object or substance into an active form. The title of this plan refers to the vision of activating Northeast Ohio in several key ways:



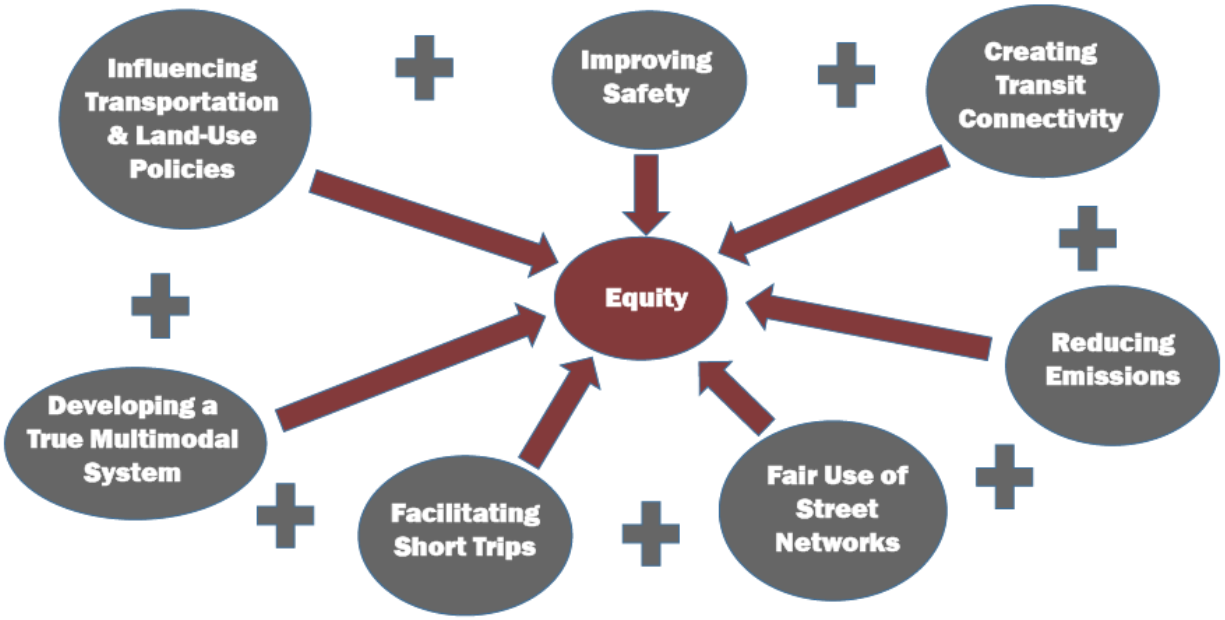
- ***ACTIVATE STREETS*** into networks for safely traveling by nonmotorized modes.
- ***ACTIVATE COMMUNITIES*** to encourage and support the use of nonmotorized modes of travel.
- ***ACTIVATE PROGRAMS*** to develop plans and policies for increasing travel share of nonmotorized modes based on best practices and new ideas from all over the world.

Doing the above will ultimately ***ACTIVATE PEOPLE*** to try biking and walking and reap the physical, economic, and social benefits of active transportation.

With the right resources, committed leaders, and a supportive public, communities can plan for both short- and long-term expansion and improvement measures of nonmotorized facilities to fulfill this vision. Particularly, this vision will be achieved by developing connected walking and biking networks in the NOACA region.

1.3 Goals

The main goals of the NOACA ACTIVATE Plan are:



- **Fair Use of Streets:** Planning for fair use of the existing and future street networks
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Achieving these goals will result in equity in the NOACA transportation system.

The NOACA ACTIVATE Plan is in consonance with *eNEO2050: An Equitable Future for Northeast Ohio (eNEO2050)*, which recently recommended substantially increasing investment in facilities for nonmotorized modes of travel. This investment will help to expand transportation options, benefit all communities, and encourage more equitable use of the roadway network in the NOACA region. With continued investment over time, a better connected multimodal infrastructure will be developed, providing greater mobility to all people, not just those with access to an automobile.

2. PREVIOUS PLANS, DEFINITIONS, CHALLENGES & OPPORTUNITIES

The fields of bicycle and pedestrian transportation planning are evolving rapidly in the United States, especially within the last decade. New designs and planning initiatives are emerging that increase the comfort and safety of those who bike and walk, often at minimal additional cost in transportation projects. Emerging projects of increasing popularity across the country include conventional and separated bike lanes, protected cycle tracks, road diets, neighborhood traffic calming, and crosswalk enhancements.

2.1 Previous Plans

NOACA's most recent regional bicycle plan was updated in 2013. The 2013 Regional Bicycle Plan primarily focused on identifying priority corridors for new bicycle facilities to be constructed. Since the plan's release, this Regional Priority Bicycle Network (RPBN) has been used in various NOACA planning efforts. Other recommendations of the 2013 plan included collaboration with external partners to improve the education of motorists and bicyclists and enforcement of laws that protect cyclists. The following list includes some of the 2013 plan recommendations that have been implemented by either NOACA or external partners:

- Run "Share the Road" Campaign
- Host Bicycle Maintenance Classes
- Participate in Bike to Work Day and Car-Free Friday Events
- Assist Bike to School Day and Bike Rodeos
- Produce and Distribute Bike Maps
- Organize Bicycle Law Enforcement Task Force Groups

Other Relevant Plans

The framework of the NOACA ACTIVATE Plan includes intentional support for the findings of a number of statewide and regional planning efforts, such as the following.

- *Walk.Bike.Ohio Policy Plan*

The Ohio Department of Transportation's (ODOT's) statewide active transportation plan was completed in 2021. Some of the public and stakeholder processes overlapped with the NOACA ACTIVATE Plan, and NOACA participated as a key stakeholder and regional convener for the *Walk.Bike.Ohio* plan. *Walk.Bike.Ohio* relied heavily on NOACA's Level of Traffic Stress methodology to develop its statewide approach.

- *NOACA's Long-Range Transportation Plans*

eNEO2050 is NOACA's newest long-range plan. It focuses on building an equitable future for all residents of Northeast Ohio. This long-range plan discusses enabling nonmotorized modes of travel by requiring capital investments in streets that serve all users, as appropriate. The plan also covers the need for first-and-last mile transit planning and Transit Oriented Development (TOD) planning.

- *NOACA SAVE Plan*

The SAVE plan was developed in response to the continued increase in crashes involving bicyclists and pedestrians within the NOACA region over the past decade. The plan highlights the need to support the widespread implementation of safety measures, including infrastructure changes and educational programs.

- *NOACA MOBILIZE Plan*

The MOBILIZE plan highlights the unique transportation needs of seniors and those with intellectual or physical disabilities. While MOBILIZE serves as NOACA's Coordinated Plan (a prerequisite for distributing federal funding for specialized transportation vehicles), the plan also identifies the barriers that seniors and many people with disabilities experience in the built environment.

- *Air Quality*

NOACA's air quality planning efforts seek to reduce air pollution for the region and raise awareness of the impact of air pollution. A key strategy to improve our region's air quality is to encourage the public to carpool, take transit, bike, or walk instead of driving alone.

- *Transportation for Livable Communities Initiative (TLCI) Program*

The TLCI is a NOACA program that funds the planning and implementation of transportation projects that improve livability, primarily through improvements to biking and walking infrastructure. Since this planning program began in Fiscal Year 2006, more than 100 TLCI studies have been completed. Each plan studies the community's need and desire for changes at the local level and recommends a series of improvements. These improvements result in a set of recommendations that reflect the local conditions and needs while also benefiting the region overall.

2.2 Definitions

The usage of nonmotorized modes may be categorized as:

A. Utilitarian Trips

Use of nonmotorized modes for utilitarian (non-recreational) trips depends on a wide range of factors:

- Individual and household socioeconomic characteristics
- Trip purpose and distance
- Presence and continuity of sidewalk, bike lanes, and trails
- Proximity of home and work locations
- Climate conditions

Socioeconomic Factors: Access to and/or owning an automobile generally reduces the incentive to walk or bike. Household income, race, age, and gender are other socioeconomic characteristics that affect the use of nonmotorized modes of travel.

Purpose and Distance: Trip distance and purpose are well-documented determinants of nonmotorized use for utilitarian travel. As the distance from a person's home to a work or non-work destination increases, the likelihood of walking or biking decreases. Most people are willing to walk for five to 10 minutes or approximately a quarter to a half-mile. Therefore, a reasonable distance to walk for utilitarian trips is about a half-mile with a maximum of three-quarters of a mile. These distances are based on a walking speed of three miles per hour. Similarly, the average distance for utilitarian biking trips is about three miles.

Facilities: The presence and continuity of nonmotorized facilities, such as sidewalks, bike lanes, and shared-use paths, may have the most influence on whether work and non-work commuters choose to bike or walk to their destination.

Locations: Travel time is a critical factor in choosing a mode of travel, and in the case of biking and walking, it mainly depends on distance. Analyzing the commute times in the NOACA region highlights a widespread spatial mismatch between the home and work locations of many workers. This pattern is detrimental to the likelihood of workers commuting by nonmotorized modes of travel.

Weather-Travel Relationship: Inclement weather has impacts on most modes of travel, and obviously, walking and cycling are the most vulnerable modes. The weather has more effect on discretionary trips such as shopping, social, etc., than mandatory trips such as daily work commutes. The frequency of walking and cycling trips is negatively affected by precipitation and wind speed, while a higher frequency is observed in a mild air temperature.

B. Access to Transit Services

Considering the acceptable walking and biking distances for land-use and transportation planning purposes, access to transit by nonmotorized modes is an important aspect of a cohesive multimodal transportation system.

Buses and trains cannot pick all riders up right at their front doors. Therefore, most transit riders must travel safely and conveniently some distance before boarding a bus or train. These connections to the regional transit network are often referred to "first mile" and "last mile" trips, and create a complete connection from commuters' origins to their destinations.

The potential connectivity of residents and commuters to the regional transit network via walking and biking can be gauged by the presence and prevalence of quantifiable characteristics. For example, intersection density is an established indicator of walkability and connectivity. Grid pattern development with many intersecting streets, narrow lanes, and interconnected roads

usually offers multiple direct routes between origins and destinations, while cul-de-sac developments or areas with fewer roadways and intersections can hinder direct shortest connections.

One important factor in increasing transit ridership is connectivity. A transit ride starts from a rider's home (origin) and requires a motorized or nonmotorized mode to reach the initial transit stop. These connections to the transit network are often referred to as "first mile" connections. Similarly, the final leg of the transit journey, or the "last mile," is from a transit stop where riders leave the public transportation system and uses an available mode of travel to end their trip at the destination. The "first mile" and "last mile" connections to the main transit corridors are the missing links in providing complete transit connectivity from riders' actual origins to their destinations. In this regard, nonmotorized modes are commonly used for the short trips as the "first mile" and "last mile" connections to create complete connectivity in a cohesive, multimodal transportation system.

The NOACA ACTIVATE Plan includes a prioritization model based on a Connectivity Quantitative Scoring (CQS) index of bus stops and train stations. Chapter 7 of this report includes more details about the walking and biking CQS.

C. Recreational Pursuits

Walking and biking modes are used for pure recreation as well as for utilitarian trips. People choose to walk and bike recreationally for many reasons, including physical activity, to reduce stress and improve mood, and the possibility of social interaction with friends and neighbors. Investments in expanding the existing network of trails, sidewalks, and bike lanes will help encourage the physical activity of residents and the building of healthier communities.

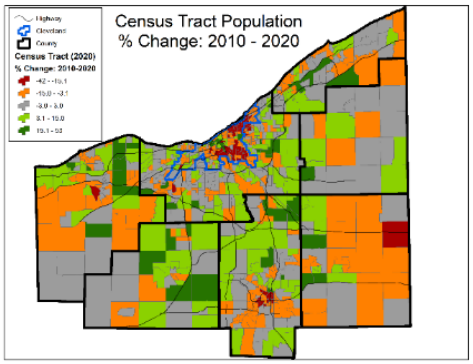
2.3 Challenges

The low rates of pedestrian and cyclist activity in the NOACA region can be attributed to many factors, including:

- The concomitant increasing usage of motorized vehicles for transportation

- The relatively low cost of operating motorized automobiles

- The auto-oriented transportation infrastructure



- The sprawling land-use patterns

- The adverse climatic conditions in Northeast Ohio

2.4 Opportunities

The increase in nonmotorized mode share will provide a variety of opportunities for the residents of the NOACA region, such as:

- Improving the overall health of residents
- Providing more opportunity for community building through social interaction in neighborhoods
- Using the street network equitably for all residents regardless of their car ownership status
- Allowing residents to more easily and conveniently support local businesses
- Increasing transit share
- Reducing the transportation carbon footprint in the NOACA region
- Mitigating the negative impacts of traffic congestion, among others

3. PUBLIC ENGAGEMENT

Public engagement in planning for nonmotorized modes of travel is important for several unique reasons as compared to traditional transportation plans.

- People who bike or walk for transportation are more vulnerable to serious injury or death as a result of even a minor crash than those who use other modes of travel, and improving safety outcomes requires a deep understanding of user needs.[1]
- In communities where designing solely around vehicle accessibility and mobility has been the status quo for decades, it can take significant public support to increase awareness and include biking and walking accessibility as goals of roadway projects.[2]
- There is limited data available for trips taken via alternative modes.[3] For example, crashes involving pedestrians or cyclists tend to be underreported by as much as 55% compared to vehicle crashes.[4] Instead, much of the information about safety risks, needs, popular destinations, and the behavioral and physical factors involved in biking and walking come from national or international research and need to be vetted for their relevance to Northeast Ohio.

3.1 Public Engagement Surveys

To develop the ACTIVATE Plan, NOACA proactively collaborated with stakeholders and our member communities to identify primary bicycle and pedestrian planning concerns. NOACA engaged stakeholders and the general public with transparent, well-advertised opportunities to exchange ideas and meaningfully contribute to the process. In addition to conducting activities dedicated to the ACTIVATE Plan, NOACA also "listened to the listeners" by gathering feedback collected by other agencies such as:

- Ohio Department of Transportation (ODOT)
- Bike and Pedestrian advocacy groups
- NOACA Bicycle and Pedestrian Advisory Council (BPAC)
- Local communities that have participated in community projects of NOACA's TLCI program

[1] Northeast Ohio Areawide Coordinating Agency (NOACA), "SAVE: NOACA's Plan for Transportation Safety," (Cleveland: NOACA, May 2019); https://www.noaca.org/home/showpublisheddocument/23712/636928352508970000.

[2] Federal Highway Administration, "A Resident's Guide for Creating Safer Communities for Walking and Biking," (Washington DC: FHWA, January 2015); https://safety.fhwa.dot.gov/ped_bike/ped_cmnity/ped_walkguide/residents_guide2014_final.pdf.

[3] Washington State Department of Transportation, "Collecting Network-Wide Bicycle and Pedestrian Data: A Guidebook for When and Where to Count," September 2017, https://www.wsdot.wa.gov/research/reports/fullreports/875-1.pdf.

[4] Federal Highway Administration, "Facts & Figures: Safety," Pedestrian & Bicycle Information Center, 2021, https://www.pedbikeinfo.org/factsfigures/facts_safety.cfm.

NOACA gathered feedback for the ACTIVATE Plan in a number of ways listed below. The rest of this section describes the type, purpose, respondent organizations, and date of the conducted surveys.

Survey Types

- **Public:** The public survey was open from October 2019 to April 2020. More than 1,900 people responded to the survey. Its purpose was to understand how perceptions of walking and biking in Northeast Ohio may differ based on the modes of transportation an individual uses. While many of the questions were geared toward those who walk and bike for transportation, the survey was advertised intentionally to gather a wide range of responses.
- **Local Government:** The local government survey was open in spring 2020. This survey focused on identifying the needs of communities, park districts, and counties as they provide infrastructure for those who walk, bike, and take transit. Forty-six organizations responded.
- **Focus Groups:** In summer 2020, NOACA held three stakeholder focus groups to gather insight into specific challenges and input for analysis components of the ACTIVATE Plan. The topics included low-stress bike networks and bike boulevards, road diets, and the walking infrastructure inventory. About 15 to 20 people attended each focus group, consisting primarily of planning and engineering staff throughout the region.

Table 3.1 displays the list of the NOACA's public engagement surveys for gleaning the data.

Table 3.1: NOACA's Public Engagement Surveys

Date	Group	Survey Description
Feb. 2019	Stakeholder Focus Group	Visioning Activity
Feb. 2019	NOACA Bicycle, Pedestrian Advisory Council (BPAC)	Regional Bike and Pedestrian Plans
May 2019	BPAC	NOACA ACTIVATE Plan Introduction
July 2019	Stakeholder Focus Group	Bike Walk Ohio statewide plan
Nov. 2019	BPAC	ACTIVATE Plan survey
Nov. 2019	Public Survey	Survey open to the public
April 2020	Public Survey	Survey closed to the public
April 2020	Local Government Survey	Survey open to select groups
May 2020	BPAC	ACTIVATE Plan update
June 2020	Local Government Survey	Survey closed to select groups
Aug. 2020	BPAC	ACTIVATE Plan update
Aug. 2020	Stakeholder Focus Group	Discussion - low-stress bike networks
Aug. 2020	Stakeholder Focus Group	Discussion - bike boulevards
Sep. 2020	Stakeholder Focus Group	Discussion - road diets
Nov. 2020	BPAC	ACTIVATE Plan update
Feb. 2021	BPAC	ACTIVATE Plan update

3.2 Results of the Implemented Surveys

Public Survey Results

The survey asked a number of questions about the needs, experiences, and preferences related to biking and walking. Some key findings of the survey are included below.

- Although most people who believe that driving a motor vehicle is a reliable form of transportation, they use more than one mode of travel. In fact, the average respondent indicated that they rely on at least three modes of transportation. This finding supports a growing understanding among transportation planners and engineers that most people are "multimodal" transportation users, relying on more than one type of mode throughout their daily routine trips.

- The feasibility of biking and walking depends largely on the type of trip. More than 65% of respondents indicated that it is feasible for them to walk or bike to accomplish errands, whereas commuting to work by nonmotorized modes of travel was seen as significantly less feasible (43% by bike and 23% walking). About 60% of respondents stated that they may consider biking and walking for attending an event.

- The finding in the previous bullet point demonstrates local support for a concept emerging in national public health and transportation discourse that prioritizes short, safe routes that connect people with everyday destinations over other types of investment in biking and walking infrastructure.[5]

- The survey asked respondents how they would feel about some of their car trips taking up to five minutes longer in exchange for greater safety. More than 50% of respondents were strongly supportive, and an additional 20% were somewhat supportive. Those that use nonmotorized modes of travel were even more supportive of longer car trips in exchange for greater safety. This is not to say that those who do not bike, walk, or take transit were entirely unsupportive. More than 50% of active transportation users were "strongly supportive" of the policies compared to 30% of those who do not use nonmotorized modes.

- The survey asked respondents to rank their preference for their community's approach to construction of a connected network of bike infrastructure. Nearly 60% of respondents preferred the strongest approach: "A new ballot initiative to build a trail network in 3-5 years." The "Do Nothing" option ("I would prefer my community not attempt to build a trail network") was ranked last by more than 80%. Two moderate approaches received similar levels of support as the second and third ranked preferences. About 68% of respondents were not aware of local plans or initiatives to improve biking and walking.

[5] Centers for Disease Control and Prevention, Activity-Friendly Routes to Everyday Destinations," https://www.cdc.gov/physicalactivity/activepeoplehealthynation/strategies-to-increase-physical-activity/activity-friendly-routes-to-everyday-destinations.html

Community Survey Results

The community survey was open to cities, villages, townships, park districts, and county governments. Responses were received from May to August 2020. The purpose of the survey was to learn how local governments and other regional agencies approach planning, engineering, enforcement, and maintenance related to walking and biking facilities. Forty-six organizations responded across the NOACA region.

The overall survey results show that most communities need additional resources, education, and support to meet the needs of biking and walking. The survey results found that many communities in the NOACA region lack access to planners, are not familiar with planning resources, and implement few bike or pedestrian projects that require site-specific transportation planning to construct. Projects required by traditional guidance, such as curb ramps, are installed routinely in roadway work, especially when communities have staff engineers assisting with projects. Planning expertise varies by community, but less than half have in-house planning staff, and very few have implemented plans or policies that support biking and walking (such as Complete Streets Policies, traffic calming programs, or land-use policies that build or retrofit walkable environments). The barriers to installing additional projects varied for project type, but in general included lack of budget, staff capacity, design expertise, and public or political support. Maintenance is also an ongoing concern in the NOACA region, and while communities have different needs and approaches to maintenance, many indicated that concerns around maintenance prevent them from installing additional bike or pedestrian projects.

In summary, the most reported community needs are:

- Bike Lanes: 69%
- Bike Path: 59%
- Bike Racks: 40%
- Sidewalks: 38%

The public, communities, and stakeholders' feedback provided significant inputs in the development of the guidelines and recommendations of the NOACA ACTIVATE Plan. The survey results were coalesced into the themes shown in Figure 3.1 and described in the following paragraphs. The appendix also includes a summary of community survey results.

Figure 3.1: Themes Resulting from Public Engagement Surveys

***Provide Options to All*:** Safe options for biking and walking are needed in urban, suburban, and rural communities. A one-size-fits-all approach will not adequately meet the needs of all of NOACA's communities, but demand for biking and walking is high throughout Northeast Ohio. As population density in Northeast Ohio continues to decrease, people are increasingly living in suburban, exurban, and rural communities without integrated high-frequency transit service, or biking or walking connections.[6] Urban areas face their own unique challenges, as decision makers must allocate limited funding to help strengthen core services, maintain existing infrastructure, and improve quality of life.

***Focus on Needs*:** Focusing on improving conditions for people who currently bike or walk will help correct regional inequalities. Biking, walking, and transit help to fill the mobility gap for those who can't afford to own a car or are unable or choose not to drive.[7] Listening to the experiences and needs of those who currently rely on nonmotorized modes of travel is a first step to improving regional inequities. People who bike or walk today notice things about the built environment that others do not; in fact, the survey responses from people who currently bike or walk expressed that their communities are in much more need of supportive infrastructure, compared to responses from people who do not bike or walk. Yet, decades of car-centric development throughout the region has led to a lack of safe pedestrian and biking options, even in communities where many people do not have a car.

[6] NOACA, "eNEO2050 Long-Range Transportation Plan Resource Document, Chapter 3," *eNEO2050: An Equitable Future for Northeast Ohio* (Cleveland: NOACA, June, 2021); https://www.eneo2050.com/final-plan.
[7] National Complete Streets Coalition, Smart Growth America, "Dangerous by Design," 2021, https://smartgrowthamerica.org/wp-content/uploads/2021/03/Dangerous-By-Design-2021-update.pdf.

***Influence Policy*:** Integrate the plan's recommendations into existing policies and programs to ensure widespread adoption. For example, low-cost safety improvements can and should be systematically implemented through existing NOACA programs. A detailed policy focus throughout the planning process will identify the strategic opportunities to guarantee that the NOACA ACTIVATE Plan will have a positive impact on the region. For example, ACTIVATE Plan data led to the inclusion of pedestrian and bicycle projects into the *eNEO2050* planning process and ultimately into the upcoming Transportation Improvement Plan (TIP) projects for years 2021-2024. In the future, the NOACA ACTIVATE Plan will be used as a baseline for biking and walking performance measures, and to help in the implementation of NOACA's Complete & Green Streets Policy.

***Support the Vision*:** Build on and enhance the existing regional vision for connected trails. NOACA's Regional Bike Plans have typically focused on creating an ideal vision for connected trail infrastructure that extends across the five-county region. In recent years, a number of county-level and/or regional TLCI studies have begun that have or will satisfy this need. Rather than recreate the wheel, the ACTIVATE Plan supports these regional visions established through the TLCI program and in partnership with Cuyahoga County Greenways and its partners. By highlighting the priorities identified in these regional efforts, the ACTIVATE Plan can focus on new data analysis for pedestrian needs while standing in unity with NOACA's previous plans and partner organizations.

***Encourage Short Trips*:** Making it easy for people to walk and bike to local, nearby destinations can reduce vehicle trips and improve quality of life region-wide.[8] Due to patterns of low-density development and suburban and exurban sprawl, it is not realistic for many people to bike long distances for daily commutes in Northeast Ohio, given that the average commute time to job hubs was 26.2 minutes in 2020.[9] Increasing commutes with safe, connected bike infrastructure is certainly realistic for urban centers and core cities in the region and is supported by the ACTIVATE Plan,[10] but enabling people across the region to make short trips by biking or walking, to neighborhood destinations and errands is an underutilized key to improving quality of life.[11]

[8] US EPA, "What If We Kept Our Cars Parked for Trips Less than One Mile?," June 2015, https://nepis.epa.gov/Exe/ZyPdf.cgi?Dockey=P100MLPQ.pdf.

[9] NOACA, "ENEO2050 Vision Plan," 2021, pg 32, https://ac6b8ef9-159f-4289-bba8-57334a8552e3.filesusr.com/ugd/9911f1_c1710dfb11434e5ba6dd8fd363cee1f6.pdf.

[10] Jennifer Dill and Theresa Carr, "Bicycle Commuting and Facilities in Major U.S. Cities: If You Build Them, Commuters Will Use Them - Another Look," in *Annual Meeting* (Transportation Research Board, 2003), 1; https://journals.sagepub.com/doi/10.3141/1828-14.

[11] AASHTO Committee on Environment and Sustainability, "Connecting Transportation & Health: A Guide to Communication & Collaboration," *Transportation Research Board* (National Cooperative Highway Research Program Project 25-25, Task 105, April 2019); https://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP25-25Task105/NCHRP25-25Task105Guidebook.pdf.

***Care about the Details*:** Just as NOACA supports a five-county regional vision, it must plan for improvements at the scale of someone walking or biking. National research indicates that communities with more vulnerable people and with more people who rely on biking and walking for mobility often have less access to amenities such as marked crosswalks and bike share stations.[12] National studies indicate, however, that the trends may vary significantly from city to city, and national trends may not hold true in Northeast Ohio.[13] To plan for equitable pedestrian and bicycle access in Northeast Ohio, the ACTIVATE Plan gathers significant new data to draw conclusions with precision in the distribution of safety and multimodal infrastructure within the region.

***Inspire Communities*:** Communities in Northeast Ohio will require the knowledge and support needed to build world-class biking and walking infrastructure. NOACA's influence to encourage and support local communities is paramount to the betterment of a regional transportation system that serves all modes. With straightforward engineering guidance, practical support, and planning assistance, NOACA can produce tools and guidance to help communities plan for the future.

***Connect the Dots*:** Rather than beginning and ending each trip using the same mode of transportation, what if it was easier to walk or bike to a bus stop, and possibly even take an electric scooter to your final destination? The concept of multimodal transportation relies on smooth and convenient connections between modes. If these connections are planned for and improved, many more people may be able to complete longer trips using modes other than driving alone. While smooth connections will ultimately need more than just roadway infrastructure, the first step is to understand the current state of these connections in Northeast Ohio.

[12] Federal Highway Administration, "Pursuing Equity in Pedestrian and Bicycle Planning," *PedBikeInfo*, March 2016, https://www.pedbikeinfo.org/cms/downloads/PBIC_WhitePaper_Equity.pdf.

[13] C. M. Thornton, T.L. Conway, K.L. Cain, K.A. Gavand, B.E. Saelens, L.D. Frank, C.M. Geremia, K. Glanz, A.C. King, and J.F. Sallis. Disparities in Pedestrian Streetscape Environments by Income and Race/Ethnicity. *SSM - population health*, (2016), 2, 206–216; https://doi.org/10.1016/j.ssmph.2016.03.004

4. NONMOTORIZED INFRASTRUCTURE DATA

Walking and bicycling are important components of a multimodal transportation system in urban, suburban, and rural settings. Planning for walking and cycling is a travel demand strategy that can alleviate vehicle traffic congestion and reduce emissions. Improving or increasing the pedestrian and bicycle infrastructure is necessary in the NOACA region, but especially critical for the population that does not have access to a personal vehicle.

Infrastructure data is essential for evaluating, planning, and managing transportation performance and future investments in various parts of a transportation system. Specifically, infrastructure inventory for nonmotorized modes could include sidewalks, midblock crossings, intersection crossings, bike lanes, shared-use paths, and trails.

Although NOACA has collected infrastructure data for different purposes, comprehensive data across the entire transportation system has been collected less frequently. This chapter offers a set of guidelines for collecting limited but purposeful infrastructure data.

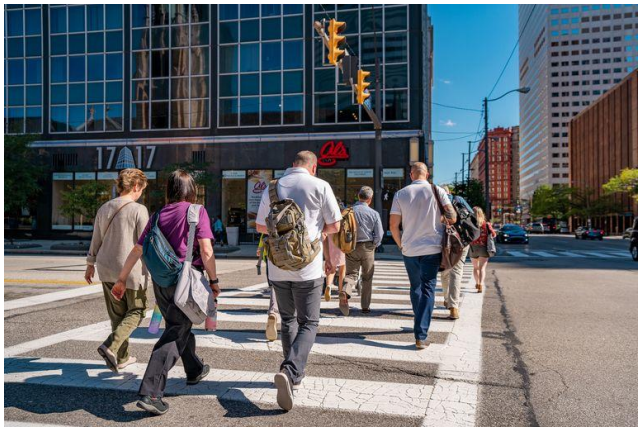
4.1 Pedestrian Crossing

Pedestrians typically take the most direct line possible to minimize the distance and time they must walk to reach their destinations. Therefore, the Federal Highway Administration (FHWA) recommends that roadway crossing facilities be located at the most direct crossing locations, which can subsequently make the safest location for crossing attractive to pedestrians. Poorly designed environments often result in pedestrians using informal paths through properties and crossing roadways at locations without pedestrian safety enhancements.

Infrastructure built specifically for pedestrians is essential to ensure that residents and visitors within the NOACA region can safely and comfortably walk to jobs, shops and restaurants, parks, schools, and countless other important destinations. Consideration of the points where pedestrians interact or conflict with other modes of travel is critical for a truly multimodal transportation system. People should be able to choose to walk when their destination is within walking distance. Often, the pedestrian experience is not prioritized when designing or implementing pedestrian crossing at intersections and midblock crossings; however, these crossings will directly affect the safety and comfort of pedestrians when interacting with other modes. Some improvements, such as curb extensions, refuge islands, traffic calming measures, etc., will encourage drivers to naturally slow down and be more aware of pedestrians.

Signalized Intersection Crossing

Roadway intersections give rise to numerous conflicts, not only among vehicles but also between vehicles and pedestrians. Signalized intersections are important locations for pedestrians because they offer a way to stop traffic and cross busy roadways safely. Yet the pedestrian infrastructure available at signalized intersections is not always as safe or comfortable as it could and should be, and roadway projects have historically not prioritized the pedestrian experience at intersections.



Midblock Crossing

Midblock crossings offer a means for pedestrians to cross the street at locations other than a signalized intersection. Pedestrians will follow the basic human tendency to take the shortest route possible to reach a destination, and are not likely to take a longer route just to reach a signalized intersection to cross. This is especially true in areas with certain land-use patterns, such as along lengthy blocks in suburban commercial districts or in downtowns and village main streets, where destinations are clustered on both sides of a roadway.

Notes from the Past

In the early 20th century, as cars and pedestrians began to compete for space in American cities, engineers reacted by separating pedestrians and vehicles as much as possible. One key strategy was controlling pedestrian crossings by directing pedestrians to cross only at established intersections. While this effort was largely aimed at ensuring safety and preventing crashes, there were also clear social undertones of racism and discrimination against those who did not own or use cars. Car companies and public health efforts joined together to discourage “jaywalking,” or crossing where there is no crosswalk. The result of this history is a tendency in roadway design that persists today and is overly reliant on controlling the locations where pedestrians can cross

the street. Over time, as communities sought to incorporate nonmotorized modes of travel into the transportation network in a meaningful way, midblock crossings have reemerged as a means of safely allowing pedestrians to cross the street at locations other than a signalized intersection. At signalized intersections, the bare minimum for pedestrians is no longer satisfactory, and many design features are being recognized as vital for a truly multimodal transportation system.

4.2 Bicycle Facilities

Facilities for bicycling can be defined as separated and shared types.

Separated

- **All-Purpose Trails:** Open to bicyclists and are fully separated from the roadways.

- **Protected Bike Lanes:** On-street bike lanes that have vertical separation from traffic in the form of posts or other barriers.

- **Buffered Bike Lanes:** On-street conventional bike lanes paired with a painted buffer space separating the bicycle lane from the adjacent motor vehicle travel lane and/or parking.

Shared

- **Conventional Bike Lanes:** On-street bike lanes for exclusive use by cyclists, that are marked with only a single painted line and accompanying signage.

- **Shared Lane Marking (Sharrow):** A roadway marking indicating a shared lane space for cyclists and drivers as well as the suggested cyclist positioning within the lane.

- **Bike Boulevard:** A combination of traffic calming measures and bike route design to prioritize bicycle travel on low-stress roads.

Lastly, **Bike Routes** are a series of connected bike facilities, often containing elements of both separated and shared bike facilities that promote bike mode share by use of route signs, wayfinding, and/or pavement markings.

4.3 Guidelines for Collecting Walking Infrastructure Data

In the absence of comprehensive walking infrastructure data and due to the vast number of intersections, mid-block pedestrian crossings, and sidewalks, project-based data collection is recommended. As an example, the following paragraph proposes guidelines for collecting sidewalk inventory data around any school as an input to the NOACA Safe Routes to School (SRTS) program.

The following four categories are recommended for sidewalk grouping:

“Complete” – sidewalks are present on both sides of the road segment for the entire length of the segment
“Partial” – sidewalks are present on only a portion of the road segment or present on only one side of the segment

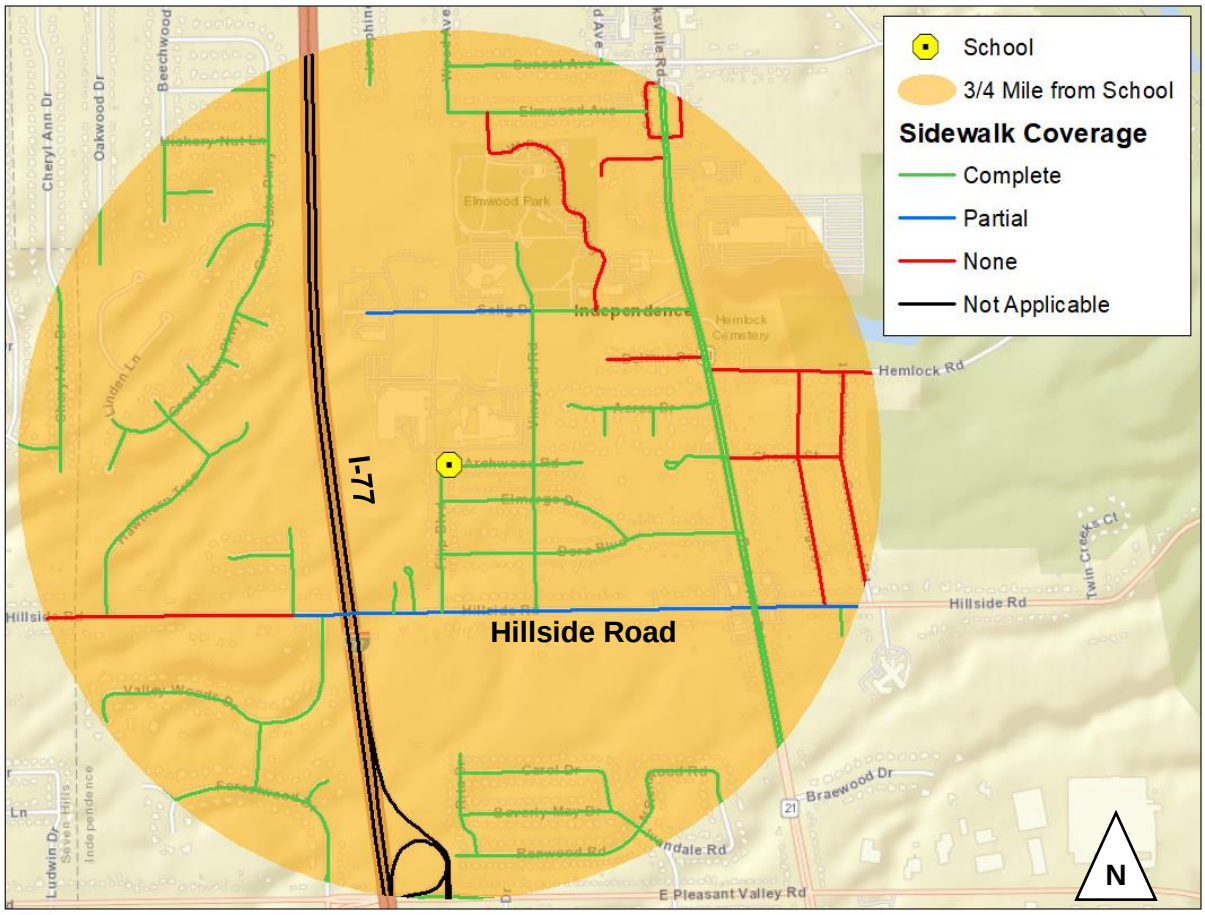
“None” – sidewalks are not present along the entire length of the road segment

“Not Applicable” – roadways where sidewalks would not be expected, such as interstates, expressways, and highway ramps.

It is recommended that a catchment area with a radius of about three-quarters of a mile (maximum acceptable walking distance) around any public or private school be considered. All functional classes of roads, from major arterials to local roads, should be included in the data collection process. Google Maps aerial imagery and Google STREETVIEW photography may be used to identify the presence of sidewalks on various roadways.

The data is collected and stored using a roadway GIS data layer (Census TIGER road network file) for future analysis and mapping. Figure 4.1 displays a typical sidewalk coverage around a school.

Figure 4.1: Sidewalk Coverage Around a School Schematic



As a technical note, be advised that producing a linear buffer to determine the walkable area around a point of interest, as in Figure 4.1 above, may indicate that some locations are within a three-quarter-mile walking distance when they are not in actuality. In the above example, this is apparent in the area north of Hillside Road and west of I-77. While there are roadways with complete sidewalk coverage in that area, they are not continuously connected to the school by other roads with sidewalks. This problem can be remedied by careful manual inspection of the results or by using a Service Area function rather than creating a Buffer in GIS. A Service Area will calculate the area within a specified distance of a point of interest only along connected roadway segments. In this case, developing the Service Area around continuous roadway segments with sidewalks within a three-quarter-mile distance of the school would produce the most accurate depiction of school area walkability.

4.4 Guidelines for Collecting Cycling Infrastructure Data

Bicycle facilities, especially separated and marked types, are less extensive than walking and unmarked bicycling infrastructure. Therefore, it is possible to maintain a more comprehensive inventory of data for the separated and marked bike lane types. NOACA, in coordination with partner agencies, currently maintains an inventory of 687 miles of existing bicycle facilities in all five counties.

Table 4.1 summarizes the existing bike lane lengths by type and county.

Table 4.1: The Bike Lane Facility Lengths by Type and County (2020)

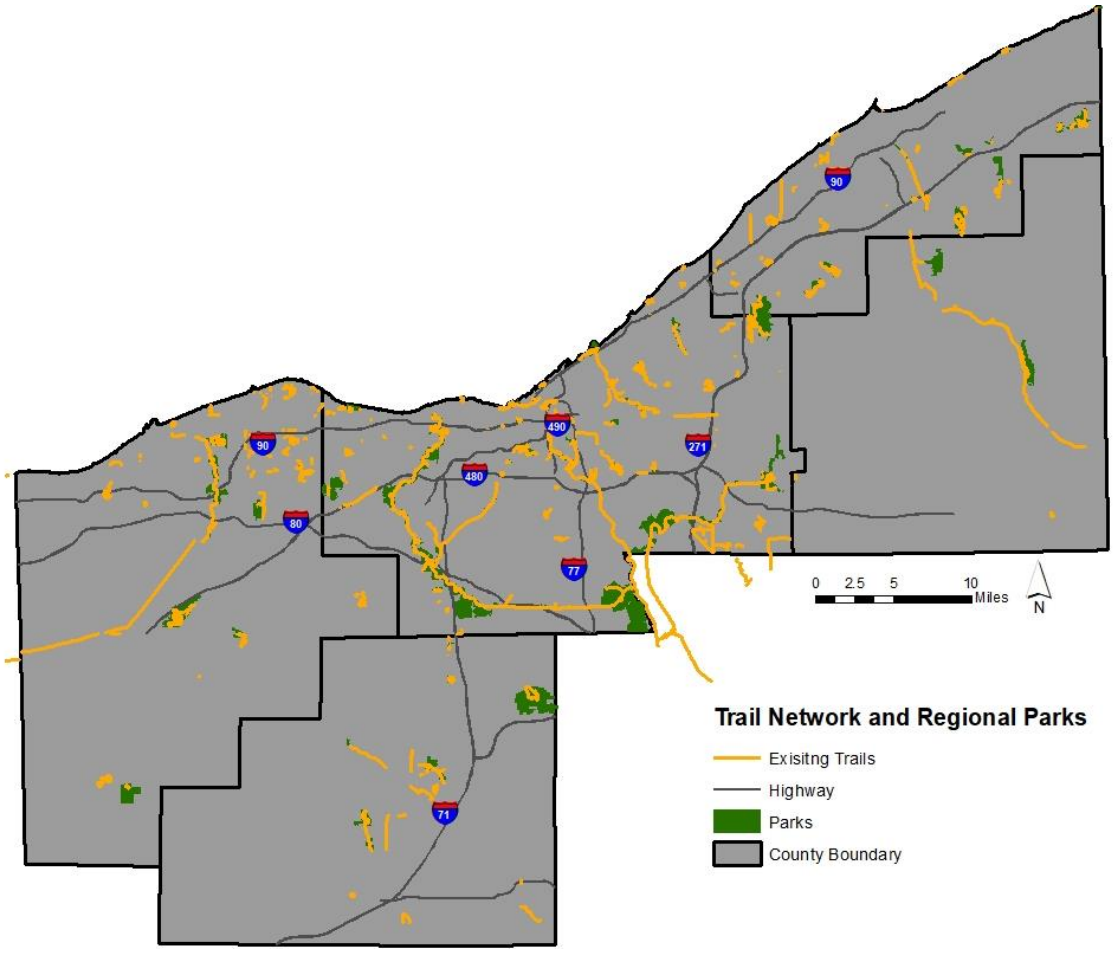
County	Bike Facility Type Length (Miles)					
	All Purpose Trail	Separated Bike Lane	Buffered Bike lane	Conventional Bike lane	Sharrow	Total
Cuyahoga	202	1	5	71	108	**387**
Geauga	25					**25**
Lake	62			19	4	**85**
Lorain	87			24	49	**160**
Medina	30					**30**
Total	**406**	**1**	**5**	**114**	**161**	**687**

It should be noted that trails generally are off-road facilities that also support walking and cycling and sometimes function as a side path next to a roadway.

Bike Facility and Park Access

Northeast Ohio is home to many recreational biking trails within park facilities, such as the Big Creek Parkway, the Towpath Trail, and the Black River Trail in Elyria. Recreational trails can become transportation assets when they are maintained throughout the year, have adequate lighting, and connect to other bike infrastructure. Map 4.1 shows the existing trail network and regional parks facilities.

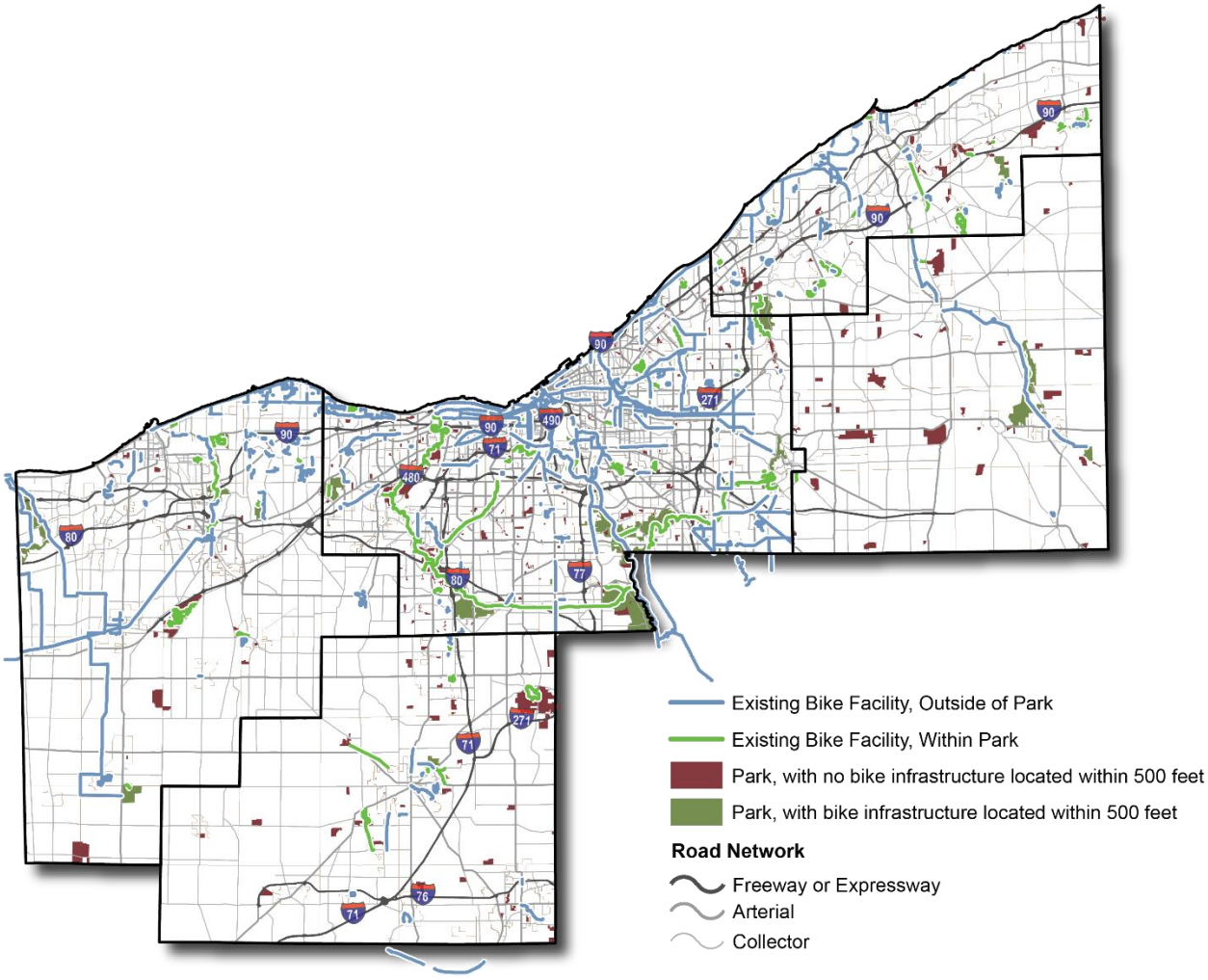
Map 4.1: Trail Network and Regional Parks



Many of the region's parks, such as the Valley Parkway and Rocky River Reservation, have significant trail infrastructure inside the park itself, however, do not have walking and biking access to residential neighborhoods. Also, very few parks in the rural areas of the NOACA region have bike facilities within a few hundred feet of the park boundary. The lack of access may prohibit the park's interior trails and amenities from being used to support active transportation. Therefore, it is recommended an inventory of nonmotorized infrastructure within a reasonable distance of a park with trail infrastructure be identified and collected.

Currently, 199 (35%) of the region's 566 parks have bike facilities located within a few hundred feet of the park boundary. Map 4.2 illustrates the park locations in vicinity of the current bike facilities.

Map 4.2: Current Bike Facilities and Park Locations

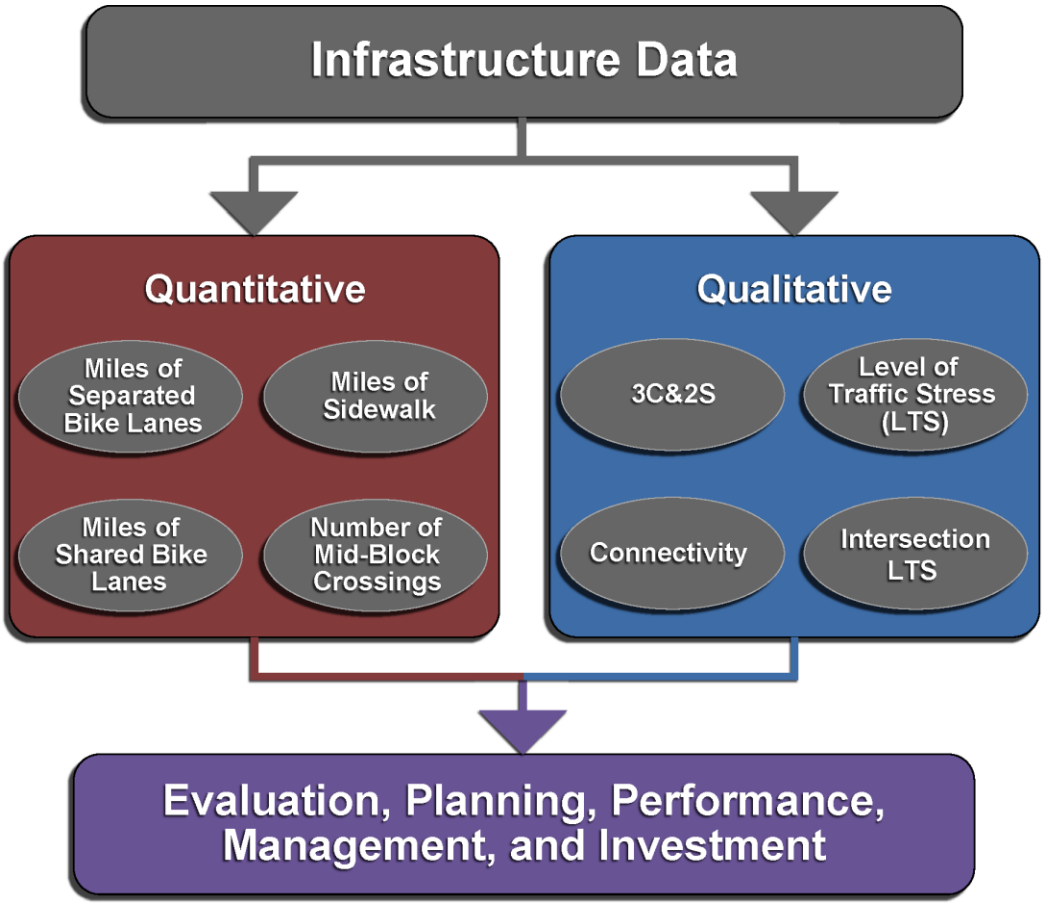


In accordance with the ACTIVATE Plan, NOACA is currently conducting a study for optimally extending the existing trail network in the Metroparks and other park areas in the NOACA region. This project is named the “Regional Metroparks Trail Connections Study” and will focus on creating a connected trail network in the NOACA region. This network will connect park areas to each other and also provide park access to residential neighborhoods. The study will also produce an implementation plan for extending the trail network in three planning decades of 2020-2030, 2030-2040, and 2040-2050.

4.5 Quality of Data

Miles of sidewalks and bike lanes are important quantitative measures, but they are not the only indicators required for a region to claim being pedestrian- and cyclist-friendly. It takes more than that. When the structure of the region is sprawl and auto oriented, those miles of bike lanes will remain underused. Qualitative measures are the other side of the coin. Building miles of high-quality walking and biking infrastructure can provide the right framework for a true multimodal transportation system. Figure 4.2 below introduces several of the qualitative measures that should be used in conjunction with the quantitative measures discussed previously to plan high-quality and well-used bicycle and pedestrian facilities. These qualitative measures are further discussed in the subsequent sections.

Figure 4.2: Quantity and Quality of Infrastructure Data



Undoubtedly, the status quo of the region's land-use pattern and transportation system is a steep mountain to climb. A dedicated effort toward creating higher-quality nonmotorized transportation infrastructure, however, is a key step in the region more fully realizing the opportunities that active modes of transportation provide.

4.6 Evaluating Quality of Walking Infrastructure

Everyone is a pedestrian. Whether walking from home to school, from work to a bus stop, or from a parked car to a shopping center, being a pedestrian is almost always necessary for any trip from an origin to a destination. Walking produces no emissions, has many health benefits, and is an ideal travel mode for short distances. A safe, secure, comfortable, convenient walking network would materialize all the benefits of walking, and travel time is the only cost incurred by walkers.

Although the length of the existing walking network is a reasonable quantitative measure for evaluating available space for pedestrians, the quality of the network is another important evaluating factor. A sidewalk separated from vehicles with a proper position of pedestrian crossings and adequate crossing times encourages residents to opt for the walking mode specifically for their short trips. Flat sidewalks without potholes or obstructions and with adequate lighting and sufficient sense of security provide a higher-quality walking network.

Table 4.2 displays a guideline for evaluating the existing local walking network of communities quantitatively and is named **3C&2S**.

Table 4.2: A Guideline for Qualitative Evaluation of Walking Network

Attribute	Descriptions
Connectivity	Residential neighborhoods/employment locations are connected to the transit system within a reasonable time/distance.
	Direct and short routes for common utilitarian trips
Convenience	Appropriate crossings for walking path continuity
	Short waiting times and adequate crossing times
Comfort	Even surface with adequate width
	Covered and/or shaded shelters in reasonable distances
	Avoiding overpasses and underpasses
Safety	Sidewalks separated from vehicles
	Safe islands for pedestrian crossing
	Safe routes to schools
Security	Adequate lighting
	Sufficient police and social service availability
	Built environment fostering “eyes on the street” informal surveillance

4.7 Americans with Disability Act (ADA) Requirements

Enacted by the United State Congress in 1990, the ADA made it illegal to discriminate against persons with disabilities. The law mandates that all public spaces, including transportation facilities, accommodate persons with disabilities. People with disabilities must be provided equal access to destinations and mobility within the transportation system. The Public Right-of-Way Accessibility Guidelines (PROWAG) provide guidance on how to design new construction or alterations to existing facilities to meet ADA requirements. Several measures to aid persons with disabilities may be applied at an intersection and to the entire sidewalk network. This includes, for example, the running slope and cross slope of pedestrian facilities, surface textures, and curb ramp design and placement. Accessible curb ramps with detectable warning surfaces must be provided at all street crossings. Detectable warning surfaces should also be provided on transit boarding platforms and other areas where pedestrians may transition between modes of travel.

4.8 Quality of Cycling Infrastructure

Level of Traffic Stress

There are currently a few methods to classify road segments based on the Level of Traffic Stress (LTS) they impose on cyclists or, conversely, the level of comfort cyclists feels. A primary method is the Bicycle Level of Service (BLOS), in which streets are graded from A to F, like the level of service for vehicles. Although this method may be used to classify road segments, it does not offer a clear relation between BLOS level and cyclists' tolerance. Similarly, another research effort developed the Bicycle Compatibility Index (BCI) based on bikeway, road, and traffic characteristics. While the BCI and BLOS formulas differ in form, their results are similar.

To establish a correspondence between level of traffic stress and cyclists' comfort level, the NOACA ACTIVATE Plan recommends the following method, which is the Dutch standard for assessing bicycle facilities.

Level of Traffic Stress (LTS) is defined as the measure of stress that vehicular traffic imposes on cyclists riding on the same roadway and crossing the same street intersection. In other words, LTS identifies the type of bicyclist who is likely comfortable biking on a given corridor and its intersections. When applied to a community or a region, it can result in a number of analysis tools that can assess the overall connectivity and prevalence of low-stress biking facilities. A bike map showing LTS measures is one of those tools that provides information on where there are bike facilities and low-stress routes to make cycling easier and less intimidating.

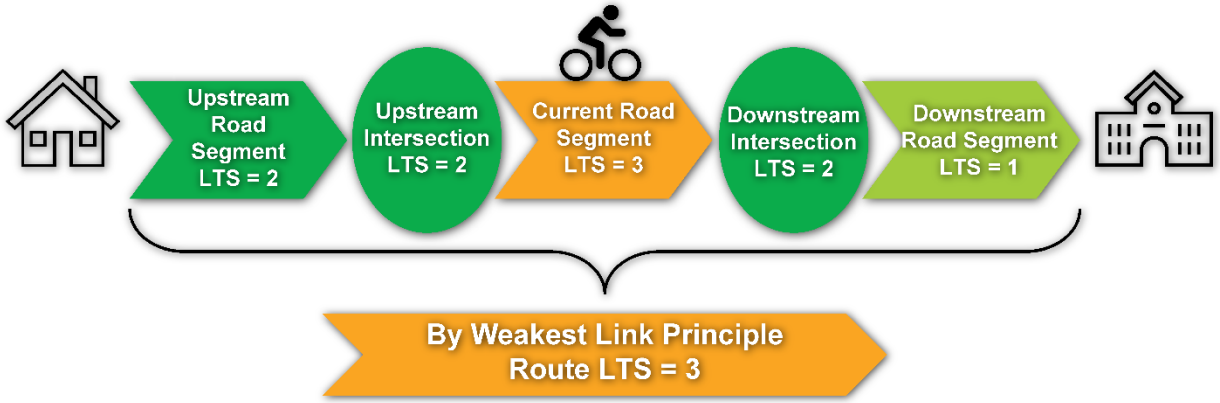
The recommended method suggests that the LTS measure of a road segment be based on two components:

- Road Segment LTS
- Downstream Intersection LTS

The LTS associated with a road segment should be aggregated with its downstream intersection LTS by applying the “weakest link” principle. In this way, the intersection LTS can make a road segment’s LTS worse, but not better. In the other words, the LTS of a road segment is determined by its most stressful component, and not by sum or average of the stress on its constituent components. This means, the low-stress intersection cannot compensate for a high-stress road segment.

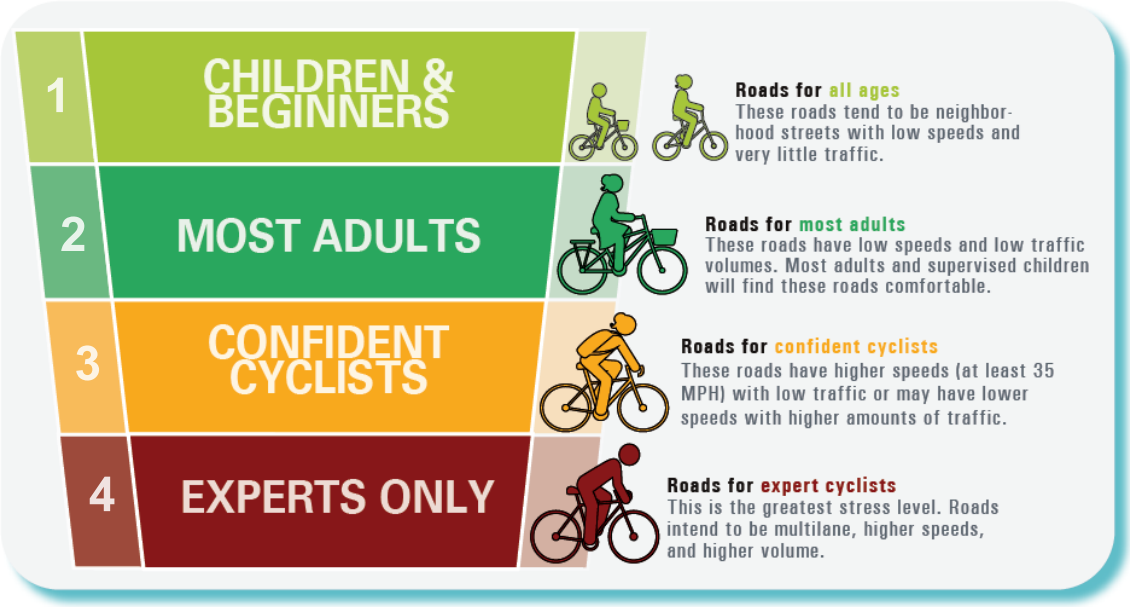
Similarly, the LTS of a route that comprises several road segments from an origin to a destination is determined by its most stressful link, not by an average. Figure 4.3 illustrates the weakest link principle to a route of three road segments.

Figure 4.3: Weakest Link Principle Example



The NOACA ACTIVATE Plan classifies roads into the audience with the lowest stress tolerance who would find the road segment with its downstream intersection comfortable. The categories, shown in Figure 4.4, range from young children to expert cyclists, or LTS 1 to 4. The descriptions of each category identifies general infrastructure conditions that may be comfortable for each group.

Figure 4.4: User Categories Based on LTS



A fifth level (LTS 5) was added as a result of public input. This level serves to indicate roads that should be avoided by even expert-level cyclists. Typically, these roads have a uniquely challenging characteristic, such as poor visibility, steep hills, or a history of dangerous interactions.

As defined earlier in this chapter, bike lanes were categorized in two major groups of “Separated” and “Shared.” The separated lanes are physically divided from the vehicular traffic and therefore, there is no traffic stress imposing on cyclists riding on those bike lanes. It should be noted that the road segment LTS discussion is more relevant to the “Shared” bike lane category where drivers and cyclists use the same roadway lanes. A bike route from an origin to a destination may comprise separated and shared bike lanes. In the route selection process based on the LTS criteria, it is recommended considering LTS 1 for the separated bike lanes; however, buffered bike lanes may be assigned to LTS 2 if the buffer space is narrower and/or the road segment includes a parking lane in the right hand.

Road Segment LTS

The input data for determining road segment LTS generally are:

- Number of through lanes
- Traffic control attributes
- Average directional Daily Traffic (ADT) volumes and peak hour volumes
- Posted speed
- Accessibility and Mobility functionality of streets in the highway and street network

Figure 4.5 shows the degree to which different road functional classes should accommodate movement and access. Movement refers to through traffic flow, while access refers to the ability of traffic to enter or exit the roadway network. The shape of the curve in this figure illustrates the defined relation between access and mobility for each road function class.

Figure 4.5: Relationship between Access and Movement Functions of Roads & Streets

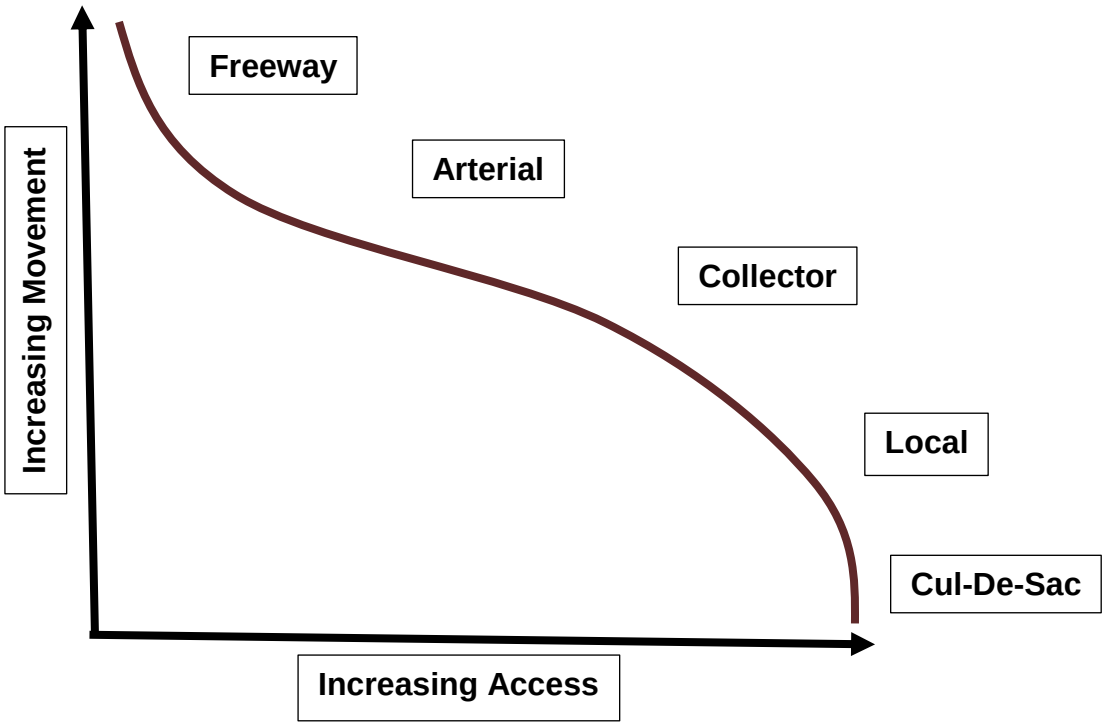


Table 4.3 displays road LTS for various road types with shared bike lanes.

Table 4.3: Road LTS for Various Road Types with Shared Bike Lane

Function		Number of Lanes per Direction	ADT Range (Total of both directions)	LTS			
Accessibility / Mobility				Posted Speed			
				=<25	<35	<45	>=45
Increasing Access	Increasing Movement	1	0 - 750	1	1	2	3
		1	751 - 1,500	1	2	3	4
		1	1,501 – 3,000	1	3	3	4
		1	>3000	2	3	4	4
		1	0 - 750	1	2	3	4
		1	751 - 1,500	2	3	4	4
		1	1,501 – 3,000	3	3	4	4
		1	>3000	3	3	4	4
		2	8,000	3	4	4	4
		2	>8,000	3	4	4	4
		3 or more		3	4	4	4

Alternatively, and depending on the degree of access and movement, road LTS may generally be estimated and rounded by using the following formulas.

For roads with the posted speed of 25mph:

$$LTS = MIN(^{ADT}/_{750}\ , 3)$$

For roads with the posted speed of 35mph:

$$LTS = MIN(^{ADT}/_{750}\ , 4)$$

For roads with the posted speed of 45mph:

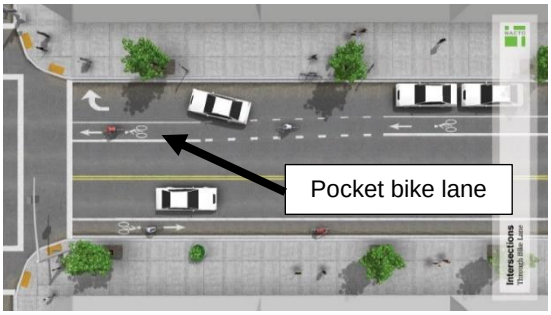
$$LTS = MIN(^{ADT}/_{250}\ , 4)$$

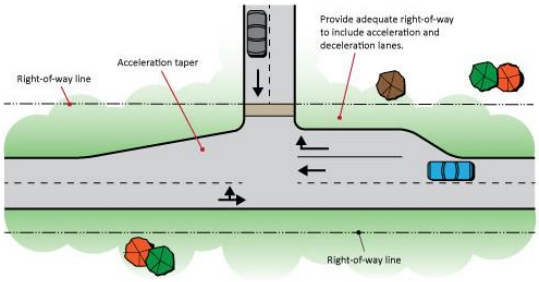
Intersection LTS

Cyclists traveling through an interconnected street or road network cross different types of conflicting points, such as signalized and unsignalized intersections. Therefore, these conflicting locations have effects on road segment LTS. This section deals with not only the street conflicting areas, such as intersections, but also street-approaching segments for crossing those intersections.

The input data for determining intersection LTS are:

- Intersection traffic control type
    - Unsignalized control
    - Signalized-controlled
- Geometric attributes of intersection approaches, such as width
- Number of through and turn lanes of intersection approaches
- Presence of right-turn lane
- Presence of pocket bike lane
- Pedestrian signal timing and push button crossing facility at the intersection





As shown in the above pictures, a right-turn lane forces the bike lane position to shift to the left, and these stressful lane configurations are part of standard road design practice in many parts of the U.S. The effects of left-turn lanes can be ignored since cyclists generally stay to the right of the road. Table 4.4 shows the proposed intersection LTS for signalized and unsignalized intersections.

Table 4.4: Intersection LTS for Various Intersection Types

Intersection Control Type	Lanes of Intersecting Road	Presence of Right-Turn and Pocket-bike Lanes	Intersection LTS
Signalized or Unsignalized	1	N/A	**2**
Signalized	Greater than 1	No	**2**
		Yes	**3**
Unsignalized	Greater than 1	No	**3**
		Yes	**4**

Connectivity Measures

The most fundamental improvements to a bicycle network are to create connected bicycle lanes with an LTS of 1 or 2. Low-stress connectivity can be used to evaluate and guide a bicycle network expansion.

In the NOACA region, low-stress connectivity generally has three types of barriers:

- Natural and man-made, such as freeways, railroads, and creeks
- Arterial streets, whose crossing streets lack the combination of a low-stress approach and a safe crossing
- Breaks in the neighborhood street grid, a common feature of newer developments that force traffic, including bicycle traffic, to use arterials to access the local streets

For evaluating the connectivity of a specific LTS, two measures are recommended:

- Percent of Origins & Destination connected by each LTS
- Percent of Traffic Analysis Zones (TAZ) or neighborhoods connected by each LTS

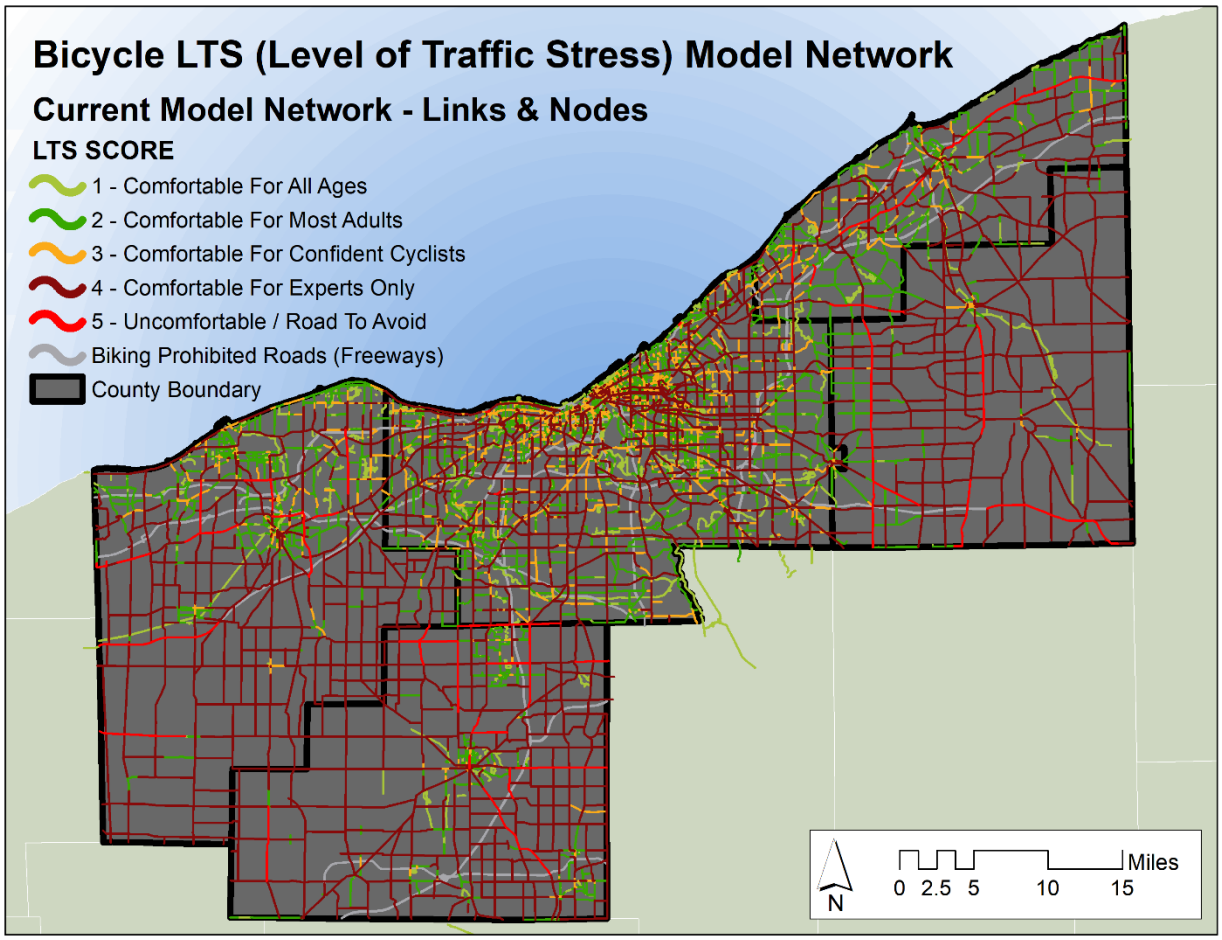
Regional trip tables in NOACA's travel forecasting model use the model TAZ system as their geographical unit of demand. Percent of connected trips by LTS of 1 and 2 is a qualitative measure for the community bicycle network. Similarly, the percent of residential areas as origins and employment centers as destinations can be used as a connectivity measure. How does supply compare with demand? Where do mismatches occur?

The low-stress networks may be conceptualized as "islands" of low-stress streets. How far can a person travel in a given neighborhood by only using low-stress streets, and only crossing major streets with a signal or another mechanism of stopping traffic, such as a HAWK beacon (**H**igh-

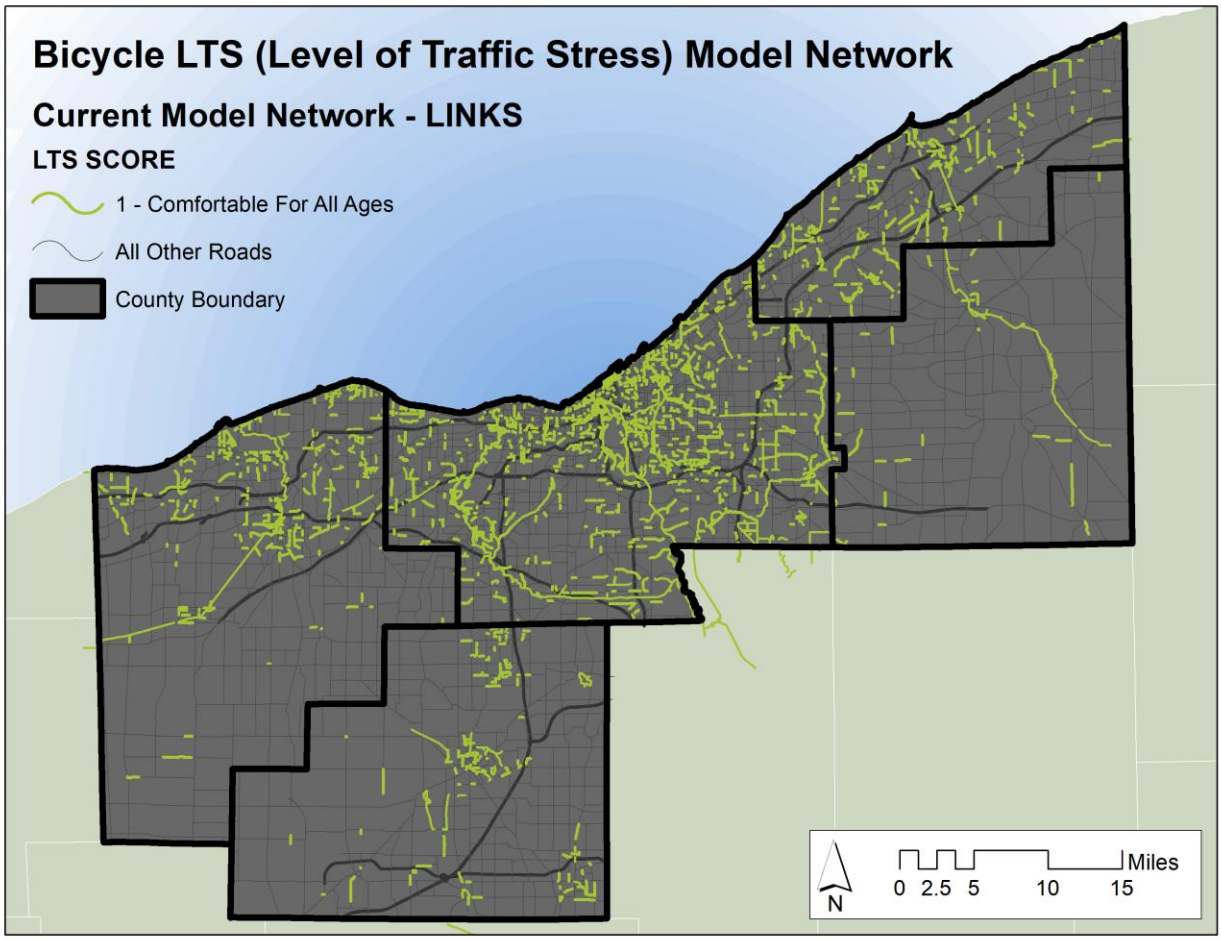
Intensity **A**ctivated cross **W**al**K** beacon) signal? This helps planners visualize how accessible destinations are in a community.

Maps 4.3 to 4.8 show roads by LTS of 1 to 5 with intersection effects.

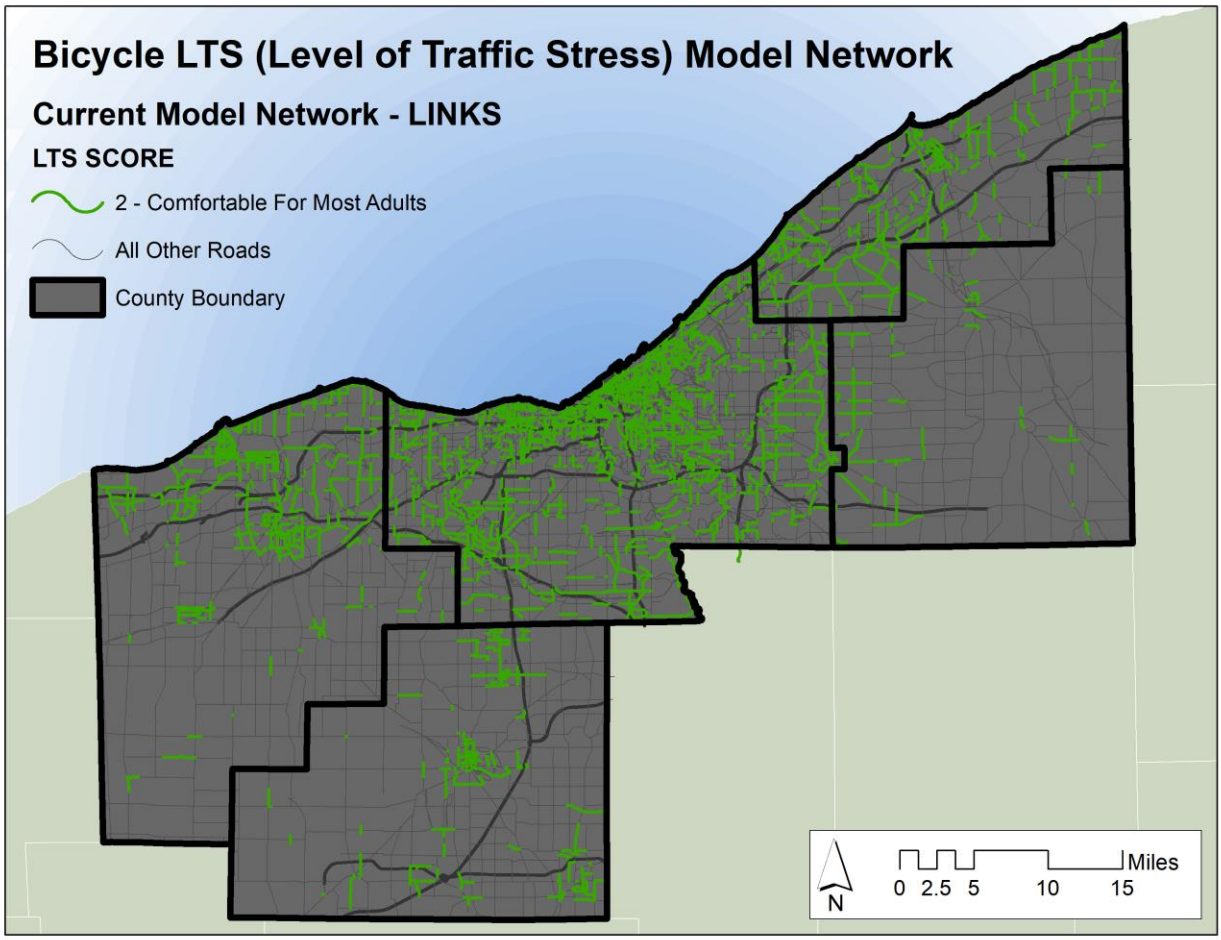
Map 4.3: Cycling LTS Networks



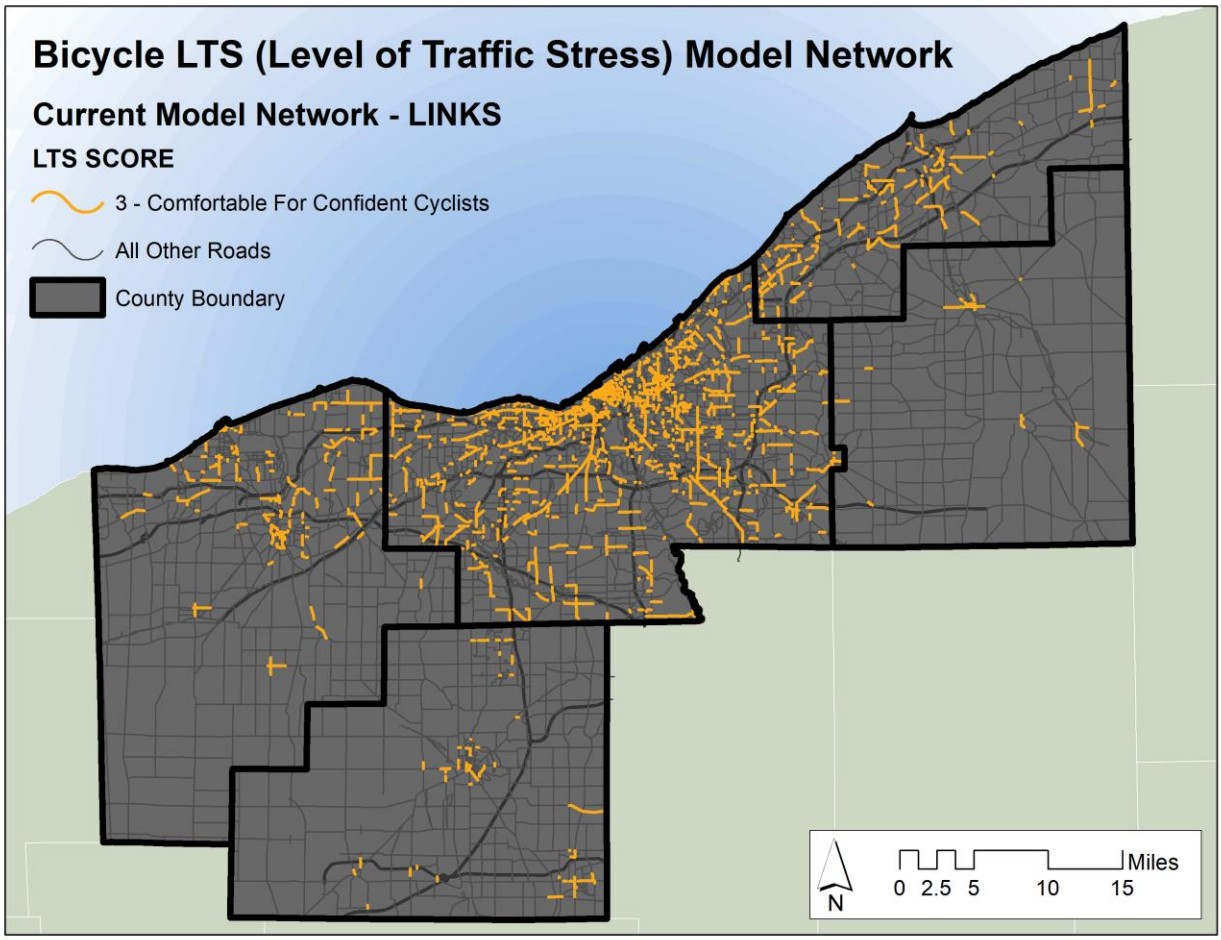
Map 4.4: Cycling LTS 1 Network



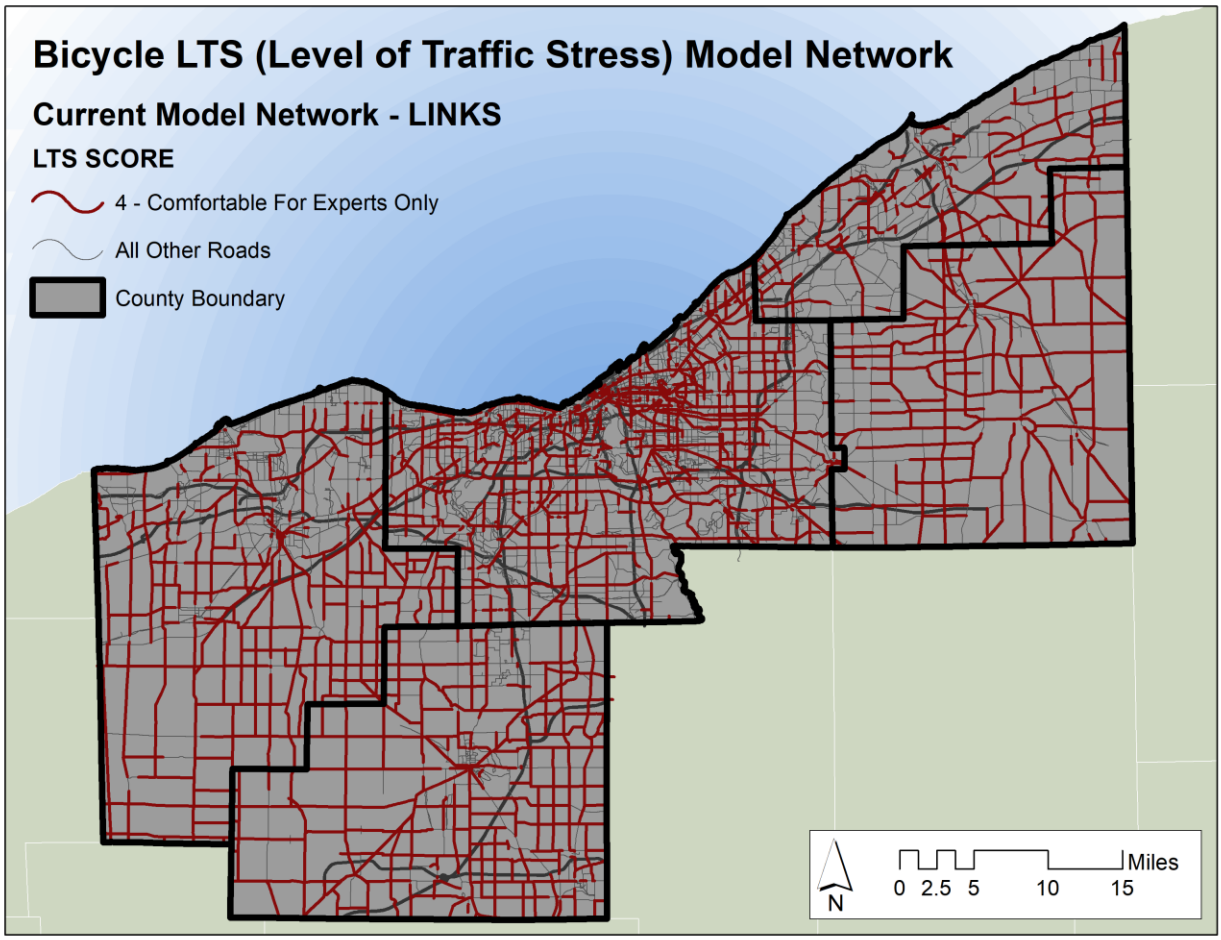
Map 4.5: Cycling LTS 2 Network



Map 4.6: Cycling LTS 3 Network



Map 4.7: Cycling LTS 4 Network



Map 4.8: Cycling LTS 5 Network

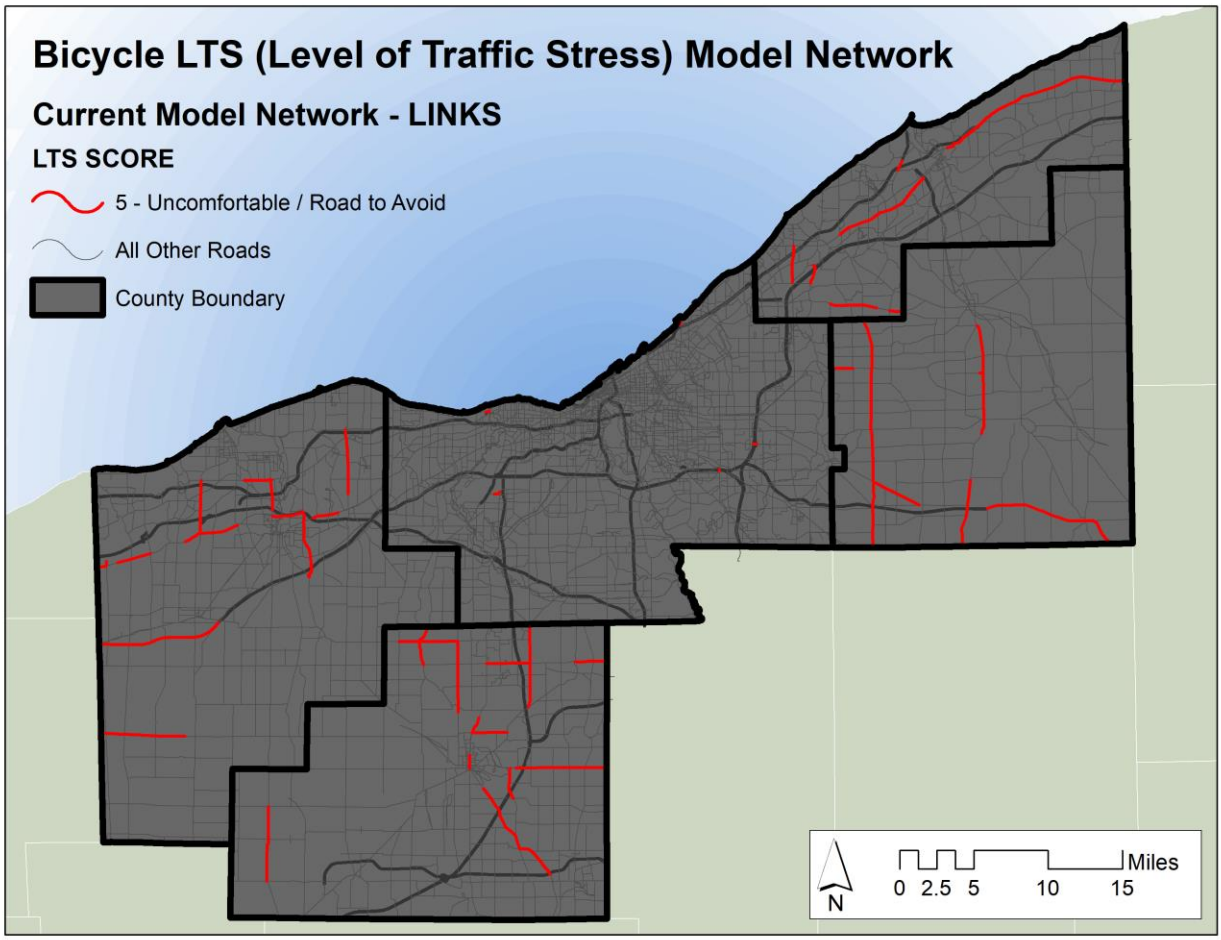


Table 4.5 and Figure 4.6 show the length in miles and percent of LTS in the NOACA region with intersection effects. It should be noted that the zone connectors in NOACA's travel forecasting model were used in lieu of the local streets that are actually located inside the neighborhoods. Those connector lengths may be less than the lengths of the neighborhood streets. This decision was made to account for the fact that many neighborhood streets are circuitous local roads or cul-de-sacs, which often provide little ability to enter the broader roadway network. Therefore, measuring the length of zone connectors helps to represent the length of LTS more effectively with respect to their utility within the overall network. Also, for the purposes of creating more realistic and legible maps, the zone connectors are not shown on the above LTS maps, although their lengths are included in the following tables.

Table 4.5: Length of LTS

LTS		Directional Length (Miles)	Length Percent
1	Comfortable For All Ages	4,580	26%
2	Comfortable For Most Adults	6,354	37%
3	Comfortable For Confident Cyclists	775	4%
4	Comfortable For Experts Only	4,361	25%
5	Uncomfortable / Road To Avoid	342	2%
Biking Prohibited Roads		925	5%
Total Model LTS Network		17,337	100%

Figure 4.6: Percent of LTS

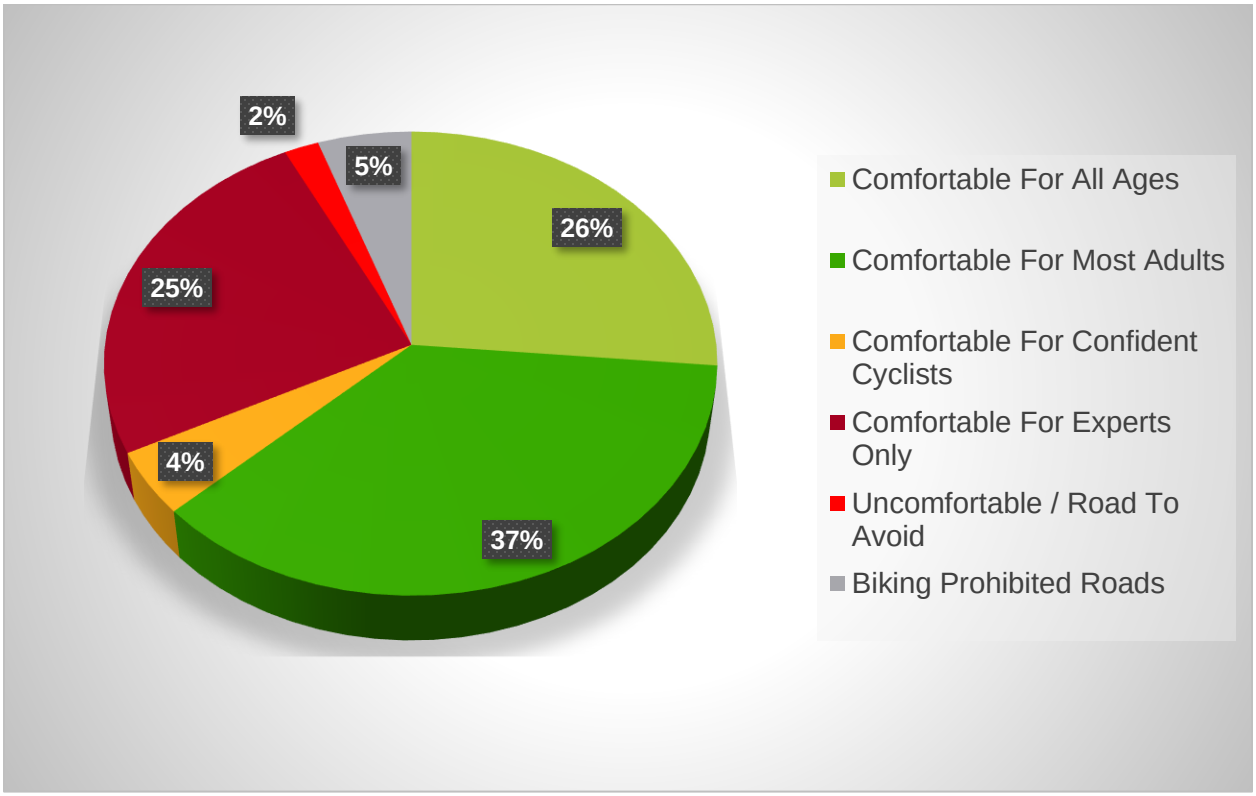


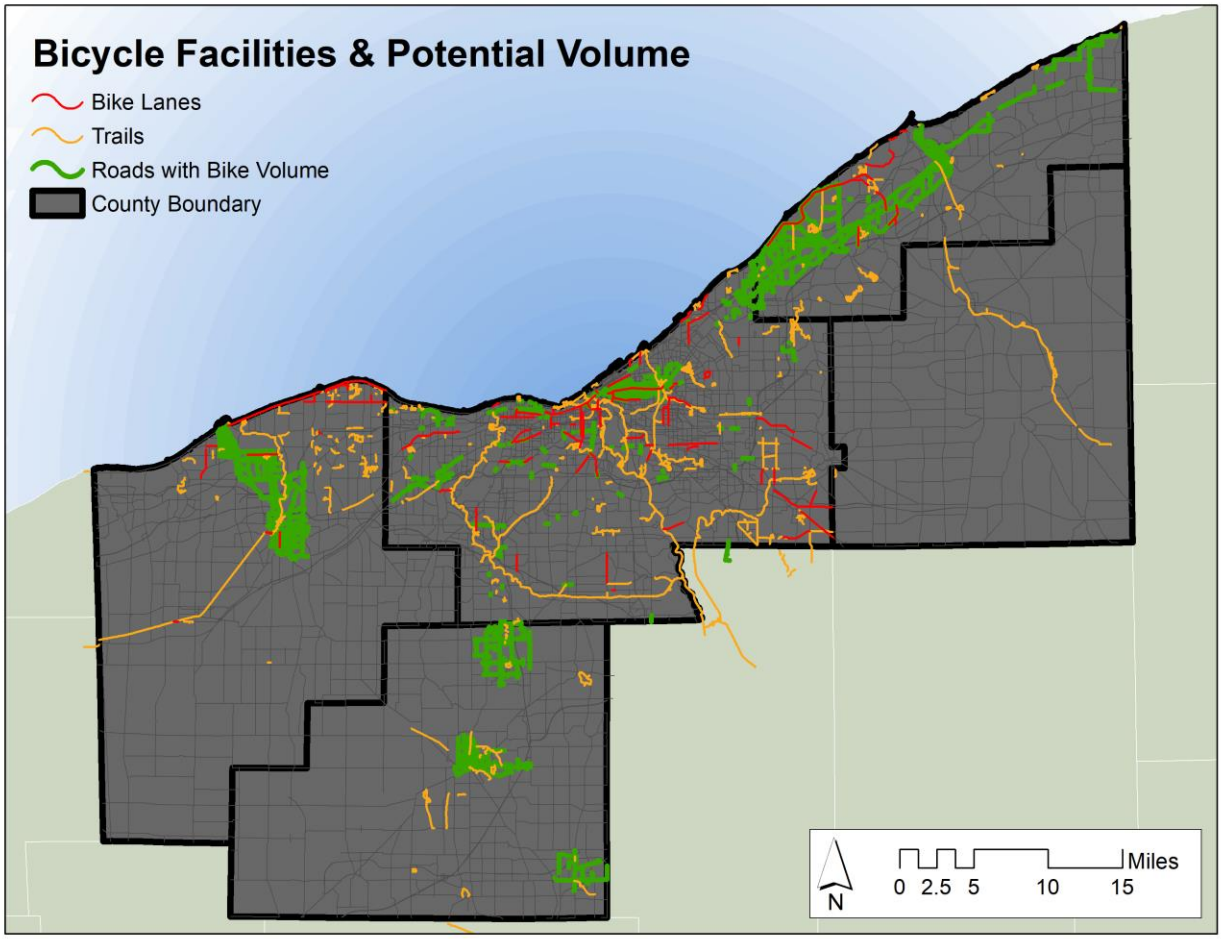
Table 4.6 below shows the results of two significant bike connectivity measures. The first measure is the percentage of neighborhoods (TAZs) within a 30-minute bike ride of each other that are connected by each increasing LTS, summed cumulatively. This measure helps to illustrate the relative **supply** of bikable roadways and trails that are available to riders of differing confidence levels to make trips between origins and destinations. For example, this measure tells us that only 10% of neighborhoods are connected by bikable roadways that are comfortable for most adults (LTS 2 or lower). The second measure is the percentage of potential bike trip **demand** between neighborhoods that are connected by each cumulatively increasing LTS. This second measure helps to express how the relative supply of facilities for each increasing LTS relates to the potential demand for daily bicycle trips. For instance, 23% of potential bicycle trips between neighborhoods take place by all ages and most adults comfortably using similar LTS. Overall, these two measures together indicate that more LTS 1 and 2 facilities are required relative to the potential demand of bike trips. Therefore, there is room for improvement to make utilitarian bike trips more comfortable for riders of all confidence levels.

Table 4.6: Neighborhood Connectivity Measures by LTS (Supply & Demand)

LTS	Percent of Traffic Analysis Zones (neighborhoods) Connected by LTS	Percent of Bike Trips Connected by LTS
1	0.3%	1.4%
1 2	9%	23%
1 2 3	37%	43%
1 2 3 4	98%	98%
1 2 3 4 5	100%	100%

Illustrating this point more broadly, Map 4.9 below displays the spatial relationship between the supply of bicycle facilities (highlighted in red and orange) relative to the locations of potential bicycle trip demand (highlighted in green). Clearly, many areas with utilitarian bike trip demand are using the available facilities, and this guideline recommends expanding bicycle facilities based on the areas of potential demand. When the supply meets the demand, this is the most effective policy to improve cyclist safety and encourage greater levels of bike mode choice.

Map 4.9: Bicycle Facilities (Supply) vs. Bicycle Potential Volume (Demand)



NOACA has produced county-based bike maps showing the LTS. An App is currently being produced for hand-held mobile phones. Cyclists will be able to install this App on their mobile device and locate the optimal route with a stress level lower than a specific LTS.

Design Recommendations

The NOACA ACTIVATE Plan recommends considering the following issues in designing bike lanes.

- Discourage high-stress bike facility designs, especially sharrows, and work to determine whether sharrows are an appropriate use of the countermeasure before designating NOACA funds to them.
    - Sharrows do not dedicate space on the road for the bicyclist, and so they do not lower the stress level of biking with traffic. The goal of sharrow projects tends to be to make high-stress bicyclists comfortable on high-stress roads, but this is no longer a primary goal of bicycle planning, which has largely shifted focus to be more inclusive of all bicyclists.
    - Major roads, especially multilane, high-volume roads, often have sharrows installed because sharrows are easy to install, regardless of concerns related to traffic congestion (Level of Service thresholds) or budget.
    - Sharrows, according to research, do not offer a significant safety benefit for users.

- Sharrows should be reserved for use in contexts that are low-stress or are short distances between low-stress bike facilities in a constrained area, such as a bridge. Major roads and multilane roads are not constrained areas.

- Encourage local communities to implement new guidance for providing low-stress bicycle facilities at intersections.
  - Although planning for linear bike facilities is still new for many communities, there is emerging guidance available about the importance of attentive design at intersections for bicyclists. More mainstream guidance is likely to be released in the next three to five years at a national level. Intersections are important pinch points for local bicyclists, too. In the public survey discussed in Chapter 3, bicyclists cited intersections as a primary source of frustration and discomfort.
- Treat one-sided bike facilities on two-way roads as high-stress facilities.
- Connect low-stress roads through bike boulevard planning and traffic calming.
- Emphasize connections to destinations for users of all ages and abilities, such as schools, libraries, shopping centers, and main streets.

The NOACA ACTIVATE Plan calls for a new approach where bicycle infrastructure is "right-sized," or offers stress reduction appropriate to the context. Just as expensive multiuse trails on minor neighborhood streets typically do not compete well for NOACA transportation funding, sharrow projects proposed on LTS 3 or LTS 4 roads should be scrutinized, and low-stress bike facilities or alternate bicyclist routes should be provided instead.

Bike Boulevards

Bike boulevards are an especially useful means of improving connectivity in the NOACA region, but they are one of the facility types that planners and engineers are the least familiar with, according to the community surveys. To formalize support for this facility type, this section provides information about what bike boulevards are along with some local and regional analyses that can support their widespread implementation in the region.

The LTS maps in this chapter illustrated many low-stress roads in the NOACA region that have bike infrastructure that separates or buffers bicyclists from moving traffic. Some low-stress roads may even have heavy traffic if they also provide a comfortable trail that fully separates bicyclists from vehicles. But for the most part, low-stress roads are low-volume and low-speed roads that are primarily residential. These roads/streets should meet the criteria below.

- Parcels fronting the road are primarily single-family or small-scale multifamily residential
- Speed limit is 25 mph or less
- Road lacks a centerline

These streets, which aren't on the Federal-Aid System and are typically not prioritized or eligible for major improvements at the state or regional level, serve a crucial and underestimated role in the region's bike network. Anecdotally, most people cite a neighborhood street as a place where they first teach their children to ride a bicycle, and many adults say they feel comfortable biking in and around their neighborhood streets.

Nationally, a new appreciation for neighborhood streets has led to the definition of a new bicycle facility, bike boulevards.[14] **A bike boulevard is a low-speed, low-volume road that has been enhanced to prioritize bicycle travel.** In the NOACA region, many neighborhood streets could form the basis of a bike boulevard network, where bicycle traffic could access common destinations without traveling on larger arterials. This is not to say that bike infrastructure on major streets is not important to continue advancing in the region and that bike boulevards offer a full alternative. Rather, bike boulevards can supplement an existing bike network by offering connections within neighborhoods, or they can be an early intervention that helps create momentum and support for larger, on-road projects. Bike boulevards can also align with goals of calming traffic and reducing vehicle speeds in neighborhoods.

Specific treatments for bike boulevards may vary but generally include efforts to slow motor vehicle speeds, control and reduce motor vehicle volumes, minimize bike delay, improve safety at crossings, and provide routing assistance to help cyclists access destinations.[15]

Final Notes on Bikes

Neighborhood streets play a crucial role in the bike network of the NOACA region, and improving bike facilities in those streets by low-cost measures will encourage biking for transportation, especially for short trips. Connecting low-stress neighborhood streets will create a safe environment for cyclists and also enhance the connectivity measures at the local and regional levels. On this matter, the NOACA ACTIVATE Plan considered the needs of bicyclists of all ages, abilities, and experience levels and found that the current network of bike infrastructure in Northeast Ohio is growing, but tends to be higher-stress than is needed to be a true choice for many would-be bicyclists. Those who bicycle out of necessity in high-stress conditions need better facilities to improve safety and quality of life; therefore planning for increasing and connecting the low-stress bicycle network, at the regional as well as local levels, is recommended.

Finally, it is important to note that bicycle facility design continues to evolve in this country, and the NOACA ACTIVATE Plan guidelines allow flexibility in the future as new designs and priorities become clear.

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[14] Federal Highway Administration, "Bikeway Selection Guide," February 2019, https://safety.fhwa.dot.gov/ped_bike/tools_solve/docs/fhwasa18077.pdf.

[15] National Association of City transportation Officials (NACTO), "Bicycle Boulevards," n.d., https://nacto.org/publication/urban-bikeway-design-guide/bicycle-boulevards/.

5. PEDESTRIAN & CYCLIST SAFETY

Safety planning traditionally relies on crash data analysis as it is the most commonly used method to determine the overall safety of a particular corridor or subarea. Crash data is directly quantifiable and reliable because crash reports are filed regularly after crash events, and crash statistics can also be compared year after year to identify trends. Yet crashes do not always provide a full picture of how safe a given area is for walking and biking.

Recently, to complement the current NOACA safety programs, a Systemic Safety Management approach was incorporated at sites to consider safety treatments that reduce the potential for crashes using Crash Prediction Models. The Systemic Safety Management approach is intended to address crash types that occur with high frequency across the roadway network but are not concentrated at individual locations, which tend to be overlooked when ranking sites using a crash-history-based approach.

Using this proactive approach, the potential for future crashes alongside crash history is considered when identifying biking and walking safety improvements. The Systemic Safety Management approach identifies safety projects further into the future based on highway, street, and intersection characteristics in the absence of high-quality historical site-level crash data, or where there is not a history of reported crashes. The number of predicted crashes is determined based on the number of predicted average crash frequency of vehicle-vehicle, vehicle-bicycle and vehicle-pedestrian collisions.

The NOACA Systemic Safety Management approach is community-based, and specific Safety Performance Functions (SPFs) are being developed for each community based on road inventory, traffic volume, and crash data. This approach also uses the FHWA Crash Modification Factors (CMF) that indicate how much crash experience is expected to change following a modification in design or traffic control.

Combining the community-based proactive approach with the current walking and biking safety issues prevalent in the NOACA region, and in addition to the specific local safety improvements for nonmotorized modes of travel, the ACTIVATE Plan recommends the following FHWA Proven Safety Countermeasures.

5.1 Proven Safety Countermeasures

FHWA recommends using proven safety countermeasures that offer significant and measurable impacts to improving pedestrian and cyclist safety. Table 5.1 illustrates these countermeasures and their safety benefits in terms of crash reductions.

Table 5.1: FHWA Proven Safety Countermeasures for Pedestrians/Bicyclists

Proven Safety Countermeasures	Safety Benefits Reduction in Pedestrian/ Bicycle Injury Crashes up to	Countermeasure Symbol
Crosswalk Visibility Enhancements	40%	
Leading Pedestrian Interval	13%	
Road Diets (Roadway Reconfiguration)	19 – 47%	
Bicycle Lanes	57%	
Medians and Pedestrian Refuge Islands	47%	
Walkways	65 – 89%	
Rectangular Rapid Flashing Beacons (RRFB)	47%	
Pedestrian Hybrid Beacons	55%	

5.2 Safe Routes to School (SRTS)

Safe Routes to School (SRTS) is a program that focuses on making it safe, convenient and fun for kids and families, including those with disabilities, to walk or bicycle to school and in everyday life.

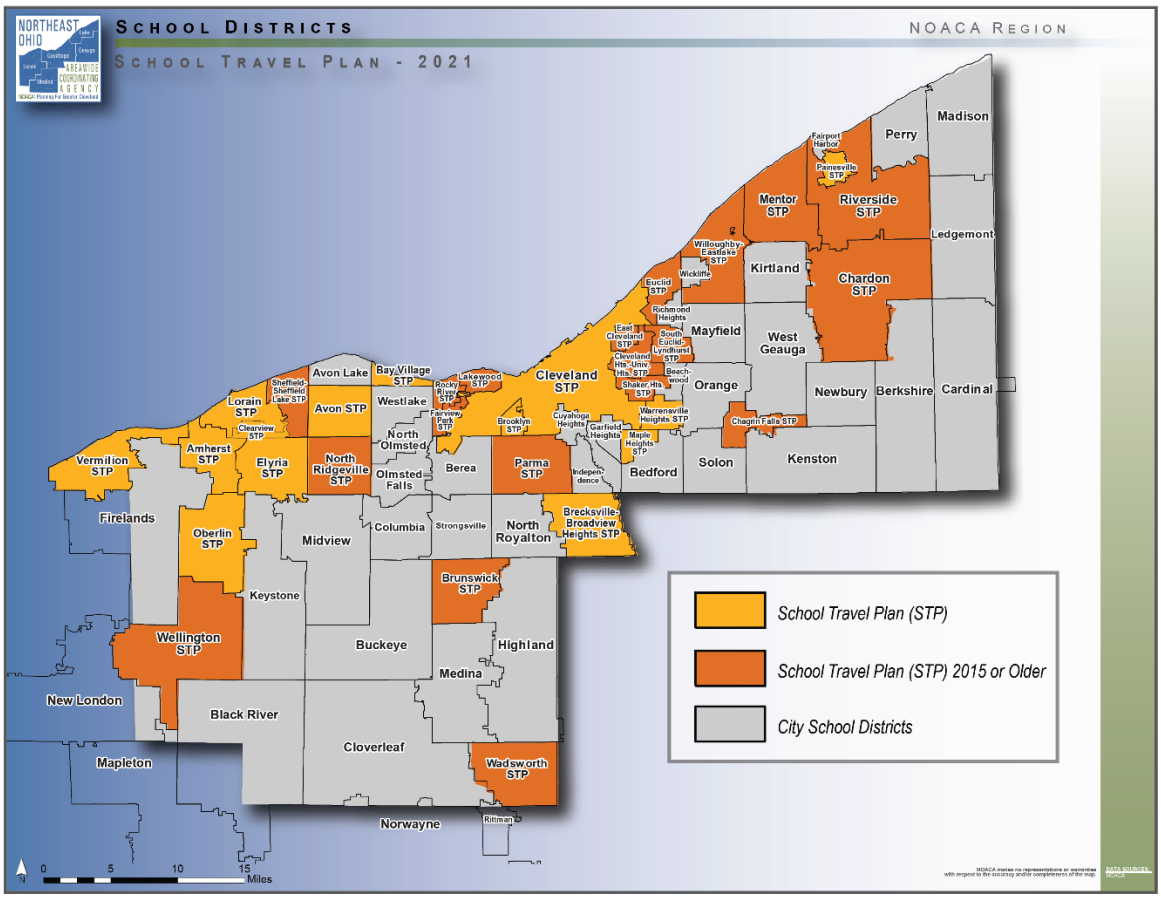
In addition to the transportation safety benefits, SRTS programs can:

- Increase youth and family physical activity opportunities
- Assist school and community health and wellness initiatives
- Help students succeed by improving cognitive learning and behavior
- Help schools meet critical education benchmarks, such as tardiness and attendance, by improving safety along routes
- Establish programs such as walking school buses, bike trains, and school pools to get kids to school safely, ontime, and ready to learn

Ohio has one of the strongest and most comprehensive programs in the nation, and NOACA is committed to supporting communities that value student transportation safety. NOACA will focus on helping start new, and support current, programs that are community-supported and consider the unique needs of each school, district, and community.

Community planning and engagement is important to a successful Safe Routes to School program. A School Travel Plan (STP) or similar Active Transportation Plan (ATP) is required to apply for SRTS implementation funding from the Ohio Department of Transportation, and must be updated every five years. Map 5.1 shows the school districts within the NOACA region with an SRTS School Travel Plan.

Map 5.1: School Districts within the NOACA Region



6. CURRENT VOLUMES & FUTURE DEMAND

According to the mode choice module of NOACA's travel forecasting model, currently there are about 29,000 daily utilitarian trips by the nonmotorized modes of walking and cycling in the NOACA region. The current share of the nonmotorized modes is about 0.5% of the total number of daily trips in the NOACA region. Also, there are some daily trips by nonmotorized modes for accessing the transit system.

The split between walking and cycling is about 86% to 14%, respectively, and the number of nonmotorized trips during peak periods is higher than those of other non-peak periods (58% vs. 42%) (*Source: NOACA travel forecasting model).*

Chapter Four discussed the quantity and quality of the nonmotorized infrastructure data as the supply side. Demand data of nonmotorized modes is another side of the traditional demand-supply relation.

Purpose of Collecting Demand Data

The demand data is generally collected for the purpose of:

- Gauging regional and local trends
- Determining the impact of facility improvements or changes
- Studying pedestrian and cyclist behavior
- Calibrating walk and bike modes in the NOACA Travel Forecasting Model
- Guiding planning and programming

To determine current demand indications, NOACA collects pedestrian and bike counts manually or using automated counters throughout the agency's five-county region. The following section describes NOACA methods and procedures for collecting current bike volumes continuously and biannually.

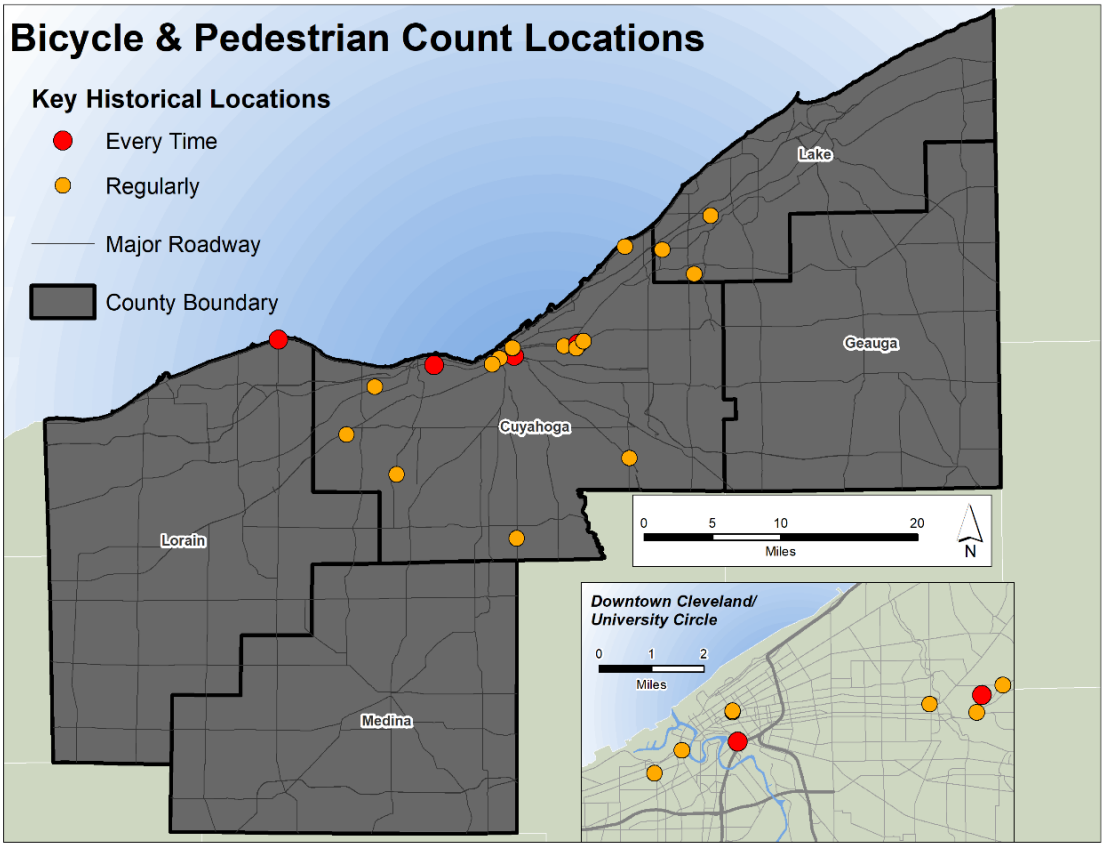
6.1 NOACA Bike Count Program

Permanent Counter Locations

In 2016, NOACA installed its first permanent, automated bicycle and pedestrian data collectors on Edgehill Road in Cleveland Heights, and a second one on the Lorain-Carnegie Bridge in Cleveland. These counters are Eco-Counter brand and have been collecting data continuously since they were installed. Using both infrared and loop detection, the counters tally bicyclists and pedestrians separately and by direction, similar to midblock and screenline data collections.

After successful initial use of the installed Eco-Counter, NOACA installed 14 additional permanent count stations in 2019. Technology advancements allowed for the installation of video-detection-style counters, which have many additional capabilities, including data collection for all traffic modes (motor vehicles, buses, bicyclists, and pedestrians), turning movement counts, video replay, additional analysis features, and the ability to use the video detection to improve traffic signal timing. Map 6.1 shows the locations of permanent count locations in the NOACA region.

Map 6.1: Permanent Nonmotorized Count Locations



Manual Count Process

NOACA has conducted bicycle and pedestrian manual counts throughout the agency's five-county region biannually since September 2011. The number of manual count locations usually is about 40 to 50 in every count session, and so far, 168 different locations have been counted at least once.

The manual count locations are selected based on the following key factors:

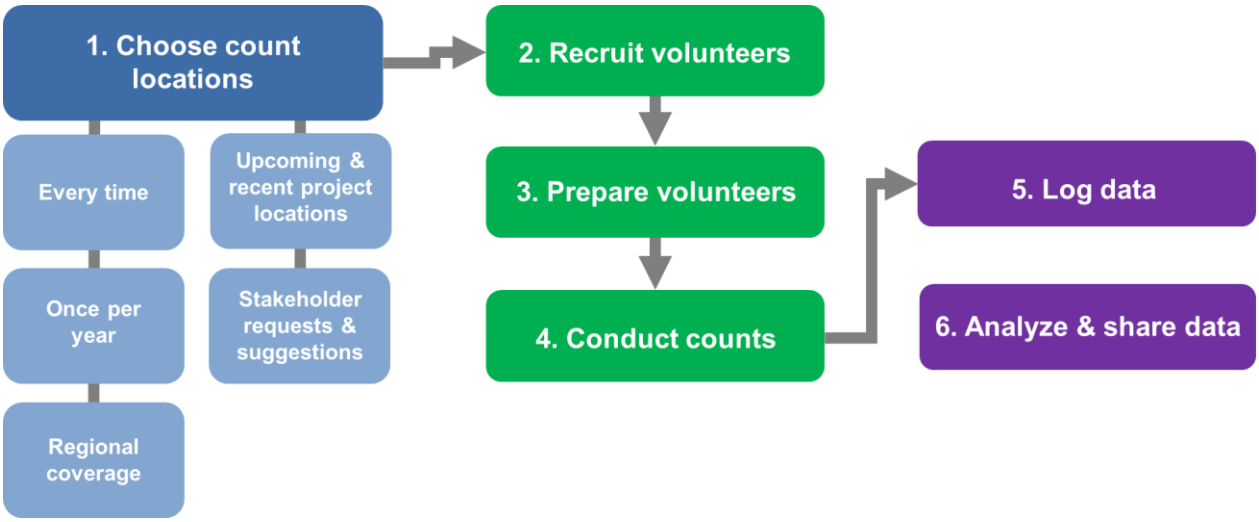
- Historical Continuity
- Project Status
- Regional Coverage
- Cost

In addition to the above factors, NOACA also considers the following range of count location characteristics in the selection process:

- Variety of bike facility types
- Variety of roadway functional classes
- Variety of geographies and land-uses
- Preference for higher volumes

Figure 6.1 displays the pedestrian and bike manual count process from choosing the count locations step to the final step of data analysis.

Figure 6.1: Pedestrian and Bike Manual Count Process

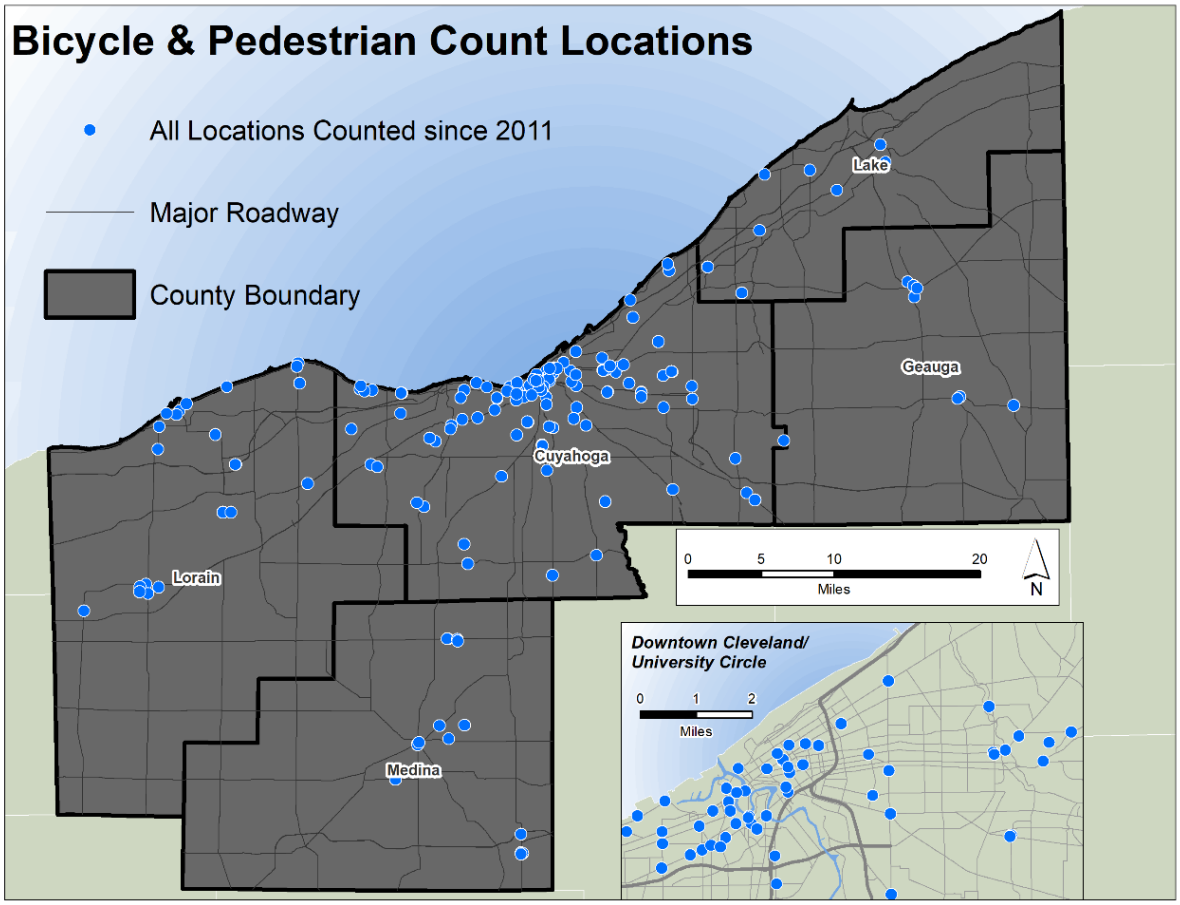


Prior to each count period, volunteers are given a selection of locations and are asked to choose a location and count on the Tuesday, Wednesday, and/or Thursday, and Saturday of the count week. Volunteers count from 5 p.m. to 7 p.m., capturing the evening commute period.

Counts are performed using the screen line method: at every location there is an imaginary line perpendicular to the roadway, and the count volunteers are instructed to count all cyclists and pedestrians moving in either direction through that line. Multiple-day counts are averaged to a single value at that location for that particular count period.

Map 6.2 illustrates the NOACA manual count locations since 2011.

Map 6.2: Manual Nonmotorized Count Locations Since 2011



Overall trends and behaviors of cyclists and pedestrians in the NOACA region can be inferred from count data collected since 2011.The appendix includes a summary of trends and behavior of cyclists and pedestrians.

6.2 Future Daily Travel Share of Nonmotorized Modes

One of the objectives of the recent NOACA Long-Range Plan (LRP), known as *eNEO2050* Plan, is to increase transit and nonmotorized mode shares. This objective is specifically and quantitatively mentioned in the Congestion Management Plan (CMP) of the NOACA LRP. The CMP objective for the transit and nonmotorized modes was developed based on the fulfillment of the NOACA long-range goals.

The total shares of work commute by transit and nonmotorized modes were set during the AM peak period as quantitative objectives for each planning decade of 2020-2030, 2030-2040, and 2040-2050. These values are to increase the total shares of transit and nonmotorized modes from the current level of 6.3% to 7%, 9%, and 11% for the next three decades, respectively.

Considering the above objectives for the work commute during the AM peak period, it is plausible to increase the current 27,000 daily nonmotorized trip level threefold by 2050. This objective may be achieved by investing not only in the expansion of the nonmotorized facilities based on an appropriate nonmotorized oriented transportation planning, but also in transit-oriented mixed-use development, high-density development, narrow roads, interconnected streets, and intersections with tighter curb radii, etc.

Table 6.1 shows the objective values for the work commute mode shares during the AM peak period.

Table 6.1: Objective Values for Work Commutes by Transit and Nonmotorized Modes

Mode of Travel	Work Commute Mode Share	
	Transit	Nonmotorized
Current Share	5.5%	0.8%
Decade	Transit	Nonmotorized
2020 - 2030	6%	1%
2030 - 2040	7.5%	1.5%
2040 - 2050	9%	2%

7. Planning & Prioritizing Nonmotorized Facility Investments

7.1 *eNEO2050* Prioritization Plans

The *eNEO2050* Plan recommends investing in nonmotorized facilities by expanding the existing walkways and bikeways and also by accessing the transit network for the purpose of creating a true multimodal transportation system in the NOACA region. Pedestrians, cyclists, and transit riders should be able to safely and conveniently reach to their destinations and transit stops via the expanded and well-connected system of nonmotorized infrastructure. Tables 7.1 and 7.2 display the *eNEO2050* Plan proposal for nonmotorized modes by facility type and implementation decades as a prioritized plan.

Table 7.1: Walkway Facilities Based on *eNEO2050* Plan

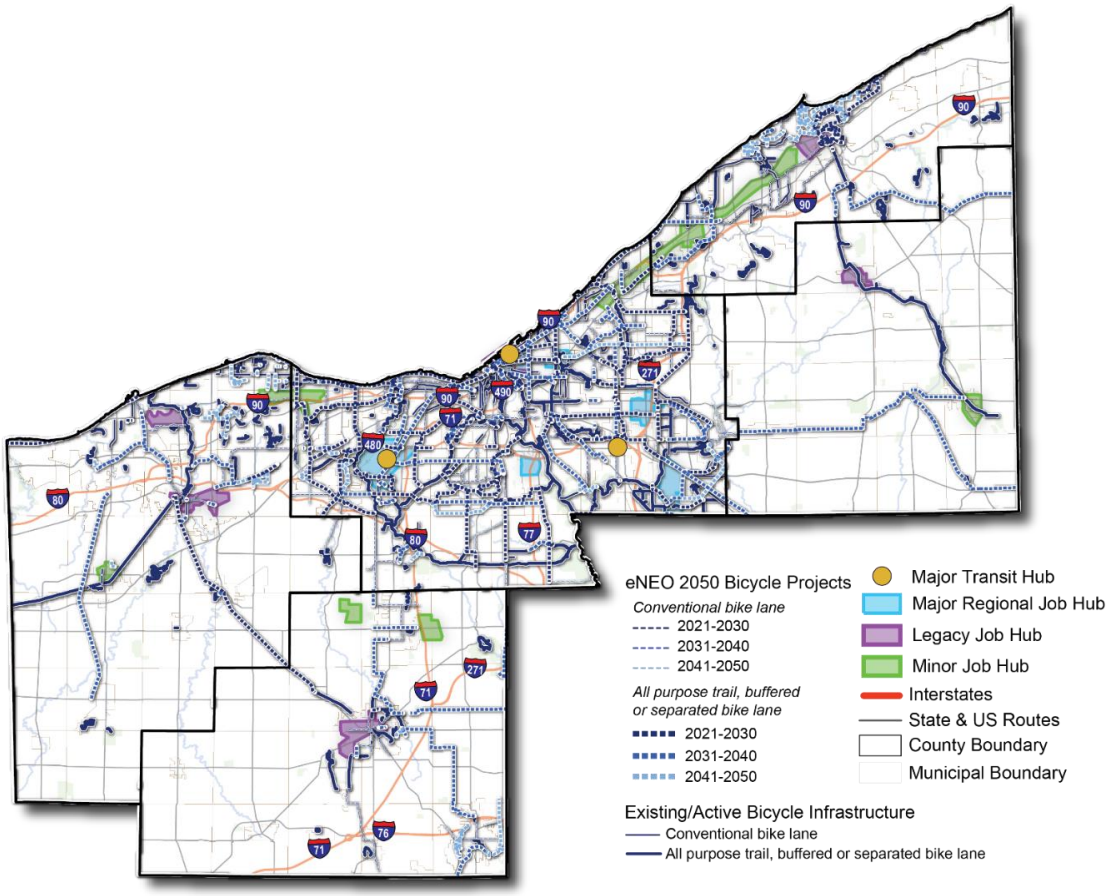
Walking Facilities	2020 - 2030	2030 - 2040	2040 - 2050	Total
Smart Pedestrian Crossing (Number)	50	50	0	**100**
ADA Curb Ramp (Number)	540	42	0	**582**
High-Visibility Crosswalk (Number)	5,858	301	0	**6,159**
Pedestrian Signal (Number)	4,058	166	0	**4,224**
Midblock Enhancements (Number)	89	15	0	**104**
Total Number	**10,595**	**574**	**0**	**11,169**

Table 7.2: Bikeway Facilities Based on *eNEO2050* Plan

Biking Facilities	2020 - 2030	2030 - 2040	2040 - 2050	Total
Conventional Bike Lanes (Miles)	17	206	45	**269**
Buffered Bike Lanes (Miles)	76	7	1	**84**
Separate Bike Lanes / Cycle Track (Miles)	15	16	0	**31**
All Purpose Trail (Miles)	205	252	85	**542**
Total Miles	**313**	**481**	**132**	**926**
Bike Storage Lockers (Number)	0	240	0	**240**

Map 7.1 illustrates the locations of the future bikeway facilities based on the *eNEO2050* Plan by decade.

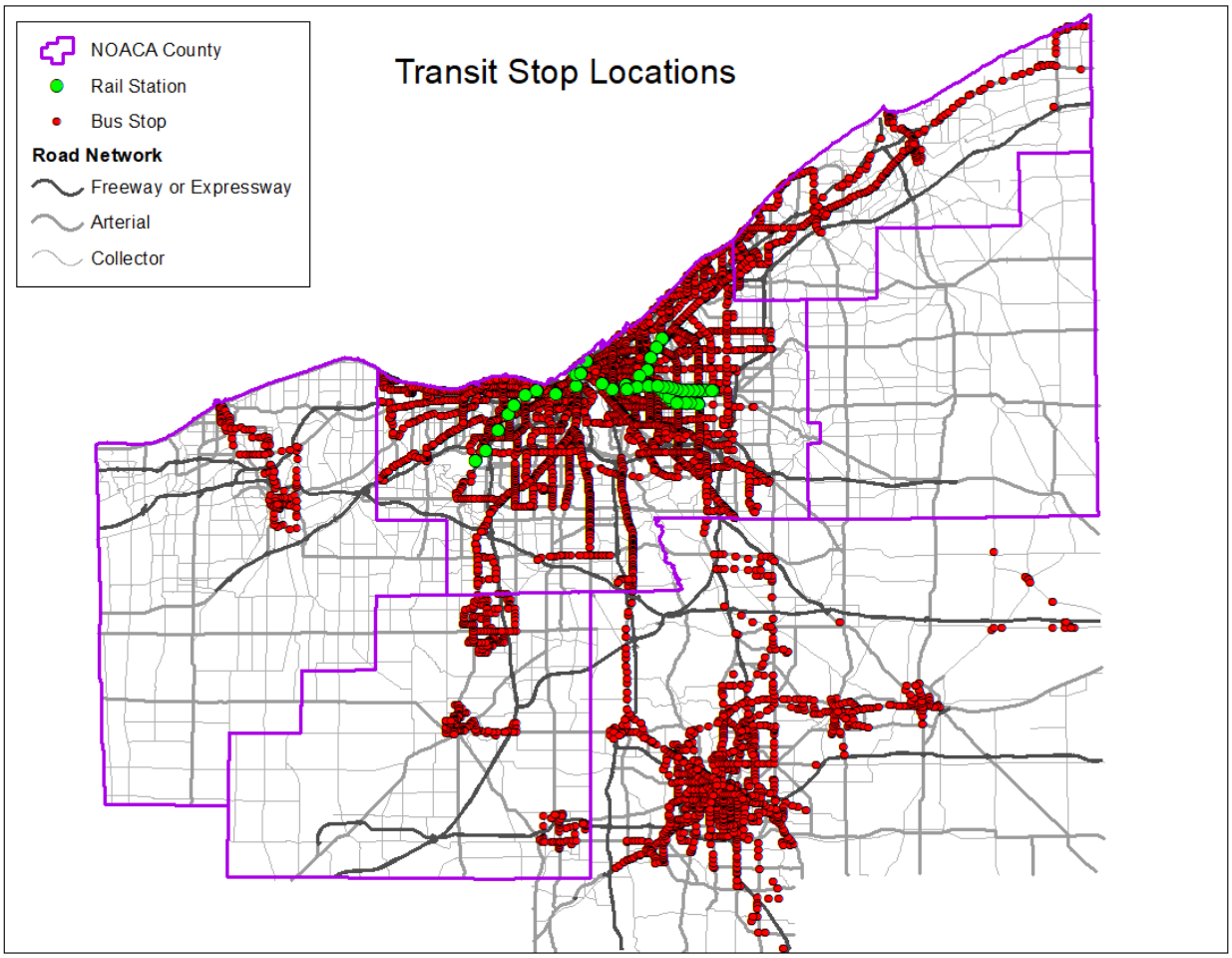
Map 7.1: Bikeway Facilities Based on *eNEO2050* Plan



7.2 Connectivity Quantitative Score (CSQ) Index

There are hundreds of transit stops in the NOACA region (shown in Map 7.2) of which a great proportion currently are not accessible by nonmotorized modes of travel safely and comfortably. Creating walking and biking connections to all stops will require a large amount of investment, and therefore, the NOACA ACTIVATE Plan is proposing a prioritization model for accessing transit stops by nonmotorized modes of travel. It is described in the following section.

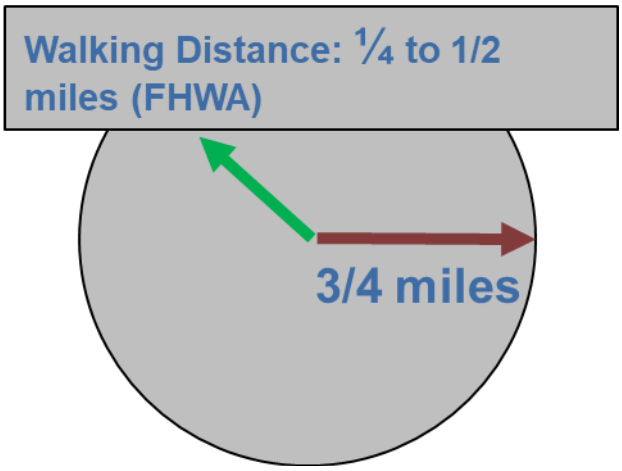
Map 7.2: Bus Stop and Rail Station Locations



The proposed prioritization model is based on a Connectivity Quantitative Scoring (CQS) index of bus stops and train stations. The estimated CQS indices of stops are used to prioritize the nonmotorized facility investments for accessing the transit network. A transit stop is quantitatively analyzed for walking and cycling modes separately. These indices generally reflect:

- Existing complete sidewalk infrastructures
- Existing bike infrastructure
- Low traffic stress roadways for nonmotorized modes of travel
- Signalized intersection density
- Close proximity of transit stops to origins and destinations of trips

CQS Walking Index: As discussed in Chapter Two, a reasonable distance to walk for utilitarian trips is about a half mile, with a maximum of three quarters of a mile. Therefore, this index is estimated based on a circular walk-accessible area with a radius of three quarters of a mile around a transit stop and using the following formula:

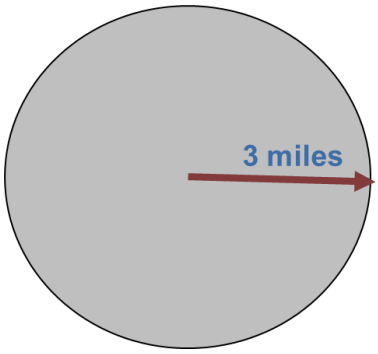


$$CQSWI = \frac{PT}{AT} + \frac{NSI}{NAI} + \frac{SML}{ASL}$$

Where

CQSWI: *CQS Walking Index*
PT: *Number of person trips produced from and attracted to the circular walk-accessible area of the stop by transit mode*
AT: *Number of all person trips produced from and attracted to the circular walk-accessible area of a stop by all modes*
NSI: *Number of signalized intersections within the circular walk-accessible area of a stop*
NAI: *Number of all intersections within the circular walk-accessible area of a stop*
SML: *Sidewalk and mid-blocking crossing length within the circular walk-accessible area of a stop (miles)*
ASL: *Sum of all street lengths within the circular walk-accessible area of a stop (miles)*

CQS Biking Index: This index is estimated based on a circular bike-accessible area with a radius of three miles around a transit stop and using the following formula:



$$CQSBI = \frac{PT}{AT} + \frac{\sum RLTS}{ASL} + \frac{DBL}{ASL}$$

CQSBI: *CQS Biking Index*
PT: *Number of person trips produced from and attracted to the circular bike-accessible area of the stop by transit mode*
AT: *Number of all person trips produced from and attracted to the circular bike-accessible area of a stop by all modes*
RLTS: *Sum of the ratio of each street length and its Level Traffic Stress (LTS) within the circular bike-accessible area of a stop*
ASL: *Sum of all street lengths within the circular bike-accessible area of a stop (miles)*
DBL: *Sum of the dedicated bike lanes within the circular bike-accessible area of a stop (miles)*

The connectivity index for a transit stop is the total of the CQS walking and biking indices:

$$CQSI = CQSWI + CQSBI$$

7.3 Guidelines for Trail Network Expansion

The NOACA ACTIVATE Plan recommends developing a connected trail network in the NOACA region for purposes of:

- Connecting regional origins and destinations by nonmotorized modes of travel
- Assisting and supporting the development of a true multimodal transportation system
- Increasing the share of the regional trail network for utilitarian trips
- Improving residential access to park areas and entrances with a strong focus on Environmental Justice communities for recreational pursuits and non-recreational usage
- Increasing nonmotorized modes of travel and support transit connectivity by focusing on first- and last-mile connections
- Improving safety for pedestrians and cyclists
- Reducing the transportation carbon footprint in the NOACA region
- Mitigating the negative impacts of traffic congestion

In addition to achieving the above goals, a trail network will be expanded primarily for non-motorized modes of travel usage and secondary for supporting the other modes of auto and transit. It should be noted that the connectivity attribute of the recommended trail network is an important aspect for planning a safe and optimal network for the nonmotorized modes of travel. NOACA is conducting a regional connectivity study for optimally extending the existing trail network in the Metroparks and other park areas in the NOACA region. The study will compare several possible connected trail networks. The following criteria will be used to select an optimal network.

- Connection of park areas to each other
- Provision of park access to residential neighborhoods
- Percent of the population within walking or biking access to the connected trail network
- Percent of the Environmental Justice communities within short walking or biking access to the connected trail network
- Percent of jobs within walking or biking distance to the connected trail network
- Percent of non-recreational trips using the trail network
- Percent of transit and nonmotorized work commute shares
- Access improvements to park entrance locations as needed
- Access to first- and last-mile connections from the trail network to transit
- Safety improvements based on the existing Federal Highway Administration (FHWA) Proven Safety Countermeasures
- Level of Traffic Stress (LTS) imposed on cyclists when connecting to the trail network
- Trail network benefits to the region based on emission reductions and mode shift
- Opportunity areas for bike and micro mobility parking
- Total cost of the trail network infrastructure

Developing a connected trail network will support a true multimodal transportation system and increase the share of the regional connected trail network for utilitarian trips. A connected trail network will also improve residential access to the park areas in the NOACA region.

A connected trail network will have higher health benefits if it focuses on connecting the Environmental Justice communities to park areas for recreational usages. A well-designed connected trail network will support complete transit connectivity and improve safety for pedestrians and cyclists. If the residents' daily trips are diverted to the developed trail network by using nonmotorized modes of travel, this will reduce the transportation carbon footprint and mitigate the negative impacts of traffic congestion.

The study will identify gaps caused by inadequate or unsafe infrastructure, including major obstacles to connections between park districts and trail networks, as well as barriers to safe and inclusive park access.

Finally, the optimal network will connect park areas to each other and also provide park access to residential neighborhoods. The study will also develop an implementation plan for extending the trail network in the three planning decades of 2020-2030, 2030-2040, and 2040-2050.

8. ESTIMATED BENEFITS OF INVESTMENTS IN NONMOTORIZED FACILITIES

It is widely accepted in literature that transportation is the second largest cost in the average American family's budget, largely because of the cost of car ownership. People who do not or cannot drive are often left with options that are slower, less safe, and inconvenient if they are available at all. For low-income NOACA residents, the high cost of car ownership means less money is available for housing, food, or health care. At the same time, many low-income residents pay to own and operate a vehicle because of the lack of jobs available within a reasonable walking, biking, or transit commute time in the NOACA region.

Investment in the transportation system generally boosts economic productivity, increases personal mobility, and consequently promotes quality of life. This section discusses the benefits of investment in infrastructure for nonmotorized modes of travel. As mentioned earlier, walking and cycling do not produce any emissions and not only consume no fuel, but also promote health.

Fuel and emissions are two primary cost items in the transportation system that place a burden on transportation users and residents in a region. Nonmotorized modes, however, heavily impact these cost items positively. These benefits can be used in a cost-benefit analysis in a transportation investment and compared with the benefits of the other modes of travel.

The following equations formulate the benefits of walking and cycling compared to the fuel and emission costs of automobiles.

- **Estimated reduction in fuel and emission costs of walking:**

$$ARFW = \frac{WWT \times DIST \times FCG \times DAC}{AAO \times MPG}$$

$$AREW = \frac{WWT \times DIST \times CE \times DAC}{AAO}$$

- **Estimated reduction in fuel and emission costs of cycling:**

$$ARFC = \frac{CWT \times DIST \times FCG \times DAC}{AAO \times MPG}$$

$$AREC = \frac{CWT \times DIST \times CE \times DAC}{AAO}$$

Where

ARFW: Annual Reduction in Fuel Cost of Walking ($)
AREW: Annual Reduction in Emission Cost of Walking ($)
ARFC: Annual Reduction in Fuel Cost of Cycling ($)
AREC: Annual Reduction in Emission Cost of Cycling ($)

WWT: Number of Daily Walking Work Trips
CWT: Number of Daily Cycling Work Trips

DIST: Distance between living and working locations, including return trips in miles
FCG: Fuel Cost per Gallon ($/Gallon)
DAC: Daily to Annual Conversion Factor
AAO: Average Auto Occupancy for work commutes
MPG: Average Miles a vehicle can travel on one gallon of fuel
CE: Costs of Emissions produced by a vehicle per Vehicle Mile Traveled ($/mile)

8.1 A Numerical Example of Benefits

According to the mode choice module of NOACA's travel forecasting model, there are more than 10,000 and 4,000 daily work trips by walking and cycling, respectively. Assuming:

- Auto fuel cost: $2.83 (2022$)
- Average traveled miles per a gallon of fuel: 24.04 miles
- Average walking distance for all trip purposes: 0.83 mile
- Average cycling distance for all trip purposes: 2.3 mile
- Average occupancy vehicle during the AM peak period: 1.21
- Average emission cost per each VMT: $0.02 (2022$)
- Number of working days in a year: 250 days

The total estimated annual reduction in fuel cost of work commutes in the NOACA region by walking and cycling modes is about $423,000 (2022$).

Also, the total estimated annual reduction in emission cost of work commutes in the NOACA region by walking and cycling modes is about $72,000 (2022$).

APPENDIX

1. Public Survey Results

The public survey was open from October to April 2020. The purpose of the survey was to understand how public perceptions of walking and biking in Northeast Ohio may differ based on the modes of transportation an individual uses. While many of the questions were geared toward those who walk and bike for transportation, the survey was publicized intentionally to gather a wide range of responses.

The survey was hosted on Survey Monkey, a free and mobile-friendly survey platform. A link to the survey was posted on the NOACA webpage and was publicized in many ways. Some of the methods used to publicize the survey were:

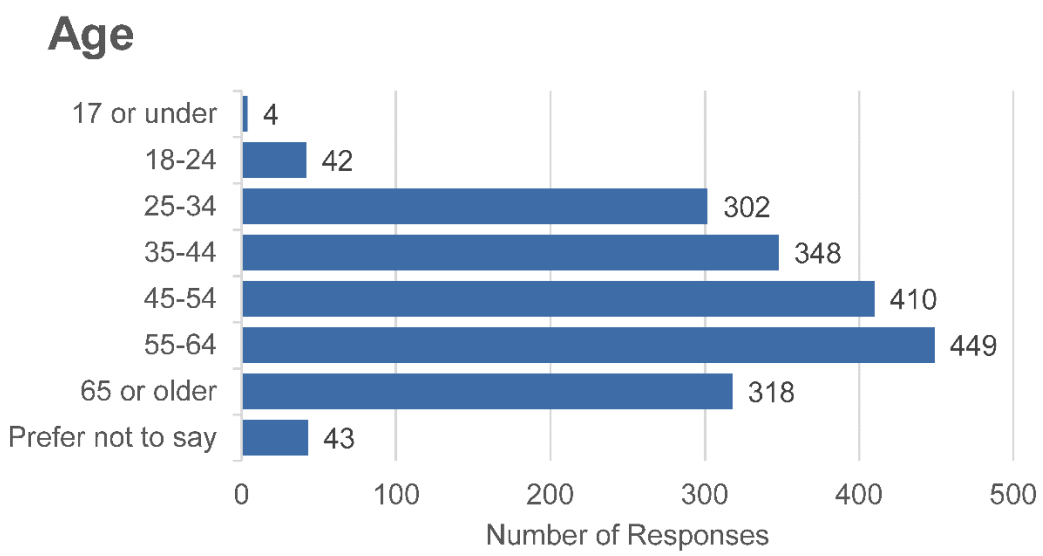
- Email messaging via the NOACA newsletter and staff communications
- Presentations to NOACA Advisory Councils, including Bike and Pedestrian, Safety and Operations, and Transit
- Community social media platforms
- NOACA homepage banner

Respondents

The survey received 1,916 responses. The survey had a 100% completion rate, meaning that everyone who started the survey submitted a response to every question. In addition to the results received online, 17 written responses were received from community organizers in the Asia-Town neighborhood of Midtown Cleveland. Community organizers shared the survey in-person with shoppers at an Asian grocery story, interpreting the survey questions into other languages when needed, and compiling the results. Because these results were not collected individually, but were summarized as one group, merging these results with the online responses was not possible.

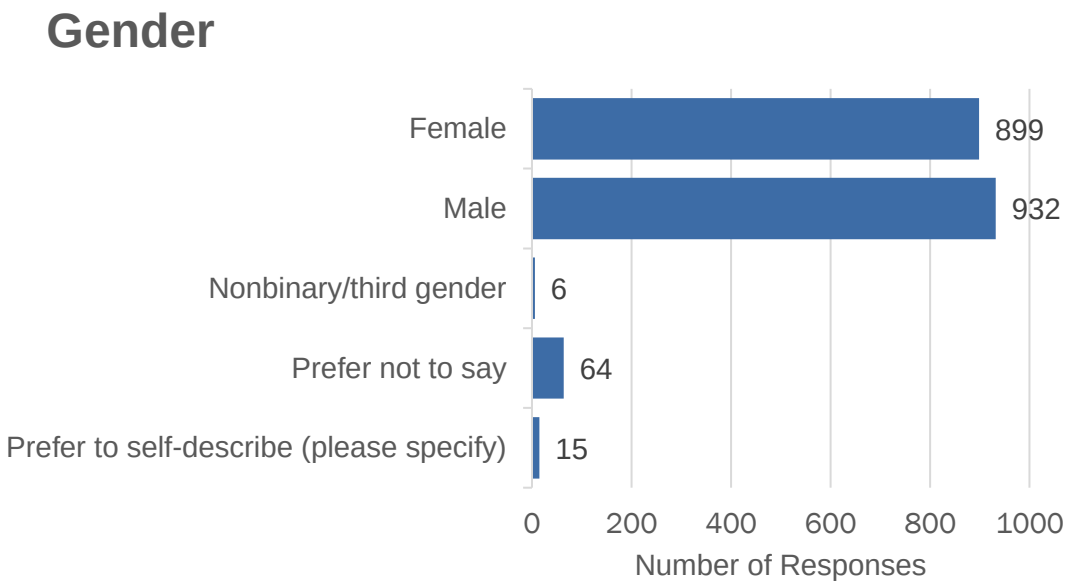
Age

The following chart shows the survey responses by age range. Most of the responses were from adults under 65. Just a small number (46) of responses came from people under age 25.



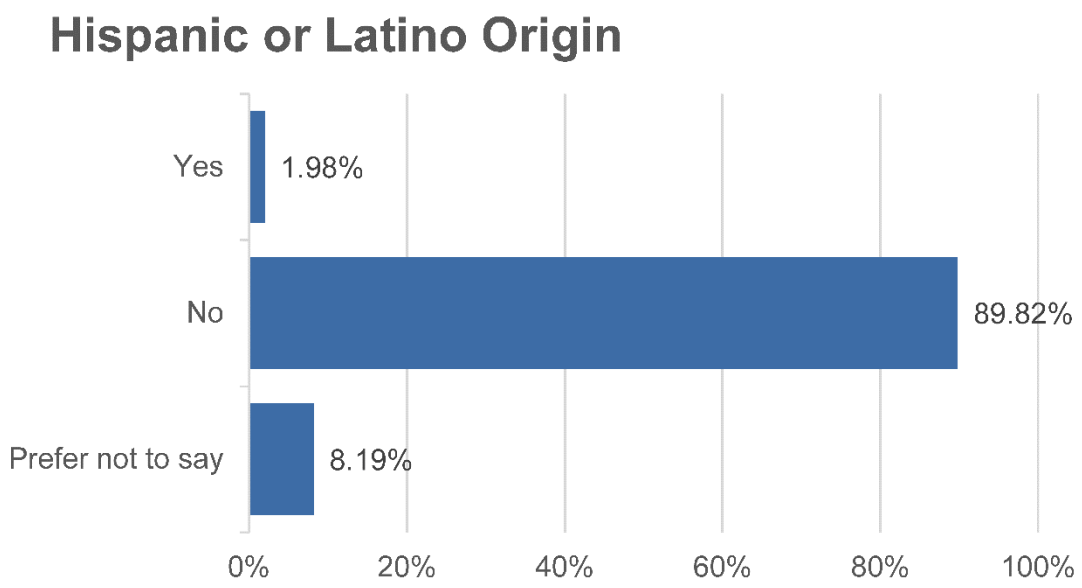
Gender

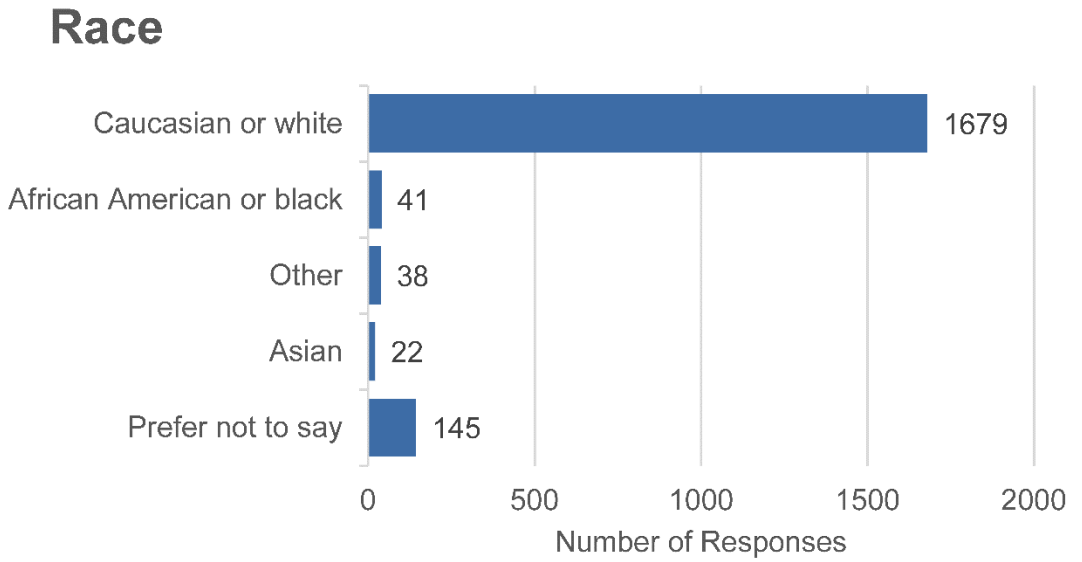
The following chart illustrates the survey responses by gender. Almost an equal number of males and females responded to the survey (899 and 932, respectively), while a small number (6) identified themselves as nonbinary or another gender identity.



Race and Hispanic or Latino Origin

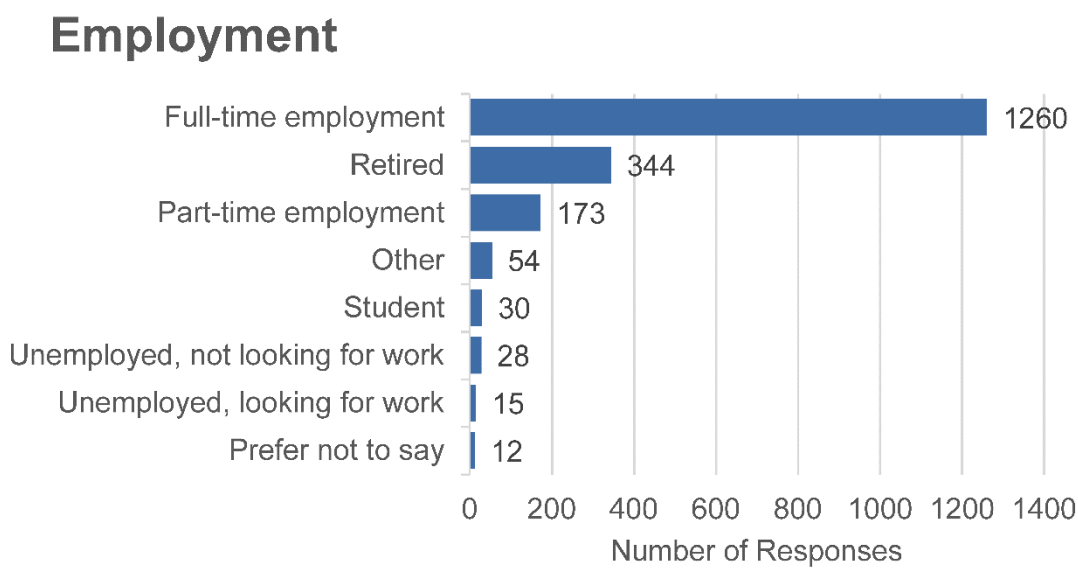
A vast majority of the survey respondents identified as white, and as shown, just 2% were African American or black. About 2% of responses were from people who identified as Hispanic or Latino.





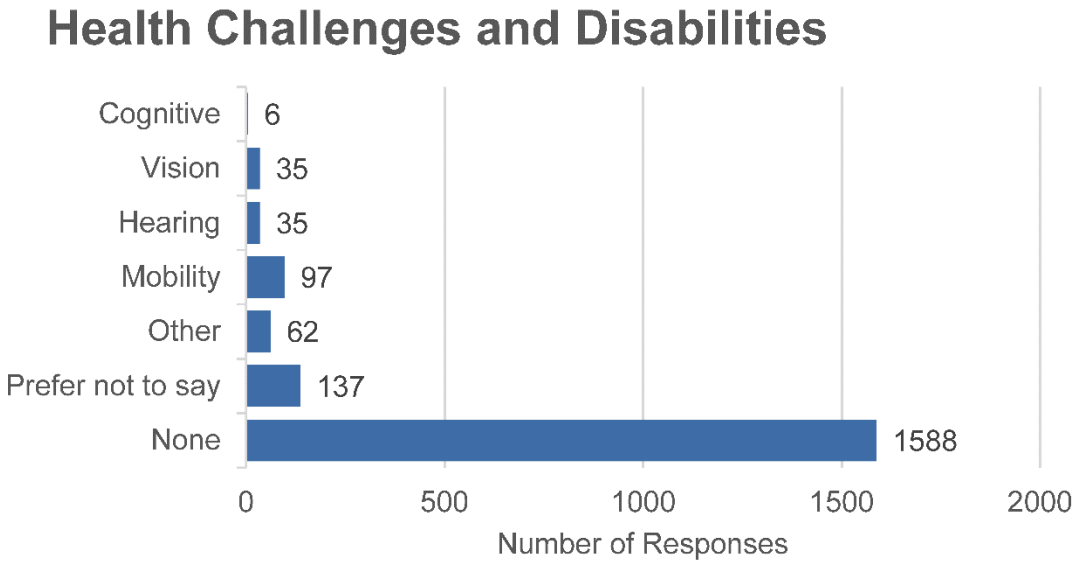
Employment Status

Employment is one way of understanding what the transportation needs may be of the survey takers. The following chart shows that most respondents were employed either full- or part-time. An additional 344 respondents were retired, while a smaller number were students or unemployed.



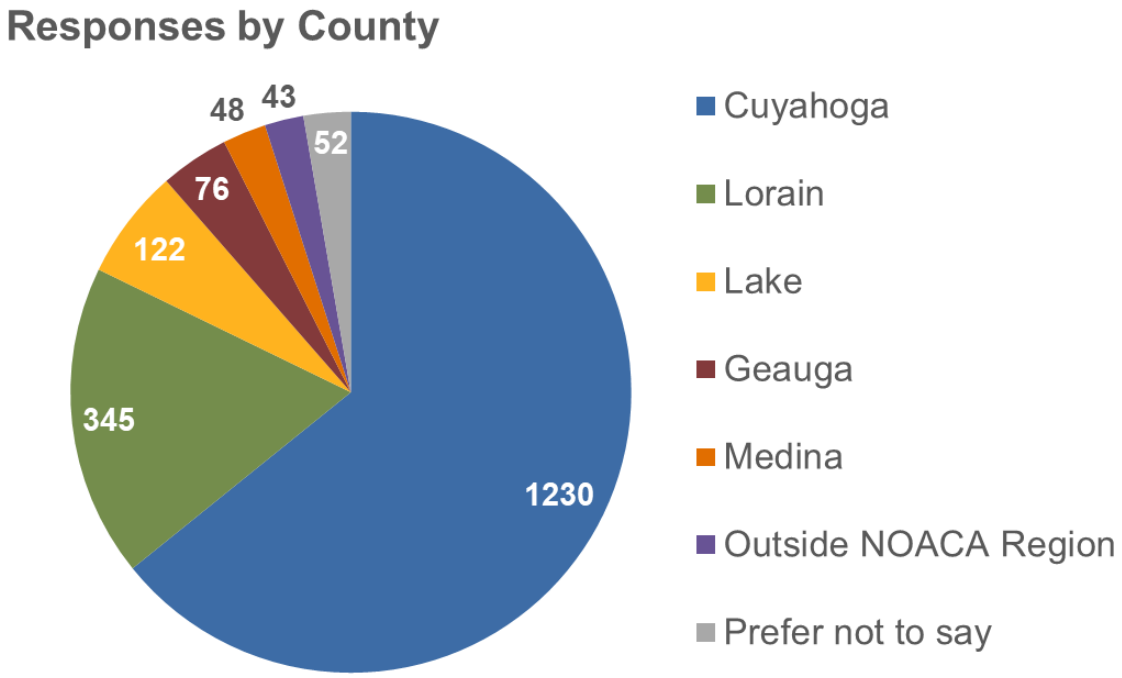
Disability Status

The following chart illustrates that most respondents did not have a disability that prevented them from walking or biking, or made walking or biking more difficult. The most frequent disability cited was mobility (97 responses). Responses provided in the “other” category included advanced age and asthma.



County

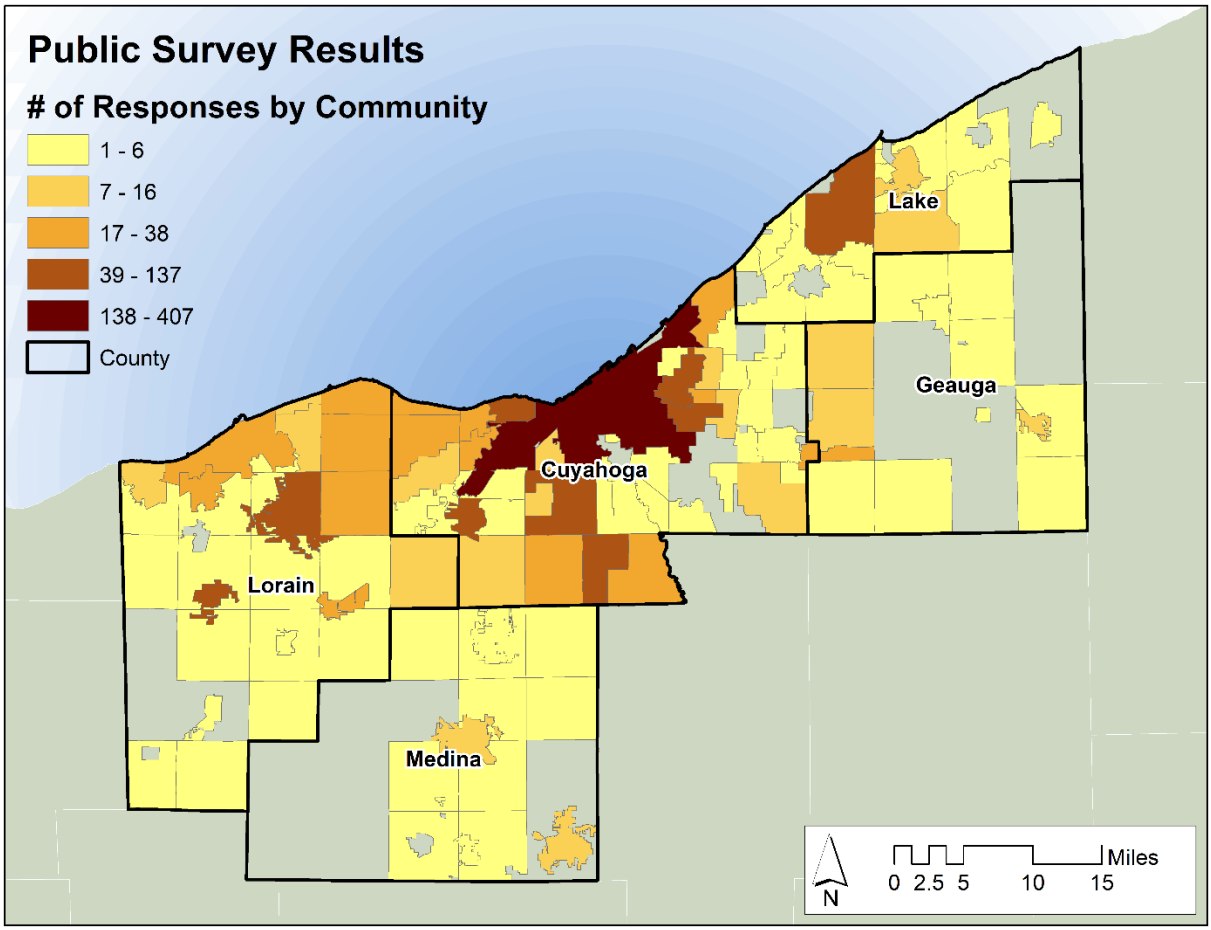
The following chart and table show the percentage of respondents' residencies by county.



County	Percent of Respondents
Cuyahoga	64%
Lorain	18%
Lake	6%
Geauga	4%
Medina	3%
Outside NOACA	2%
Prefer not to say	3%

Represented Communities

About 97% of survey respondents provided the name of a city, village, or township where they live. Responses from inside the NOACA region are shown on this map.



2. **Bicycle and Pedestrian Data Collection**

Findings based on manual count data gathered between September 2011 and September 2018 include the following.

Overall Bike Count Trends

- **5% Increase in cyclists since 2012 based on 20 locations counted in 2012 – 2013 and 2017 – 2018.**
- **70% of locations stable or trending positively for the number of cyclists counted since 2011, based on trend lines for locations counted at least three times.**

Cycling and Gender

- **23% of cyclists were identified as female. This is below the national rate (29%).**

Helmet Usage

- **49% of cyclists were wearing a helmet. This is above the 46% of riders nationally who wear a helmet at least sometimes.**

Effects of Weather

- **26% fewer pedestrians when the weather is poor.**
- **28% fewer cyclists when the weather is poor.**

Roadway and Bike Lane Usage

- ### Presence of Bike Lane
  - **50% used the road when no bike lanes were present.**
  - **79% used the road when bike lanes were present.**

- ### Effects of Traffic Stress
  - **35% used the road when it was a principal arterial with no bike lanes.**
  - **77% used the road when it was a local road with no bike lanes.**

NORTHEAST OHIO
Lake
Geauga
Cuyahoga
Lorain
Medina
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