

*Planning for Complete Communities in Delaware:*

# Research to Develop the Low-Stress Bikeability Assessment Tool

*March 2016*

*Written by*

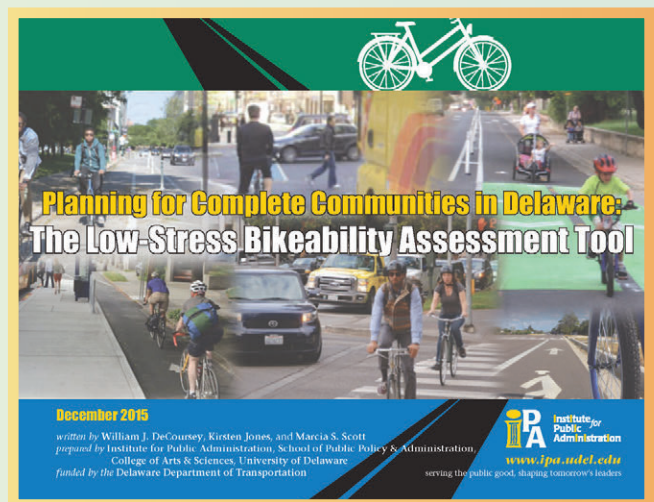
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**Institute for Public Administration**  
School of Public Policy & Administration  
College of Arts & Sciences  
University of Delaware

*For the*

Delaware Department of Transportation



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*serving the public good, shaping tomorrow's leaders*

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Delaware Department of Transportation

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## Preface

As the Director of the Institute for Public Administration (IPA) at the University of Delaware, am pleased to provide this white paper, which provides outcomes of the research used to prepare ***Planning for Complete Communities in Delaware: The Low-Stress Bikeability Assessment Tool***. The tool is available online as a downloadable document at: <https://goo.gl/xf0ajZ>.

The *Low-Stress Bikeability Assessment Tool* is a resource for Delaware local governments that are considering ways to improve the low stress bikeability for areas within their communities. It is designed to guide local governments in evaluating the extent to which average bicycle riders can easily access low stress areas, and developing strategies to leverage state investments to improve local cycling networks and bicycle infrastructure. The tool is designed for use in tandem with the Delaware Department of Transportation's (DelDOT) new method for modeling the state's low stress bicycling network, which is slated to become part of DelDOT's project prioritization process.

Preparation of this assessment tool is part of a larger *Planning for Complete Communities in Delaware* initiative that is an ongoing collaboration between IPA and the Delaware Department of Transportation (DelDOT), which provided funding for this project. Associate Policy Scientist William DeCoursey, Public Administration Fellow Kirsten Jones, and Policy Scientist Marcia Scott comprised the project team that researched several low stress approaches to attract the mainstream population in Delaware to bicycle networks, gained input from stakeholder groups, and prepared the assessment tool. In addition to being available as a downloadable publication, new "Low Stress Bikeability" content has been added to IPA's Delaware Complete Communities Toolbox ([www.completecommunitiesde.org/](http://www.completecommunitiesde.org/)) and may be viewed under the Complete Streets element of the Planning Tools section.

I hope that local government officials and stakeholders will use this assessment tool to plan for complete communities that provide complete streets and active transportation opportunities. Bicycle networks that are designed for everyone, provide connected routes, and offer low stress traffic conditions will foster biking as a viable choice for transportation in Delaware.

Jerome R. Lewis, Ph.D.  
Director, Institute for Public Administration

## Acknowledgements

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Dover/Kent County MPO's Technical and Public Advisory Committees

Walkable & Bicycle Friendly Communities Committee of the Governor's Delaware Council

Health Promotion and Disease Prevention (CHPDP)

Newark Bicycle Committee

State of Delaware Pedestrian/Bicycle Safety Working Group

WILMAPCO's Nonmotorized Working Group



## Table of Contents

Preface.....	i
Acknowledgements .....	ii
Table of Contents .....	iii
1. Executive Summary .....	1
2. Introduction.....	2
2.1 Problem Statement.....	2
2.2 Low Stress Cycling Approach .....	3
2.3 Research Objectives and Methodology .....	3
3. National and Statewide Policy Support for Bikeability.....	6
3.1 National Level Support .....	7
3.2 Support for Bike Friendly Environments in Delaware.....	8
4. Options for Assessing Bikeability.....	14
4.1 Bicycle Safety Index Rating .....	14
4.2 Bicycle Stress Level .....	14
4.3 Bicycle Compatibility Index .....	14
4.4 Access to Destination Studies .....	15
4.5 Bicycle Level of Service .....	15
4.6 Low Stress Cycling Approach .....	17
5. The Low Stress Cycling (LSC) Approach .....	18
5.1 Low Stress Cycling Goals in Relation to Walkability .....	18
5.2 How Is Low Stress Cycling Measured?.....	18
5.3 Classifications of Users.....	18
5.4 Classifications of Roadways .....	21
5.5 Designing for Low Stress Cycling .....	22
5.6 Connectivity Barriers.....	22
5.7 Assessing Low Stress Bikeability in Delaware .....	25
6. Infrastructure Designs for Low Stress Cycling .....	29
6.1 Sharrows .....	29
6.2 Bicycle Boulevards .....	29
6.3 Shouldered Bikeways .....	30
6.4 Bike Lanes .....	30
6.5 Cycle Tracks.....	31
7. Profile of No or Low Choice Bicycle Riders.....	33

7.1	National Characteristics of No and Low Choice Bicycle Riders.....	34
7.2	Delaware Characteristics of No and Low Choice Bicycle Riders .....	35
8.	Outreach on Community Assessment Tool Options.....	40
8.1	Phase 1 Outreach.....	41
8.2	Phase 2 Outreach.....	41
8.3	Phase 3 Outreach.....	43
9.	Development of Low Stress Bikeability Assessment Tool .....	45
9.1	Three Step Process .....	45
9.2	Dissemination of Tool .....	46
10.	Appendices .....	47
	Appendix A: Level of Detour	
	Appendix B: Illustration of Low Stress Cycling (LSC) Facility Types	
	Appendix C: Outreach – Governor’s Delaware Council on Health Promotion and Disease Prevention	
	Appendix D: Questionnaire – LSC Approaches	
	Appendix E: Display/Handout – LSC Approaches	
	Appendix F: Presentation to Dover/Kent County MPO Committees, Newark Bicycle Committee, and State Pedestrian/Bicycle Safety Working Group	
	Appendix G: Assessment Tool Options	
	Appendix H: Newark Bicycle Committee Meeting Notes	
	Appendix I: Summary Notes from Dover/Kent MPO PAC & TAC	
	Appendix J: Summary Notes from State Pedestrian/Bicycle Safety Working Group	
	Appendix K: Low and o Choice Rider Basemaps	
	Map – Households with No Vehicles	
	Map – Household Poverty Rate	
	Map – Worker to Vehicle Deficit	
	Appendix L: References	

# 1. Executive Summary

The state of Delaware has long recognized the benefits of developing an integrated multi modal transportation system. State policies and legislation—including the statewide bicycle policy (2000), Complete streets policy (2010), Vulnerable Users Law (2010), Walkable Bikeable Delaware (2011), and First State Trails and Pathways Initiative (2011)—have set the stage for the development of comprehensive, statewide bicycle network. Delaware has strategically invested considerable state and federal funding to create an interconnected network of on road bicycle facilities, shared use trails, and pathways to advance non motorized travel and recreation opportunities for Delawareans and visitors.

Delaware is recognized as one of the nation’s most bicycle friendly states thanks to its supportive policy framework, advocacy from partner organizations, education, and outreach. Despite considerable investments in developing Delaware’s bicycle network and strong support for cycling, barriers to bikeability still exist. Research on low stress cycling (LSC) suggests that simply providing bicycle facilities—such as bike lanes—does not ensure that the facility is accessible or riders will experience safe and comfortable conditions. If bicyclists are riding on a road or experience high stress cycling conditions, the facilities will not be used—regardless of how well transportation infrastructure is planned, designed, built, or maintained.

This report provides an overview of the process used by the Institute for Public Administration (IPA) at the University of Delaware to develop *Planning Complete Communities in Delaware: The Low-Stress Bikeability Assessment*. To prepare the tool, IPA’s research team conducted a literature review of bikeability assessment approaches. The review focuses on “Level of Traffic Stress” (LTS) analysis. Developed by Dr. Peter Furth, this relatively new quantitative method is designed to rate the bikeability of roads, streets and pathways. Using a simple scale from 1 to 4, a LTS analysis considers how bicycle riders with diverse skill levels interact with the roadway, tolerate traffic stress, and make trips under low traffic stress conditions.

The Delaware Department of Transportation (DelDOT) recently implemented LTS analysis to help plan effective, safe, and well connected bikeway networks. This report explores how community assessment tools can be used in conjunction with DelDOT’s low stress bicycle network modeling to engage community stakeholders in a process of evaluating existing facilities and constraints to low stress bicycling in Delaware. Finally, it provides the context used to develop *Planning for Complete Communities in Delaware: The Low-Stress Bikeability Assessment Tool* (<https://goo.gl/xf0ajZ>). The downloadable document, designed for use by Delaware local governments, can be found within the “Low Stress Bikeability” section of the *Delaware Complete Communities Planning Toolbox* (<http://goo.gl/n7RbnZ>).

## 2. Introduction

### 2.1 Problem Statement

Historically, transportation planning, policy, and investments have focused on auto centric roadway improvements. After decades of building car oriented roadway networks, many streets lack connectivity and do not safely accommodate pedestrians or bicyclists. Individuals from no car households, students, migrant or seasonal workers, youth, and people who are unable to drive (for various reasons)—or “no choice” bicyclists—face substantial challenges and transportation inequities in such a car dominated culture. In recent years, a new transportation policy and planning framework—called complete streets—has emerged that focuses on moving people instead of cars. This framework emphasizes the need for transportation systems to be designed, constructed, and maintained to meet the needs of roadway users of all ages and abilities including motorists, pedestrians, bicyclists, and transit users.

Yet, new research shows that if bicyclists fear riding on a road, or experience high stress cycling conditions, the facilities will not be used—regardless of how well transportation infrastructure is planned, designed, built, or maintained. Even if a bike lane is available, a high Level of Traffic Stress (LTS) may deter use by a bicyclist with average skills.

*The chief deterrent to riding a bike in the United States is the high stress of riding without protection from the danger of fast traffic, or, more briefly, traffic stress. Some streets have low traffic stress, while others have high stress. Sometimes a treatment such as bike lanes is effective in eliminating most of the traffic stress; but other times even where there's a bike lane, it can be very stressful.*

— Peter G. Furth, Ph.D.,  
Professor of Civil Engineering at Northeastern University

Delaware is taking great strides to advance a multi modal transportation system. In the past several years, Governor Jack Markell's administration has approved funding that supports the development of an interconnected network of shared use trails, pathways, and on road facilities that provide non motorized travel and recreation opportunities. Delaware has also achieved top ranking and is recognized as one of the nation's most bicycle friendly states. However, the safety of bicyclists remains a concern. Improving the safety, accessibility, and connectivity of Delaware's transportation system is paramount to addressing high stress conditions that may discourage the average bicycle rider.

## 2.2 Low-Stress Cycling Approach

New research asserts that the most fundamental need in a bicycling network is low stress conditions and connectivity (Furth and Maaza, 2013). The transportation system needs to provide routes between origins and destinations that do not require cyclists to exceed tolerable levels of traffic stress or considerable detours. High stress streets are considered to be those with high speed limits, limited or non-existent lanes/markings and signage, and long distances to cross at intersections. While transportation agencies make bicycle facility related improvements to make bicycling safer and more appealing, these improvements may not represent the network of paths or roadways that people consider to be safe for bicycling. Research points to the need to consider connectivity, levels of a street network's stressfulness, and the classification of populations according to tolerance for traffic stress as critical aspect of bicycle network planning.

The state of Delaware has developed a plan and policy framework that supports a multi-modal transportation system. The League of American Bicyclists named Delaware as the third best Bike Friendly State in the United States in recognition of the state's supportive policies, dedicated funding for bicycle facilities, safety campaigns, and strong advocacy. In 2014, the Delaware Department of Transportation (DelDOT) contracted with Dr. Peter Furth, a co-author of the "Low Stress Bicycling and Network Connectivity" study, to consult in the implementation of a new method for modeling Delaware's low stress bicycle network. As a result, DelDOT has initiated low stress bicycle network modeling as a method to measure low stress connectivity that can be used to evaluate and guide bicycle network planning in Delaware. The modeling tool, and corresponding maps of Delaware's low stress bicycle networks, will help to inform DelDOT's project prioritization process. The extent to which a prospective infrastructure project can improve bicycle route linkages, access, and trip connectivity to origins/destinations—while reducing the level of stress for an average bicyclist—may be viewed more favorably in a highly competitive project prioritization process for inclusion in a Transportation Improvement Program (TIP).

## 2.3 Research Objectives and Methodology

While DelDOT's low stress bicycle network modeling provides critical and quantifiable data, local public involvement is also needed. Involving the local stakeholders in a low stress bicycle network planning process is essential to inform the prioritization of bicycle infrastructure/facility improvements, as well as programs and policies of education, enforcement, and advocacy. Local knowledge can "ground truth" quantitative data and address information gaps on barriers to bikeability, top safety concerns, problem areas, key origins/destinations for bicycle travel, suggestions for bicycle route connectivity, and locations lacking bicycle facilities (e.g., bicycle parking or storage). Public engagement and involvement

provides an opportunity to identify champions who can help build support for local plans, policies, funding, and advocacy to improve bicycle network conditions and connectivity.

DelDOT has piloted the use of WikiMapping, an online, crowdsourcing public engagement tool that utilizes maps and surveys, to obtain feedback on challenges and experiences from bicyclists to plan for bicycle route improvements. In addition to crowdsourcing tools, other communities have utilized social media platforms, checklists, LTS analyses, bicycle facilities inventories, traffic engineering approaches, and/or a combination of techniques to gather information and plan for bicycle system improvements.

This report provides an overview of the low stress cycling methodology as a quantitative tool to determine LTS designations for bicycle route segments and intersections. It highlights the need to identify low or low choice bicycle riders, who rely on this mode of transportation. It also explores how community assessment tools can be used in conjunction with DelDOT's low stress bicycle network modeling to engage community stakeholders in a process of evaluating existing facilities and constraints to low stress bicycling in Delaware. Finally, it provides the context used to develop *Planning for Complete Communities in Delaware: The Low-Stress Bikeability Assessment Tool* (<https://goo.gl/xf0ajZ>). The downloadable document, designed for use by Delaware local governments, can be found within the "Low Stress Bikeability" section of the *Delaware Complete Communities Planning Toolbox* (<http://goo.gl/n7RbnZ>).

## Scope of Work

### *Literature Review*

With an end goal of developing a low stress bikeability assessment tool for use by Delaware communities, the project team's scope of work consisted of three primary tasks. First, IPA project team members conducted a review of relevant literature on the national and state policy frameworks in support of bikeability, options to assess bikeability of a transportation network, the low stress cycling approach to assessing bikeability, and the use of community assessment tools. An overview of literature review outcomes summarizes approaches to bicycle network planning that (1) considers the need to reduce the level of stress for an average bicyclist and (2) addresses the needs of "low or low choice bicycle riders," or individuals who may ride bikes as a primary mode of transportation. Geospatial analysis and mapping are provided for likely locations of low and low choice bicycle riders in Delaware.

### *Outreach on Community Assessment Tool Options*

Second, IPA's project team conducted outreach to obtain public and expert input on the use of community assessment tools, which can augment DelDOT low stress mapping, to improve low stress bike connections in Delaware. Originally, the team had planned to form and convene a

working group of various stakeholders involved in enhancing non motorized transportation options, health promotion, pedestrian and bicycle safety, municipal government, and transportation planning in Delaware. However, the team determined that three phases of outreach would best obtain stakeholder input on low stress bikeability needs and initiatives, favored data collection approaches, and the preferred format of a low stress bikeability assessment checklist for Delaware communities.

### *Develop Tool*

Outcomes of the literature review, research on bikeability assessment tools, and outreach on community assessment tool options were used to develop *Planning for Complete Communities in Delaware: The Low-Stress Bikeability Assessment Tool*. Available online via the *Delaware Complete Communities Planning Toolbox*

([www.completecommunitiesde.org/planning/complete streets/low stress bike/](http://www.completecommunitiesde.org/planning/complete%20streets/low%20stress%20bike/)), the resource is designed to assist Delaware local governments that are considering ways to improve the low stress bikeability for areas within their communities. It is designed to guide local governments in evaluating the extent to which average bicycle riders can easily access low stress areas and in developing strategies to leverage state investments to improve local cycling networks and bicycle infrastructure. It is intended to be used in combination with DelDOT's low stress bikeability maps to help communities target high priority locations to plan for infrastructure improvements, bridge network connectivity gaps, and reduce levels of traffic stress for the average bicyclist.

### 3. National and Statewide Policy Support for Bikeability

Bicycling makes up a small portion (less than 1 percent) of all commuting trips in the United States. However, cycling for recreation, health, and transportation purposes has experienced a surge in popularity in the last several years. Updated bicycling commuting data, released in 2014 by the American Community Survey, reports that commuting to work by bike is on the rise nationwide. Substantial growth in commuting by bike has been realized in communities that support Complete Street policies and invest in non motorized transportation options (McKenzie, 2014). The report notes that:

- The U.S. Census Bureau estimates that there were 882,198 bicycle commuters in 2013.
- Approximately 0.62 percent of commutes are made by bicycle in 2013, which represents a modest 0.5 percent increase from 2012.
- Commuting by bicycle experienced a larger percentage increase than that of any other commuting mode in the last decade—up 2 percent from 2000 to 2008–2012.
- The combined rate of bicycle commuting for the 50 largest U.S. cities increased from 0.6 percent in 2000 to 1.0 percent in 2008–2012.
- Commutes by car or public transit are often supplemented by non motorized travel modes (McKenzie, 2014).

Improving conditions, infrastructure, and opportunities for walking and bicycling, as well as integrating walking and bicycling into local transportation networks, is critical to instituting complete streets. Yet investments and improvements to bicycle infrastructure and facilities may not be enough to ensure that cycling is a safe, convenient, and fun transportation option. At a gathering of American mayors in 2015, U.S. Transportation Secretary Anthony Foxx reported that bicyclist deaths increased by 15 percent between 2009 and 2014 (Vock, 2015). The Governors Highway Safety Association reports that 722 bicyclist deaths occurred in 2012, up 6 percent from 2011 and 16 percent from 2010 (Williams, 2014). In 2012, the national bicyclist death rate was approximately 2.3 deaths per 1 million.

According to a report by the League of American Bicyclists, while Delaware ranks 31<sup>st</sup> among states for bicycle commuting mode share, it has experienced a 35 percent increase in total bicycle commuting from 2005 to 2012. Yet, on a per capita basis, Delaware recorded an annual average of about 2.2 cyclist deaths per million residents, ranking 11<sup>th</sup> among all states (Governing.com, 2014). Low stress cycling may be an ideal approach to assess the safety of bicycle network conditions and connectivity in order to foster safe, connected travel by bicycle.



### 3.1 National-Level Support

Creating connected transportation networks is one of four overarching policy priorities for the U.S. Department of Transportation (US DOT). Federal legislation and regulations require inclusion of convenient, safe, accessible, and context sensitive bicycle and pedestrian components into all transportation plans and project to meet the needs of people of all ages and abilities. Recent federal policy initiatives have increased an emphasis on bikeable environments, or “bikeability,” which describes the extent to which individuals feel comfortable navigating their community by bike.

In 2010, the US DOT issued a policy statement that articulates the need to develop fully integrated active transportation systems that includes bicycling facilities and networks (FHWA, 2010). The policy encourages transportation agencies to plan, fund, and implement improvements to their walking and bicycling networks, including linkages to transit. Federal statutes also require state transportation agencies and metropolitan planning organizations (MPOs) to integrate walking and bicycling facilities and programs in their transportation plans “to ensure the operability of an intermodal transportation system.”

The Federal Highway Administration (FHWA), an agency within US DOT, supports a flexible approach to bicycle and pedestrian facility design. It advocates the use of American Association of State Highway and Transportation Officials’ (AASHTO) *Guide for the Development of Bicycle Facilities* as the primary national resources for planning, designing, and operating bicycle and pedestrian facilities. It also advocates the use of provisions within the federal *Manual of Uniform Traffic Control Devices* and the National Association of City Transportation Officials’ (NACTO) *Urban Bikeway Design Guide* to build upon the flexibilities provided in the AASHTO guide. These resources support a framework to plan and design safe and convenient facilities for bicyclist and non motorized transportation networks (FHWA, 2013).

US DOT has also launched a comprehensive and coordinated approach to improve pedestrian and bicycle safety. The strategy promotes design improvements to ensure safe and efficient routes for pedestrians and bicycles, promote behavioral safety, and provide education to help individuals make safer travel choices. The national safety campaign, Toward Zero Deaths, articulates the goal of “working toward no fatalities across all modes of travel” (TowardZeroDeaths.org, 2014).

### 3.2 Support for Bike-Friendly Environments in Delaware

A bicycle friendly community has essential elements across five categories known as the “Five Es” (The League of American Bicyclists, n.d.):

1. **Engineering** – Presence of infrastructure that provides an interconnected and well maintained bicycling network.
2. **Education** – Delivery of a bicycle safety education program that builds cycling skills, provides training, and improves awareness of cycling/motorist rights and responsibilities.
3. **Encouragement** – Institution of a strong bike culture.
4. **Enforcement** – Adoption and enforcement of laws to treat bicyclists equitably within the transportation system.
5. **Evaluation and planning** – Creation of an interconnected and well maintained cycling network that emphasizes short trip distances, fosters multi modal trips, and integrates educational programs.

#### Delaware’s Policy Framework Support

The State of Delaware has long recognized the benefits of developing an integrated multi modal transportation infrastructure to improve the economic and environmental sustainability of communities and quality of life for all Delawareans. The state has prioritized the need to plan for an integrated, non motorized pathway and recreational

trail network for recreational and transportation purposes. In 2015, Delaware earned the rank from the League of American Bicyclists as the third best Bike Friendly State in the United States thanks to state policies, dedicated funding for cycling projects, safety campaigns, and strong advocacy (The American League of Bicyclists, 2014 a).

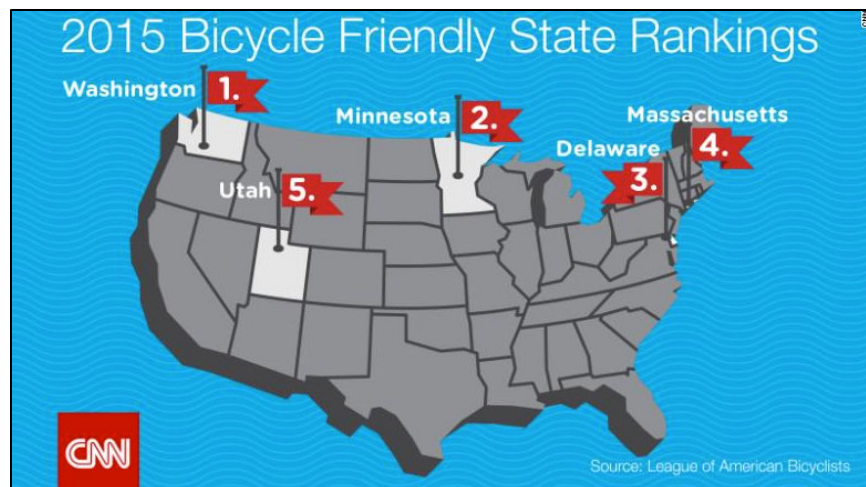


Figure 1: 2015 Ranking of Delaware as Third Most Bicycle Friendly State (League of American Bicyclists)

Delaware has worked for over two decades to improve bikeability in Delaware. Consistent with federal transportation investment policies and directives, DelDOT has shifted from away from

an auto centric transportation system to one that provides safe, efficient, and multi modal options. Formed in 1990, the Delaware Bicycle Council has been instrumental in integrating bicycling into Delaware's transportation network. Appointed by the governor, its members consist of state agency officials and private citizens who are charged with reviewing and improving upon bicycling, bicycle safety, and bicycle safety education in Delaware. In 1995, Statewide Facilities Master Plan was approved that recognizes bicycling as an integral part of the transportation system and includes bicycles within transportation planning. DelDOT appointed its first bicycle/pedestrian coordinator in 2001 to address transportation issues of non motorized users. Delaware's strong policy framework for bikeability includes adoption/implementation of:

### *Delaware's Safe Routes to School (SRTS) Program*

This program was established in 2002 to allocate state funding toward infrastructure projects that directly supported increased safety and convenience for elementary and middle school children to bicycle or walk to and from school.

### *Statewide Bicycle Policy/Plan*

Issued in 2000, this policy preserves a minimum of a five foot wide shoulder for cyclists as the transportation system expands and encourages the placement of new facilities in transportation improvement projects.

The Delaware Bicycle Facility Master Plan was subsequently adopted in 2005 to define and implement a statewide system of designated on road bicycle routes. It states, "his Bicycle Facility Master Plan was developed in order to implement the Bicycle Policy and to provide more specific guidance as to the location and nature of 'appropriate accommodations' along DelDOT maintained roadways" (DelDOT, 2005, ). The facility plan set forth three primary goals:

1. Integrate existing bicycle routes and trails into a larger statewide bicycle network.
2. Establish bicycle routes among municipalities, activity centers, and recreational areas.
3. Improve local cycling conditions through consideration of bicycle facilities in all DelDOT roadway projects.

In addition to developing a statewide system of on road bikeways, it provided corresponding design recommendations for three types of bikeway designations: bike lanes, shared shoulders, and wide outside travel lanes. DelDOT subsequently updated its bicycle maps for each county in 2011. The maps identify locations of statewide routes, regional routes, and recreational connector routes that may provide accommodations and connectivity to achieve a statewide

system of on road bikeways. Not all bicycle routes identified had bicycle facilities or segments suitable for an average cyclist.

### *Delaware Rail-to-Trail/Rail-with-Trail Facility Master Plan*

Adopted in 2006, this plan identified 11 railroad corridors for potential off road bicycle and pedestrian use. It evaluated the potential for rail–trail corridors to provide interconnectivity “with the existing and proposed statewide trail systems, greenways, and pedestrian/bicycle networks in conjunction with existing state policies, programs, and guidelines (DelDOT and JMT, 2006, 1).” This plan implements Delaware’s Bicycle Policy by establishing a statewide network of bicycle facilities and coordinating connections between on and off road facilities.

### *Complete Streets*

On April 24, 2009, Delaware Governor Jack A. Markell issued Executive Order No. , and DelDOT subsequently adopted a Complete streets policy in 2010. A complete street is a transportation facility that is planned, designed, operated, and maintained to provide safe mobility for users of all ages and abilities including bicyclists, pedestrians, transit riders, and motorists appropriate to the function and context of the facility (DelDOT 2009).

### *Vulnerable Users Law*

Delaware became the second state to sign this into law in August 2010. The law increases penalties for drivers convicted of careless driving that results in the injury of a vulnerable user of the state’s roads. A “vulnerable user” includes pedestrians, individuals working on the road, cyclists, skateboarders, and anyone on roller skates, scooters, mopeds, motorcycles, farm tractors, or those riding animals (State of Delaware, Office of Governor, 2010).

### *Walkable Bikeable Delaware*

The Delaware General Assembly unanimously passed Walkable Bikeable Delaware in May 2011. This initiative calls for Delaware to strategically invest in walking and biking connectivity to design, build, maintain, and link non motorized transportation networks both within and among Delaware communities. Since 2011, the Delaware General Assembly and the Wilmington Area Planning Council (WILMAPCO) have invested considerable state and federal funding in statewide pedestrian and bicycle improvements, greenways, and trails projects (Bike Delaware, n.d.).

### *First State Trails and Pathways Initiative*

In 2011, Delaware Governor Markell challenged a team of state agencies to “create a world class statewide network of pathways and trails for Delaware’s citizens and visitors, to promote biking, walking, walking and active living” (Delaware.gov, 2011). To meet this challenge, DelDOT and the Department of Natural Resources and Environmental Control (DNREC) led and formed



a partnership with regional and local organizations and government to create the First State Trails and Pathways Initiative. The goal is to create an interconnected network of shared use trails and pathways that will support non motorized travel and recreation opportunities for Delawareans and visitors. The focus is on bicycling and walking and providing safe and convenient ways to reach local work, shops, schools, recreational sites, and transit.

To support the Initiative, Delaware legislators passed Senate Concurrent Resolution 13 in June 2011 (Delaware General Assembly, 2011). It approved the study of the building and maintaining of non motorized travel connections within and between communities, cities, and towns in Delaware and the linkage of these connections to form uninterrupted networks for walking and bicycling. The legislation also dedicated funding (\$7M in Fiscal Year FY 2012 and \$13M in FY 2013) for improvements and connections to the state's extensive trail network. Subsequently, the Delaware General Assembly approved a FY 2015 capital budget bill Delaware that authorizes \$6.3M for DelDOT bike and pedestrian Improvements and DNREC off road trail improvements (Delaware General Assembly, 2014).



Figure 2: Ribbon-cutting Ceremony at July 2015 Opening of Junction and Breakwater Trail in Lewes, Delaware  
Credit: Eli Chen, Delaware Public Media

Prioritization of funding is determined by several factors. These include whether the project provides improvements that foster non motorized transportation and recreation opportunities, is supported by an officially adopted plan, creates critical and low stress linkages between communities, leverages additional sources of funding, generates jobs resulting in investments

for bicycling and walking, and improves safety for non motorized travelers. The long term strategy is to make statewide connections beginning with cluster of communities, which have an existing network of trails/pathways. Phased in trail construction/improvements are slated for eight trail systems in New Castle County, including the New Castle Industrial Track Trail (connecting to Wilmington) and Chesapeake & Delaware Canal Trail; five trail systems in Kent County, including the Dover to Clayton Rail Pathway; and six trail systems in Sussex County, including the Assawoman Canal Trail in Bethany Beach (DNREC, 2011).



Figure 3: The third and final phase of New Castle Industrial Track Trail will cross the Christina River, an active rail line, and extensive tidal wetlands (State of Delaware, 2015).

## Advocacy and Advisement

Statewide advocacy is strong thanks to a network of partner organizations that seek to promote healthy lifestyles, improve opportunities for active transportation, and help plan effective, safe, and well connected bikeway networks. Bike Delaware, a non profit advocacy organization, has been working to make bicycling a safe, convenient, and fun transportation option in Delaware. The Delaware Council on Health Promotion and Disease Prevention (CHPDP) was established in May 2010 by Governor Jack Markell “to advise the Governor and Executive Branch on the development and coordination of strategies, policies, programs and other actions statewide to promote healthy lifestyles.” Other groups working to support active lifestyles include the Delaware Coalition for Healthy Eating and Active Living (DE HEAL), the Get Up and Do

Something campaign, Delaware Greenways, Sussex Outdoors, and Nemours Health & Prevention Services (NHPS).

## Education and Outreach

Delaware has also utilized education and outreach to ramp up support for safe cycling. In 2013, DelDOT formed the Pedestrian/Bicycle Safety Working Group. Comprising various highway safety stakeholders, its goal is to identify, evaluate, and implement pedestrian and bicycle related safety improvements throughout the state and along several corridors that exhibit higher than average pedestrian crash rates. Several municipalities have also appointed bicycle committees to improve cycling facilities and infrastructure to enhance bikeability. The 2015 Delaware Strategic Highway Safety Plan: Toward Zero Deaths is a statewide coordinated safety plan that provides a framework to reduce fatalities and serious injuries on Delaware roadways through a multi agency approach (DelDOT, 2015).

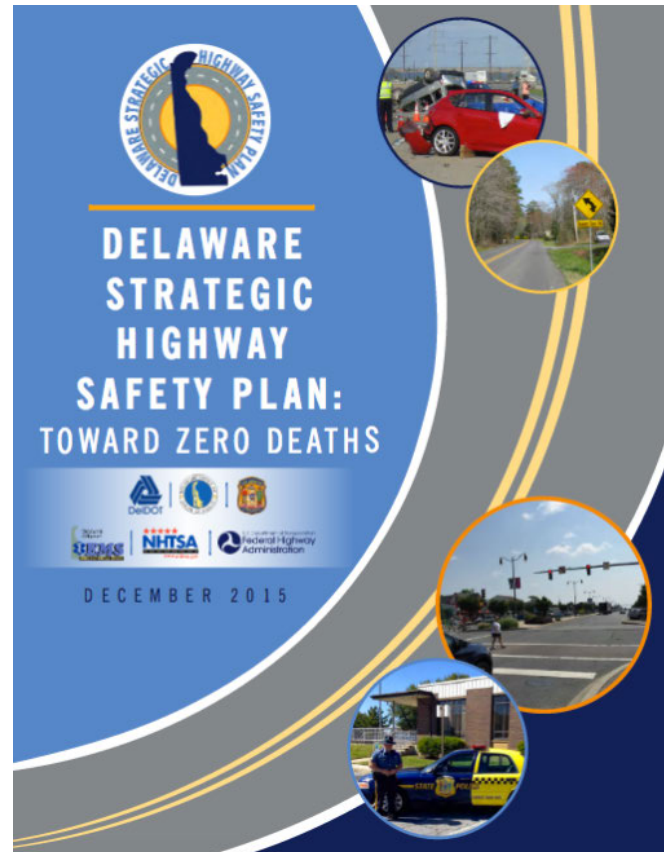


Figure 4: 2015 Delaware Strategic Highway Safety Plan



## 4. Options for Assessing Bikeability

In recent years, there has been recognition that simply providing bicycle facilities—such as bike lanes—does not ensure that the facility is accessible or riders will experience safe and comfortable conditions. As noted in research by Lowry et al. (2012, ), previous methods to assess the quality of bicycle travel have focused on bicycle suitability (i.e., the safety of the roadway) rather than bikeability (i.e., ability of riders and perceived comfort and accessibility to key destinations). Bikeability assessment approaches have evolved from a universal assessment of the suitability of all roadways for bike riding to much more nuanced and targeted approaches. Options for assessing low stress bicycle networks are summarized below.

### 4.1 Bicycle Safety Index Rating

In 1987, the bicycle safety index rating (BSIR) was developed to provide a “mathematical model for indexing bicycle safety to physical roadway features” (Davis, 1987). “The purpose of the model was to relate bicycle safety to the physical and operational features of the roadway” (Federal Highway Administration, 1998). This study established a way to relate bicycle usage and connectivity to safety measures. While very basic in its methodology and analysis, it inspired many other studies to follow.

### 4.2 Bicycle Stress Level

Many other tools have been created to measure the safety and comfort of bicycling on roadways. Alex Sorton and Thomas Walsh created the first methodology to systematically identify bicycle safety on roadways through the creation of a “bicycle stress level index.” The goal was to supply missing information to existing data on bicycle safety. To do so, roads were categorized on a scale of 1 to 5 (1 meaning very low stress, 5 meaning very high stress) based on numerous factors, including conflict with motor vehicles and strenuous concentration for long portions of riding along narrow, high speed, high volume roads (Sorton and Walsh, 1994).

### 4.3 Bicycle Compatibility Index

Bicycle stress level was expanded upon in 1998 when FHWA sought to develop a methodology to “determine how compatible a roadway is for allowing efficient operation of both bicycles and motor vehicles” (FHWA, 1998). To do this, FHWA developed the Bicycle Compatibility Index (BCI) to measure the conditions of roads to evaluate if they are suitable for both bicyclists and motorists. The goal was to create a universal measurement, the first of its kind, that could be used by bicycle coordinators, transportation planners, traffic engineers, and others” (FHWA RD 98 095, 1998).



## 4.4 Access to Destination Studies

Access to destination studies look at travel behavior by various modes and trip purposes. These studies assess the extent to which a person will travel by a particular mode, such as bicycling, to reach a given destination. Researchers Kevin J. Krizek, Michael Iacono, Ahmed El Geneidy, Ben Fu Liao, and Robert Johns were the first to create an accessibility formula in 2010 that illustrated that the “attractiveness of a destination greatly diminishes when the destination is more than a mile away” (MN/RC 2009 24, 2009). However, this study was incomplete due to the fact that it does not include any acknowledgement to the importance of bicycle suitability, or perceived comfort, to the riders.

McNeil follows a similar pattern by studying access, creating a very thorough measurement of bike networks. “The method assigns points to various destination types (e.g., grocery store, movie theater) and calculates a score out of 100 for a given location by summing any points for destinations within a 20 minute bike ride from the given location” (McNeil, 2010). While this score does not account for suitability, it provides an accessible and meaningful way to analyze neighborhoods to determine strengths and weaknesses of the infrastructure in specific sections of a city, thereby making it possible to determine areas of improvement.

Closely related to McNeil’s research is the method created by the Pedestrian and Bicycle Information Center (PBIC). While McNeil’s method creates a situation wherein large neighborhoods or entire cities can be analyzed, albeit lacking certain safety information, the PBIC method allows citizens to analyze their own communities using a simple two page checklist. The units of observation within the checklist include both safety and road conditions, thereby providing a relatively complete understanding of the areas surveyed (Pedestrian and Bicycle Information Center, 2002). As a qualitative method, the checklist is simple for non experts to use and in data can be collected through direct observation. However, this system does not provide an overall survey or catalog of citywide bicycle infrastructure and can be somewhat subjective.

## 4.5 Bicycle Level of Service

Recently, there have been further developments made in providing a more holistic approach to bikeability measurements. Bicycle level of service (BLOS) is considered one of the most comprehensive methods of delineating between inadequate and satisfactory bicycle infrastructure throughout a city. The BLOS method is considered state of the art. It builds on dozens of earlier studies and was developed through a massive effort to improve “the reference guide used by planners and engineers to calculate the ‘level of service’ for automobiles and non motorized transportation on various road types and intersections” (Lowry, et al, 2012). Also, because the concept of level of service is already widely accepted by

planners and engineers as industry vernacular, it's easy to transfer the knowledge of LOS from automobile to bicycle planning.

Researchers, including Lowry et al. (2012), have repeatedly highlighted the benefits of BLOS due to its ability to rate both segments and entire networks within a city. A computer program is employed to color code the streets based on the ten attributes identified within BLOS. The ten attributes considered within BLOS analysis are (1) width of outside lane, (2) width of bike lane, (3) width of shoulder, (4) proportion of occupied on street parking, (5) vehicle traffic volume, (6) vehicle speeds, (7) percent heavy vehicles, (8) pavement condition, (9) presence of curb, and (10) number of through lanes. The result is a map that identifies each road's level of service for bicycles. Network connectivity can then be analyzed.

To calculate BLOS, however, requires very complex mathematical analysis and must be done using a computer after the initial survey is completed. Therefore, it is not possible to simply look at a road and identify whether or not it is sufficiently bikeable. This can result in a layer of detachment, making it difficult for local residents and non experts to understand or be involved in the process.

While this information will combine to create a highly rich image of bicycle conditions, the data is sometimes very difficult to attain (Mineta, 2012). Furthermore, "there is no clear correspondence between BLOS level and user tolerance; that is, the method makes no attempt to establish a particular level of service as the minimum required to serve the mainstream population" (Mineta, 2012). In BLOS, bicycle infrastructure is analyzed from the perspective of the road; road conditions are measured independently from perceived safety of the cyclist or the connectivity of the roads.



Figure 5: BLOS Mapping through Geographic Information Systems Mapping

## 4.6 Low-Stress Cycling Approach

Using BLOS, there is no way to link the level of service provided to cyclists on a road with information about whether an “average” cyclist will actually feel comfortable given those road conditions. To address this issue, a new “low stress cycling” (LSC) approach has been developed to assess LTS by evaluating the network of connected streets and pathways accessible for bicycling under low stress conditions. To conduct a LTS analysis, a new scheme was developed to classify road segments into four levels. The segments are not only categorized by levels of traffic stress, but are also aligned by types of cyclists. This can be extremely helpful in determining which types of roads are suitable for different types of cyclists. Section 5 provides an in depth description of the LSC approach, classifications of users and roadways, designing for low stress cycling, and implementation of the LSC approach in Delaware.

## 5. The Low-Stress Cycling (LSC) Approach

The Low Stress Cycling (LSC) approach seeks to establish a bicycling network that connects low stress streets or routes and is suitable for use by casual cyclists who lack confidence and tolerance for traffic stress. The central tenant of the LSC approach is the recognition that the single biggest factor that deters would be cyclists is fear of cars and traffic. To the casual rider, a high level of traffic equals stress.

### 5.1 Low-Stress Cycling Goals in Relation to Walkability

The needs of cyclists and pedestrians are often paired together when planning for complete streets. While street design over the last several decades has prioritized ease of use for drivers above all other users, the complete streets philosophy seeks to improve the safety and comfort of other users relative to drivers. However, research indicates that factors affecting travel mode choice are quite different for cyclists versus pedestrians. A literature review of studies assessing bicycle and pedestrian mode choice by Muhs and Clifton found that “walking responds to the built environment characteristics that can be changed through land use policy, including levels of density, mixing, and connectivity. Bicycling, on the other hand, is influenced much more by the quality of the network, its completeness and connectivity, level of separation, and grade” (Muhs and Clifton, 12). This suggests that support for these two travel mode choices may be more effectively accomplished through distinct planning strategies. These differences were considered during the development of IPA’s low stress bikeability assessment tool for use Delaware local governments.

### 5.2 How Is Low-Stress Cycling Measured?

To ensure that people are able to take advantage of low stress cycling conditions, the network must be defined according to user tolerance and likelihood of use. This requires combined analysis of both the varying *levels of confidence of the bicyclists* and the *conditions of the roadways*. This means that to complete a proper evaluation of a low stress network, it is necessary to categorize both the riders and the roads.

### 5.3 Classifications of Users

Roger Geller, the Bicycle Coordinator at the City of Portland Bureau of Transportation, has conducted extensive research on the types of riders who utilize bicycle infrastructures throughout a city. Geller classified bike riders into four distinct groups according to (1) *levels of confidence of the bicyclists* and (2) *conditions of the roadways*. Potential riders may be classified as (1) not able or interested (37%), (2) interested but concerned (53%), (3) enthused and confident (9%), or (4) strong and fearless (1%) (Furth, 5).

## Strong and Fearless

On the continuum of cyclists, “strong and fearless” riders are at one extreme; they “are the people who will ride in Portland regardless of roadway conditions” (Geller, 2009). This group will cycle through inclement weather, poor road conditions, and a high level of traffic stress. They are commonly seen integrating with traffic and traveling at high speeds and on busy streets. “They are ‘bicyclists;’ riding is a strong part of their identity” and they are generally undeterred by obstacles that may prohibit others from riding (Geller, 2006). They make up a very small proportion of cyclists, fewer than half of a percent of people in Portland. Low stress bicycle planning does not apply to them due to the fact that they generally wish to operate in the traffic lanes and do not need, or want, special accommodations for their bicycles.

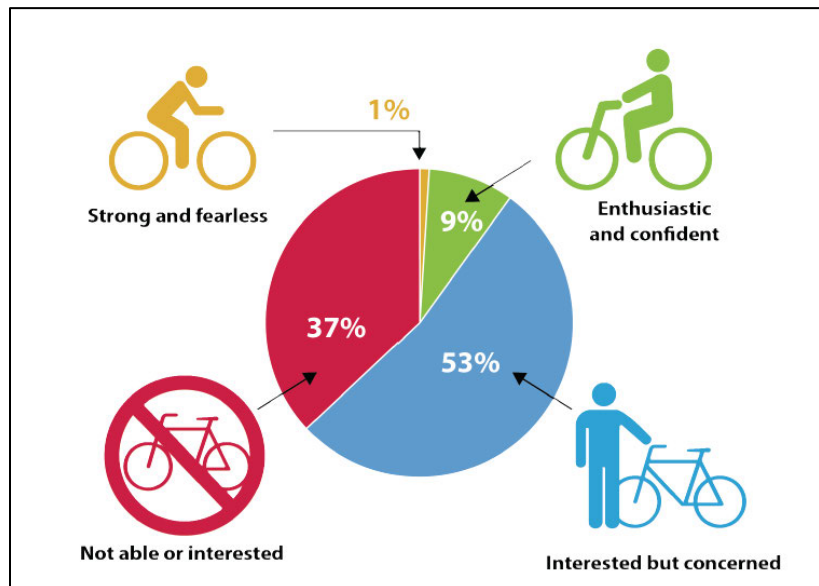


Figure 6: Percentage of Cyclists Categorized by Tolerance for Levels of Stress (MassDOT, 2015)

## Enthusiastic and Confident

“Enthusiastic and confident” riders are slightly more common, making up approximately 9 percent of riders in Portland. These people “are comfortable sharing the roadway with automotive traffic, but they prefer to do so operating on their own facilities (Geller, 2006). While these people would benefit from having separated bike lanes, they are still willing to share the roadway with automobile traffic in order to arrive at a destination. However, they greatly appreciate when infrastructure is created specifically for bicycles. The existence of bicycle design has attracted them to cycling, so they have a deep appreciation for designs such as bicycle lanes and bicycle boulevards (Geller, 2006). Providing low stress connectivity to these cyclists, their comfort and satisfaction related to bicycling will improve greatly.

## Interested but Concerned

The “interested but concerned” cyclists make up the largest category. These are people who enjoy riding their bicycles, but are deterred because their fears related to traffic. There have been multiple studies as to the reasons why people do not use bicycles as a form of transportation. Repeatedly, it has been shown that it is a result of the fear caused by being in

the roadway, surrounded by moving cars. “They are generally not afraid of other cyclists, or pedestrians, or of injuring themselves in a bicycle only crash. When they say they are ‘afraid’ it is a fear of people driving automobiles” (Geller, 2006). Sixty percent of people in Portland fall into this category, highlighting its importance. This fear has discouraged people from pursuing an activity that is both good for them and the environment. By creating low stress bicycle routes, this group is drastically better off.

In the first scientific study of its kind, Portland State University’s National Institute of Transportation and Communities released findings stating that adding protected bike lanes dramatically improves conditions for riders. “Survey data indicates that 10 percent of current riders switched from other modes, and 24 percent shifted from other bicycle routes” (Monsere et al., 2014). Furthermore, “most residents [surveyed] agreed with the statement ‘I would be more likely to ride a bicycle if motor vehicles and bicycles were physically separated by a barrier,’ with ‘interested but concerned’ residents expressing the highest level of agreement at 85 percent” (Monsere et al., 2014). This group of riders would benefit the most from the creation of low stress bicycle networks.

### **No Way, No How**

The last group is made up of traffic intolerant people who are “currently not interested in bicycling at all, for reasons of topography, inability, or simply a complete and utter lack of interest” (Geller, 2006). Therefore, they are classified at the other end of the continuum as the “no way, no how” riders. They will not be persuaded to get on a bicycle, regardless of condition improvements or incentives.

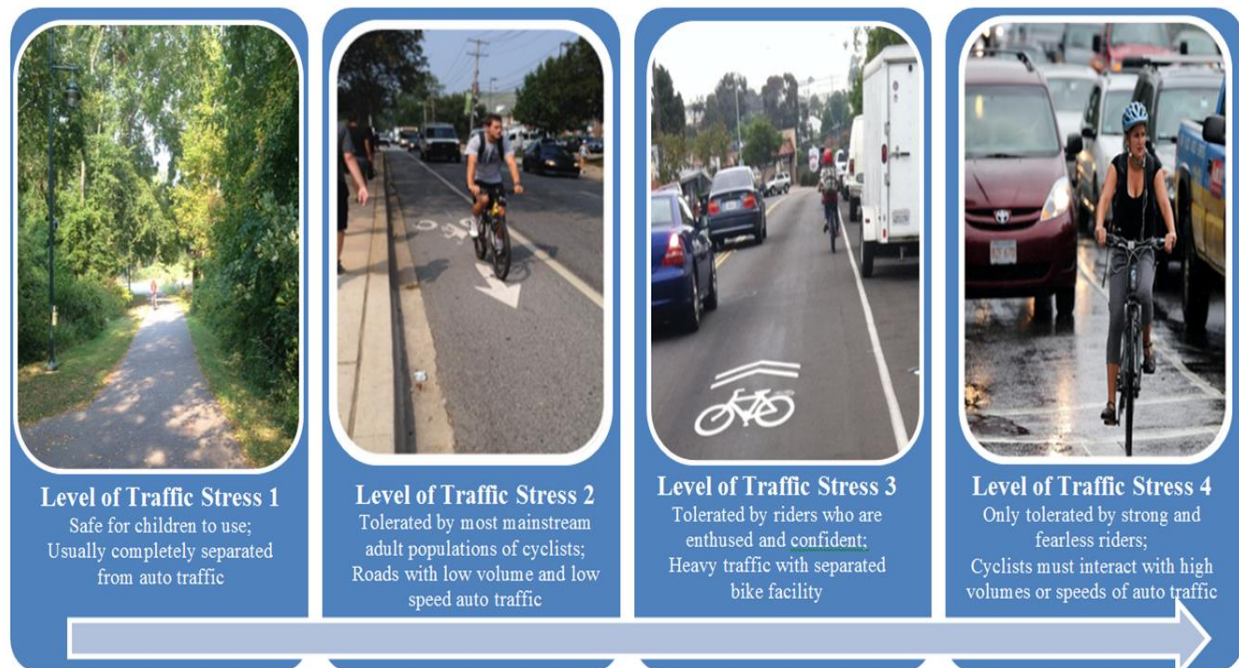


Figure 7: Images Depicting Levels of Traffic Stress (LTS)

## 5.4 Classifications of Roadways

To identify the conditions of the roadways, every roadway of the study area (usually an entire city) must be categorized. Dr. Peter Furth of Northeastern University has conducted extensive research in this area. LTS is used as a proxy for understanding the conditions of the road, including congestion, traffic speed, noise, danger, and exhaust levels. There are four LTS that are used to identify the increasing level of stress felt by users on different types of roads. LTS 1 is meant to be a level that most children can tolerate; LTS 2 is the level that will be tolerated by the mainstream adult population; LTS 3 is the level tolerated by American cyclists who are “enthused and confident,” but still prefer having their own dedicated space for riding; and LTS 4 is a level tolerated only by those characterized as “strong and fearless” (Mineta, 1).

Furthermore, when identifying LTS, it is important to survey roads for a multitude of environmental factors. This means that conditions such as the type of bicycle facilities provided, traffic conditions, topography, and the absence of lighting must all be designed around the hesitant cyclist (Mineta, 2012). Bicycle facilities, such as bike lanes, also must be kept in good repair and clear of debris, snow, and leaves so as to allow cyclists to travel easily on the street. All of these factors affect whether a person will feel safe and interested in traveling on a road. Furthermore, community conditions, such as the aesthetics of the surroundings, crime, and noise impact a person’s willingness to cycle. Therefore, a holistic approach is needed to address these concerns (Mineta, 2012).



## 5.5 Designing for Low-Stress Cycling

When designing a low stress system, the types of users and roadways must be considered in conjunction to determine the most useful network infrastructure to ensure the most people are able and willing to cycle. All groups of riders, except the strong and fearless, would benefit from the design a low stress network among roads that rank in LTS 1 or 2. Some people who are traffic intolerant may choose to ride if facilities improve dramatically, but any shift in the ridership from that group will be an externality, as opposed to the intention of the improvements.

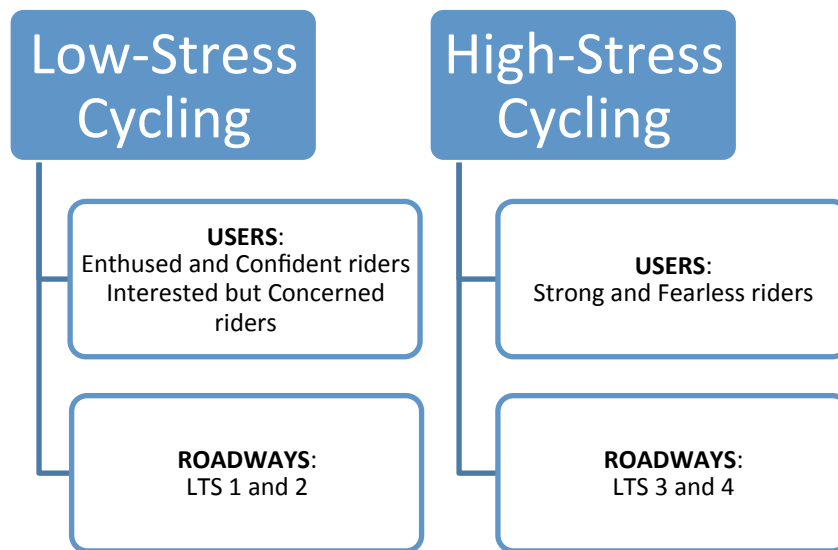


Figure 8: Classifications of users and roads are needed to enable low-stress cycling.

Enthusied and confident riders will also greatly benefit from including LTS roadways into the low stress network, but such efforts will not entice riders who are either traffic intolerant or interested but concerned (the largest percentage of total riders). Strong and fearless riders already utilize LTS 4 roads, do not want or need separated facilities, and therefore are excluded from this discussion. Given this targeted audience, the development of low stress facilities can be developed and improved specifically to dispel the concerns and fears of these riders.

## 5.6 Connectivity Barriers

Once a city's roads have been categorized based on levels of traffic stress, it is easy to see patterns emerge. Commonly, residential streets are ranked as LTS 1, providing large swaths of road that are accessible for all levels of cyclists. While the large numbers of roadway mileage is encouraging, the areas are not connected, creating a network that is disjointed and isolated. This creates an environment in which islands of access occur. By default, trips between these pockets would be at an unacceptably high level of stress, greatly reducing the utility and benefit



of the existing low stress lane miles and relegating them mostly to recreational cycling, not meaningful trip making.

While low stress designs have been accepted in numerous municipalities across the country, as of yet there are no documented attempts to create low stress networks that would traverse an entire metropolitan area. This approach to bicycle infrastructure development consists of creating links between specific nodes, focusing on a finite number of roads or destinations that attract high numbers of cyclists. A key advantage of this approach is that the planner or engineer can focus on key choke points, or “low hanging fruit.” Ideally, the utilization of the low stress cycling approach will reveal choke points and key missed connections that may be given special attention or engineering solutions. In this way, meaningful connections can be made without the wholesale and costly re engineering of all bicycle unfriendly roadways.

### Level of Traffic Stress 2 (LTS 2) Islands

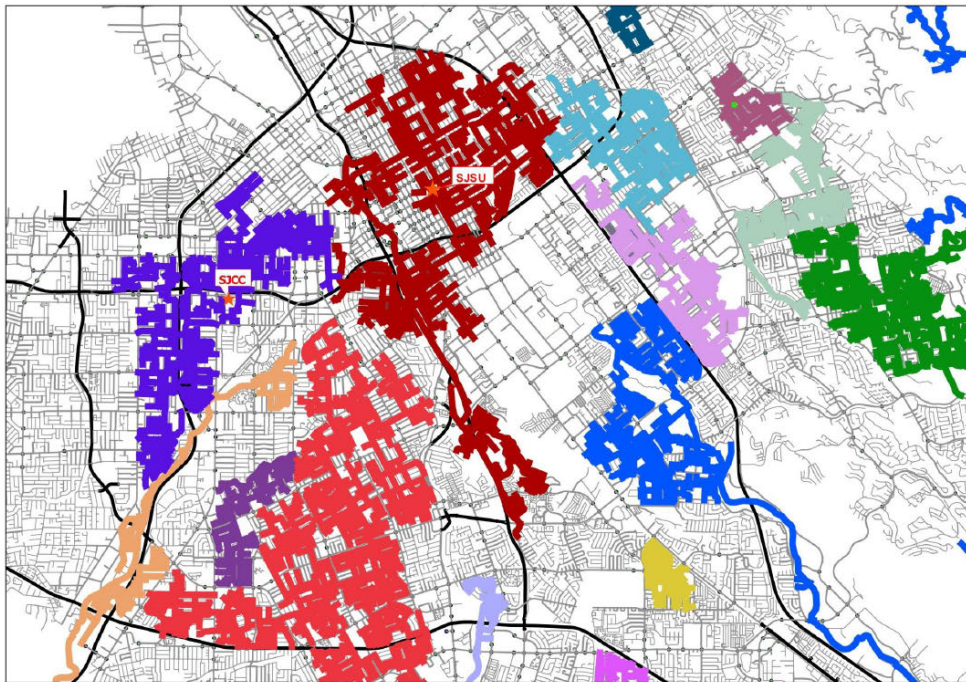


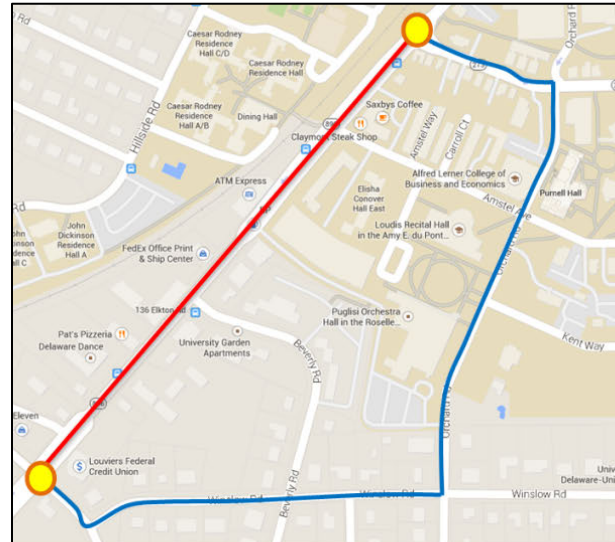
Figure 9: Each colored area represents networks of LTS 2 roads in San Jose, California. While there are numerous roads, the areas are not connected to each other so, for example, a cyclist trying to get from the purple area to the red area could not, even though the areas are very close in proximity.

### Acceptable Level of Detour

Furth and Mekuria assert that most “mainstream population” bicyclists are intolerant of high traffic stress conditions on roadways. To attract this group, it is critical to provide “*low-stress connectivity*, or routes providing routes between people’s origins and destinations that do not require cyclists to use links that exceed their tolerance for traffic stress, and that do not involve an undue level of detour” (Furth and Mekuria, 2013).

When identifying whether a community is bikeable, it is vitally important to consider connectivity. While connectivity includes low stress infrastructure that links destinations, the amount of detour required to utilize that infrastructure is equally significant. This is because cyclists are reluctant to travel out of their way to find lower stress bike routes; when their routes are not conducive to easy travel, cyclists are likely to not ride the routes and may even decide to not cycle at all. Therefore, the level of detour must be limited.

Level of detour is one of the many factors that influence whether people are willing and able to consider cycling as a viable transportation option. Other factors, such as weather and topography, are outside of the purview of policy and therefore cannot be affected. However, the measure of detour is clearly within the government regulatory and policy frameworks, and therefore an important focus when creating a low stress cycling network. Providing a network through which the most number of people may travel on an acceptable route “that provides relatively direct access between people’s homes and destinations” is both possible and necessary when evaluating the effectiveness of the bikeability of a community (Mekuria, M.C., Furth, P., & Nixon, H., 2012).



**Figure 10: If the length of the detour exceeds the length of the most direct path by more than 25 percent, people will not take the detour.**

According to Furth, the acceptable “length of the lower stress path should not exceed the length of the most direct route by more than 25 percent or, for short trips, 0.33 miles” (Mekuria, M.C., Furth, P., & Nixon, H., 2012). This means that a cyclist should not have to travel more than a third of a mile, approximately a two minute ride, to reach the desired destination. This limit is very important because it will incentivize more people to bike due to the accessibility and ease of the option. If the detour is too long, people will not use it and the network is incomplete (see Appendix A, Level of Detour).

As previously mentioned, topography factors into a cyclist's willingness to travel on a given route. Therefore, when calculating the acceptable distance, planners should consider the effort needed to travel the route as well as the best route available through which to construct the detour.

This technique of LSC has been implemented with great success in large cities such as Portland, Oregon. It is also recognized as a successful system of measuring bikeability by a variety of

advocacy organizations, such as PeopleForBikes and the League of American Bicyclists (Wilkes, 2013; Lusche, 2015). The National Association of City Transportation Officials (NACTO) strongly endorses the concept of LSC measurements, illustrating ways in which low stress design can positively impact cities. At the federal level, USDOT supports the use of the NACTO Urban Bikeway Design Guide, which compiles best practices of bicycle infrastructure design from around the world. “Not only are [the initiatives outlined in the Design Guide] aimed at improving physical infrastructure, but improving perceived safety and lowering stress for walkers and bikers as well” (Thompson, 2015).

## 5.7 Assessing Low-Stress Bikeability in Delaware

In recent years, there has been intense interest in not only improving bicycle infrastructure and facilities in Delaware, but also enhancing the accessibility of bicycle travel on roadways. Adopted in 2011, the Dover/Kent County Metropolitan Planning Organization’s 2030 Regional Bicycle Plan for Kent County, Delaware, was developed to improve bicyclists’ safety and access to local facilities and services, increase the number of trips made by bicycle, and reduce automobile use. The plan recommended a series of bicycle policies, including factors to determine appropriate on street bicycle facility design. In addition, the plan recommends that existing bikeway gaps and discontinuities be addressed to improve accessibility, safety, and bicycle usage for transportation and recreation purposes (Dover/Kent County MPO, 2011, 42). It recognizes the need to not only design safe roadways for bicycle travel, but also assess the comfort and convenience of bicyclists to plan for bicycle friendly improvements. The 2015 City of Dover Bicycle Plan complements objectives of the MPO’s 2030 Regional Bicycle Plan. It acknowledges the need for DelDOT to evaluate specific low stress bike routes within the city and makes a series of engineering recommendations to improve Dover’s bike friendliness (City of Dover, 2015).

The Wilmington Area Planning Coalition (WILMAPCO), the metropolitan planning organization for New Castle County, Delaware, and Cecil County, Maryland, recognizes the value in LSC measurements. WILMAPCO has worked with several communities to advance cycling as a viable transportation mode. Developed by the Newark Bicycle Committee, WILMAPCO, and the City of Newark, the 2014 Newark Bicycle Plan recognizes that bicycle facilities are not “one size fits all.” It focuses on developing facilities, policies, and programs to address the needs of “interested, but concerned” bicyclists, provide low stress bike routes, and increase network connectivity to desired links and destinations. The recommended bicycle network provides a comprehensive network of facilities that connect homes, work sites, schools, parks, community centers, library, retail, and other destinations (City of Newark, 2014, 35). A stated objective to “identify links needed to connect low traffic, low stress routes” for cyclists (Newark Bicycle Plan, 2014).



In 2013, the University of Delaware’s Center for Applied Demography and Survey Research (CADSR) published a report on behalf of DelDOT titled *Development of a Comprehensive, Multi-Modal Travel Accessibility Indexing System at the Tax Parcel Level* (Racca, 2013). The report noted limitations of the trip generation model that is commonly used in transportation forecasting. It surmised that while the trip generation model can be used to estimate the number of trips from given origins and destinations, it fails to consider the need to measure the ease of accessibility in reaching the destination by a particular mode—particularly walking or biking. The research “developed a process allowing transportation analysts in Delaware to evaluate the degree to which potential or proposed system improvements for each of the road, transit, bike, and pedestrian modes in a given study area might affect the individual accessibilities for each mode and how they affect the overall accessibility” (Racca, 2).

Building upon the low stress cycling research and growing interest to assess both the bikeability and bicycle friendliness of communities, DelDOT began a process of engaging stakeholders and implementing a new method of modeling the state’s low stress bicycle network.

### Bike at the Beach

During the summer of 2014, DelDOT piloted an interactive bike mapping effort to gain rider input on routes ideally suited to less experienced cyclists and suggestions to make routes more bicycle friendly. DelDOT targeted bicycle riders in Delaware’s coastal resort areas to test an online public input tool called Wikimapping. Accessed at [bikeatthebeach.com](http://bikeatthebeach.com) via smart phones or mobile devices, the Wikimapping web app gathered input on popular routes, people’s comfort on those routes, barriers, and opportunities to improve the network of trails and

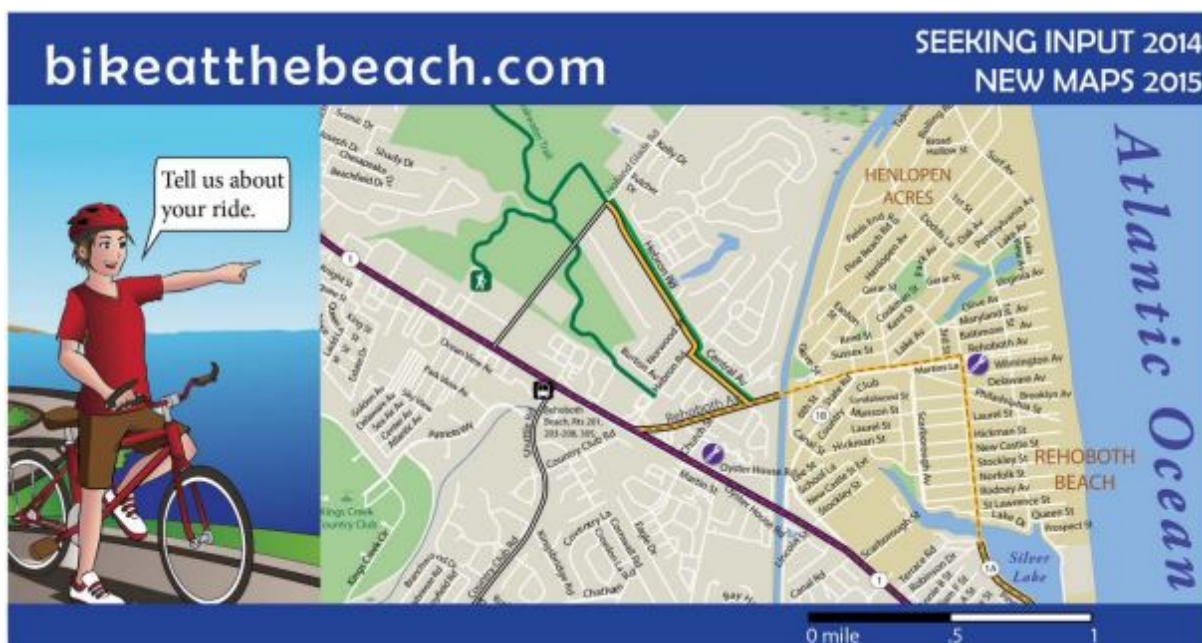


Figure 11: DelDOT Bike at the Beach Wikimap

bicycle facilities. The information gathered is being used by DelDOT to address problem areas, barriers to bikeability, and bicycle facility improvements as well as to map family friendly bicycle routes. Wikimapping is one approach to apply local knowledge and qualitative data to the quantitative data generated from the LSC approach and other bikeability assessment options.

## DelDOT Low-Stress Bicycle Network Modeling in Delaware

In 2014, DelDOT began the implementation of low stress bicycle network modeling in Delaware. Dr. Peter Furth, a co author of the “Low Stress Bicycling and Network Connectivity” study, was enlisted as a consultant to DelDOT. The idea behind the low stress bicycle network modeling is to collect data along a specific roadway, corridor, jurisdiction, or neighborhood to identify the set of streets that don’t exceed a less confident bike

rider’s level of tolerance for traffic stress. The goal is create a series of maps that show the low stress bicycle network, or the segments of low stress stress that are disconnected from one another by high stress segments and prevent a trip being completed by bike.

According to DelDOT’s Paul Moser, “low stress network models provide...analytics to qualify how new roadway or bikeway projects will affect the size of the low stress network, how many people have access to it, and how many potential trips can be completed using the low stress network. This modeling tool is slated to become part of DelDOT’s project prioritization process, favoring projects [that] provide low stress links to expand the network and connect the most potential trip origins to the most potential trip destinations. In other words, infrastructure projects that help make bicycling a safe, comfortable, and practical transportation option for the most people possible” (Moser, 2015).

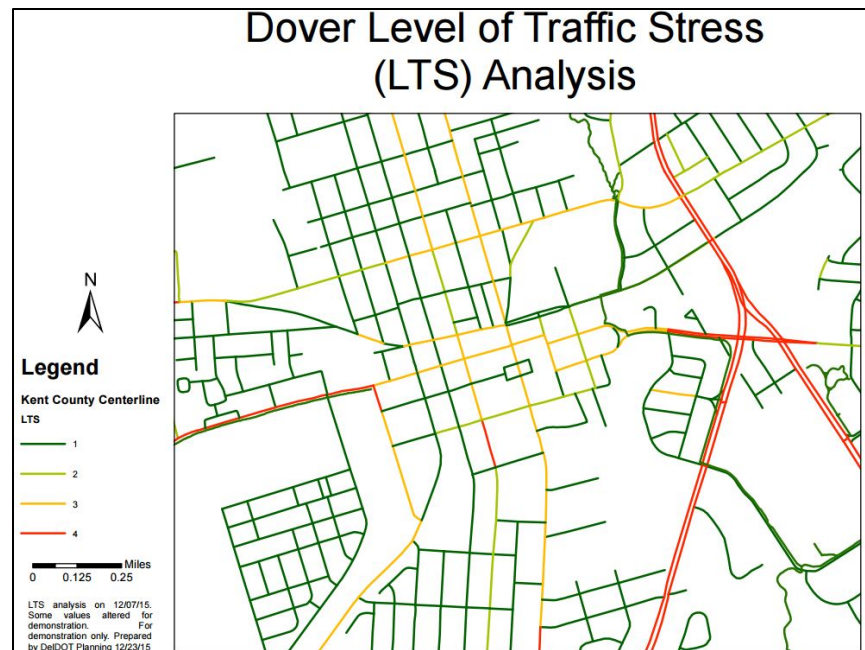


Figure 12: Draft Level of Traffic Stress/Low-Stress Cycling Basemap of a Section of Dover, Delaware (Produced by DelDOT)

DelDOT has developed low stress cycling basemaps for most areas within the state of Delaware. The maps—such as the draft Dover LTS Analysis Map (Figure 12)—show the level of traffic stress that cyclists may experience on given road segments using the new method for modeling the low stress bicycle network. DelDOT is using the model to perform network analysis and gather data on potential projects to prioritize feasibility spending. The methodology uses statewide data on traffic, lane width, traffic speed, traffic volume, the availability of shoulders and/or separate cycling facilities, and safety. It then assigns road segments and intersections as Level of Traffic Stress (LTS) 1 and 2 (relatively safe and bikeable) and LTS 3 and 4 (more challenging and less accessible to the “interested but concerned” cyclist).

In Figure 13, the statewide analysis shows roads in light green as easy and safe to cycle. Those suitable for the “enthused and confident” rider are shown in blue. Roads where only a “strong and fearless” cyclist would dare to venture are left out. This leaves the appearance of disconnected areas or “holes” in the transportation network, or roads where the average bicyclists probably would not ride. Therefore, the oval area of the map, highlighted in blue, is the likely targeted area for a low stress bikeability assessment in the City of Newark, Delaware.



Figure 13: Low-Stress Bicycle Network for Newark, Delaware

Delaware Bicycle Council makes available interactive bicycle route maps on DelDOT’s website ([www.deldot.gov/information/community\\_programs\\_and\\_services/bike/biking\\_in\\_delaware/maps.shtml](http://www.deldot.gov/information/community_programs_and_services/bike/biking_in_delaware/maps.shtml)). DelDOT is considering how the low stress bicycle network maps will be made available to local jurisdictions for bicycle network planning. A Delaware jurisdiction that wishes to conduct a low stress bikeability assessment should contact DelDOT’s Planning Division to obtain the low stress cycling basemap(s) from DelDOT. A high priority area, which appears to have missing roads the transportation network, may be targeted for a low stress bikeability assessment. Obtaining the basemap(s) eliminates the need for the jurisdiction to conduct engineering studies, conduct traffic volume counts, measure vehicular speeds, or measure the width of lanes of a roadway.



## 6. Infrastructure Designs for Low-Stress Cycling

Many of following infrastructure design strategies can be incorporated to compose a low stress network. However, some are considered more “low stress” than others. Below is a continuum of the types of design techniques. The designs are listed in order of those most suitable for bicyclists comfortable riding in higher stress situations to those suitable for less experienced cyclists. The level of protection in design increases as one progresses down the list, making it a more comfortable and low stress condition for cyclists. (See appendix B, Illustration of Low Stress Cycling Facility Types, for further examples of each type of infrastructure.)

### 6.1 Sharrows

Shared roads, commonly referred to as “sharrows,” are a type of retrofit for bicycles wherein a previously constructed road is painted with a decal notifying drivers and bicyclists that the full lane can be used by bikes. Sharrows are “often used on streets where bicycle facilities are desirable but motor vehicle speeds and volumes do not necessitate a separated bikeway” (Washington County, Oregon 2012). However, such a design is not considered low stress, due to the fact that bicycles are traveling with traffic with no separation. There is also ambiguity as to where cyclists should ride;



Figure 14: Sharrow ([bikesd.org](http://bikesd.org), 2012)

the marking is painted eleven feet from the curb (or four feet from parked cars), so as to allow cyclists to avoid being struck by opening car doors, but the proper spacing of bicycles within the lane is sometimes debated (Cleveland City Planning Commission). Furthermore, it is also not possible to utilize sharrows on high speed high volume roadways.

### 6.2 Bicycle Boulevards

Bicycle boulevards are similar to sharrows in that roadway design indicates to drivers that cyclists have the right to use the full lane. This type of design is most common on local roads that have lower speeds and volumes than roads with sharrows. Often there are traffic calming measures, such as speed bumps or



Figure 15: Bicycle Boulevard ([Bostonbiker.org](http://Bostonbiker.org), 2008)

islands installed as traffic calming measures. The major difference between a bicycle boulevard and a sharrow is that the former provides the absolute priority to cyclists (Portland Bureau of Transportation, 2010). Unlike sharrows, where drivers navigate around cyclists, cars must yield to bicycles within a bike boulevard. The design benefit is to increase driver attentiveness and provide deference for the presence of cyclists. Despite the attention given to alert drivers to the fact that they must yield to bicycles, however, “many people bicycling along...bicycle boulevards, particularly more vulnerable or less confident cyclists such as children, seniors and families—for whom the bicycle boulevards/neighborhood greenways are meant to serve—still feel uncomfortable, threatened, or usurped by motorists in the travel lane” (Portland Bureau of Transportation, 2010). Therefore, other steps must taken to increase cyclist safety.

### 6.3 Shouldered Bikeways

Shouldered bikeways are outside curb lanes or shoulders than can be used by bicycles. They are generally thought of as most ideal for country roads, but can also be practical for local streets (Metro, 2014). The difference between a shouldered bikeway and a bike boulevard is that there is a painted line that demarcates where automobiles may travel, which provides bicycles with a separate travel lane. However, the shoulder may also be used for stopped traffic. Bicycle right of way is not always designated or clearly marked.



Figure 16: Shouldered Bikeway

### 6.4 Bike Lanes

Bike lanes provide more protection than shouldered bikeways due to the fact that streets with bike lanes are specifically signed and marked to designate the space occupied by cyclists on the roadway. Buffered bike lanes take this concept one step further by providing space of some sort between the automobile travel lane and the cycle travel lane (Metro, 2014).



Figure 17: Bike Lane



## 6.5 Cycle Tracks

Cycle tracks are the most protective, providing a physical barrier of some sort to separate automobiles and cyclists. The separation can be provided by something as simple as a striped space painted on the road or as substantial as a concrete barrier, with countless variations in between (Frank, 2014). Within each of these categories, there are variations and adaptations including contra flow and raised designs.

### Contra-Flow Cycle Tracks

Contra flow design, where cyclists travel in the opposite direction as motor traffic, is possible—and even considered to be safer than other alternatives—in certain situations. AASHTO and FHWA both concur that left side cycle tracks should only be considered if that configuration would reduce conflicts. Some road reasons to consider the use of a left side cycle track are:

- Frequent bus stops;
- High parking turnover;
- High volume of right turning motor vehicles; and
- High volume of left turning bicyclists.



Figure 18: Contra-flow Cycle Track

Contra flow design is also highly valuable when designing a two way cycle track on a one way street. This ensures that cyclists are still abiding by traffic laws. Cyclists traveling with the traffic flow would be closest to moving vehicles, while cyclists traveling in a contra flow pattern would be on the far right side of the track, placing them in the legally acceptable location on the road. Contra flow bike lane design is safer because drivers are more inclined to look to their left for oncoming traffic. Where contra flow cycle tracks are not necessary or possible, contra flow bike lanes are an option. These follow the same design guidelines as contra flow cycle tracks.

## Raised Cycle Tracks

Raised bike lanes and cycle tracks bicycle facilities are vertically separated from motor vehicle traffic. When vehicles turn and cut across the raised cycle track, the vertical separation acts as a speed bump to moderate vehicular speed. Additionally, similar to physical barriers, it helps to ensure that drivers are less likely to cut into the bike lane on curves or high volume areas of road (ACTO, 2014).



Figure 19: Raised Bike Lane

## 7. Profile of No- or Low-Choice Bicycle Riders

The low stress bicycle network modeling approach can be used to identify areas within the transportation network that have on road bike travel safety concerns, lack connectivity for bicyclists, are stressful for less confident bicycle riders, and are critical routes to destinations.

One factor that is not accounted for is the needs of no- or low choice bicycle riders. Low stress cycling basemaps provide essential data and a starting point to conduct a low stress bikeability assessment. In addition, local knowledge is critical to understand needs and route preferences of bicycle riders in order to select a priority area.

No- or low choice bicycle riders—also referred to as captive users—differ from individuals who are recreational riders or fitness enthusiasts who elect to ride or commute by bike. Conversely, captive bike riders are often from car households and rely on biking “as a means of transportation that’s cheaper than a car and faster than walking” (Keatts, 2015).

Because “most bicycling in the United States is discretionary,” low stress cycling improvements may be regarded as a luxury, rather than a necessity in streetscape design. “If people can’t get to their destinations on a safe, low stress bike route, most of them will use a different mode of travel” (Mineta). However, such a mindset disenfranchises captive users who rely on safe and comfortable bicycle infrastructure to travel to and from a destination, commute to work, or connect to transit.

This mindset may be changing as bicycling comes more mainstream and with the growth of bike sharing programs—particularly in urban areas. Bike sharing is

emerging as a viable, low cost transportation option in many urban areas and college towns. In addition to its Urban Bikeway Design Guide, NACTO has released new guidance on the placement of bike share stations and infrastructure to enhance safety, extend the reach of transit, and promote bicycling as a transportation mode (NACTO, 2016).

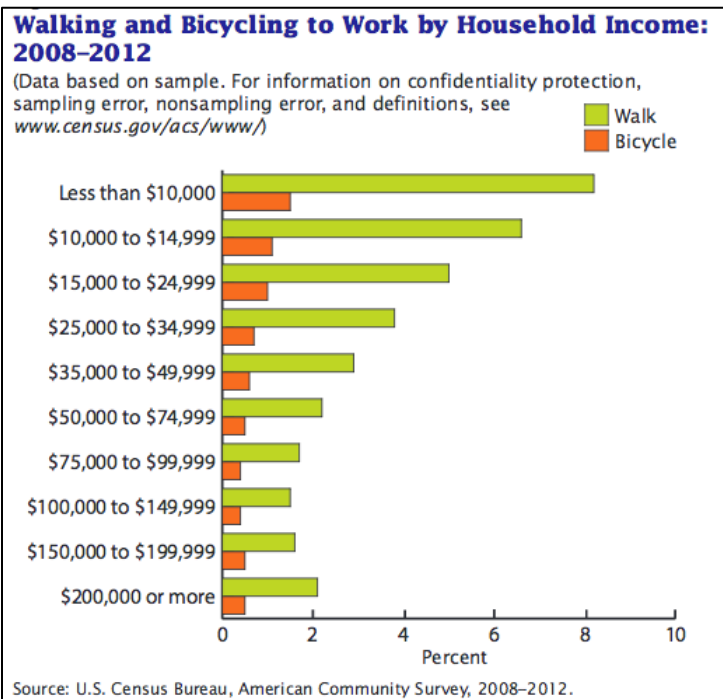


Figure 20: College students are often no- or low-choice riders.

## 7.1 National Characteristics of No- and Low-Choice Bicycle Riders

No choice and low choice bike ridership occurs among those with restricted or no access to a car or public transportation that must commute a greater distance than can be walked. No choice riders may be a stigmatized group, thought of as those who cannot afford a car or unable to obtain a driver's license. However, it is far more wide ranging group. Youth without driver's licenses, college students, people living in no car households, and low income adults may rely on bicycles as their primary mode of transportation.

A 2014 U.S. Census Bureau report on walking and biking indicates that people with low incomes are more likely to walk or bike to work than more affluent Americans. According to the report, among those making \$10,000 a year or less, about 1.5 percent bike and 8.2 percent walk to work—nearly twice the rate of individuals making \$25,000 or more a year. There is also a correlation between vehicle ownership and active commuting. Individuals from no car households walked four times more and biked three and a half times more than commuters with access to a vehicle (McKenzie, 2014). More young adults—between the ages of 16 to 24—choose to actively commute to work as they opt not to obtain a driver's licenses or delay getting a driver's license due to state graduated licensing requirements or high insurance costs.



**Figure 21: Low-income individuals are more likely to walk or bike to work than more affluent Americans.**

Often, bicycling is a primary mode of transportation for individuals who cannot afford a car, are unable to drive, or are under the age of 18. A study by Ewing, Schroeer, and Greene presented a nested logit mode choice model for 12 students in Gainesville, Florida. It places biking, walking, and bus under the same umbrella as an alternative to driving (2004). However, in some contexts, these three travel options cannot be treated as equal alternatives. Biking may be the only option available for non drivers traveling to areas that are too far to walk, yet are also not served by public transit.

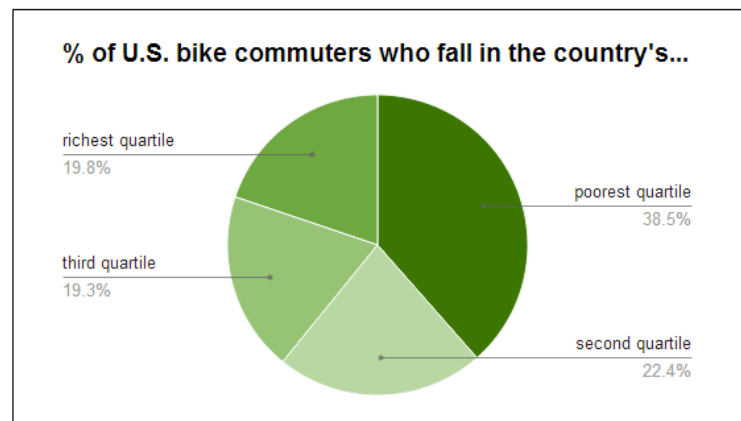
Moreover, 2012 article by Stewart et al. reviews previous studies on active travel to school (ATS) to identify barriers to walking or biking to school. They looked at 42 independent



variables found to influence travel mode choice to school among students aged 18 and younger. These factors included distance of trip, family resources, and scheduling constraints.

Others are unable to drive due to their immigration status or other legal restrictions. While undocumented workers may obtain driver's licenses in Delaware, this is not the case in many states. Therefore, undocumented workers who cannot obtain driver's licenses may be more likely to be no choice riders (National Immigration Law Center, 2015). No choice riders may also be licensed and belong to a household that owns a car, but does not have regular access to that car.

If available, public transit commonly serves as an alternative mode of transportation for individuals in no car households or for those who are unable to drive. Some cyclists are no choice riders because they have origins or destinations that cannot be accessed by public transit, such as in rural, suburban, or other low density areas. Others cannot use public transit because their commute schedules do not align with the public transit service schedules. This group includes employees who must commute very early in the morning, late at night, on weekends, during holidays—such as workers in construction, service jobs, food and entertainment industries, and seasonal jobs. For people who rely on public transit, biking may provide a critical first and last mile connection to that mode of transportation.



**Figure 22: In the United States, 38.5 percent of bike commuters represent the poorest quartile of the population.**

## 7.2 Delaware Characteristics of No- and Low-Choice Bicycle Riders

It is likely that the profile of no and low choice (“captive”) cycle riders in Delaware mirrors the characteristics of those nationwide. While Delaware’s bicycling population includes commuters who elect to ride bikes to work and people who favor this environmentally friendly form of transportation, it also consists of people who ride bikes not by choice but due to economic necessity.

Delaware no and low choice bicycle riders include low income populations, individuals who are unable to drive, people from no car households, immigrants or seasonal workers, and people who are unable to obtain driver’s licenses for various reasons. Biking is often a necessity for Delawareans who live in rural areas that are not served by public transit.

## GIS Maps of Low- and No-Choice Bicycle Riders in Delaware

IPA prepared a series of three summary maps to identify possible concentrations of low or no choice bicycle riders in Delaware (see Appendices K1, 2, and K3).

### *Poverty*

The first map (Appendix 1) displays household poverty rate, as defined by federal poverty thresholds, by U.S. Census block group in Delaware. This map shows locations where Delaware residents, who may not be able to afford an automobile, may rely on alternative modes of transportation—including bicycling. In New Castle County, high rates of poverty are evident in and around the cities of Wilmington, Lew Castle, and Newark and in unincorporated areas south of Wilmington. While Lew Castle County is served well by public transit, bicycling may be used in addition to or in combination with other transportation modes.

In Kent County, small pockets of poverty are evident in the Dover and Milford. In Sussex County, the Town of Seaford displays a pocket of high poverty, with less intense poverty apparent in and around Georgetown, Millsboro, and rural western Sussex County.

### *No Vehicle*

The second map details the prevalence of households reporting no access to a vehicle. Unsurprisingly, it has considerable overlap with the poverty map. Only the City of Wilmington shows any areas of “high” no vehicle access. However, “medium” lack of access can be seen in central Lew Castle County, the Delaware City vicinity, and the City of Newark.

No tracts displayed as “high” no vehicle access in Kent or Sussex Counties. Portions of Clayton, Dover, Milford, and rural western Kent County displayed as “medium.” In Sussex County, aside from one tract in rural western edge of the county, it is interesting to note that the highest reported lack of access to a vehicle is along the eastern coast/beaches—typically the most affluent areas of Sussex County. IPA’s project team could not prove definitively why this would be the case, but speculates that likely factors include vacation homes that are purchased due to proximity to walkable/bikeable destinations and retirees who may no longer drive or own cars.

### *Vehicle Deficit*

Perhaps most instructive was the analysis of vehicle deficit. IPA’s project team compiled data for all of the state’s census tracts for workers in households and worker access to vehicles. A one worker household reporting access to one vehicle would yield a neutral score. However, one worker households with no vehicle, two worker households with one vehicle, or three worker households with access to two vehicles represent a vehicle deficit of one.

Similarly, two worker households with no vehicle available and three worker households with only one vehicle available represent a deficit of two. Only three worker households with no vehicle available represented a three vehicle deficit. The data was collected as “three or more workers,” rather measurement was not possible.

The deficits of one, two, and three were then applied to all census tracts and normalized on a zero to one scale. The resulting map gives a more nuanced view of the possible location of no or low choice cyclists. Instead of displaying extreme poverty, or the total lack of access to any vehicle, it attempts to show where there is less access to vehicles than likely demand for transportation. Put simply, there is a greater chance of someone in these households relying on a mode of transportation other than a private vehicle for some trips, even though they may have occasional or part time access to a vehicle.

In New Castle County, again, areas surrounding the Wilmington metropolitan area, central New Castle County, and portions of Newark, “high” or “moderate” vehicle deficits are displayed. For the first time, Middletown shows areas of moderate vehicle deficit. Likewise, Claymont shows as an area with a high vehicle deficit.

In Kent County, the area just west of Dover shows as reporting a “high” vehicle deficit, as does the tract just east of the city, encompassing the town of Little Creek as well as a census tract just north of Frederica. Georgetown is the only area in Sussex County showing a high worker to vehicle differential or deficit, though pockets of rural western Sussex to register as “moderate.”

## **Discussion**

This analysis cannot definitively show locations of no and low choice riders in Delaware. It can only show likely areas based upon responses to the 2014 American Communities Survey that correlate with what available literature suggests as good indicators.

The maps illustrate that concentrations of no and low choice riders are largely centered in and around municipalities, and more developed areas. However, there does appear to be a limited, but noticeable, rural component. Clearly then, engagement of local stakeholders in a no stress bikeability assessment process has the potential to identify types and locations of no and low choice cyclists in Delaware, which is extremely valuable when applying local knowledge to target an area for a low stress bikeability assessment.

As suggested by the literature, other factors are also likely at work. These include concentrations of students, tourists, seasonal workers, and transit users. Many college students attending institutions of higher education in Delaware (e.g., University of Delaware, Delaware State University, Wilmington University, and Delaware Technical Community College) do not have cars. This results in considerably higher bicycle usage in concentrated areas than in other

parts of the state. For example, in Newark, home of the University of Delaware, four percent of all trips are taken by bicycle, compared to a statewide average of two percent (Newark Bicycle Plan, 2014). Many of these students are not able to afford a car on campus or they live close enough that bicycling is the most practical form of transportation. Other students may use a combination of transportation modes and walk or bike as a first and last mile connection to transit.

The influx of summer tourists to Delaware's resort areas also accounts for high levels of bike riding as the population of coastal communities swells during summer vacation. According to 2014 U.S. Census estimates, the full time population of Delaware's five primary resort communities of Bethany Beach, Dewey Beach, Fenwick Island, Lewes, and Rehoboth Beach ranges from a low of 363 (Dewey Beach) to a high of 2,943 (Lewes) (U.S. Census Bureau, 2014). Yet, the population for these communities can explode to as many as 30,000 people during the summer or holiday weekend. Many families bring bicycles for recreation purposes and as means of transportation to the beach or key tourist destinations.

In addition, places that employ low income workers on a temporary or seasonal basis and are not well served by transit may comprise a major demographic of Delaware's no or low choice bicyclist population. For example, for both American and international students working summer jobs in Delaware's resorts, bicycling is the primary form of transportation. Each year, DelDOT—in cooperation with ResortQuest, seasonal employers, and non profit organizations—provide a bicycling safety orientation course, free bicycles, and helmets to international students working in resort area service industry jobs (Giangreco, 2014). Delaware's poultry and agriculture industries rely heavily on migrant and seasonal farm workers. Many are from no car, low income households and live in rural communities in Sussex and Kent Counties that are not served by public transit. In addition, seasonal employers—like Amazon's distribution centers in Middletown and New Castle—generate thousands of jobs during the holidays that may attract individuals who do not own cars and cannot access public transit (Goss, 2015).

However, for the purposes of no and low choice mapping, why an individual can't afford (or chooses not to) own a vehicle is less important than where they are. In either case, these are the populations most likely to benefit from planning for and making improvements to low stress bicycle networks.

It's also important to point out that census tract level or even block group level data aggregation does not paint a perfect, high definition picture. They provide a broad brush overview. Understanding where concentrations of no and low choice bicyclists may be located is part of the data gathering process to conduct a low stress bikeability assessment. The low stress cycling basemaps are a starting point, but must be augmented by detailed local



knowledge and input from local stakeholders on primary routes of bicyclists, known problem areas, primary trip origins and destinations, and concentrations of no and low choice cyclists.

## 8. Outreach on Community Assessment Tool Options

IPA's research team conducted outreach to obtain both public and expert input on the use of community assessment tools to plan for low stress bicycle improvements in Delaware jurisdictions. The intent was to obtain diverse opinions on the types of assessment tools that Delaware local governments can use in an engagement process—involving a community workshop and in field assessment—that can be used independently or in conjunction with DelDOT's low stress network modeling method.

Originally, the team had planned to form and convene a working group of various stakeholders involved in enhancing non motorized transportation options, health promotion, pedestrian and bicycle safety, municipal government, and transportation planning in Delaware. However, the team determined that a comprehensive outreach strategy, conducted in three phases, would best obtain diverse stakeholder input. Outreach obtained feedback on low stress bikeability needs and initiatives, favored data collection approaches, and the preferred format of a low stress bikeability assessment checklist for Delaware communities.

The outreach was conducted over a period of ten months from January to October 2015. The goal was to obtain input to develop a user friendly low stress bikeability assessment tool, visual prompts, checklist, and related sources that could be used by all Delaware jurisdictions—even those with limited professional or planning staff. In the process of developing the assessment guide, there were three distinguishable phases of outreach to stakeholders to obtain input on the type, format, and content of the tool to be used by “citizen planners” and stakeholders to assess low stress cycling conditions for a roadway segment within their communities. Table 1 (below) provides the schedule of meetings that comprised each phase of outreach activities.

### Schedule of Outreach and Input Meetings, 2015

Phase 1 – Input: Improving Low-Stress Bikeability in Delaware			
Name/Group/Event	Date	Location	# Attending
DE HEAL Presentation	1/22/15	Dover	12
Governor's Delaware Council on Health Promotion and Disease Prevention (CHPDP), Walkable & Bicycle Friendly Communities Committee Meeting	1/28/15	Dover	N/A
Paul Moser, DelDOT	7/7/15	Newark	3
Meeting with DelDOT and DNREC GIS Representatives	8/10/15	Dover	4
Phase 2 – Outreach: Types of Assessment Tools for Low-Stress Bikeability in Delaware			
Name/Group/Event	Date	Location	# Attending
DelDOT Research Showcase	5/5/15	Dover	50
2015 Walkable, Bikeable Delaware Summit	5/7/15	Dover	100+
Delaware League of Local Governments Meeting	5/21/15	Dover	60
Sussex County Association of Towns Meeting	6/3/15	Milford	65

## Schedule of Outreach and Input Meetings, 2015

Phase 3 – Outreach: Checklist/Prompt Options for Low-Stress Bikeability Assessment Tool			
Name/Group/Event	Date	Location	# Attending
WILMAPCO's Nonmotorized Transportation Working Group	8/4/15	Newark	15
Dover/Kent MPO TAC Committee	10/14/15	Camden	12
Newark Bicycle Committee	10/15/15	Newark	13
Dover/Kent MPO PAC Committee	10/27/15	Camden	18
State Pedestrian/Bicycle Safety Working Group	10/29/15	Smyrna	20

Table 1: Schedule of Outreach and Input Meetings, 2015

### 8.1 Phase 1 Outreach

The first phase focused on consulting with experts and stakeholder groups on the topic of low stress cycling. As shown in Table 1, the research team presented and discussed the concept of low stress bicycling and obtained input on the need to identify and address bikeability barriers for people with a low tolerance for traffic. The team made presentations to the Delaware Coalition for Healthy Eating and Active Living (DE HEAL), a health promotion advocacy group, and the Walkable & Bicycle Friendly Communities Committee of the Governor's Delaware Council on Health Promotion and Disease Prevention, which is developing an "overarching statewide strategy" for promoting healthy lifestyles (see Appendix C). Both groups endorsed the concept of low stress bicycling and the need to develop an assessment tool that is user friendly and engages local government stakeholders.

IPA's research team also had conversations/meetings with DeIDOT Planning's Anthony Aglio, Jeff Iezgoda, and Paul Moser to obtain information on the agency's work planning for low stress bicycle networks/connectivity and their outreach/engagement strategy to develop the low stress map for the Delaware resort area. A subsequent meeting was held with Paul Moser and Delaware State Park's Michael Krumrine to better understand the possibility of integrating DeIDOT's low stress bicycle network modeling maps with DNREC's Parks and Recreation bicycle/pedestrian service area modeling initiative. The discussion focused on the state agencies' interest in working cooperatively to identify priority connections between on road, low stress bicycle networks and off road recreation trails systems, pathways, and facilities).

### 8.2 Phase 2 Outreach

Information gathered in this outreach phase and from a review of the literature allowed the research team to identify strategies that may be used by communities to assess low stress cycling conditions and how the data may be incorporated into a low stress bikeability assessment process.

The researchers used this input to develop five approaches that community members may use to assess low stress cycling:

1. Crowdsourcing and social media (to generate user submitted map data)
2. A community checklist (to be used for field documentation of road conditions)
3. Level of Traffic Stress (LTS) analysis
4. Bicycle facilities inventory
5. Traffic engineering approaches (Bicycle Level of Service and Bicycle Compatibility Indices)

The team attended and presented the five approaches listed above at informational tables at four events (listed in Table 1). A poster display and handout materials were developed and displayed/distributed at events to summarize the benefits and challenges of each of the five approaches (see Appendix C).

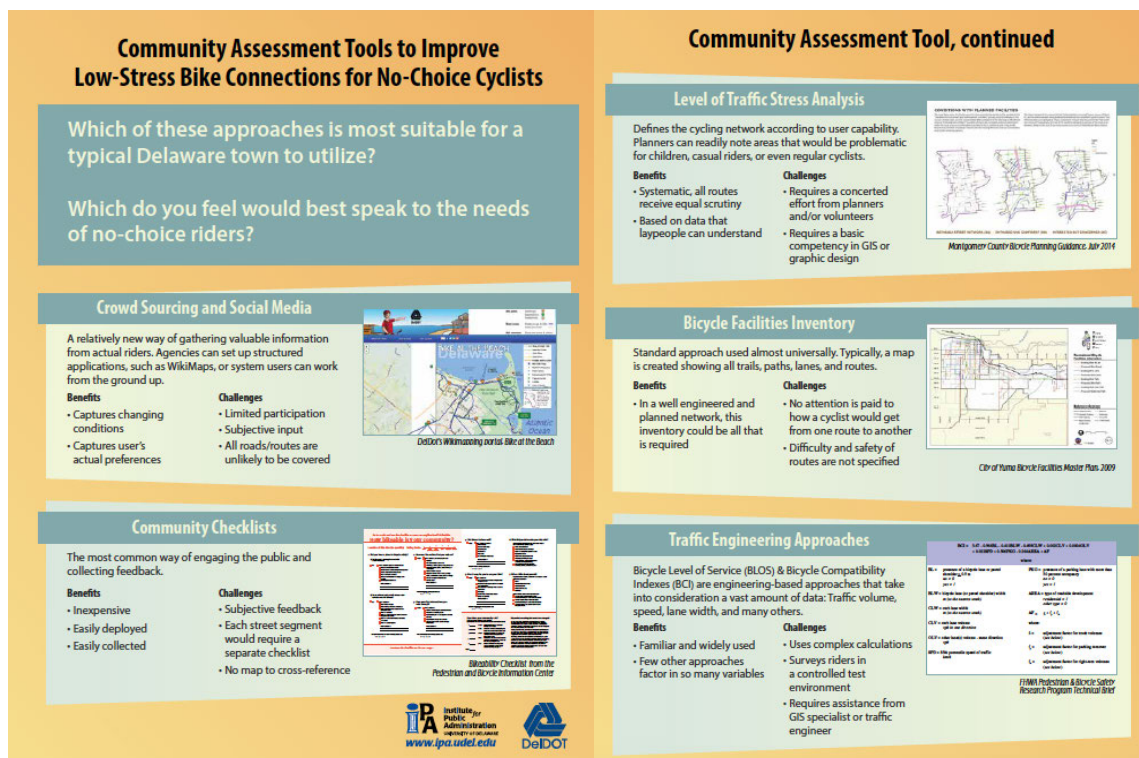


Figure 23: Poster Display of Community Assessment Tool Options

The team gathered input from meeting participants both verbally and via a paper questionnaire (see Appendix E). The questionnaire was distributed and collected during events to obtain input on “approaches... most suitable for a typical [Delaware] town to utilize” in:

- Identifying bikeability issues and facility improvement strategies for no choice bike riders in Delaware (e.g., high stress streets, lack of coordinated connectivity among transportation networks and modes); and
- Developing bikeability assessment tool, which can be used by communities to help identify priorities for improving low stress bicycle networks and connectivity to local destinations (including recreation facilities and trails).

### 8.3 Phase 3 Outreach

Feedback from these meetings guided the researchers in their decision to further develop the community checklist assessment approach. The researchers developed three options for this checklist. Option 1 (the “prompt”) is the simplest format and provides prompts regarding particular bikeability conditions to which users respond with comments and the locations of observed issues.

	Prompt	Comments	Location
<b>Facilities</b>	1. Presence of bicycle facilities		
	2. Accessibility of bicycle facilities		
	3. Ease of entry and exit of the facilities		
	4. Presence of bike parking at destinations		
	5. Drainage grates perpendicular to bicyclist travel direction		
	6. Presence of design features that may adversely affect cyclist safety (ie: curbs, railings, and/or other structures)		
<b>Network</b>	7. Bicycle facilities located in areas that are useful to riders		
	8. Presence of any abrupt endings for the bicycle facility		

Table 2: Option 1, the “Prompt”

Option 2 (the “checklist”) provides yes/no checkboxes in addition to boxes to record comments and locations.

	Prompt	Yes	No	Comments	Location
<b>Facilities</b>	1. Are bicycle facilities present?				
	2. Are the facilities wide enough to accommodate bicyclists?				
	3. Can you easily enter and exit the facilities?				
	4. Is there secure bike parking or storage at meaningful destinations?				
	5. Do drainage grates run perpendicular to bicyclist travel direction?				
	6. Are there design features that may adversely affect cyclist safety (e.g., curbs, railings, and/or other structures)?				
<b>Network</b>	7. Are bicycle facilities located in areas that are useful to riders?				
	8. Are there any abrupt endings for the bicycle facility?				

Table 3: Option 2, the “Checklist”

Option 3 (the “scale”) allows users to rate the extent of the presence of each issue on a five option scale from “Strongly Agree” to “Strongly Disagree,” with an “Undecided” option at the midpoint of the scale. All three options may be found in Appendix G.

Facilities						
1. What type of bicycle facility is present?	None	Sharrow	Shoulder	Dedicated Bike Lane	Protected Bike Lane	Separated Bike Path
2. The facilities are wide enough to accommodate cyclists.	Strongly Agree	Agree	Undecided	Disagree		Strongly Disagree
3. The facilities are easily accessible.	Strongly Agree	Agree	Undecided	Disagree		Strongly Disagree
4. There is bike parking or storage at all meaningful destinations.	Strongly Agree	Agree	Undecided	Disagree		Strongly Disagree
5. The facilities are safe and easy to navigate	Strongly Agree	Agree	Undecided	Disagree		Strongly Disagree
6. Are there design features that may obstruct cyclist movement or cause safety concerns? (check all that apply)						
<input type="checkbox"/> Drainage grates running parallel to travel direction						
<input type="checkbox"/> Lampposts or other obstructions in the bike lane						
<input type="checkbox"/> Railings or tall curbs close to the bike lane						

Network						
7. Bicycle facilities are located in areas that are useful to riders.	Strongly Agree	Agree	Undecided	Disagree		Strongly Disagree
8. There are abrupt endings for the bicycle facility.	Strongly Agree	Agree	Undecided	Disagree		Strongly Disagree

Table 4: Option 3, the “Scale”

Input was gathered from stakeholder groups regarding the relative merits of each of the three tool options. The tool options were presented as slide presentations to four relevant advisory committees of WILMAPCO, Dover/Kent County MPO, the Newark Bicycle Committee, and the State Pedestrian/Bicycle Safety Committee. These meetings are listed in Table 1. Presentation materials are provided in Appendices H, I, and J).

In three out of four of the meetings, consensus was in favor of Option 3 (the “scale”), with Option 1 being the least popular. While Option 3 was preferred in part because it required less writing in the field, members of the Newark Bicycle Committee recommended that space for writing comments should also be provided in this option. This suggestion was incorporated into Option 3 along with spaces to record locations of observed issues.

Committee members also emphasized the importance of marketing and outreach for the guide. Some of the issues raised included how to target specific audiences and identify priority areas for low or no choice bicyclists. Suggestions relating to outreach included piloting the tool on a road segment in Newark or Wilmington and creating and distributing a brief (“one pager”) summary of the guide to stoke the interest of towns and organizations. Additionally, meeting attendees expressed interest in the possibilities offered by mobile apps and user submitted GIS data, which the researchers have continued to explore throughout the development of the assessment tool.



## 9. Development of Low-Stress Bikeability Assessment Tool

IPA developed a simple, three step process to guide local governments in evaluating the extent to which average bicycle riders can easily access low stress areas and developing strategies to leverage state investments to improve local cycling networks and bicycle infrastructure. The tool is intended to be used in combination with DelDOT's LSC maps. Identifying where there are disconnected or fragmented segments of low stress stress will enable communities to target high priority locations to plan for infrastructure improvements, bridge network connectivity gaps, and enhance low stress conditions for the average bicyclist.

### 9.1 Three-Step Process

The assessment tool and three step process were developed for use in a facilitated workshop setting to engage stakeholders—either a formal committee appointed by a local government, or an informal or ad hoc group consisting of diverse community representatives. It is recommended that the workshop be organized and facilitated by a designated workshop leader/facilitator who is an authorized representative(s) of a Delaware local government (e.g., planner, consultant, or municipal staff member).

#### Step 1: The Pre-Assessment

The first step provides an advanced preparation process to ensure the success of the low stress bikeability assessment. Because public involvement is a fundamental part of the assessment process, it is suggested that diverse stakeholders be identified and involved throughout the process. A review of existing local plans, policies, and programs is recommended to build on current initiatives or previous assessments of existing bicycle network conditions and needed links/connections. State, regional, and federal documents that serve as resources for planning, designing, and operating bicycle and pedestrian facilities should also be reviewed.

During Step 1: Pre Assessment, the designated workshop leader/facilitator should obtain the area's LSC basemap from DelDOT and apply local knowledge to prioritize an area targeted for assessment. Once the assessment area has been determined, it is advised that a pre tour be conducted to identify safety issues and ensure the route length is reasonable.

In advance of the workshop, participants should become familiar with what to look for during an field audit of bikeability conditions. A narrated presentation, "Conducting a Low Stress Bikeability Assessment: An Overview of What to Look for"

([www.youtube.com/watch?v=pBmOFsdio\\_8](http://www.youtube.com/watch?v=pBmOFsdio_8)) and Low Stress Bikeability Visual Prompts have been developed to familiarize workshop participants with issues with respect to bicycle facilities, network, road conditions, visibility, intersections, and transit interaction.

## Step 2: The Low-Stress Bikeability Assessment

This step focuses on facilitating the workshop and conducting the in field, low stress bikeability assessment. The Low Stress Bikeability Assessment Checklist, which corresponds to the visual prompts and narrated presentation, has been designed to enable participants to record observations and bikeability conditions during the in field bikeability assessment. Upon completing the in field assessment, participants immediately reconvene in a facilitated workshop setting for a debriefing and mapping exercise.

## Step 3: Post-Assessment

The final step focuses on building a consensus, interest, and momentum on long term bikeability improvements. It describes a process that involves prioritizing concerns; preparing written summary; presenting findings to key local officials and funding entities; gaining support and strengthening partnerships; and developing an action plan that considers the need for plans, policies, design changes, funding support, maintenance plans/agreements, and technical assistance. This step suggests enlisting public safety officials, bicycle committees, advocacy groups, parks and recreation departments, the private sector, and non profit organizations to educate citizens and improve awareness on the needs and rights of bicyclists.

## 9.2 Dissemination of Tool

An outcome of this project is the publication of *Planning for Complete Communities in Delaware: The Low-Stress Bikeability Assessment Tool*. The resource was developed by IPA to assist Delaware local government officials and community members in assessing the low stress bikeability of a priority roadway segment to address the needs of “interested but concerned” and choice riders.

The tool, narrated video, and Low Stress Bikeability Assessment Checklist can be found within the “Low Stress Bikeability” section of the *Delaware Complete Communities Planning Toolbox* (<http://goo.gl/n7RbnZ>). The full publication is also available as a downloadable document at (<https://goo.gl/xf0ajZ>).

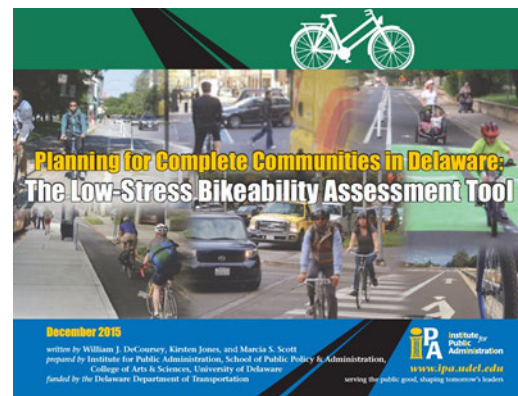


Figure 24: Low-Stress Bikeability Assessment Tool

## **10. Appendices**

**Appendix A: Level of Detour**

**Appendix B: Illustration of Low-Stress Cycling (LSC) Facility Types**

**Appendix C: Outreach – Governor’s Delaware Council on Health Promotion and Disease Prevention**

**Appendix D: Questionnaire – LSC Approaches**

**Appendix E: Display/Handout – LSC Approaches**

**Appendix F: Presentation to Dover/Kent County MPO Committees, Newark Bicycle Committee, and State Pedestrian/Bicycle Safety Working Group**

**Appendix G: Assessment Tool Options**

**Option 1 – Prompts**

**Option 2 – Checklist**

**Option 3 – Scale**

**Appendix H: Newark Bicycle Committee Meeting Notes**

**Appendix I: Summary Notes from Dover/Kent MPO PAC & TAC**

**Appendix J: Summary Notes from State Pedestrian/Bicycle Safety Working Group**

**Appendix K: Low- and No-Choice Rider Basemaps**

**Map 1 – Households with No Vehicles**

**Map 2 – Household Poverty Rate**

**Map 3 – Worker to Vehicle Deficit**

**Appendix L: References**

## Appendix A: Level of Detour

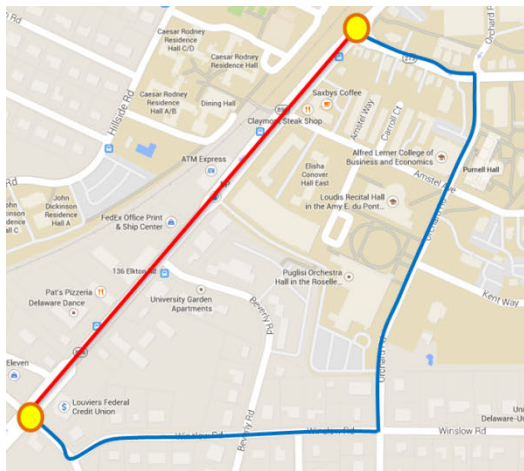
To formally calculate the acceptable level of detour, the following two equations can be used:

$$\frac{L_k}{L_4} \leq 1.25; \text{ OR}$$

$$L_k - L_4 \leq 1760 \text{ ft. (Note: 1760 ft = .33 miles)}$$

Where:  $L_k$  = length of the shortest path between two points using LTS 1, 2, or 3  
 $L_4$  = length of shortest path between two points using LTS 4

To use this equation, it is important to note that  $L_k$  requires the planners of the detour to identify the acceptable level of stress prior to beginning the analysis. For example, if planning the detour for Interested but Concerned riders, the roads chosen for the detour must be either LTS 1 or 2. If planning for the Confident and Enthused riders, roads with LTS 3 would be acceptable. Once the target LTS is identified, the route with such a LTS can be identified, mapped, and measured. This distance is then compared to the shortest possible route to take by bicycle, regardless of the high LTS (represented by  $L_4$ ). Using the determined distances of both the lower LTS route and the route that would be the shortest, the level of detour can be identified and deemed acceptable or not. If the level of detour is too long, it will not be a viable option for cyclists to use and therefore is not worth counting as a low-stress option.



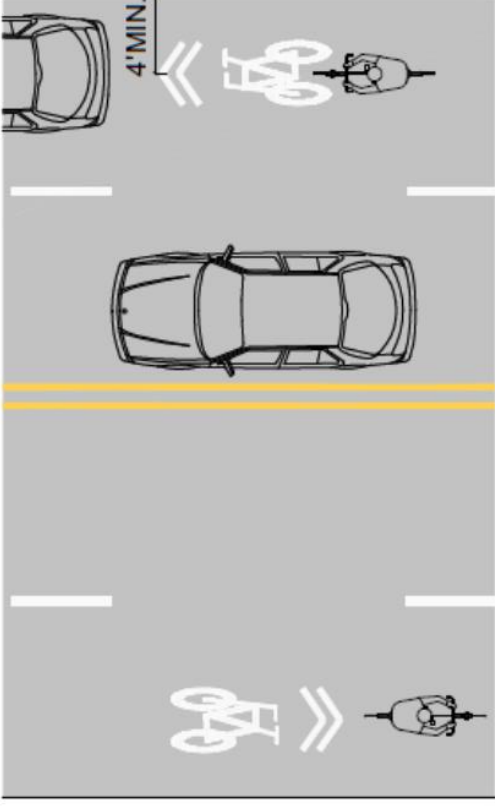

$$L_k = L_2 = .8 \text{ miles}$$

$$L_4 = .2 \text{ miles}$$

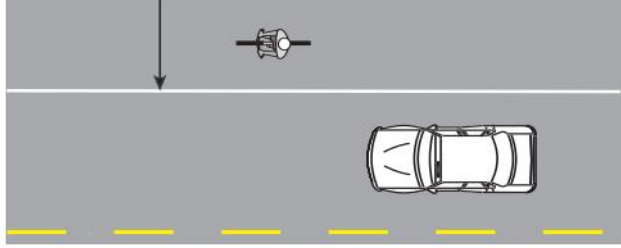
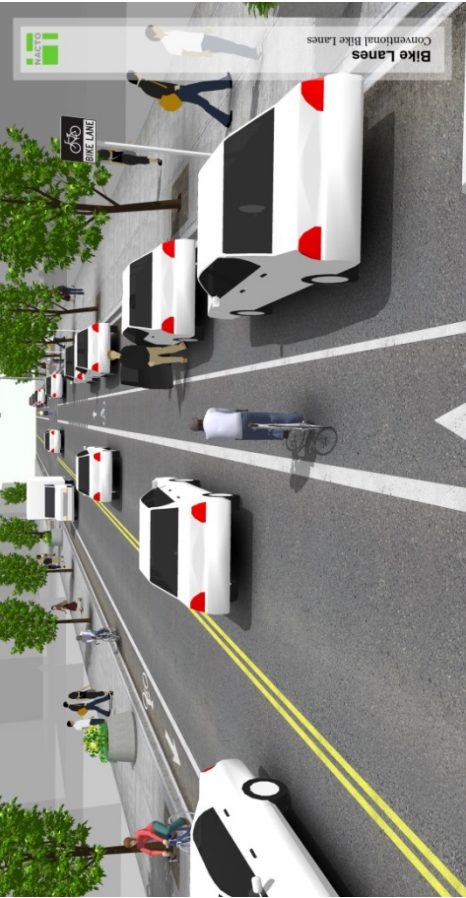
$\frac{L_2}{L_4} = \frac{.8}{.2} = 4$  which is not  $\leq 1.25$  so this level of detour is unacceptable. People would not choose to take the detour with a lower level of traffic stress because it would take them too long and be too far out of their way. Instead, they may choose to not bike at all.

Google Maps, 2015.

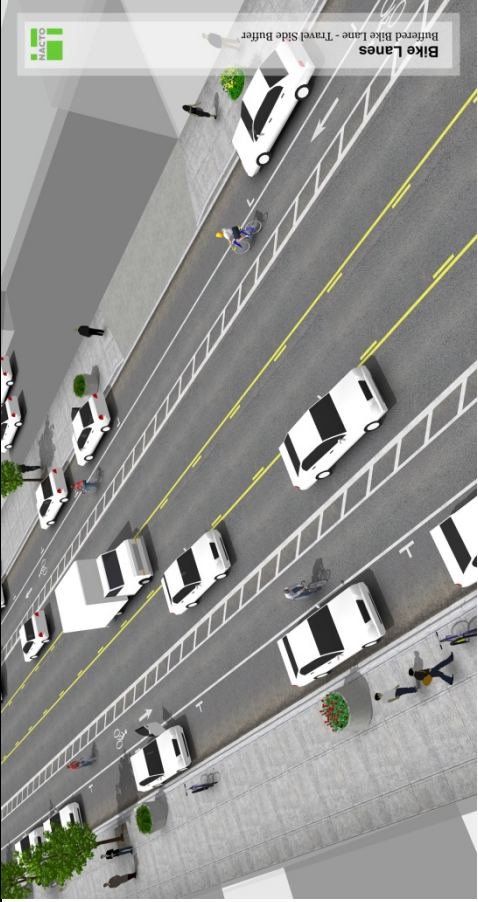

## Appendix B: Illustration of Low-Stress Cycling Facility Types

Type	Description	Design Requirements	Picture
<b>Shared Lane “Sharrow”</b>	The road as constructed is painted with equal notifying drivers and bicyclists that the full lane and used by bikes. They are generally incorporated to side streets post hoc.	<ul style="list-style-type: none"> <li>- <i>Type of road:</i> low volume, w speed local streets</li> <li>- <i>Alternative streets possible:</i> minor collectors, nd w volume rural roads</li> <li>- <i>Width requirement:</i> travel lanes ust e etween 4 16 feet wide</li> <li>- <i>Design feature:</i> Painted emblem on road</li> </ul>	 <p>Photo credit: Maryland State Highway Association</p>
<b>Bicycle Boulevard</b>	A local street is modified to function as a through street exclusively for bikes. Local access for automobiles is maintained.	<ul style="list-style-type: none"> <li>- <i>Type of road:</i> low volume, w speed local streets only</li> <li>- <i>Width requirement:</i> local roads left at existing widths; traffic calming measures needed throughout (speed bumps, roundabouts, curves, ect)</li> <li>- <i>Design feature:</i> Signage and paintings on road</li> </ul>	 <p>Photo credit: NACTO</p>



Type	Description	Design Requirements	Picture
Shoulder Bikeway	Can either be a wide outside (curb) lane, a bikeable shoulder, or a local street where the shoulder can be used by bikes.	<ul style="list-style-type: none"> <li>- <i>Type of road:</i> generally used on rural roads</li> <li>- <i>Width requirement:</i> 5 feet when placed next to curb, parking, or guardrail; 4 feet when placed next to open shoulder</li> <li>- <i>Design feature:</i> paved and at the same height as regularly traveled lanes</li> </ul>	 <p><b>Shoulder Lane Stripe</b> Pavement marking line 100 mm (4 in) wide solid white</p> <p><b>Optional:</b> Sign shoulders as a bikeway on designated bicycle routes and/or popular bicycling roadways when ADT &gt; 2,000, average vehicle speeds &gt; 56 km/h (35 mph), and when there is inadequate sight distance (e.g. corners and hills)</p> <p>Photo credit: Minnesota Department of Transportation</p>
Bike Lane	Street lanes that are signed and marked to designate the space occupied by cyclists on the roadway.	<ul style="list-style-type: none"> <li>- <i>Type of road:</i> collector or local streets with low-medium volume and speed</li> <li>- <i>Width requirement:</i> 4 to 6 feet</li> <li>- <i>Design feature:</i> Signage and painted white solid line to designate specific lane for bicycle travel only; green paint may also be used on all or part of the lane segments</li> <li>- <i>Special note:</i> when on street parking is allowed, bike lanes are located to the travel lane side of parking</li> </ul>	 <p>Photo credit: NACTO</p>



Type	Description	Design Requirements	Picture
<b>Buffered Bike Lane</b>	A bike lane that has a striped cross hatched area between bicyclists and motor vehicles.	<ul style="list-style-type: none"> <li>- <i>Type of road:</i> collector streets with medium volume and speed</li> <li>- <i>Width requirement:</i> Buffer 2 3 feet; lane 4 6 feet</li> <li>- <i>Design feature:</i> painted lines hatched to separate automobile travel and bicycle travel lanes</li> </ul>	 <p>Photo credit: NACTO</p>
<b>Cycle Track (also called Separated Bike Lane)</b>	Physically separated from motor traffic and distinct from the sidewalk, where bicycles travel in one direction.	<ul style="list-style-type: none"> <li>- <i>Type of road:</i> high volume, high speed arterial</li> <li>- <i>Width requirement:</i> 4 6 feet</li> <li>- <i>Design feature:</i> physical barrier and buffer zone placed between automobiles and bicycles; separate from sidewalks</li> <li>- <i>Special note:</i> can be one or two way; can be raised on even with roadway</li> </ul>	 <p>Photo credit: NACTO</p>

## Appendix C: Outreach - Governor's Council for Health Promotion and Disease Prevention

### Council on Health Promotion and Disease Prevention Walkable & Bicycle Friendly Communities Committee 1/28/15 Discussion Item: Low-Stress Biking/Streets

**Background:** For a bicycling network to attract the widest possible segment of the population, its most fundamental attribute should be low-stress connectivity, that is, providing routes between people's origins and destinations that do not require cyclists to use links that exceed their tolerance for traffic stress, and that do not involve an undue level of detour.

**Purpose:** a) Identify bikeability issues and facility-improvement strategies for non-choice bike riders in Delaware, e.g., high-stress streets, lack of coordinated connectivity among transportation networks and modes. "Non-choice" or "captive" or bicycle riders have lost or are unable to secure a driver's license, must bike as a primary mode of transportation, and have limited transportation options. b) Develop low-stress biking assessment tool, checklist, and

related resources to be uploaded to the Institute for Public Administration's (IPA's) user-friendly

*Delaware Complete Communities Planning Toolbox and Toolkit for a Healthy Delaware.*

1. **P** Preparation/Planning: Assuming project funding becomes available, IPA will convene a working group—consisting of representatives from DelDOT, Bike Delaware, Governor's Council on Health Promotion and Disease Prevention, Delaware Bicycle Council, and other stakeholders.
2. **P** Partnerships: See above.
3. **P** Promotion: Resources uploaded to – and promoted on - IPA's *Delaware Complete Communities Planning Toolbox and Toolkit for a Healthy Delaware*.  
<http://completecommunitiesde.org/>  
<http://www.ipa.udel.edu/healthyDEtoolkit/>
4. **P** Programs: Newer research is pointing to growing support for bicycle-supported development. Bicycle infrastructure (e.g., buffered bike lanes, off street paths, protected bike lanes, parking, storage, bike-sharing stations at transit stops/hubs) needs further study for further applicability in Delaware.

5. **P** Policy: Continue to create governmental champions at the legislative, county, and municipal levels leading to passage of bicycle-friendly public policies (e.g., comprehensive land use plans, zoning ordinances, local development plans).
6. **P** Physical Project: The State, county and local transportation systems needs to provide low-stress routes between origins and destinations that do not require cyclists to exceed tolerable levels of traffic stress or considerable detours. (High-stress streets are considered to be those with high speed limits, limited or non-existent lanes/markings and signage, and long distances to cross at intersections.) While transportation/planning agencies make bicycle-facility related improvements to make bicycling safer and more appealing, these improvements may not represent the network of paths or roadways that people consider to be safe for bicycling.

## **GOALS**

Working over 15 months (2014-Q4 through 2015-Q4), the Institute for Public Administration, working with partner organizations, will develop low-stress biking assessment tool, checklist, and related resources to be uploaded to the Institute for Public Administration's (IPA's) user- friendly *Delaware Complete Communities Planning Toolbox*: <http://completecommunitiesde.org/> and *Toolkit for a Healthy Delaware*: <http://www.ipa.udel.edu/healthyDEtoolkit/>

As additional funding becomes available, IPA hopes to test the resources in two target communities.

## Attachment 1

### Institute for Public Administration (IPA) University of Delaware 2014-15 Project Proposal - DelDot

#### Low-Stress Bike Connections

Research by Dr. Peter Furth of Northeastern University's Civil and Environmental Engineering program asserts that the most fundamental need in a bicycling network is low stress connectivity.<sup>1</sup> The transportation system needs to provide routes between origins and destinations that do not require cyclists to exceed tolerable levels of traffic stress or considerable detours. High stress streets are considered to be those with high speed limits, limited or non-existent lanes/markings and signage, and long distances to cross at intersections. While transportation agencies make bicycle facility related improvements to make bicycling safer and more appealing, these improvements may not represent the network of paths or roadways that people consider to be safe for bicycling. Research points to the need to consider connectivity, and levels of a street network's stressfulness, as critical aspect of bicycle network planning. Newer research is pointing to growing support for bicycle supported development in major cities.<sup>2</sup> Bicycle infrastructure (e.g., parking, storage, bike sharing stations at transit stops/hubs) needs further study for applicability in Delaware.

IPA will conduct a literature review of recent research, which builds on the foundation of Dr. Furth's research, and can add to the discussion on low stress approaches to attract the mainstream population in Delaware to bicycle networks. The literature review will specifically focus a possible 5<sup>th</sup> category that was not identified in previous research—"captive users" or "non choice" bicycle riders that have lost or are unable to secure a driver's license, must bike as primary mode of transportation, and have limited transportation options.

In addition to the literature review, IPA will convene a working group—consisting of representatives from DelDOT, Bike Delaware, Governor's Council on Health Promotion and Disease Prevention, Delaware Bicycle Council, and other stakeholders. Working group tasks will include 1) identify bikeability issues and facility-improvement strategies for no-choice bike riders in Delaware (e.g., high-stress streets, lack of coordinated connectivity among transportation networks and modes), and 2) provide input on the development of a Bikeability Assessment Tool for Delaware Communities (similar to IPA's [Walkability Assessment Tool](#)). Outcomes (e.g., issue identification/improvement strategies, assessment tool, checklist, resources) will be summarized in a white paper and loaded in user friendly format on the *Toolbox*.

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<sup>1</sup> Furth, Peter and Mekuria, Maaza. (2013). Network Connectivity and Low-Stress Bicycling. Submitted to TRB for the 2013 Annual Meeting and publication in *Transportation Research Board*, <http://docs.trb.org/prp/13-0427.pdf>.

<sup>2</sup> Clifton, Morrissey, and Ritter. (May-June 2012). "Business Cycles: Catering to the Bicycling Market." *TR News*. Number 280. <http://onlinepubs.trb.org/onlinepubs/trnews/trnews280.pdf>.

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1. Which of these approaches do you feel is most suitable for a typical Delaware Town (choose one or two):  
a) Crowd-Sourcing/Social Media, b) Community Checklist, c) Level of Traffic Stress Analysis, d) Bicycle Facilities Inventory, or e) Traffic Engineering (i.e. Bicycle Level of Service)? Please explain.

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2. Which approach do you feel would be best suited to address the needs of no-choice riders (choose one or two):  
a) Crowd-Sourcing/Social Media, b) Community Checklist, c) Level of Traffic Stress Analysis, d) Bicycle Facilities Inventory, or e) Traffic Engineering (i.e. Bicycle Level of Service)? Please explain.

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3. What population segments or geographic areas do you feel are most important to consider in working to serve no, or low-choice riders?

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4. I'd be willing to serve on an advisory panel and would be willing to attend a meeting(s) to give input into this research. **Yes, No**

Name 

---

Affiliation 

---

Email address 

---

Daytime phone # 

---



## **Appendix E: Display/Handout –LSC Approaches**

## Community Assessment Tools to Improve Low-Stress Bike Connections for No-Choice Cyclists

Which of these approaches is most suitable for a typical Delaware town to utilize?

Which do you feel would best speak to the needs of no-choice riders?

Please, share your thoughts!

### Crowd Sourcing and Social Media

A relatively new way of gathering valuable information from actual riders. Agencies can set up structured applications, such as WikiMaps, or system users can work from the ground up.

#### Benefits

- Captures changing conditions
- Captures user's actual preferences

#### Challenges

- Limited participation
- Subjective input
- All roads/routes are unlikely to be covered



DelDot's Wikimapping portal, Bike at the Beach

### Community Checklists

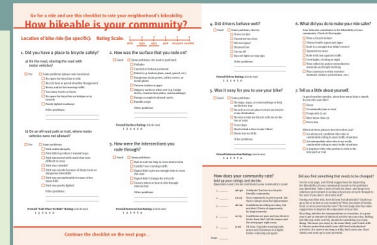
The most common way of engaging the public and collecting feedback.

#### Benefits

- Inexpensive
- Easily deployed
- Easily collected

#### Challenges

- Subjective feedback
- Each street segment would require a separate checklist
- No map to cross-reference



Bikeability Checklist from the Pedestrian and Bicycle Information Center

# Community Assessment Tools to Improve Low-Stress Bike Connections for No-Choice Cyclists

## Level of Traffic Stress Analysis

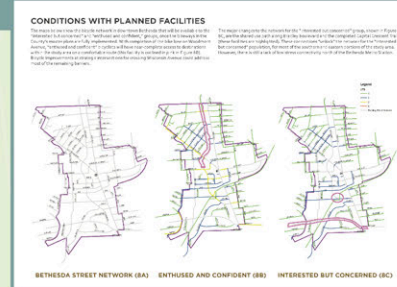
Defines the cycling network according to user capability. Planners can readily note areas that would be problematic for children, casual riders, or even regular cyclists.

### Benefits

- Systematic, all routes receive equal scrutiny
- Based on data that laypeople can understand

### Challenges

- Requires a concerted effort from planners and/or volunteers
- Requires a basic competency in GIS or graphic design



Montgomery County Bicycle Planning Guidance, July 2014

## Bicycle Facilities Inventory

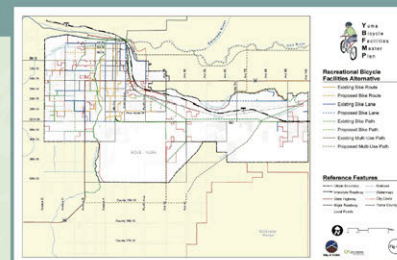
Standard approach used almost universally. Typically, a map is created showing all trails, paths, lanes, and routes.

### Benefits

- In a well engineered and planned network, this inventory could be all that is required

### Challenges

- No attention is paid to how a cyclist would get from one route to another
- Difficulty and safety of routes are not specified



City of Yuma Bicycle Facilities Master Plan, 2009

## Traffic Engineering Approaches

Bicycle Level of Service (BLOS) & Bicycle Compatibility Indexes (BCI) are engineering-based approaches that take into consideration a vast amount of data: Traffic volume, speed, lane width, and many others.

### Benefits

- Familiar and widely used
- Few other approaches factor in so many variables

### Challenges

- Uses complex calculations
- Surveys riders in a controlled test environment
- Requires assistance from GIS specialist or traffic engineer

$$BCI = 3.67 - 0.96BL - 0.41BLW - 0.89CLW + 0.002CLV + 0.004OLV + 0.025SPD + 0.564PKG - 0.264AREA + AF$$

where:

BL = presence of a bicycle lane or paved shoulder $\geq 0.9$ m no = 0 yes = 1	PKG = presence of a parking lane with more than 50 percent occupancy no = 0 yes = 1
BLW = bicycle lane (or paved shoulder) width m (to the nearest tenth)	AREA = type of roadside development residential = 1 other type = 0
CLW = curb lane width m (to the nearest tenth)	AF = $f_1 + f_2 + f_3$
CLV = curb lane volume $\geq 800$ in one direction	where:
OLV = other lane(s) volume - same direction $\geq 800$	$f_1$ = adjustment factor for truck volumes (see below)
SPD = 85th percentile speed of traffic km/h	$f_2$ = adjustment factor for parking turnover (see below)
	$f_3$ = adjustment factor for right-turn volumes (see below)

FHWA Pedestrian & Bicycle Safety Research Program Technical Brief

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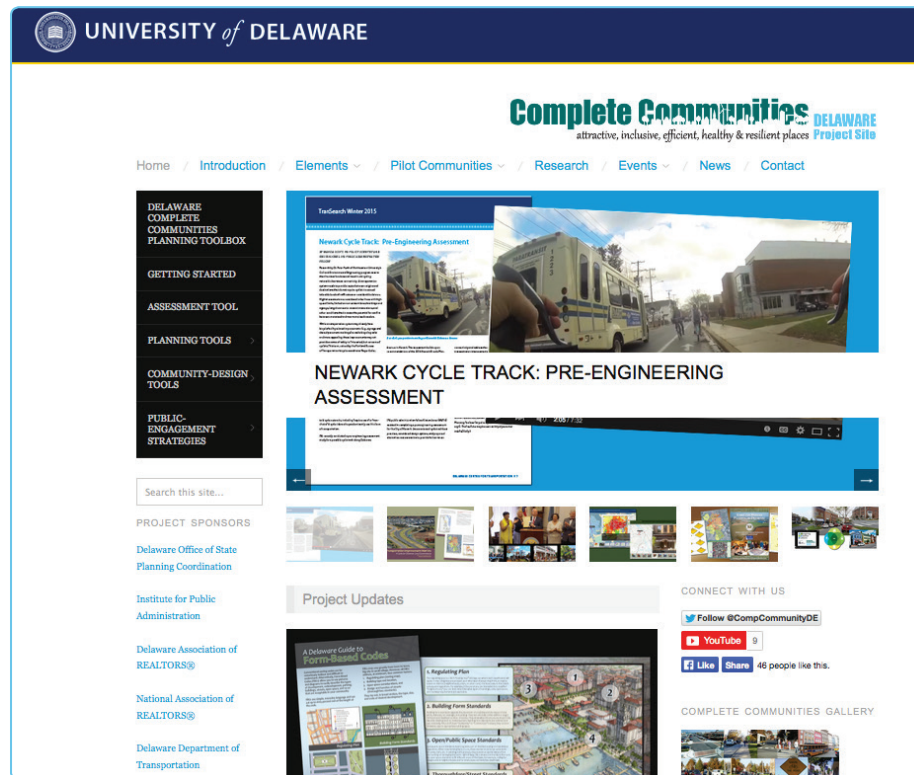
**DELAWARE Project Site**

A “complete” community promotes healthy lifestyles, economic growth, and sustainability through an integrated approach to transportation, land-use, and community design.

The Delaware Complete Communities Planning Toolbox is a resource for community leaders and local government officials to utilize:

- **Complete-Communities Planning Approaches** in 5 key areas of land-use and development.
  1. Complete Streets
  2. Efficient Land Use
  3. Healthy and Livable
  4. Inclusive and Active
  5. Sustainable and Resilient
- **Community-Design Tools** to create places that are dynamic and reflect community changes, oriented toward people not cars, reflective of a town’s architectural and cultural heritage, visually attractive and enjoyable, accessible and inclusive, and economically vibrant.
- **Public Engagement Strategies** to foster communication with residents about community development plans.

[www.completecommunitiesde.org](http://www.completecommunitiesde.org)





# Low-Stress Bikeability

Presented by the  
Institute for Public Administration  
University of Delaware



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## Complete Communities Project

- Designed to build local government capacity on planning or practice, inclusive, efficient, healthy & resilient places
- Launched website to provide "Toolbox" with:
  - Planning Tools
  - Community Design Tools
  - Public Engagement Strategies



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## Project Overview - LSC

- Part of ongoing Complete Communities project of DelDOT
- Tasked with evaluating approaches of assessing bikeability with the goal of determining the ideal approach(es) for a Delaware town.
- Creating a guide/template usable to the enthusiastic amateur or interested official
- Strong emphasis on no/low choice cyclists
- Presenting to WILMAPCO, Dover/Kent County AC & PAC, State's Pedestrian and Bicyclist Safety Committee
- Feedback, feedback, and more feedback.

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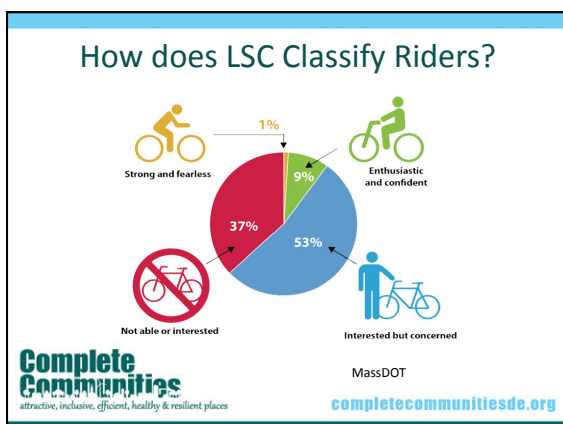
## What is Low-Stress Bicycling?

Providing routes between people's origins and destinations that do not require cyclists to use links that exceed their tolerance or efficiency, and that do not involve an undue level of detour.

Peter Furth, Northeastern University

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## What Does LSC Look Like?

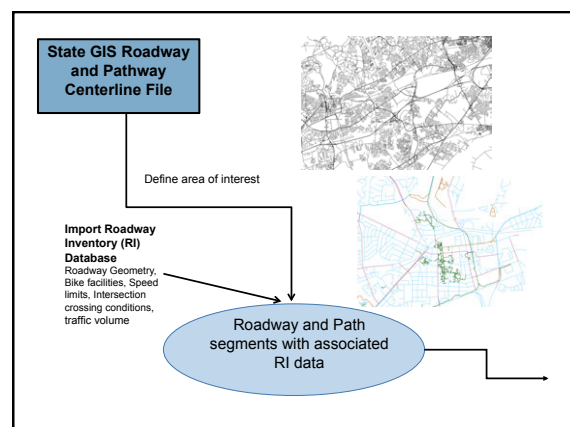
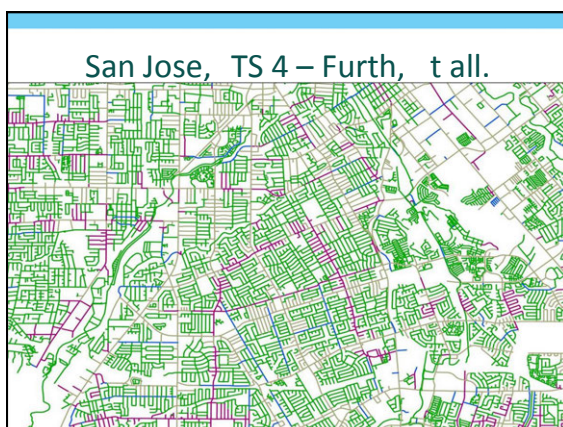
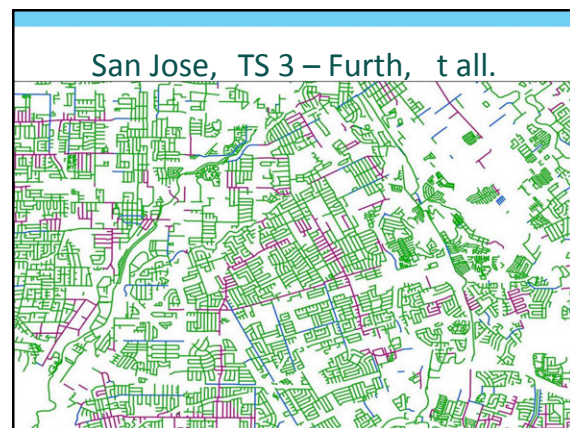
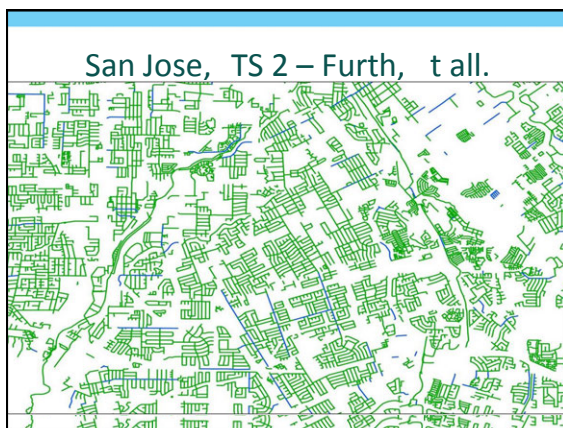
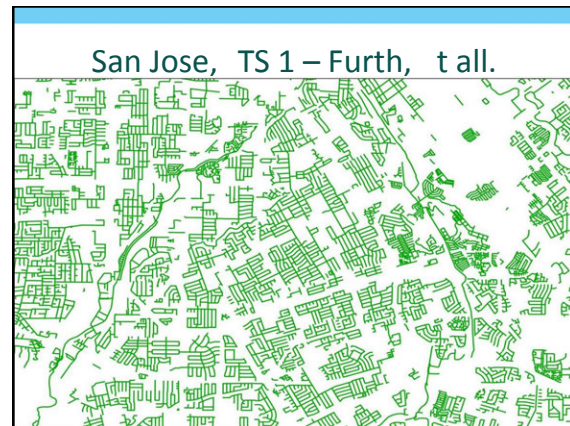
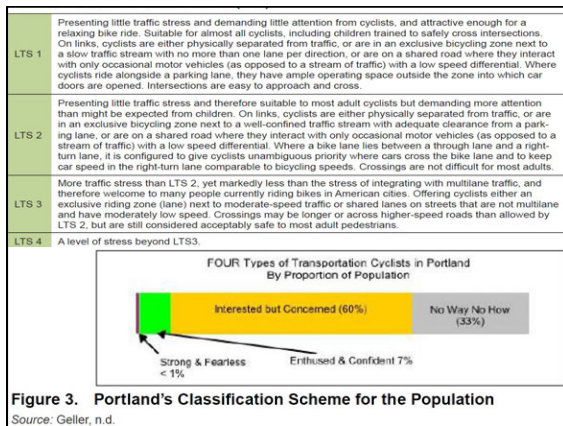


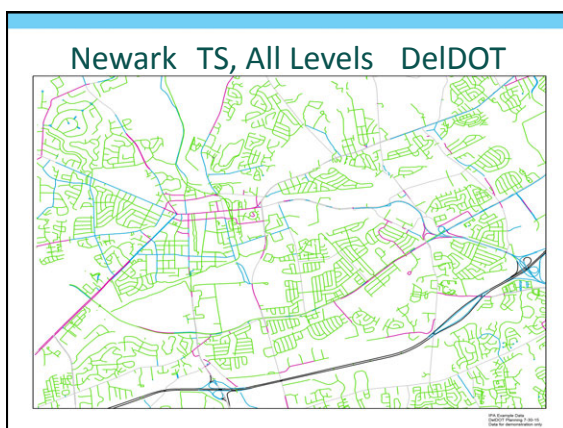
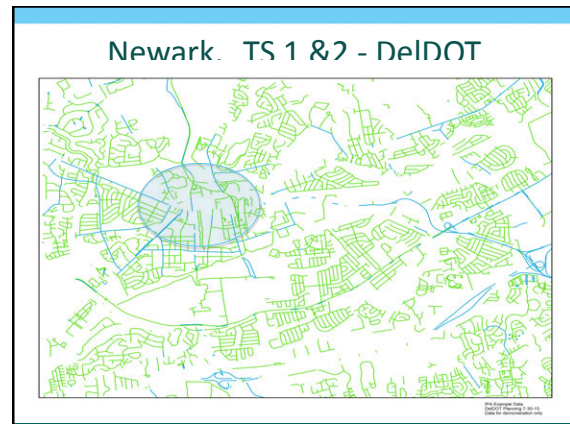
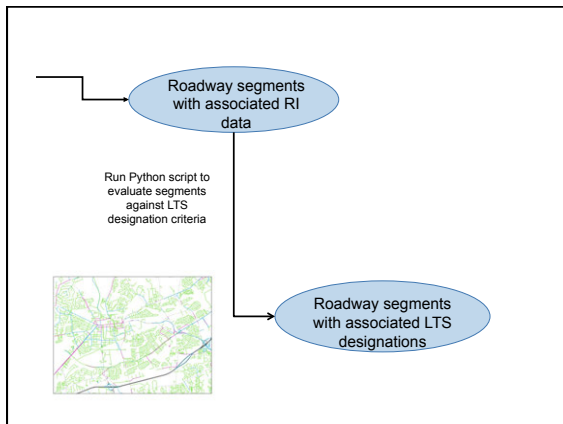
Figure 2: Examples for each Level of Traffic Stress

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### Low-Stress Cycling Assessment Guide/Tool

**Purpose:**

- Engage stakeholders!
- Convene a local government committee or group to assess the low stress bikeability of a roadway segment
- Designed for use in a facilitated workshop setting

**3-Step Engagement Process:**

- Pre-Assessment
- Assessment
  - What to look for (visual prompts/PowerPoint)
  - In field observation
  - Mapping exercise
- Post-Assessment

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### Process/Partnerships

- Make full and early use of all DeIDOT & MPO resources.
- Obtain and review LSC map of municipality
- Apply local knowledge to ground truth map, identify issues, and target priority area(s) for field analysis.
- Train volunteers (prompts and checklist) and conduct field survey... preferably with assistance from MPO, DeIDOT, or consultant.
- Collaborate with DeIDOT and/or MPO for inclusion in

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### 1. Pre-Assessment:

Consider needs of No/Low Choice Cyclists

- What populations?
- What concerns are unique to low-choice cyclists?
  - Routes/street types
  - Time of day
  - Destinations
- How can these concerns be addressed in municipal/small-area planning?


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### 1. e-Assessment: Collect data

- Review with Stressing Basemap on IDOT
- Review relevant plans from town and/or MPO



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### 1. e-Assessment: Collect data

#### Crowd Sourcing and Social Media


A relatively new way of gathering valuable information from actual riders. Agencies can set up structured applications, such as WikiMaps, or system users can work from the ground up.

**Benefits**

- Captures changing conditions
- Captures user's actual preferences

**Challenges**

- Limited participation
- Subjective input
- All roads/routes are unlikely to be covered



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### Level of Traffic Stress Analysis


Defines the cycling network according to user capability. Planners can readily note areas that would be problematic for children, casual riders, or even regular cyclists.

**Benefits**

- Systematic, all routes receive equal scrutiny
- Based on data that laypeople can understand

**Challenges**

- Requires a concerted effort from planners and/or volunteers
- Requires a basic competency in GIS or graphic design



*Montgomery County Bicycle Planning Guidance, July 2014*

### Bicycle Facilities Inventory


Standard approach used almost universally. Typically, a map is created showing all trails, paths, lanes, and routes.

**Benefits**

- In a well engineered and planned network, this inventory could be all that is required

**Challenges**

- No attention is paid to how a cyclist would get from one route to another
- Difficulty and safety of routes are not specified



*City of Yuma Bicycle Facilities Master Plan, 2009*

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### Traffic Engineering Approaches

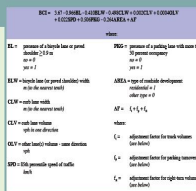
Bicycle Level of Service (BLOS) & Bicycle Compatibility Indexes (BCI) are engineering-based approaches that take into consideration a vast amount of data: Traffic volume, speed, lane width, and many others.

**Benefits**

- Familiar and widely used
- Few other approaches factor in so many variables

**Challenges**

- Uses complex calculations
- Surveys riders in a controlled test environment
- Requires assistance from GIS specialist or traffic engineer




*PIMA Pedestrian & Bicycle Safety Research Program Technical Brief*

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### 1. e-Assessment: Prepare or workshop

- Invite stakeholders/public
- Pre-select roadway segment to be evaluated
- Prioritized in advance based on:
  - Data collection
  - Citizen concerns/surveys
  - Public safety incident/accident reports
  - Popular destinations and routes
  - Known trouble spots
  - Major inconsistencies
  - Segments that lack connectivity



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### 2. Assessment

- Show Visuals:
  - PowerPoint
  - Within Guide/Tool
- Walk or bicycle the selected area
- Mark up maps and checklists in field
- Take Pictures!



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## 2. Assessment : Series of Visuals



## Types of Questionnaires

Three types:

- 1) Prompt
- 2) Checklist
- 3) Scale

- Vary in level of specificity, but all cover the same information
- Accompanied by descriptive information
- The same information is provided for all types

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## Type 1: Prompt

Facilities	Prompt	Comments	Location
	1. Presence of bicycle facilities		
	2. Accessibility of bicycle facilities		
	3. Ease of entry and exit of the facilities		
	4. Presence of bike parking at destinations		
	5. Drainage grates perpendicular to bicyclist travel direction		
	6. Presence of design features that may adversely affect cyclist safety (e.g. curbs, railings, and/or other structures)		
Network	7. Bicycle facilities located in areas that are useful to riders		
	8. Presence of any abrupt endings for the bicycle facility		

- Generalized
- Room for comments
- May be best for larger scale areas

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## Type 2: Checklist

Facilities	Prompt	Yes	No	Comments	Location
	1. Are bicycle facilities present?				
	2. Are the facilities wide enough to accommodate cyclists?				
	3. Can you easily enter and exit the facilities?				
	4. Is there secure bike parking or storage at meaningful destinations?				
	5. Do drainage grates run perpendicular to bicyclist travel direction?				
	6. Are there design features that may adversely affect cyclist safety (e.g. curbs, railings, and/or other structures)?				
Network	7. Are bicycle facilities located in areas that are useful to riders?				
	8. Are there any abrupt endings for the bicycle facility?				

- More specific; forces user to pick a single answer
- Simple Yes/No responses possible
- Maybe best for smaller survey areas

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## Type 3: Scale

Facilities	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1. What type of bicycle facility is present?					
2. The facilities are wide enough to accommodate cyclists.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
3. The facilities are easily accessible.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
4. There is bike parking or storage at all meaningful destinations.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
5. The facilities are safe and easy to navigate.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
6. Are there design features that may obstruct cyclist movement or cause safety concerns? (Check all that apply)					
a. Drainage grates running parallel to travel direction					
b. Lampposts or other obstructions in the bike lane					
c. Railings or rail curbs close to the bike lane					
Network					
7. Bicycle facilities are located in areas that are useful to riders.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
8. There are abrupt endings for the bicycle facility.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree

- Specific; allows user to choose from several options
- Responses more directly based on perception
- Maybe best for smaller survey areas

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### Example

**Prompt** →

Prompt	Comments	Location
1. Presence of bike parking at destinations		




**Checklist** →

Prompt	Yes	No	Comments	Location
4. Is there secure bike parking or storage at meaningful destinations?				

**Scale** →

Prompt	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
4. There is bike parking or storage at all meaningful destinations					

**Description:** →  
Same or all options

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### Key Questions

- Which checklist format do you feel is most appropriate for the average Delaware municipality?
- What information is best gathered at the local level?
- How can a municipality own more effectively engage with DeIDOT and their MPOs?

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### 3. Post Assessment

- Aggregate responses to a master map
- Summarize common themes from checklists
- Consider amending town's comprehensive plan or transportation plan.
- Collaborate with MPO and/or DeIDOT to explore potential remedies to noted concerns and to begin the process of being considered for the TIP/CIP.



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### Thank you

Please forward your comments and suggestions to:

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UofD/IPA Planner  
[decourse@udel.edu](mailto:decourse@udel.edu)  
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## Appendix G: Assessment Tool Options, Option 1 - Prompts

	Prompt	Comments	Location
<b>Facilities</b>	1. Presence of bicycle facilities		
	2. Accessibility of bicycle facilities		
	3. Ease of entry and exit of the facilities		
	4. Presence of bike parking at destinations		
	5. Presence of fall through hazards at drainage grates		
	6. Presence of design features that may adversely affect cyclist safety (i.e., curbs, railings, and/or other structures)		
<b>Network</b>	7. Bicycle facilities located in areas that are useful to riders		
	8. Presence of any abrupt endings for the bicycle facility		
	9. Continuation of bike lanes through all intersections		
<b>Road Conditions</b>	10. Smoothness of road surface		
	11. Cleanliness of facilities: presence of leaves, snow, rocks, debris, etc.		
	12. Automobile traffic following posted speed limits		
	13. Drivers' caution and respect towards people on bikes		
	14. Presence of cars stopped, parked, or driving in the bike lane		
<b>Visibility</b>	15. Clear sight lines for cyclists to see vehicles/pedestrians and vice versa		
	16. Presence of lighting throughout the entire facility		
	17. Presence of caution signs and pavement markings along the roadway		
	18. Warning signs posted at entrances and driveways		

## Appendix G: Assessment Tool Options, Option 1 - Prompts

<b>Intersections</b>	19. Presence of traffic signals that account for bicyclist movements		
	20. Conflicting traffic movements during bicycle crossing phases		
	21. Minimized need for cyclist unnecessary stopping		
	22. Presence of safe railroad crossings		
	23. Presence of protected space (i.e., median refuse island and/or bike box) to facilitate pedestrian and cyclist crossings		
<b>Transit</b>	24. Facilities for cyclists separated from mass transit stops		
	25. Bicycle accommodations (such as bike racks) at transit stops		

## Appendix G: Assessment Tool Options, Option 2 - Checklist

	Prompt	Yes	No	Comments	Location
<b>Facilities</b>	1. Are bicycle facilities present?				
	2. Are the facilities wide enough to accommodate bicyclists?				
	3. Can you easily enter and exit the facilities?				
	4. Is there secure bike parking or storage at meaningful destinations?				
	5. Is there a fall through hazard surrounding drainage grates (i.e., openings run parallel to bicyclist travel direction)?				
	6. Are there design features that may adversely affect cyclist safety (e.g., curbs, railings, and/or other structures)?				
<b>Network</b>	7. Are bicycle facilities located in areas that are useful to riders?				
	8. Are there any abrupt endings for the bicycle facility?				
	9. Do bike lanes continue through all intersections?				
<b>Road Conditions</b>	10. Are the facilities smooth and free of pot holes?				
	11. Are the bike facilities free from obstacles (e.g., leaves, snow, ice, rocks, debris, tree limbs, etc.)?				
	12. Do vehicles seem to be following the posted speed limit?				
	13. Are drivers cautious and respectful of people on bikes?				
	14. Are there any cars driving, stopped, or parked in bike lane?				
<b>Visibility</b>	15. Are there clear sight lines for cyclists to see vehicles/pedestrians and vice versa?		68		

## Appendix G: Assessment Tool Options, Option 2 - Checklist

<b>Visibility</b>	16. Is there lighting throughout the entire bike facility?					
	17. Are there caution signs and pavement markings along the roadway?					
	18. Are warning signs posted at entrances and driveways?					
<b>Intersections</b>	19. Do the traffic signals account for bicyclist movements?					
	20. Are there any conflicting traffic movements during bicycle crossing phases?					
	21. Has the need for cyclists to unnecessarily stop been minimized?					
	22. Are all railroad crossings safe for cyclists to cross?					
	23. Is there a protected space (i.e., median refuse island and/or bike box) to facilitate safe crossing of both cyclists and pedestrians?					
<b>Transit Interaction</b>	24. Are bike facilities separated from mass transit stops?					
	25. Are there bicycle accommodations (i.e., as bike parking or storage) at transit stops?					

## Appendix G: Assessment Tool Options, Option 3 - Scale

Facilities							Location
1. What type of bicycle facility is present?	None	Sharrow	Shoulder	Dedicated Bike Lane	Protected Bike Lane	Separated Bike Path	
2. The facilities are wide enough to accommodate cyclists.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree		
3. The facilities are easily accessible.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree		
4. There is bike parking or storage at all meaningful destinations.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree		
5. The facilities are safe and easy to navigate	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree		
6. Are there design features that may obstruct cyclist movement or cause safety concerns? (check all that apply)							
Drainage grates that prevent fall through hazards for cyclists							
Lampposts or other obstructions in the bike lane							
Railings or tall curbs close to the bike lane							
Comments:							

Network							Location
7. Bicycle facilities are located in areas that are useful to riders.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree		
8. There are abrupt endings for the bicycle facility.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree		
9. Bike lanes continue through all intersections	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree		
Comments:							



## Appendix G: Assessment Tool Options, Option 3 - Scale

Road Conditions					Location
10. Facility surfaces are smooth and free of potholes or other impediments.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
11. Bike facilities are free from obstacles (e.g., leaves, snow, ice, rocks, debris, etc.)	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
12. Drivers are following the posted speed limit.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
13. Drivers are cautious and respectful of people on bikes.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
14. Cars do not drive, stop, or park in the bike lane.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Comments:					

Visibility					Location
15. There are clear sight lines for cyclists to see vehicles and pedestrians and vice versa.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
16. Sufficient lighting is present throughout the entire bike facility.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
17. Sufficient caution signs and pavement markings are present along the roadway.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
18. Adequate warning signs are posted at entrances and driveways.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Comments:					

## Appendix G: Assessment Tool Options, Option 3 - Scale

Intersections					Location
19. Traffic signals account for bicyclist movements	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
20. Conflicting traffic movements have been eliminated during bicycle crossing phases of a traffic light.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
21. The need for cyclists to unnecessarily stop has been minimized	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
22. Railroad crossings are safe for cyclists.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
23. A protected space (i.e., median refuse island and/or bike box) to facilitate safe crossing of both cyclists and pedestrians	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Comments:					

Transit					Location
24. Bicycle facilities are separated from transit stops.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
25. Bicycle accommodations (e.g., bike parking or storage) are made at transit stops.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Comments:					

## Appendix H: Newark Bicycle Committee Meeting Notes

Notes: Newark Bicycle Committee Meeting, WILMAPCO, October 15, 2015

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### Low-Stress Cycling Assessment Guide/Tool

Following an overview of the concept of low-stress cycling, and work being conducted by DelDOT, the IPA team provided an overview of their work to develop a Low-Stress Cycling Assessment Guide/Tool. The following was discussed:

#### Purpose of Guide/Assessment Tool

- To enable a local government committee (e.g., Newark Bicycle Committee or planning commission) or neighborhood group (e.g., civic association) and key officials (representatives of MPOs, local government, advocacy groups, civic leaders, DelDOT) to assess the low-stress bikeability of a roadway segment.
  - The guide/tool is designed to be used in a workshop setting, to be facilitated by a planner or professional staff member from DelDOT, a MPO, local government, IPA, or consultant. It is part of a three-part process that includes a pre-assessment (information gathering), a workshop and bikeability assessment (on-site observations, mapping, and consensus building), and post-assessment (report development and project funding).
  - The guide/tool is not designed for use independently by citizens.
  - The selection of the roadway segment to be evaluated has ideally been prioritized in advance by the group. This prioritization may be based on pre-assessment work and data collection that may include:
    - Concerns raised by citizens
    - Public safety incident/accident reports
    - Citizen surveys
    - Review of DelDOT LTS/bikeability and other maps
    - Other data gathering methods (e.g., crowd sourcing/social media, bicycle facilities inventory, engineering studies, official plans)
- Components of Guide/Assessment Tool
  - Visual component – The online guide would provide visual images and descriptions of conditions to be reviewed prior to the workshop and on-site assessment. There are 6 categories to assess that have various elements.
  - Presentation – It's proposed that a video or PowerPoint also be shown during the workshop to highlight what to look for.
  - Three tool options (that are color-coded to match 6 assessment categories) were presented to the group to capture information from participants during the on-site assessment; Each of the tools were designed to capture

information from workshop participants and be used as the basis for mapping, engagement, and consensus building

- Three Assessment Tool Options Presented
  - “Prompt” – simplest format. Users simply record comments and locations of issues observed.
  - “Checklist” – intermediate format that allows users to check “yes” or “no” and also record comments and locations of issues observed
  - “Scale” – The group referred to this format as the “Technical” tool. The majority of the group preferred this format, but believe that there should be a space to add comments under each question or prompt.
- Input from Committee Members
  - Once the guide/tool is developed, it needs to be marketed for widespread use
  - How can the guide/tool be targeted to certain audiences (e.g., “safe routes to school,” commuters, advocacy groups, civic associations, neighborhoods with safety issues); How can outreach be conducted to communities/populations of interest?
  - Interested:
    - Developing a similar app that could be used on a tablet or mobile device
    - In piloting the use of the assessment tool on a roadway segment of concern either in Newark or in Wilmington
  - The group was confused about information presented on “low-choice and no-choice riders.” The majority felt that needs of low-choice and no-choice riders should possibly be explained as the basis for where an assessment should be undertaken. It is not germane to the use of the assessment tool during a workshop setting.

## Appendix I: Summary Notes from Dover/Kent County MPO Meetings

Notes: IPA's Presentation on Low-Stress Cycling Assessment Guide/Tool  
Dover/Kent County MPO's Technical Advisory Committee (TAC) on  
October 14, 2015 and Public Advisory Committee (PAC) on October  
27, 2015

*10/14/15 – TAC*

Participants agreed the presented tool was a good step forward and that it accounted for all the important variables citizen planners were likely to encounter.

There were some questions regarding scoring of the checklists, particularly option three. Some members wondered how the checklist or spreadsheet scoring would then translate into a map of priority areas, and, ultimately, to priority projects to be funded.

The group felt the checklist(s) needed to be packaged and distributed in such a way that there was ample context to guide would-be participants through the entire process (pre-assessment, assessment, and follow up), and that they may not be able to make effective use of the tool without a step-by-step process.

Concerning no/low choice riders, some members questioned whether a training component on basic bicycle skills or laws (or a link to a similar resource) should not be included in the guide. Several mentioned they had witnessed cyclists riding on the incorrect side of the road and not always obeying traffic control devices.

Participants showed no strong preference between option 1,2, or 3. They indicated each might be useful, depending upon the setting, involved volunteers, and level of project complexity.

*10/27/15 – PAC*

The group quickly agreed that town input into the process, at all stages, was of great importance and that a guide to walk them through the process would be a great help.

Others noted the continued presence of cul-de-sacs and dead end (stub-streets) that continue to impede effective low-stress cycling connections. In some cases, they felt that connections between neighborhoods must be coerced. The group also noted the irony of how much residents often enjoy or even seek out connections and opportunities for active recreation in the home-buying process, but how opposed they can be to establishing connections when they already own a home in a largely unconnected area.



The group had some reservations about the checklist approach in general. Citing an ongoing East/West Cycling study in Dover, Del, some noted that conditions changed street to street, block to block, even along the same road segment between intersections. They felt that in dynamic areas like this, the checklist approach would require “a lot of pages for one small area,” and noted that it could be overwhelming for the uninitiated.

Assuming all three might be eventually available, the group suggested commonality in wording and verbiage to ensure consistency in responses among the checklists. They were also keen on extrapolating data and trends, were enough checklists filled out and returned to allow for such an analysis.

Overall, they felt option 3 best suited to data collection and small, targeted problem areas. They felt option 2 was best for small towns with a less well identified area of interest. They also noted that option 3 did not have a field for issue location like the other two.

## Appendix J: Summary Notes from Statewide Pedestrian and Bicycle Safety Committee

Notes: Pedestrian/Bicycle Safety Committee, DelDOT TMC, Smyrna, Del. October 29, 2015

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### IPA's Presentation on Low-Stress Cycling Assessment Guide/Tool

Following an overview of the concept of low-stress cycling, and work being conducted by DelDOT, the IPA team provided an overview of their work to develop a Low-Stress Cycling Assessment Guide/Tool. The following was discussed:

#### Purpose of Guide/Assessment Tool

IPA explained that the purpose of the low-stress cycling assessment tool/guide is to engage stakeholders. It is designed for use in a facilitated workshop setting involving a local government committee or group that represents, or serves in an advisory role, to a local government.

#### Process

IPA described the use of the assessment guide/tool as part of a 3-step engagement process:

##### 1. Pre-Assessment:

Ideally, a group of stakeholders has been selected and has prioritized a roadway segment to be evaluated in advance of a meeting/workshop. This prioritization may be based on pre-assessment work and data collection that may consider/include:

- Needs of no-choice/low-choice riders (e.g., children ages 18 and under, seasonal or migrant workers, no-car populations)
- Review of DelDOT's low-stress cycling base map
- Review of relevant town or MPO plans
- Concerns raised by citizens
- Public safety incident/accident reports
- Citizen surveys
- Other data gathering methods (e.g., crowd sourcing/social media, bicycle facilities inventory, engineering studies, official plans)

##### 2. Assessment

- The assessment guide will provide a "What to look for" visual prompt that can be reviewed prior to the workshop. In addition a PowerPoint can be viewed prior to the in-field observation and convey "What to look for" during the assessment.
- In-field observation – Participants will use an assessment tool to document in-

field observations, which is formatted and corresponds to the “What to look for” visual prompt

- Mapping exercise – Following the in-field observation/assessment, participants will come back to the workshop setting, engage in a discussion and mapping exercise of in-field observations, and build consensus on priority needs.

### 3. Post-Assessment

- Following the workshop, workshop participants may:
  - Summarize outcomes and present recommendations to their jurisdiction’s Planning Commission, elected officials, and/or representatives of DelDOT or their MPO. Recommendations may include the need to:
    - See technical assistance and/or funding
    - Update the jurisdiction’s comprehensive plan or develop new plan(s)
    - Budget for transportation-related bikeability improvements
    - Develop education/outreach strategies

### Questions/Comments from Ped/Bike Safety Committee:

- Q: It would be helpful to have participants self-select their LSC classification on the assessment tool (e.g., strong/fearless, enthusiastic/confident, interested but concerned, not able/interested).
- A: Acknowledged idea
- Q: Terms within “What to look for” visual prompt aren’t well defined.  
A: Similar to a road safety audit, the prompt/assessment tool is designed for the average “citizen planner” who does not have an engineering background
- Q: Participants need to be trained  
A: The visual prompts (downloadable, static copy and PowerPoint) will provide a sense of what to look for in terms of facilities, network, road conditions, visibility, intersections, and transit.

### Three Assessment Tool Options Presented

- IPA presented the following three options and pros/cons for each assessment tool:
  1. “Prompt” – simplest format. Generalized; may be best for larger areas. Users simply record comments and locations of issues observed
  2. “Checklist” – More specific; forces user to select an option; may be best for smaller survey areas
  3. “Scale” – Specific; allows user to choose from several options. Responses more directly based on perception. Maybe best for smaller survey areas.
- Input from Committee Members
  - Most stakeholder don’t want to be burdened with writing comments; simply

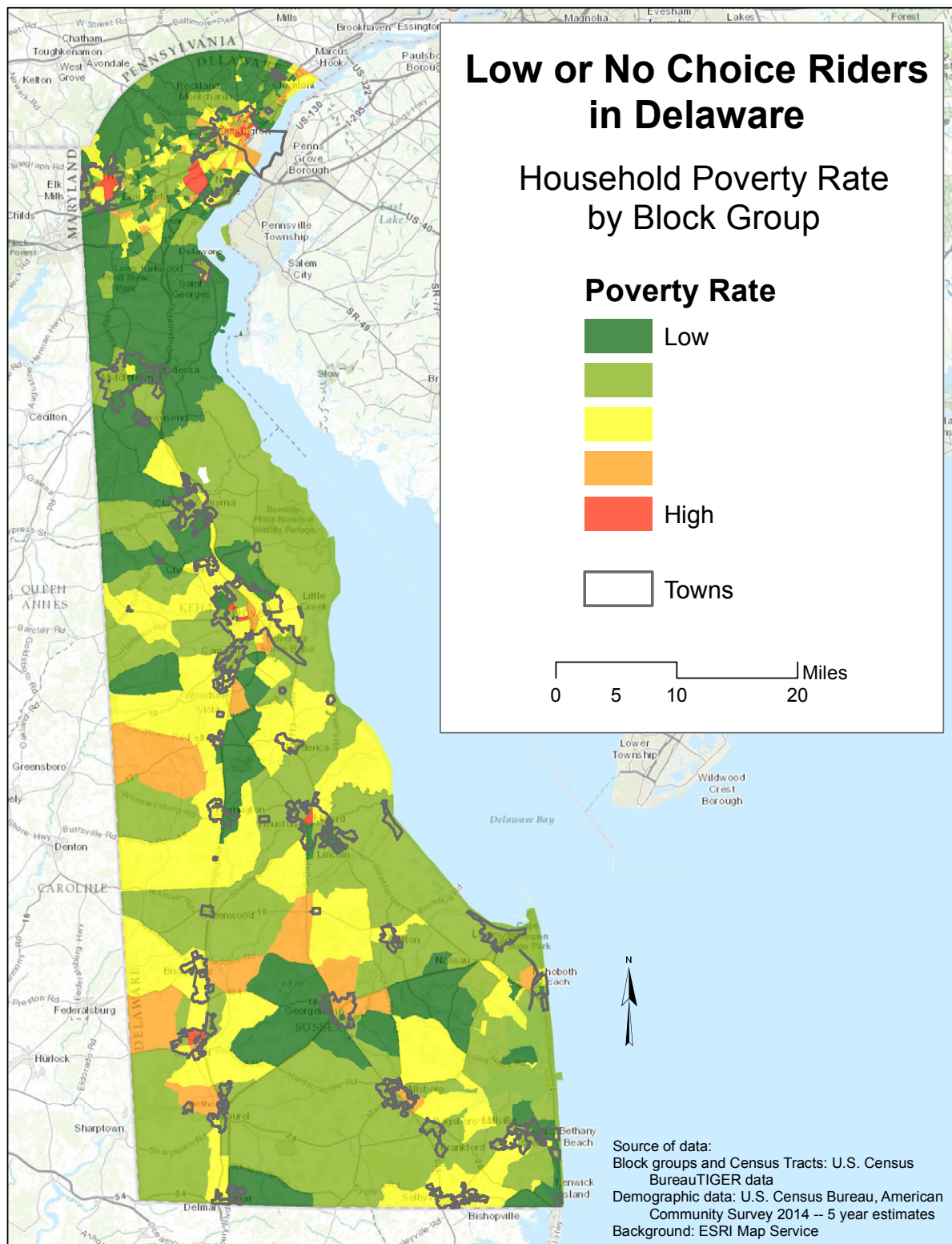
want to select a response

- For assessing smaller areas, #3 (Scale) is best; for assessing larger areas #2 (Checklist) is best.
- Assessment tool is most effective when used with DelDOT LSC base map that pre-identifies areas of need/concern in advance
- Majority of committee members (9) favored the use of #3 (Scale), followed by #2 (Checklist)
- Assessment guide/tool should have stakeholders consider/document/acknowledge information about nearby destinations of daily living (recreation trails/sites, schools, employment, transit, shops) and needs of no-choice/low-choice riders

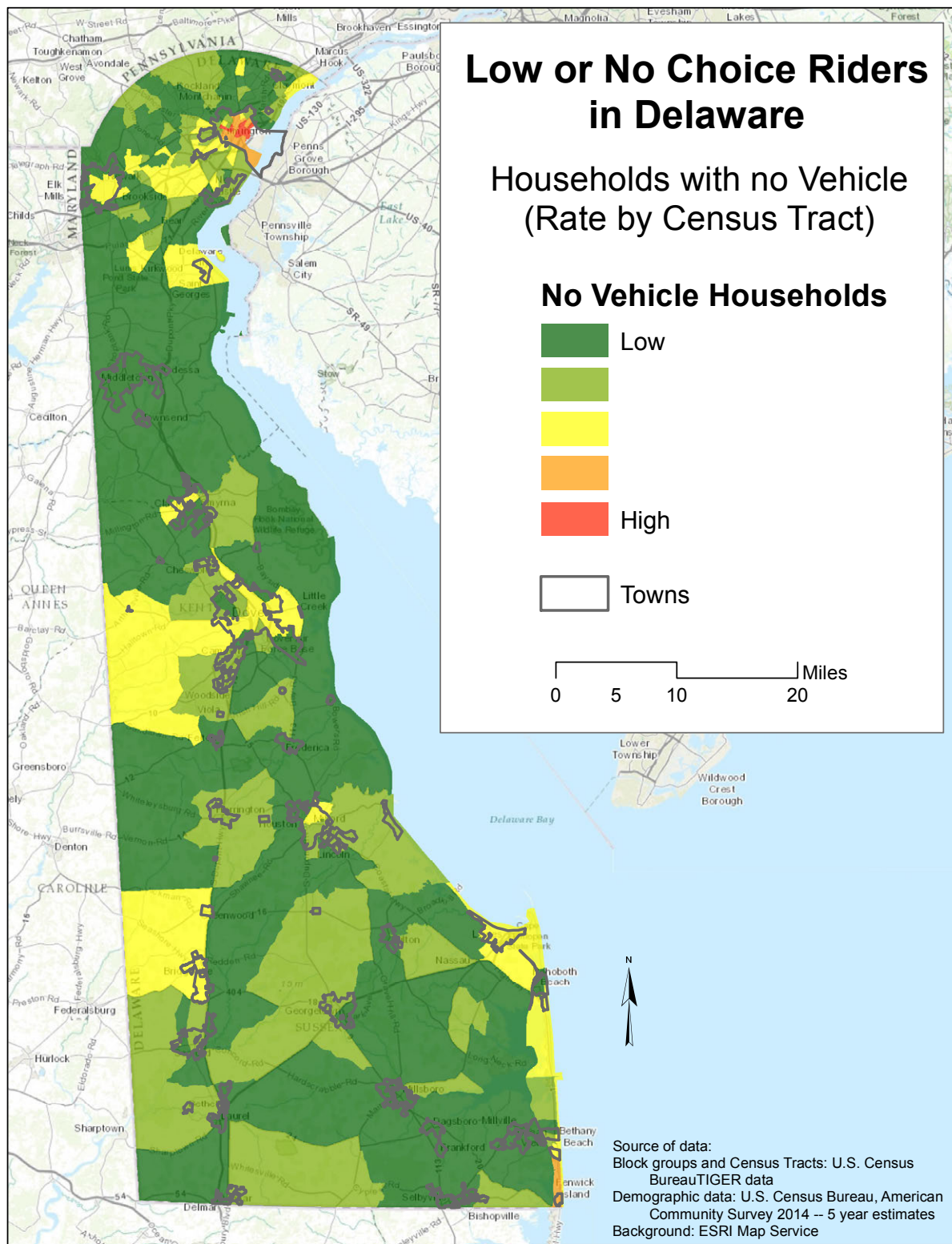
**Takeaways:**

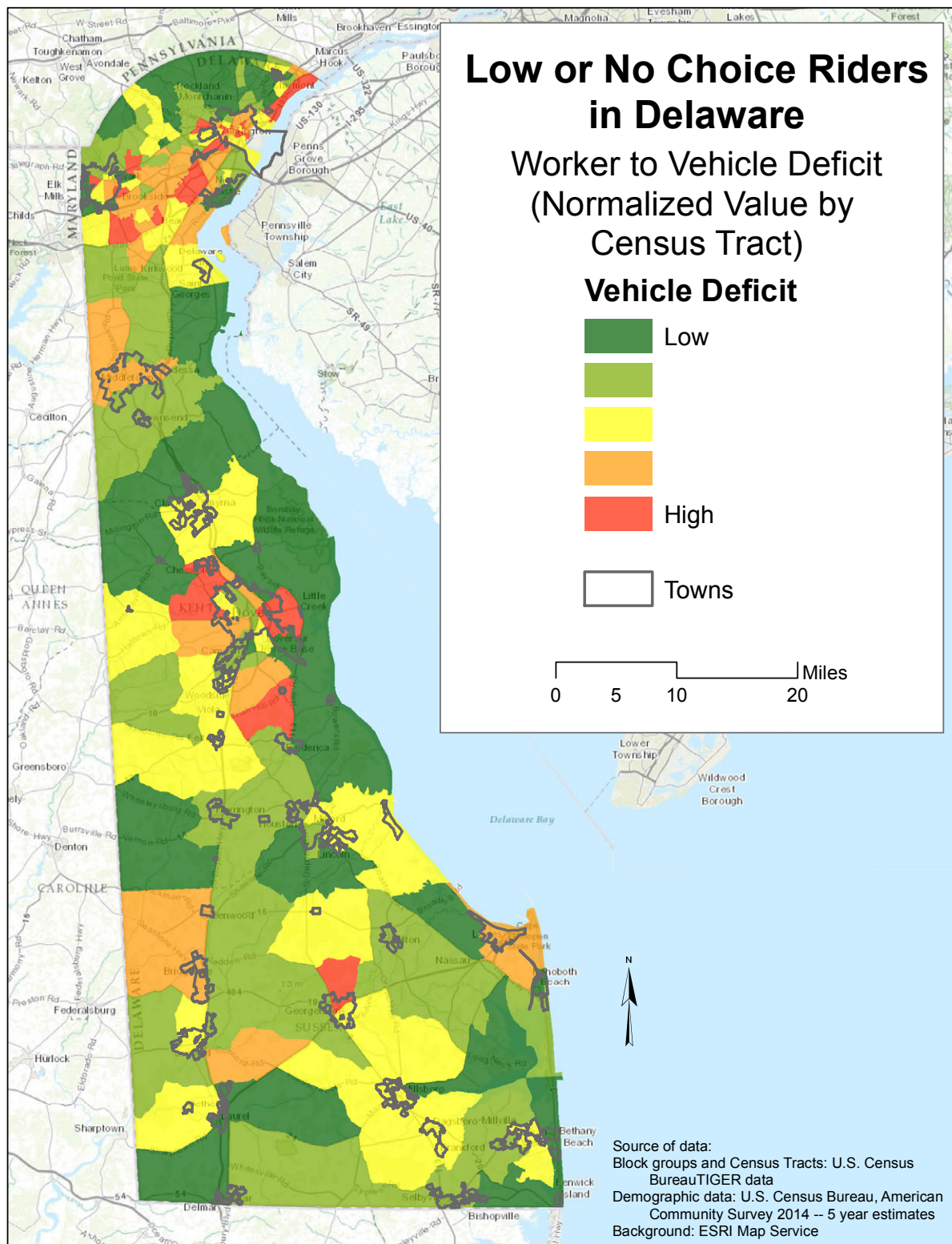
- Community engagement, outreach, and training/orientation of stakeholders are critical components of assessment process
- While committee members like the idea of an assessment tool, they also believe it's important to acknowledge/inform stakeholders of other data collection methods
- Ideally, the assessment guide/tool should be used in tandem with DelDOT's LSC base map to target an area of concern
- Education of cyclist behavior and safe cycling is needed in the post-assessment or follow-up phases
- Assessment tool should also be destination oriented and consider needs of no-choice/low-choice riders

## **Appendix K: Low- and No-Choice Rider Basemaps**









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