BICYCLE **FACILITY SELECTION** TOOLKIT

FEBRUARY 2019

Hillsborough MPO
Metropolitan Planning
for Transportation

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EXECUTIVE SUMMARY

The ability to walk and bike in a community is typically deterred by how comfortable or safe a person walking or biking feels using the network. In order for the general population to walk or bike for transportation, they need to feel safe for the entire trip. The Hillsborough MPO developed their existing multi-modal level of service methodology over 20 years ago. Over time, the needs of non-motorized users across the MPO area and the tools available to serve those needs have changed drastically. The MPO recently compiled national best practices on measuring multi-modal comfort on the street network and applied a new approach that considers not only whether a bicycle facility is present, but whether it is comfortable for even an 8-year old. The MPO applied a network-wide Bicycle Level of Traffic Stress analysis, which gives a score of LTS 1 through 4, to measure the comfort and level of stress bicyclist experience on bike facilities and in mixed traffic. In this analysis, an LTS 1 facility is considered low stress and suitable for the general population and an LTS 4 is considered high-stress, where even confident and strong bicycle riders will not travel.

Building on this methodology, the MPO developed this Bicycle Facility Toolkit to provide guidance to planners and implementation staff on projects. This guide outlines a decision-making framework that leverages the LTS assessment and helps planners identify the necessary bicycle facility type to make the street a low stress trip. The guide also provides planners a framework for network panning in a way that leverages existing low stress streets and assets such as trails and shared-use paths. Finally, the toolkit provides design guidance for implementation staff on the bicycle facilities themselves.

INTRODUCTION

MISSION STATEMENT

TO PROVIDE FLEXIBLE DESIGN GUIDANCE FOR THE IMPLEMENTATION OF APPROPRIATE BICYCLE FACILITIES ON HILLSBOROUGH COUNTY'S STREET NETWORK.

PURPOSE

This toolkit is designed to help Hillsborough County planning and implementation staff make well-informed decisions about bikeway design. Selecting the right facility for a given roadway can be challenging due to the range of factors that influence bicycle users' safety and comfort level. One of the most important factors is to determine what type of bicyclist the facility is meant to attract. Section III outlines the differing levels of comfort and skill bicyclists have.

HOW TO USE THE TOOLKIT

This toolkit has taken design best practices and compiled them in a framework that is intended to be useful for staff undertaking high-level planning efforts as well as implementation staff seeking to advance projects through their design and construction phases.

The sections in this toolkit are broken down by,

"For Planning Staff"

&

"For Implementation Staff"

callouts to tailor the application of the facility guidance to the user's need.

WHAT IS LEVEL OF TRAFFIC STRESS?

For Planning Staff: The primary goal is to select a bicycle facility that will provide the greatest amount of safety and protection within the existing roadway design for the expected user group. During the planning phase, the expected user group should be determined based on the surrounding environment. For example, a high-speed arterial with a high volume of traffic will not attract 'low skill' bicyclists who ride recreationally, but rather determined commuters who make routine trips. A breakdown of the various user groups is provided in Section III.

The decision to ride a bike in Hillsborough County can strongly rely on how comfortable someone will feel making the trip by bike. The first and most basic condition that must be met in order for people to consider riding a bike is they must feel safe doing so and must feel safe for the entire trip. The Level of Traffic Stress (LTS) provides a high-level look at how bicyclists are likely to experience each roadway in Hillsborough County.

This can be used to show a project's usefulness in

1. connecting important destinations and places that are already bike-suitable to one another

and

2. extending bike travel as a viable option into more of Hillsborough County neighborhoods.

It can also be used to select which facility type is appropriate in a given location depending on who it is purported to serve.

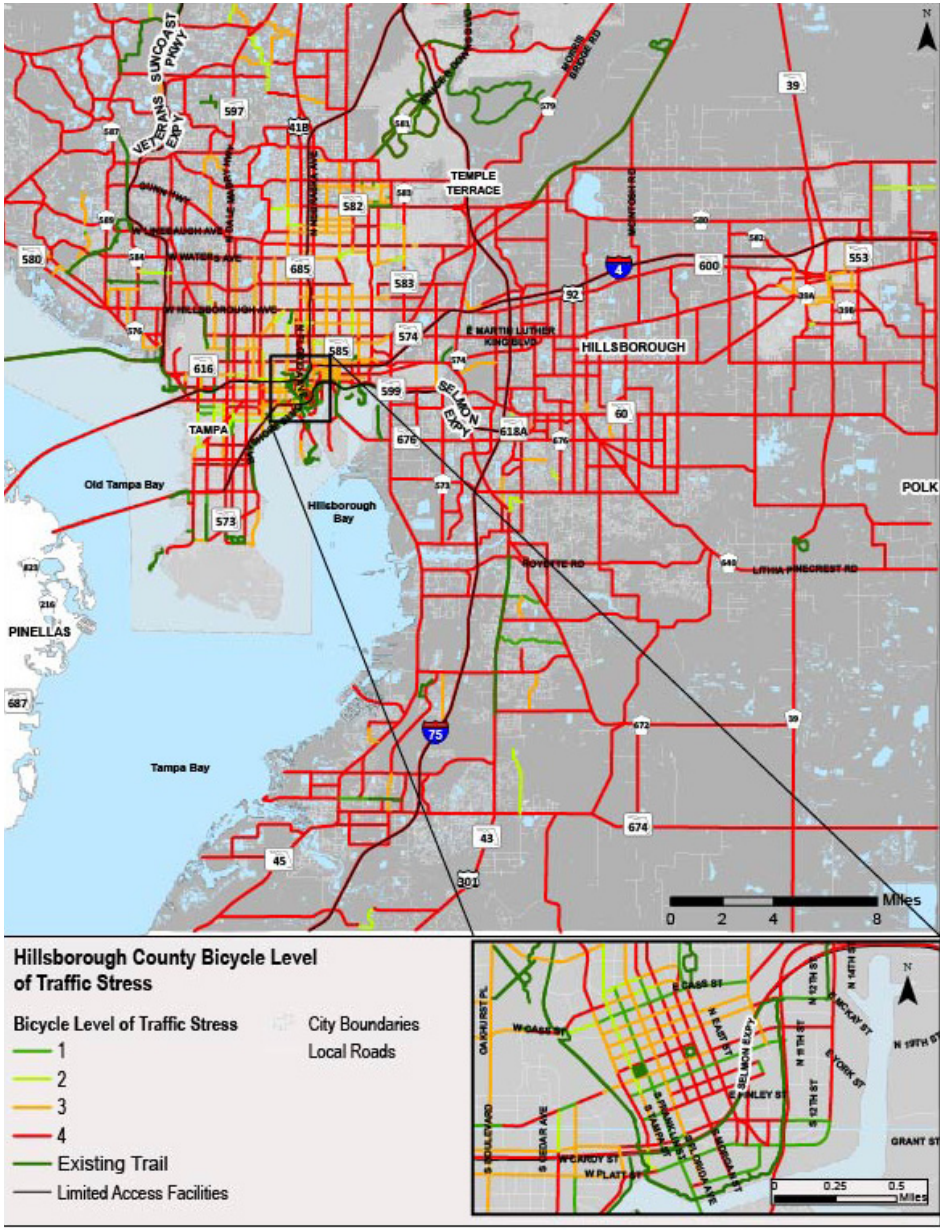
A DATA-DRIVEN PROCESS TO PLAN A BICYCLE FACILITY SYSTEM BASED ON COMFORT

The LTS analysis uses a "weakest link" methodology of assigning stress level; this reflects the reality that people on bikes experience various types of traffic stress (speed of traffic, volume of traffic, degree of separation from traffic, incursions into their space) simultaneously. For example, if even one of these factors is excessive, the whole street segment is a high stress experience for most potential riders.

A roadway stress level can depend on as few as one factor. Thus, roadways are first evaluated based on whether they have existing bike facilities. The methodology has two assessment processes, one for roadways with a bicycle facility and one for mixed traffic conditions. The following five factors are considered in both: (1) traffic speed; (2) surrounding land use; (3) traffic volume (as assumed from the number of travel lanes); (4) the level of separation from traffic; and, (5) incursions into the space used by people on bikes (e.g. high turnover parking).

The LTS scores range from an LTS 1, which is comfortable for most of the general population, to an LTS 4, which is uncomfortable for even experienced bicyclists. The LTS scores can help plan a complete bicycle network that is useful to the general population, leverage low-stress streets that are already comfortable for most people, and help identify the appropriate bicycle facility based on key characteristics of the street.

With the goal of assessing every roadway segment in the County true comfort level by bicycle, the County applied LTS to the entire County and State roadway network. This is depicted in the map to the right.



LEVERAGING LTS FOR NETWORK PLANNING

Once LTS scores are identified for all roads in the Network, LTS can be used to identify the ideal location(s) for adding or upgrading bike facilities. This is thought of as "unlocking" or "interconnecting" the low-stress system by identifying and overcoming the barriers to a complete network of facilities. This section provides important context as to how the application of LTS in-network planning is applicable for planning and implementation staff as defined below:

For Planning Staff: LTS provides a network-wide assessment of the locations where different user groups feel comfortable, enabling network planners to identify strategic corridors, sub-networks, and spot-improvements that will achieve maximum value, in terms of enabling safe and comfortable bike travel in more parts of Hillsborough County. These strategic interventions should be organized into 'projects' of one or more corridors/spot improvements and undertaken in a strategic order to maximize the area around the project that can reach it via low-stress streets/trails. With this, each individual project should be thoughtfully linked to its "catchment" area.

LTS FOR FACILITY SELECTION

Bicyclists categorized in User Group A (Strong and Fearless) are comfortable riding on busy roads with little physical separation from motorist through travel lanes.

User Group B (Enthused and Confident) cyclists are generally recreational and utilitarian riders who will ride on busy streets if there are facilities provided, but may also deviate from the most direct route to ride on low-traffic or shared use paths.

The majority of the population is categorized into User Group C (Interested but Concerned). This group includes a wide range of people of all ages who enjoy cycling, but may only ride on shared use paths, low traffic local streets, or protected on-street facilities.

User Group D (No way no how) will not choose to bicycle for transportation or recreation, regardless of provided infrastructure.

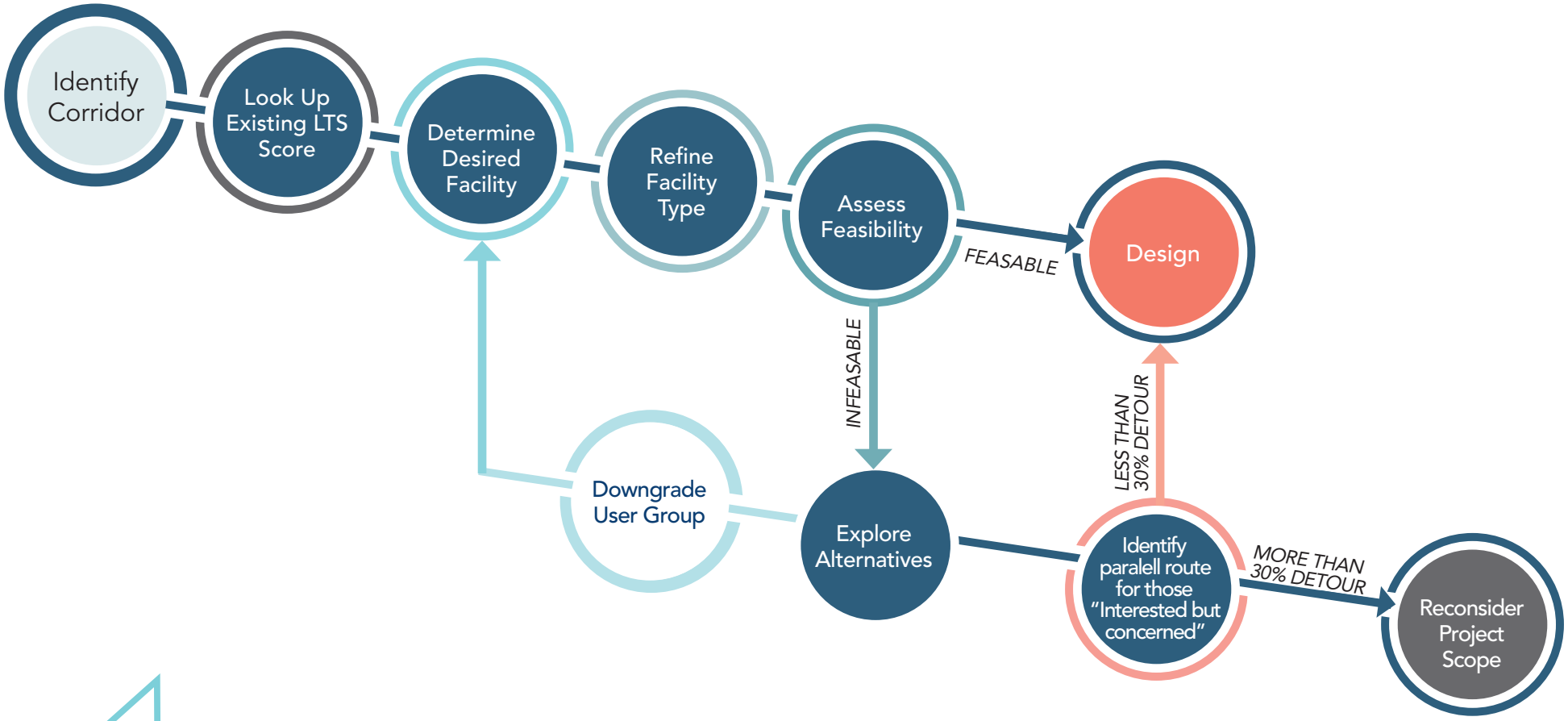
It is generally accepted that less-experienced and risk-averse bicyclists in User Group C account for most of the population. These bicyclists need to be connected via bike facilities/streets that are LTS 1 or 2 for the entirety of their trip. This makes it crucial to create connected networks, as shown above, AND to select and build a well-designed facility that meets the needs of these riders. In general terms, this user group prefers:

- Physically separated facilities such as protected bike lanes and trails
- Wide, preferably-buffered bike lanes on medium to low speed and low volume streets, adjacent to the curb (not a parking lane)
- Bike boulevard treatments on low-stress neighborhood streets

With the above context in place, this section will breakdown how facility selection, based on LTS, is applied for planning and implementation staff:

For Planning Staff: The use of the existing LTS map and field visit (if applicable) should be sufficient to determine the general existing stress level of a street or road, which can be used to select the appropriate general facility type for a corridor. It may be sufficient to simply designate the level of physical separation from traffic that these general population riders would need to feel comfortable and leave more detailed assessment to design and implementation staff. The flow chart in Figure 4 provides a planning-level process that helps determine the level of separation necessary for the corridor.

FACILITY SELECTION PROCESS



For Implementation Staff: A project will likely reach its implementation phase as a concept, at best, or a drawing as a line on a map with a general level of required separation. Additionally, it will depend on the implementation and design team to refine this into a plan that:

- Fits within the space that is available (this should have been determined in the planning phase)
  - Sometimes a road diet is assumed in the planning phase. In rare cases, if planning assumptions cannot be realized it may be necessary to choose a parallel, nearby route that can perform a similar bike network function.
- Achieves a low-stress bicycling condition
  - This is to be determined at each specific segment of the corridor, and at each intersection, bus stop, and other special-case locations.
- Is this acceptable to community members and stakeholders
  - It may be necessary to develop several alternatives to achieve a low-stress condition and engage in a public engagement process to choose a preferred alternative.

Implementation staff typically encounter irregularities in the corridor cross section in the design phase that is not found or realized at the planning stage. In these cases, the below table can be used to identify possible mitigations. To build on to the below table, we can add a column that references best practice resources (the City's Manual, NACTO Guidance, AASHTO etc.).

CONSIDERATION	MITIGATION
Bus stops along bike route	Bike lanes: Minimize and clearly mark conflict areas to alert bicyclists and buses Physically seperate facilities: Provide pedestrian queuing, landing, and shelter (if preseent) between bike facility and roadway, if feasible.
Bikeway adjacent to on-street parking with low occupancy	Consider removal or consolidation of parking
Bikeway adjacent to on-street parking with high turnover	Wide or buffered bike lanes preferred to reduce risk from opening car doors
Front-in perpendicular or angled parking	The use of back-in angled parking preferred
Bikeways along streets with numerous commercial driveways and/or unsignalized intersections	Clearly sign and mark conflict areas with colored pavement to warn motorists and bicyclists. Design high-volume driveways as intersections
Bikeways crossing a major signalized intersection	Consider bike boxes, turn-queue boxes, warning signs and markings, bicycle signals (especially at separated bicycle facility)
New bicycle route connecting existing facilities	Provide continuity with adjacent facilities, where possible. Provide bicycle facility at same or higher level of protection compared to adjacent facilities.
Bikeway on a truck route or road with greater than 10% heavy vehicles	Step up to next level of protection recommended by the chart (i.e. from mixed traffic to bike lanes, from buffered bike lanes to separated bicycle facility). Generally, separated bicycle facilities preferred, bike lane with buffer optional, depending on speed & volume characteristics of the roadway.

FACILITIES

Once a facility type is selected, the appropriate design practices must be applied to design a useful facility based on the street context. The following toolkit provides a summary of design best practices for each facility type as well as additional design resources available to reference in further detail

CONVENTIONAL BIKE LANE

BUFFERED BIKE LANE

BICYCLE BOULEVARD

ONE-WAY SEPARATED BIKE LANE

TWO-WAY SEPARATED BIKE LANE

SHARED-USE PATHS

WAYFINDING/SIGNAGE

MEDIAN REFUGE ISLANDS

THROUGH BIKE LANES

BIKE BOXES

TWO-STAGE TURN QUEUE BOXES

BIKE SIGNALS

CONVENTIONAL BIKE LANE

DESIGN SUMMARY

Shoulder bike lanes provide spaces for bicyclists to ride, separate from motor vehicle traffic. They are generally used on arterial and collector streets, where higher traffic volumes and higher speeds warrant more separation. Bike lanes increase safety, while reducing wrong-way riding.

DIMENSIONS

- 6′ recommended
- 5′ if no on-street parking is present
- 4′ minimum in constrained locations
- If on-street parking or buffer, total width 14.5′ – minimum 12′

TYPICAL APPLICATION

- Low traffic volumes (≥ 3,000 AADT)
- Posted travel speed ≥ 25 mph

LAND USE CONTEXT

- Urban and suburban

ADDITIONAL GUIDANCE

- MUTCD: Chapter 9C
- NACTO Urban Bikeway Design Guide: Pages 7-11
- FDOT Complete Streets Design Handbook: Chapter 4

EXPECTED COST

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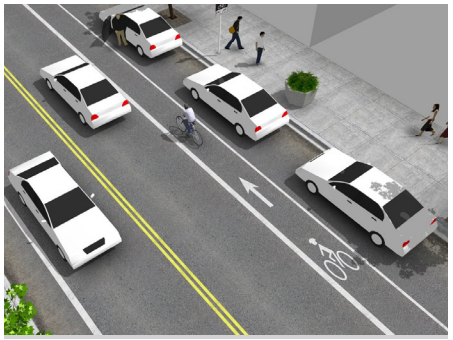
CONSIDERATIONS FOR LTS

Interested but Concerned

- Conventional bike lanes are only appropriate for inexperienced riders if the street is low-volume or low-stress. Typically, try to not place parking next to the bike lane, as inexperienced riders can find the car turnover and doors opening to be an unsafe environment (or add a buffer between parking and bike lane).
- Standard bike lanes should be used in conjunction with traffic calming measures (bottlenecks, chicanes, neckdowns, etc.) for LTS 2 roadways. More separation is required for an LTS 2 street to ensure the comfort of the range of riders.

Enthusiastic and Confident

- More experienced riders are comfortable with bike lanes next to parking lanes.



Images (Source: NACTO)

BUFFERED BIKE LANE

DESIGN SUMMARY

Buffered bike lanes are designed to increase space between bike lanes and the travel lane(s). They work best on high-volume or high-speed roadways or spaces where cars are parked too close to bike traffic. These conditions can be dangerous or uncomfortable for bicyclists.

DIMENSIONS

- Same as conventional bike lane (5′ – 6′), plus 2′ – 3′ painted buffer
  - Typically, paint buffer with diagonal lines to increase visibility
  - Buffer may be on the travel lane or parking lane side
- Together, the bike lane and buffer should be at least 7′

TYPICAL APPLICATION

- High traffic volume (≥ 10,000 AADT)
- Travel Speed ≥ 25 mph

LAND USE CONTEXT

- Urban, suburban, rural

ADDITIONAL GUIDANCE

- MUTCD: Chapter 9C
- *NACTO Urban Bikeway Design Guide*: Pages 21-25
- FDOT Complete Streets Design Handbook: Chapter 4

EXPECTED COST

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CONSIDERATIONS FOR LTS

Interested but Concerned

- For inexperienced riders, a painted buffer between parked cars and the bike lane is helpful. It protects bicyclists from car doors opening and adds to their overall safety. The buffer should be painted with diagonal lines to make it clear to drivers to keep out of the designated bike space.

Enthusiastic and Confident

- More experienced and confident riders require buffered bike lanes when traffic volumes or speeds are high. Consider adding flex posts or a traffic calming device (daylighting, chicanes, narrowing roads, etc.) to ensure the bicyclist feels comfortable and is a safe distance from high speed traffic on through streets.

Images (Source: NACTO)

BICYCLE BOULEVARD

DESIGN SUMMARY

Bicycle boulevards are used on low-volume streets where motorists and bicyclists share the same space. Through traffic calming measures, they generally travel at the same speed, which creates a more comfortable environment for all users. Bike boulevards incorporate cost-effective and less physically-intrusive treatments compared to other bicycle facilities. Residents who live on bicycle boulevards benefit from reduced vehicle speeds, creating a safer environment.

DIMENSIONS

- Use Wayfinding signs, standard traffic calming measures (choker, chicane, neckdown, etc.)

TYPICAL APPLICATION

- Low traffic volumes (≤3,000 AADT)
- Posted travel speed ≤ 25 mph

LAND USE CONTEXT

- Urban and suburban
  - Avoid major streets

ADDITIONAL GUIDANCE

- MUTCD: Chapter 9C
- NACTO Urban Bikeway Design Guide: https://nacto.org/publication/urban-bikeway-design-guide/bicycle-boulevards/, and Page 240

EXPECTED COST

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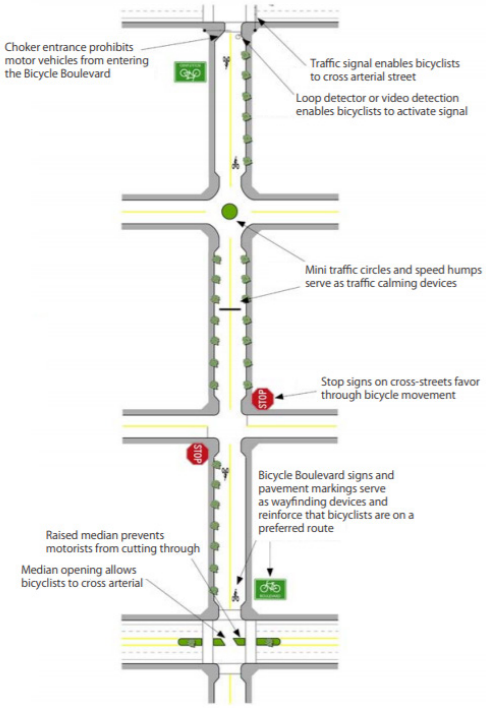
CONSIDERATIONS FOR LTS

Interested but Concerned

- Bicycle boulevards are perfect for low-stress streets, because little mitigation needs to be done. Residential streets or roads to public parks/ schools work best due to their slower speeds. Inexperienced riders can easily ride on these streets, as they generally have lower motor speeds or volumes. Ideally, bicycle boulevards should be used as parallel/alternative routes in comparison with higher stress streets.



Images (Source: NACTO)

ONE-WAY SEPARATED BIKE LANE

DESIGN SUMMARY

Also called 'protected cycle tracks,' separated bike lanes are on-street facilities that provide the comfort and safety of multi-use paths within the road right-of-way. This is done by combining a painted buffer with a physical barrier, such as flex posts, a parking lane, or a landscaped buffer. The added protection separates bicyclists from high-speed or high-volume motor traffic.

DIMENSIONS

- 5′ – 7′ bike lane
- 2′ – 3′ painted buffer (see buffered bike lane standards)

TYPICAL APPLICATION

- High traffic volumes (≥ 10,000 AADT)
- Travel speeds ≥ 40 mph
- Multi-lane streets with few intersections and driveway access points

LAND USE CONTEXT

- Urban and suburban

ADDITIONAL GUIDANCE

- MUTCD: Chapter 9C
- NACTO Urban Bikeway Design Guide: Pages 62-70
- FDOT Complete Streets Handbook: Chapter 4

EXPECTED COST

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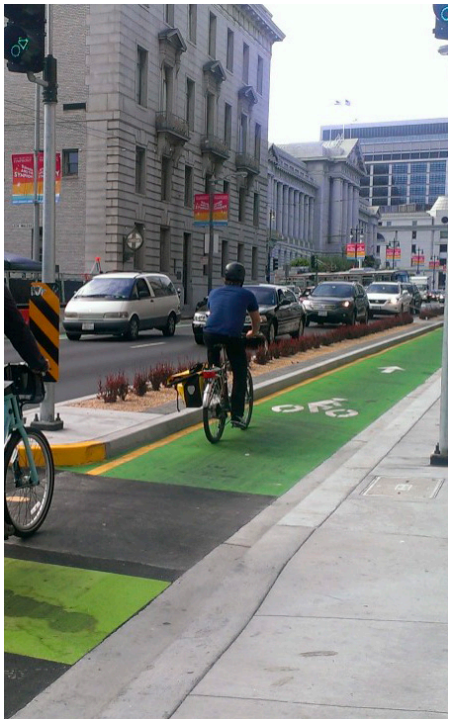
CONSIDERATIONS FOR LTS

Interested but Concerned

- Arterials are not safe or comfortable for inexperienced riders and therefore demand more separation for interested but concerned riders to be able to bike on or near the road. A physical barrier helps motorists stay in their space, away from bicyclists – giving even inexperienced riders a comfortable and safe environment, despite higher speeds and volumes.
- Typically, avoid a separated facility for a lower stress corridor, as it is more expensive and often conventional or buffered bike lanes will work. However, implementation of separated facilities is still important, as the raised buffer or flex posts give riders a sense of security due to the physical separation.

Enthusiastic and Confident

- Confident riders tend to ride faster than inexperienced riders, and thus the geometry of the facility should allow room for them to pass slower riders, space permitting.



Images (Source: NACTO)

TWO-WAY SEPARATED BIKE LANE

DESIGN SUMMARY

Also called "two-way cycle tracks," separated bike lanes allow bicycle travel in two directions on the same side of the road. Additional safety design is required because bicyclists travelling in the opposite direction of traffic is often unexpected and can cause confusion for drivers. Two-way cycle tracks are preferred when cyclists are already riding the "wrong" way on corridors where alternate routes are unsafe or have no bike facilities, or where there is not room for a one-way separated bike lane on both sides of the street.

DIMENSIONS

- At least 9' bike lane (total width)
- 2' – 3' painted buffer (see buffered bike lane standards)

TYPICAL APPLICATION

- High traffic volumes (≥ 10,000 AADT)
- Travel speeds ≥ 40 mph
- Multi-lane streets with few intersections and driveway access points

LAND USE CONTEXT

- Urban and suburban

ADDITIONAL GUIDANCE

- MUTCD: Chapter 9C
- NACTO Urban Bikeway Design Guide: Pages 62-70
- FDOT Complete Streets Handbook: Chapter 4

EXPECTED COST

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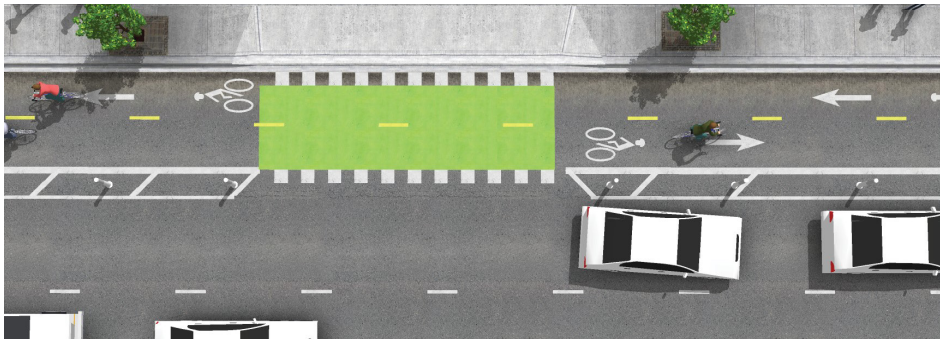
CONSIDERATIONS FOR LTS

Interested but Concerned

- Arterials are not safe or comfortable for inexperienced riders, and therefore demand more separation for interested riders to be able to bike on or near the road. A physical barrier helps motorists stay in their space, away from bicyclists – giving even inexperienced riders a comfortable and safe environment, despite higher speeds and volumes.
- Typically, avoid a separated facility for a lower stress corridor, as it is more expensive and often conventional or buffered bike lanes will work. However, implementation of separated facilities is still important, as the raised buffer or flex posts give riders a sense of security due to the physical separation.

Enthusiastic and Confident

- Confident riders tend to ride faster than inexperienced riders, and thus the design of the facility should allow room for them to pass slower riders, if space permits.



Images (Source: NACTO)

SHARED-USE PATHS

DESIGN SUMMARY

Shared-use paths, also called "multi-use paths," provide additional width for pedestrians and bicyclists, over a standard sidewalk. Paths next to roadways must have some sort of vertical or horizontal buffer – for example, a curb or landscaped barrier, respectively. Off-street paths are commonly found in urban and rural settings across the country.

DIMENSIONS

- 10' minimum in low traffic conditions
- 12' for high-use areas, or in areas where multiple users such as pedestrians, bicyclists and rollerbladers share the same space. In that context, pavement markings may be appropriate to separate them.

TYPICAL APPLICATION

- High volume, high speed roads with constricted right-of-way
- Few at-grade crossings, like driveways or alleyways

LAND USE CONTEXT

- Urban, suburban, and rural

ADDITIONAL GUIDANCE

- NACTO Urban Bikeway Design Guide: http://www.fdot.gov/design/training/DesignExpo/2016/Presentations/Multi-UseTrails-RobinBirdsongAndMaryAnneKoos.pdf
- FDOT Complete Streets Handbook: Chapter 4
- AASHTO Guide for Development of Bicycle Facilities: Chapter 5

EXPECTED COST

$$$$

CONSIDERATIONS FOR LTS

Interested but Concerned

- In high-volume and high-speed conditions, additional separation from drivers can make bicyclists feel more comfortable. The extra pavement also gives the cyclist more space to ride.
- In areas with very high motorist traffic, shared-use paths grant cyclists and pedestrians a safe space away from drivers. The raised separation between motor traffic and bicycles also adds to the overall environment, making it more comfortable for all users of the space.

Enthusiastic and Confident

- In areas where shared use paths are provided, usually bicyclists are mandated to ride them. Because of this, enthusiastic riders may want extra space to overtake slower pedestrians or cyclists. Appropriate sight distance should also be integrated accordingly, as experienced riders tend to travel faster.

WAYFINDING/SIGNAGE

DESIGN SUMMARY

Wayfinding signs are typically placed at key locations leading to and along bicycle boulevards. They are also helpful where multiple routes intersect, and at key bicyclist "decision points." Wayfinding signs displaying destinations, distances, and approximate riding time can dispel common misperceptions about time and distance, while simultaneously increasing comfort and accessibility to destinations. Aside from signage, wayfinding can also exist in the pavement, in the form of shared arrow markings (sharrows), pavement markings, etc.

DIMENSIONS

- Too many signs clutter the right-of-way, so signs should be posted at a level most visible to bicyclists and pedestrians rather than following the per vehicle signage standards
- Should be placed consistently along designated bike routes to be most effective

TYPICAL APPLICATION

- Designated bicycle routes (conventional bike lane, buffered, cycle tracks, etc.)
- Bicycle boulevards

LAND USE CONTEXT

- Urban, suburban, rural

ADDITIONAL GUIDANCE

- MUTCD: Chapter 9B
- NACTO Urban Bikeway Design Guide: Pages 246-252

EXPECTED COST

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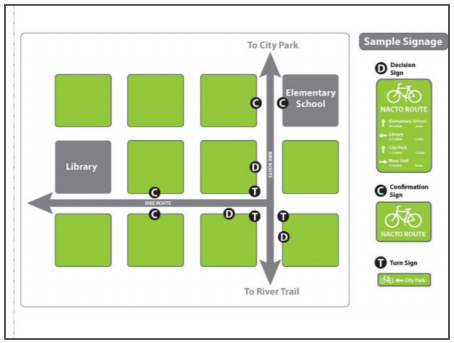
CONSIDERATIONS FOR LTS

Interested but Concerned

- Wayfinding and signage are only appropriate on low-stress streets because they do not improve physical separation between traffic and bicyclists, but rather improve the environment for the rider. Wayfinding and signage are strictly communication tools. Make sure the signs are at an appropriate eye level and are spaced at consistent intervals, to increase efficiency and visibility.

Enthusiastic and Confident

- Since these riders tend to bike at higher speeds, it is important to place the signs in a way that they can read it and gather the important information quickly as they pass it by.



Images (Source: NACTO)

MEDIAN REFUGE ISLANDS

DESIGN SUMMARY

Median refuge islands provide a space for pedestrians and bicyclists to wait to cross populated or long intersections. They help facilitate crossing one direction of traffic at a time and can be used in conjunction with bike boxes or cycle track crossings for additional safety. Median refuge islands provide a protected space for bicyclists to take advantage of gaps in traffic while simultaneously reducing delays to cross. They can also act as a traffic calming device, by narrowing the roadway and restricting turning movements.

DIMENSIONS

- Want 10' wide with an absolute minimum of 6'
- Place the median in the middle of the right-of-way
- Want the height to be curb level (6" typically

TYPICAL APPLICATION

- Where a bikeway crosses high-volume, high-speed traffic
- Signalized or unsignalized intersections
- Where cycle tracks end or intersect with motor traffic

LAND USE CONTEXT

- Urban and suburban

ADDITIONAL GUIDANCE

- MUTCD 3I.02
- NACTO Urban Bikeway Design Guide: https://nacto.org/publication/urban-bikeway-design-guide/intersection-treatments/median-refuge-island/, page 157-160
- FDOT Complete Streets Handbook: Chapter 4

EXPECTED COST

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CONSIDERATIONS FOR LTS

Interested but Concerned

- A median refuge island shields bicyclists from incoming traffic and gives them a protected area to wait to cross an intersection.
- On higher volume and higher speed roadways, the full design suite (longer widths, reflective markers the approach to the island, angled cut-through, etc.) should be used to make inexperienced riders feel more comfortable crossing busy intersections. The raised median provides them with more visibility and allows them to wait until an appropriate gap in traffic before they cross.
- They work well in conjunction with raised cycle tracks, to give structure to the floating parking lane. Medians also provide shelter to bicycles making a two-stage turn.

Enthusiastic and Confident

- Confident riders can take advantage of an angled-cut through across the median, to position them to face traffic and judge when the best time to cross would be. Medians should be wide enough to allow for two-way traffic, or for these cyclists to pass the less experienced ones.

Images (Source: NACTO Design Guide pg 159)

THROUGH BIKE LANES

DESIGN SUMMARY

Through bike lanes are design approaches to intersections that allow bicyclists to correctly position themselves in anticipation of upcoming intersections. They typically work well in areas where a bike lane merges into a turning lane or parking lane, or on streets with right-turn only lanes.

DIMENSIONS

- Dashed white lines, 6" wide, 2' long
- Right-turn only lanes should be as short as possible

TYPICAL APPLICATION

- In context with right-turn only lanes
- Areas where the bike lane merges with a parking lane

LAND USE CONTEXT

- Urban and suburban

ADDITIONAL GUIDANCE

- MUTCD: Chapter 9C
- NACTO Urban Bikeway Design Guide: Pages 173-176

EXPECTED COST

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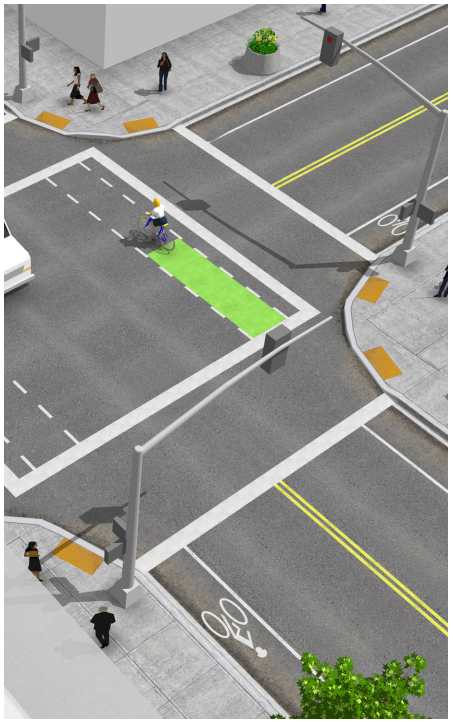
CONSIDERATIONS FOR LTS

Interested but Concerned

- A through bike lane does not provide any additional separation from motorists, but instead keeps the same bike lane intact throughout the intersection. This can be helpful for inexperienced riders to stay in their lane, but traffic often uses the lane to merge into a turning lane, therefore creating a difficult environment for them.

Enthusiastic and Confident

- More experienced riders should be able to navigate around turning traffic. Painting the through lane green will help bicyclists and motorist both identify conflict areas to help maintain awareness.
- This intersection treatment works well in conjunction with conventional or buffered bike lanes, as it acts as a continuation to the lane.



Images (Source: NACTO page 175)

BIKE BOXES

DESIGN SUMMARY

Bike boxes move the stop bar back for vehicles at signalized intersections. This creates a designated area for cyclists to wait during the red light phase. Bike boxes create a comfortable environment for riders by making them more visible and providing them a way to get ahead of queued traffic.

DIMENSIONS

- Use transverse lines to create a box 10' – 16' deep, and indicate where motorists are required to stop
- Center a bike symbol in the ox, between the crosswalk like and stop line
- Can also dye the pavement green for extra visibility

TYPICAL APPLICATION

- Signalized intersections on streets with bike lanes or cycle tracks
- Intersections with high-volume traffic, or a high number of right-turn movements

LAND USE CONTEXT

- Urban and suburban

ADDITIONAL GUIDANCE

- MUTCD: Chapters 3B, 9C
- NACTO Urban Bikeway Design Guide: Pages 110-116

EXPECTED COST

$$

CONSIDERATIONS FOR LTS

Interested but Concerned

- Bike boxes give cyclists an area to wait in front of drivers, to improve their visibility and give them additional space to wait ahead of queued traffic. They work best at signalized intersections, when the light is already red, as it gives the cyclist time to position themselves before the green light. If a cyclist arrives at a green light, see Two-Stage Queue Boxes.

Enthusiastic and Confident

- In higher volume or higher-turning-movement areas, green-colored bike boxes increase visibility and safety of the cyclist. By putting the cyclist ahead of motorists, the bike box allows cyclists to get a head start through the intersection and safely merge into their own lane once they cross it.
- If the bicycle box spans across multiple lanes, and is sufficiently deep, experienced cyclists have a chance to move in front of slower riders, without having to weave through traffic at an intersection.

TWO-STAGE TURN QUEUE BOXES

DESIGN SUMMARY

Two-stage turn queue boxes are treatments for intersections with a high-volume of left-turning cyclists or where bike facilities merge onto the main road. In a two-stage left-turn, cyclists proceed through the intersection on a green light, and wait in a marked queue box on the cross street to proceed through the intersection on the next green phase. Whereas a bike box works well for riders arriving during the red phase, a two-stage box gives riders the opportunity to be equally safe arriving during the green phase.

DIMENSIONS

- The queue box needs to be in a protected area (within on-street parking, or between the bike lane and pedestrian crosswalk, for example)
- Include pavement makings to indicate bicycle direction and positioning
- Can dye the pavement green for increased visibility

TYPICAL APPLICATION

- Signalized intersections with high volumes or speeds
- Streets with a significant amount of bike riders making left turns

LAND USE CONTEXT

- Urban, suburban, and rural

ADDITIONAL GUIDANCE

- MUTCD: Chapters 3B, 9C
- NACTO Urban Bikeway Design Guide: Pages 146-149

EXPECTED COST

$$

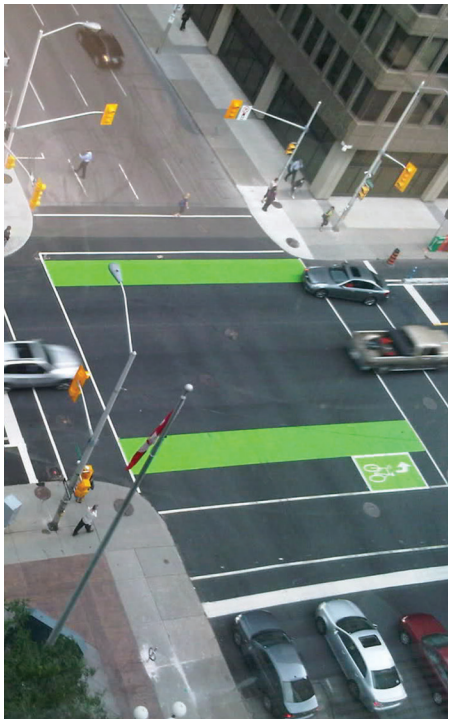
CONSIDERATIONS FOR LTS

Interested but Concerned

- For intersections with high speeds or volumes, a painted two-stage queue box gives inexperienced riders a designated safe area to wait before crossing. This treatment reduces conflict with motorists, as the cyclists will always travel parallel to through traffic.

Enthusiastic and Confident

- Two-stage queue boxes also separate turning cyclists from through bicyclists and works well in conjunction with cycle tracks or conventional and buffered bike lanes. More experienced riders can use the space to navigate the intersection at their own speed, with the additional room in the intersection.



Images (Source: NACTO)

BIKE SIGNALS

DESIGN SUMMARY

At intersections with conflicting movements, such as areas with high pedestrian or cyclist volumes, transit movements, or high motorist traffic, bicycle signal heads can be used to provide additional guidance to bicyclists and other users. Bike signals are used in conjunction with conventional traffic signals, and have the same standard green, yellow, and red light phases. They also prioritize bike movements and separate the traffic from conflicting movements.

DIMENSIONS

- Signal head should be clearly visible to cyclists and motorists
- Bicycle-only phase should provide adequate clearance time and actuation detection if it's not pretimed

TYPICAL APPLICATION

- Intersections with high volumes of bicyclists
- Transitions from trails or shared-use paths to on-street facilities

LAND USE CONTEXT

- Urban, suburban, and rural

ADDITIONAL GUIDANCE

- MUTCD: Chapter 9C
- NACTO Urban Bikeway Design Guide: Pages 206-213

EXPECTED COST

$$

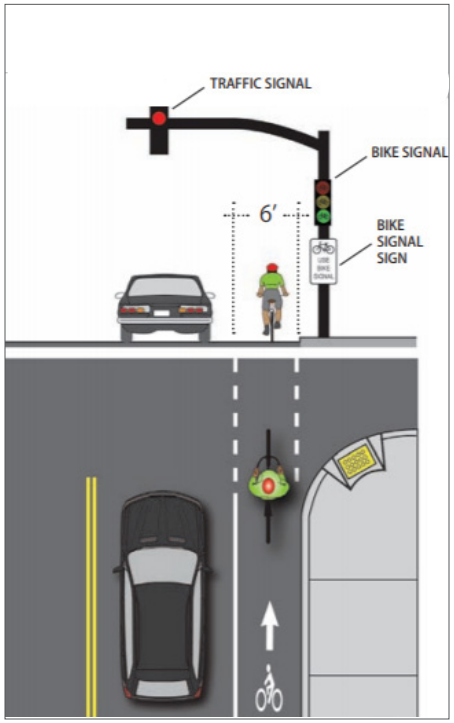
CONSIDERATIONS FOR LTS

Interested but Concerned

- Bike signals can help slower riders pace themselves through the intersection during the bike-only phase. During this phase, they do not have to compete with motorists for the right of way.

Enthusiastic and Confident

- In areas with high car and bicycle ridership, a bike-only phase is helpful in separating cyclists from motor traffic. The bicycle signal head allows cyclists to move safely through crowded intersections, and their protected phase also gives them an accurate sense of how much time they have to cross an intersection.
- For high stress areas, a bike box may also be used in conjunction with a signal head for increased separation.

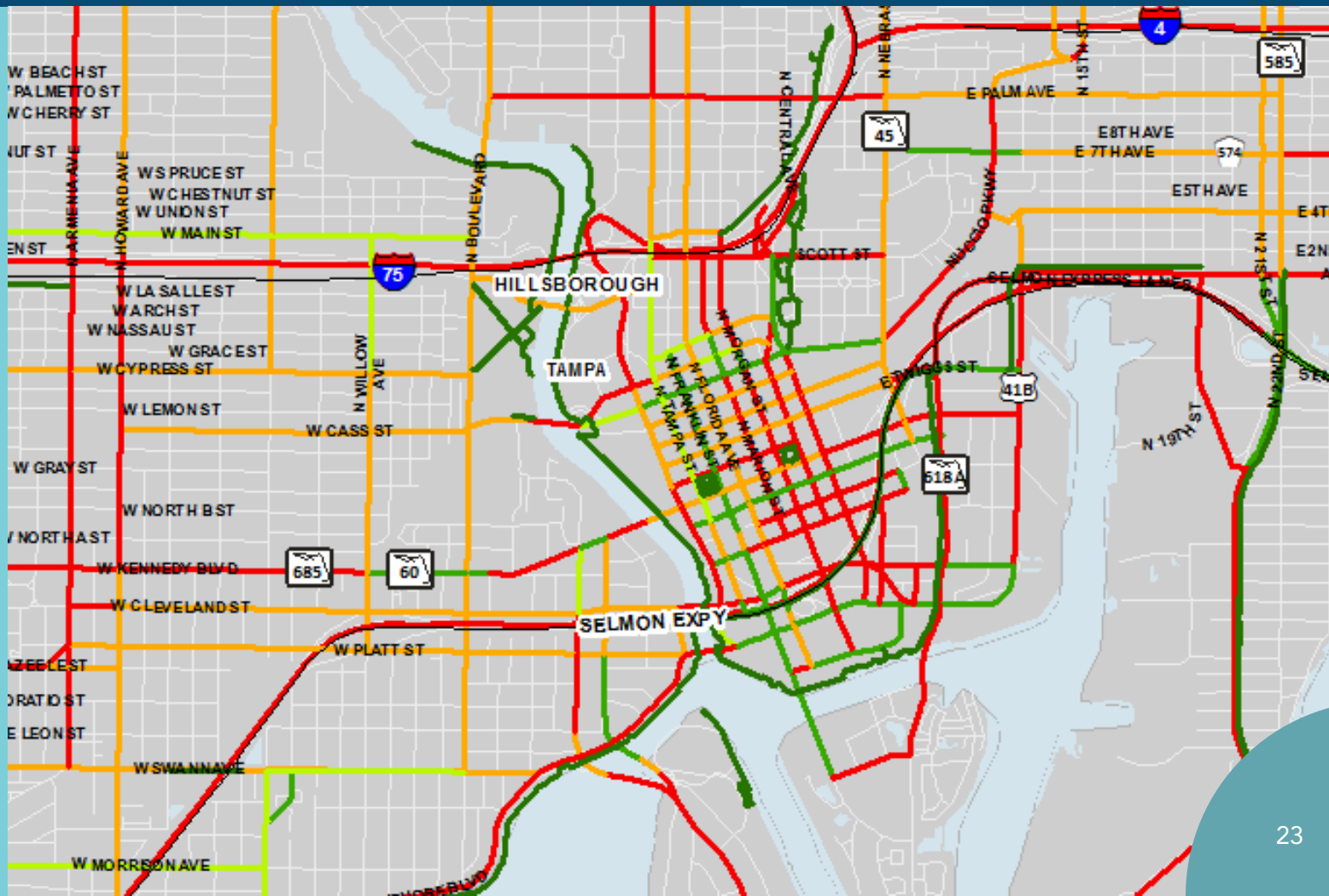


Images (Source: NACTO)

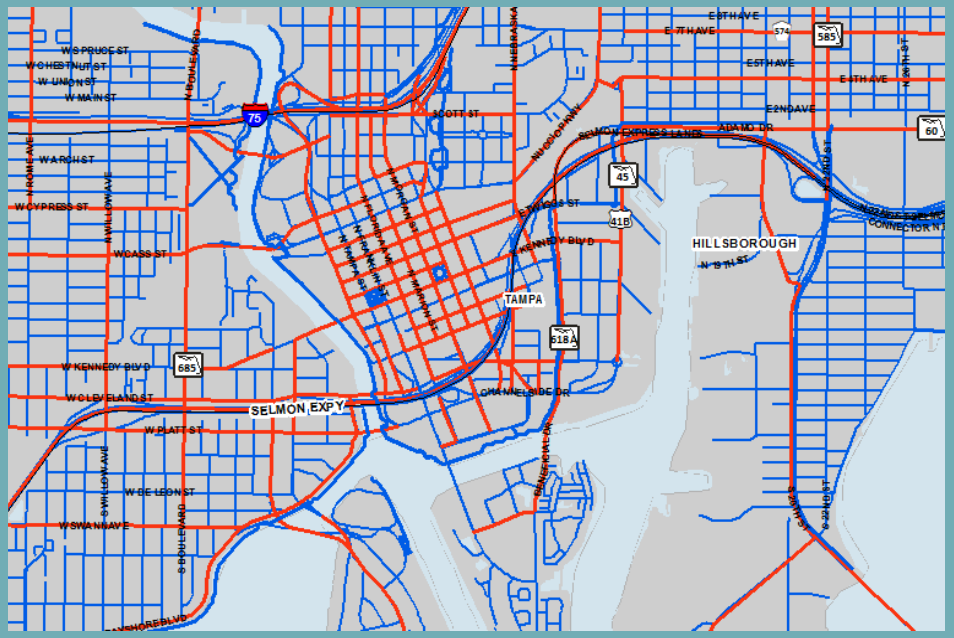
APPENDIX A – TAMPA, FL CASE STUDY

This section summarizes a case study of an LTS analysis conducted in Hillsborough, FL and applied in Downtown Tampa to understand how the LTS analysis can be used to identify critical infrastructure. The below maps show the greater Tampa area within Hillsborough County.

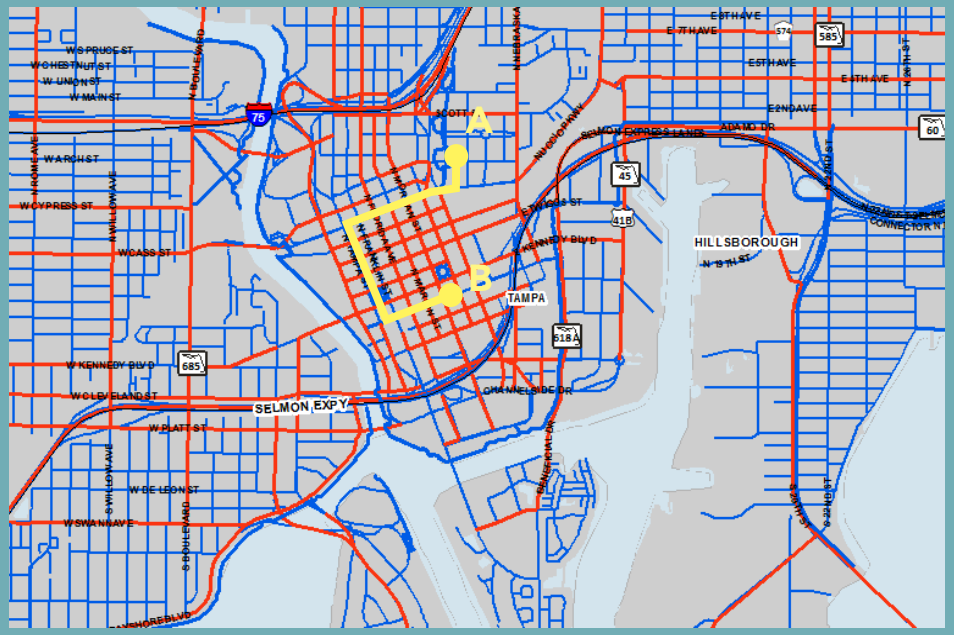
This map shows the LTS score for all FDOT and County roads. In this case, all local roads are assumed to be an LTS 1.



The second map shows the portion of the network that is lower stress and useful to the general population in blue (LTS 1 and 2, plus trails) and the streets that act as barriers to the general population (LTS 3 and 4).



The below map shows how the network breaks down for bicyclist. To get from point A to Point B via a continuous, low stress trip, bicyclist must travel 10 blocks out of their way. This can be reduced to a low stress 2-block diversion with the construction of a 4-block facility (green dashed lines) to connect the existing low stress facilities.



For Implementation Staff: LTS provides a relatively up-to-date map of the perceived level of stress of each roadway in COH as a useful tool for implementation staff. When a bike project reaches an implementation staff member, this is an additional opportunity to review the preliminary planning process, and check if changing real world conditions have modified the need.

Questions that an up-to-date LTS map can help implementation staff answer:

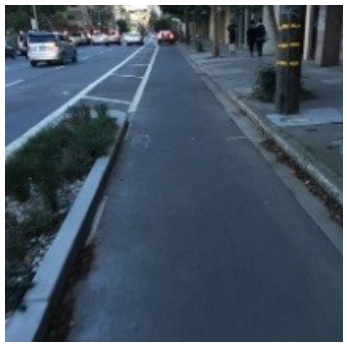
- Does this project connect to a significant low-stress network?
- Would a short extension or a nearby spot improvement significantly increase this project area's "low-stress catchment"?
- Is there an intersecting street that is listed as low-stress on the map that could use traffic calming, wayfinding, or other low-cost upgrades, to improve the function of this project?
  - If so, can this traffic calming/wayfinding be rolled into this project?.

APPENDIX B - BICYCLE FACILITY TOOLKIT SUMMARY MATRIX

	COST	TYPICAL APPLICATION	REQUIRED	RECOMMENDED	PREFERRED
SIGNED ROUTES/WAYFINDING					
	$	• Placed at designated bike routes or bicycle boulevards • Good for urban areas to improve visibility • Appropriate LTS: 1	• Follow MUTCD Section 9B.01 – Application and Placement of Signs (as per NACTO Urban Bikeway Design Guide pg. 246)	• Design signs should be placed in advance of all turns at the near side of intersection • Include direction, destinations; with closest place on top • See pg. 247 of NACTO	• Periodically place bike route maps on/under signage • Use a routing number system if there is a route map (see MUTCD Section 9B2.1 for more) • See pg. 250 of NACTO
BICYCLE BOULEVARDS					
	$	• Low traffic volumes (≤3,000 AADT) • Posted travel speed ≤ 25 mph • Avoid major streets • Appropriate LTS: 1, 2 (Apply full suite of traffic calming)	• Use Wayfinding signs (starting on pg. 240) • Indicate how bicyclists can stay on path if boulevard turns onto another road • https://nacto.org/publication/urbanbikewaydesignguide/bicycleboulevards/	• Pavement marking should be standard size (112" x 40") • If narrow roads, place signs closer • (See link for more)	• Curb heights lower than 6" can be used on diverters and medians for emergency vehicles • (see link for more)

Figure 5: https://nacto.org/publication/urbanbikewaydesignguide/bicycleboulevards/signsandpavementmarkings/

BIKE LANES					
	$	• Streets with traffic volumes ≥ 3000 AADT • Streets with travel speeds ≥ 25 mph • Most appropriate on arterials and collectors • Appropriate LTS: 1, 2	• Desired width is 6' with a minimum of 4' along street edge • If next to a parking lane, want parking/bike/buffer width total to be 14.5' with a minimum of 12' • Words, symbols to define lane periodically throughout (as per MUTCD Figure 9C3) • 68" solid line to mark the difference between motor travel and bike • See page 7 of NACTO Urban Bikeway Design Guide	• Make wider than minimum widths wherever possible • If next to a parking lane, solid white line of 4" between parking and bike lanes to avoid encroachment • If there's space, separation between parking and bike lane – maybe by buffer • If turning vehicles must merge into bike lanes, increase dashed line length from 50 to 200' • See pg. 9 of NACTO	• Color the lanes to enhance space • Bike lane signs before the beginning of a marked bike lane to designate preferential bike use • Bike lanes adjacent to curbs, make it "No Parking" (see MUTCD R83) • See pg. 11 of NACTO

	COST	TYPICAL APPLICATION	REQUIRED	RECOMMENDED	PREFERRED
BUFFERED BIKE LANES					
	$$	• Motor traffic volume ≥ 10,000 AADT • Travel Speed ≥ 25 mph • High volume or higher speed warrant greater separation • Appropriate LTS: 1, 2, 3	• Mark the bike lane with words or symbol/arrow • Buffer marked with 2 solid white lines with diagonal hatching if 3ft or wider • See page 21 of NACTO Urban Bikeway Design Guide	• Next to parking, 5′ minimum width • If high speed, buffer and bike lane should be 7′ • Buffers at least 2′ wide • intersection, transition to through bike lane • See pg. 22 of NACTO	• Wide (68″) solid line to mark the line closest to adjacent traffic • Separation between bike lane striping and parking • Color the beginning of each block • See pg. 23 of NACTO
ONEWAY SEPARATED BIKE LANES					
	$$$	• Multi lane traffic • Traffic volume ≥ 10,000 AADT • Travel speeds ≥ 40 mph) • Streets with few intersections and driveway access points • Appropriate LTS: 2, 3, 4	• Use a cycle track, as outlined by MUTCD • Need the symbol or arrow at the beginning and periodically throughout the track • See page 62 of NACTO Urban Bikeway Design Guide	• Desired is 5′ but if high bicycle volume, want 7′ • At least a 3′ buffer • When using a pavement marker buffer, combined parking and buffer width should be 11′ • See pg. 64 of NACTO	• Cycle tracks can be closer to travel lane as intersections approach, to put bicyclists in clear view of drivers • Color pavement to define bike space • See pg. 68 of NACTO
TWOWAY SEPARATED BIKE LANES					
	$$$	• Multi lane traffic • Traffic volume ≥ 10,000 AADT • Travel speeds ≥ 40 mph) • Streets with few intersections and driveway access points • Contraflow bike travel is desirable • Appropriate LTS: 2, 3, 4	• Word, symbol or marking to indicate bike lane periodically throughout length • "Do Not Enter" with "Except Bike" (as per MUTCD R51) • Traffic controls along the street oriented towards contraflow • See page 95 of NACTO Urban Bikeway Design Guide	• 8′ minimum, want 12′ • 3′ buffer if next to parking lane • Dashed yellow line to separate the directions of flow • Two stage turn boxes to assist in making turns from the cycle track • See pg. 97 of NACTO	• On minor intersections, can shift track more closely to travel lane • Can configure the track to be raised for better visibility • See pg. 99 of NACTO

	COST	TYPICAL APPLICATION	REQUIRED	RECOMMENDED	PREFERRED
SHARED USE PATH					
	$$$$	• Existing roadway has high traffic speed and volumes in a constrained rightofway • Appropriate LTS: 3, 4	• Separation between path and road • See FDOT for more http://www.fdot.gov/design/training/DesignExpo/2016/Presentations/ultiUseTrailsRobinBirdsongAndMaryAnneKoos.pdf	• Want 14' width, 8' minimum • Use a design speed of 18 mph (See AASHTO Guide for Development of Bicycle Facilities, 2012)	• 10' Vertical clearance, with 8' minimum • Meet ADA requirements very often • See Ch 8 of FDOT
INTERSECTION TREATMENTS: BIKE LANE					
THROUGH BIKE LANES					
	$	• See page 172 on NACTO Urban Bikeway Design Guide, Case study on St. Petersburg, FL (Evaluation of a Green Bike Lane Weaving Area)	• Dashed white lines 6" wide, 2' long • Rightturn only lanes should be as short as possible • Color/add signage to enforce bike right of way • See pg. 173 of NACTO	• Use a bike box instead to designated through turn lane (See pg. • Bike warning signs or "share the road" signs in advance of transition • See pg. 175 of NACTO	• Use a bike box instead to designated through turn lane (See pg. • Bike warning signs or "share the road" signs in advance of transition • See pg. 175 of NACTO
MEDIAN REFUGE ISLAND					
	$$	• Want 10' or wider, absolute minimum is 6' • See Section 3I.02 MUTCD for pavement markings • Outline median in retroreflective white or yellow • See page 157 of NACTO Urban Bikeway Design Guide	• Length should be greater than 6' • Height of island should be curb level (6") • Wide enough for 2way • Angled cutthrough so bicyclists can face oncoming traffic • See pg. 159 of NACTO	• Median Refuge Island: • Can provide landscaping if it doesn't compromise visibility • Install lighting for night • Can carry the median refuge across entire street to act as diverter • See pg. 160 of NACTO	• Can provide landscaping if it doesn't compromise visibility • Install lighting for night • Can carry the median refuge across entire street to act as diverter • See pg. 160 of NACTO

Figure 6: FDOT Design Expo, Slide 20

	COST	TYPICAL APPLICATION	REQUIRED	RECOMMENDED	PREFERRED
INTERSECTION TREATMENTS: BIKE BOX					
	$$	• Signalized intersection with high volumes of motorists or bicyclists • Frequent motorist right turns or bicycle left turns	• 10 – 16' deep transverse lines to create the box • Use a stop line to show where motorists must wait • Center a pavement marking of a bike rider with a helmet between crosswalk and stop line • see Page 110 of NACTO	• Place a "Stop here on red" sign at the stop line for cars • Color the pavement green to encourage compliance • Define potential areas of conflict across the intersection with green paint • See pg. 112 of NACTO	• Stop lines can be placed up to 7' in advance of bike box • Bike box can extend across multiple travel lanes • Can combine with exclusive bike signal phase I high volume of bicyclists • See pg. 115 of NACTO
INTERSECTION TREATMENTS: CROSSINGS SHARED USE PATH					
	$$$	• Conventional Bike Lanes • See above in table • Bicycle Signal • Intersections with bicycleonly movements	• Conventional Bike Lanes • See above in table • Bicycle Signal • Clear standards are not defined, consider MUTCD general guidance	• Conventional Bike Lanes • See above in table • Bicycle Signal • Signal head should be clearly visible to oncoming bicycles • Bicycle phase should provide adequate clearance time and actuation/ • detection (if not pretimed)	• Conventional Bike Lanes • See above in table • Bicycle Signal • Clear standards are not defined, consider MUTCD general guidance
INTERSECTION TREATMENTS: TWO STAGE QUEUE BOX					
	$$$	• Areas with high left turning volume • Works best for green lights, in contrast with bike box at red lights	• A designated area to hold queuing bicyclists • Include a bicycle stencil and turn arrow to indicate proper bicycle positioning • Place bike box in protected area • See Page 146 of NACTO	• Color the pavement green to further define the space • Using markings throughout the intersection • See pg. 147 of NACTO	• Position the queue box laterally in cross street parking, instead of in front of the travel lane • Can use bike signals in conjunction with twostage queue box • See pg. 148 of NACTO

Hillsborough MPO
Metropolitan Planning
for Transportation

BICYCLE **FACILITY SELECTION** TOOLKIT