KITTELSON & ASSOCIATES

SEMINOLE COUNTY TRAILS & GREENWAYS SAFETY IMPROVEMENT PLAN

SEMINOLE COUNTY, FL

May 2022

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Seminole County Trails & Greenways Safety Improvement Plan

Seminole County, FL

Prepared for:
Seminole County | Leisure Services

,

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STOP

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SEMINOLE COUNTY
Leisure Services Department
SEMINOLE WEKIVA TRAIL
OPEN DAYLIGHT HOURS ONLY
PLEASE REMEMBER TO:
Be Courteous
Obey Trail Signs
Keep Right
Pass on the Left
Give Audible Signals When Passing
Travel in a Predictable and Consistent Manner
Not Block the Trail
Yield When Entering or Crossing Trails
Not Use This Trail Under the Influence of Alcohol or Drugs
Clean up your Litter
Keep Pets on Leashes
Not Drive Motorized Vehicles, Which are Prohibited and Subject to Citation (Except for Low Power/Low Speed Handicap Accessible Vehicles).
LEGEND
Sylvan Lake Park
Seminole Soccer Club
Sylvan Lake Station
Rinehart Rd
Paola Rd
Pearl Lake Overlook
Markham Trailhead
I-4 Trail Overpass
Freshwater Marsh Overlook
Wekiva River
Trail Underpass
Lake Mary Trailhead
Lake Mary Blvd
Jones Trailhead
YOU ARE HERE
Markham Woods Rd
Lake Emma Rd
E.E. Williamson
Range Line Rd
S.R. 434
Seminole County Softball Complex Trailhead Sanlando Park
Trail Underpass
OVERVIEW MAP
San Sebastian Trailhead
Montgomery Rd
Douglas Ave
S.R. 436
For further information, please call (407) 665-2180.
www.seminolecountyfl.gov/leisure/trails/
NATIONAL RECREATION TRAIL

INTRODUCTION

IMPETUS FOR THE STUDY

Seminole County has long been a regional leader in providing connected trails and greenways. Since the inception of the idea of a network of trails throughout Seminole County in the mid-1990's, the County has created a legacy of trails and active transportation facilities. With over 140 miles of trails, greenways, and connector facilities the County has built a robust network of trails that serve residents and visitors for both recreation and transportation purposes. However, the County's trail system has seen a significant increase in use due to the COVID-19 pandemic, where people sought outdoor recreation opportunities similar to many other communities with active transportation networks. This record trail use has highlighted certain safety issues where the differing modes and speeds of users creates conflicts among pedestrians, cyclists, micro mobility, and motor vehicles. These issues manifest themselves primarily where transitions occur such as driveway and street intersections with trails, downhill segments such as those coming off of bridges over roadways, or pinch points where visibility and usable trail width are constrained.

This study and set of design guidelines were commissioned by Seminole County Leisure Services to address these issues and develop a set of safety measures that could be implemented easily on existing trail facilities and incorporated in the design of new trails. As the County continues to expand its network of trails and connectors, and subsequent usage continues to rise, incorporation of best practices related to the multitude of trail users and their chosen modes will provide a safe and efficient trail system that can serve both recreational and commuter use.

While the County has a set of design guidelines for trails, little guidance is included that focuses on the issue of speed differential or conflict resolution where trails intersect with the motor vehicle realm. In addition, much new guidance and best practices in trail design have come about since the County began designing trails in the mid 1990's. Design practices from countries such as the Netherlands has been adapted and adopted in the U.S. due to the efforts of groups such as NCHRP, AASHTO, FHWA, and NACTO. In addition, peer communities in the Southeast and other regions have been using newer design guidance directed at these safety issues for many years as systems are built out. This study includes a literature review of best practices related to trail design focused on these specific issues, as well as a series of interviews with peer agencies to better understand how they are dealing with these speed and conflict issues in other systems.

This study document and guide is organized in the following sections:

- A brief examination of current County design and user guidance and summary of national and state best practices related to safe trail design focused on user speed differential and interface with the motor vehicle realm;
- A summary of interviews with peer jurisdictions from Central Florida and the metropolitan Denver area to better understand their approach to safety in trail design related user speed differential and street and driveway intersections, and key takeaways from those interviews;
- Evaluation of nine specific pilot locations on the County trail system where demonstrated safety issues related to speed differential and user conflicts have occurred, including a summary of issues observed during the field review, concept plans to rectify the issue including safety best practices from the peer agency and literature review process, and estimates of probable cost for the recommended actions; and
- A set of standard details of the measures included in the concept designs for the pilot locations that can be used in other trail areas or in new designs for trails and connectors as design guidance for the County's trail facilities.

Nationally, the past few years have seen significant interest in active transportation facilities resulting in community residents expecting and demanding trails and greenways, as well as connected on-street bike

and pedestrian facilities for mobility as well as recreation. Seminole County has long enjoyed a high quality of life due in part to its commitment to providing these facilities, but as the system continues to grow and expand the safety issues that have become evident due to user speed differential and motor vehicle conflicts will increase. By expanding the toolbox of safety measures available to address these concerns, the County can continue to develop a world class active transportation network that is safe for all users, serves all residents and visitors regardless of their age or abilities, and contributes to the high quality of life that Seminole County is known for.

EXISTING DESIGN AND USER GUIDANCE DIAGNOSIS

ESTABLISHED DESIGN GUIDLINES

The trail system inclusive of typical section and crossing standards for Seminole County is designed according to the Public Works Engineering Manual, Section 1.13. In addition to these standards, the County has also completed a Trails Master Plan that outlines the hierarchy of existing trails listed below.[1]

- Signature Trails: paved 12'-14' urban and unpaved rural multipurpose trails with countywide and regional connections
- Pathways: paved 8'-10' urban and unpaved rural multipurpose trails for travel between and within cities and major activity centers, connect to Signature trails
- Connectors: paved 8' sidewalks (urban and rural) linking shorter distances such as neighborhoods
- Wilderness Trails: unpaved paths for pedestrian, mountain bike, and equestrian usage within and between Preserved Lands and Natural Greenways
- Destination Trails: paved 12'-14' multipurpose trails with public gathering spaces that loop within a property and are connected to neighborhoods through other trails

These guidelines outline the form and function of the trail system. For the purpose of this safety-focused study, these designations were used to better understand the expected right-of-way widths and user conflicts with respect to motorist interactions.

USER GUIDANCE

For the purpose of this study, input from Seminole County staff indicated that the primary users of focus were cyclists, particularly those traveling at high speeds (in excess of 15 MPH), those using a Personal Electric Vehicle (e-scooters and bikes, electric unicycles, One Wheels, etc.) with the potential to travel upwards to 25-30 MPH, and motorists where streets cross trail alignments. These users were placed at the focal point as their speed and size pose potential risk to themselves and other users on the trail, such as pedestrians and low-stress cyclists.

At the time of this study, the County has established a set of trail rules related to user behavior and interactions. These include standard practices found on the larger state-owned trail systems and require the user to understand audible and visual signals on the trailway and maintaining control of their immediate space and vehicle. In correspondence with the County, it was learned that there is also a speed limit expectation meant for trail users on bicycles and PEVs set at 15 MPH. Additionally, it was noted that there is a 50% or less compliance rate for trail users appropriately stopping at intersections. While these rules are in place, enforcement (other than informal peer enforcement) is not possible due to limited resources and the scale of the trail system. A wayfinding study was also being completed concurrent to this safety study.

[1] Designations noted here https://www.seminolecountyfl.gov/core/fileparse.php/3273/urlt/210907-SeminoleCoTrails_MasterPlanreduced.pdf

While updated design guidance is included in the new Trails Master Plan, the recommendations do not address the safety issue associated with the user speed differentials and the compliance and conflict avoidance where the trails intersect with streets. Due to the noted increased use of the trails from those locally and regionally, the guidance identified here should be updated to reflect the desired operation and speed of trail users and motorists where their interaction is warranted. The following section outlines the trends and best practices nationwide as it relates to recreational trails.

National Trends and Best Practices

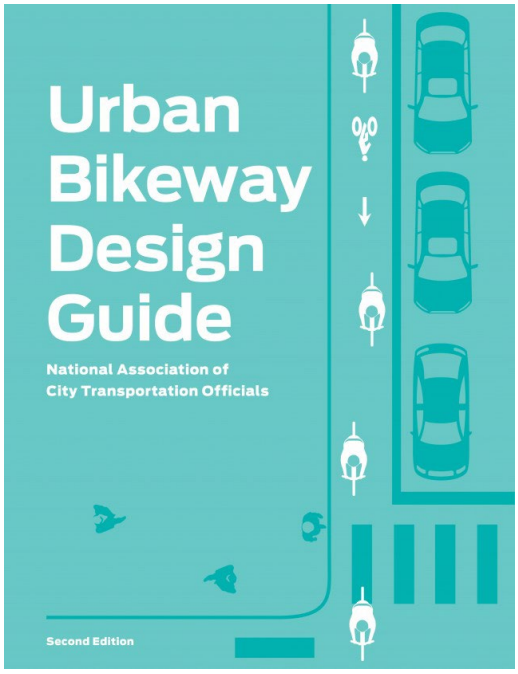
As noted previously, national trends in recreational and commuter use of trails has increased dramatically since the start of the COVID-19 pandemic. However, nationwide agencies have been identifying and updating relevant trail standards over the last ten years to better reflect the changes in trail user equipment and changing urban, suburban, and rural dynamics. This study reviewed the updated design guidance in an effort to capture what could be applied to the changing context of Seminole County.

Best practices guidelines from the following agencies and organizations were included in this research:

- National Association of City Transportation Officials (NACTO)
- Federal Highway Administration (FHWA)
- Rails to Trails Conservancy

NATIONAL ASSOCIATION OF CITY TRANSPORTATION OFFICIALS (NACTO)

NACTO is an association of over 90 major cities and transit agencies that share transportation ideas and best practices for national transportation issues. NACTO has published ten design guides to help cities make use of their streets and includes speed management strategies, user-conflict remedies, and intersection treatments. One such report is the Urban Bikeway Design Guide, which provides reference material for reducing turning conflicts. Some best practices include the following:



- Reducing turn speeds to allow motorists more time to stop and avoid collision with bicyclists. Smaller turn radii, centerline hardening, turn speed bumps, and raised bike crossings can all reduce the speed at which drivers turn;
- Making bicyclists visible by increasing line of sight. Strategies include setting back the bikeway crossing, installing recessed (early) stop lines for motor vehicles, and building raised bikeway crossings all make it easier for drivers to see people using the bikeway; and
- Giving bicyclists the right of way through bike-friendly signal strategies, prohibiting right on red, and allowing bicyclists to move past stopped vehicles while waiting for signals.

Within the Urban Bikeway Design Guide, NACTO provides design components for protected intersections. These include specific requirements for pedestrian islands (minimum width of 6 feet and desired width of 8 feet), small radii for corner islands to reduce turning speeds, and bike queue areas that are large enough to accommodate anticipated bike volumes. These strategies can be applied to trail crossings at major intersections and for areas with high crashes due to motorists turning onto a driveway with a trail crossing.

NACTO has also published the Designing Sidewalks and Trails for Access Part II of II: Best Practices Design Guide (2001) and provides recommendations for conflicting pedestrian needs, trails intersecting roadways, and trails intersecting railroads. The guide suggests splitting shared use paths to provide separate travel paths for slower users and to reduce the user conflict created by speed differentials. The following trail design considerations are recommended to maximize safety and accessibility at trail intersections:

- Intersect at 90-degree angle;
- Increase trail width at intersection to reduce user conflicts;
- Provide good line of sight for both motorists and trail users;
- Signage to indicate if trail users or motorists have right of way; and
- Use curb ramps or raised crossings.

The United States Department of Transportation's FHWA supports states and local governments in the design, construction, and maintenance of the highway system. FHWA's Manual on Uniform Traffic Control Devices (MUTCD) defines the standards for all traffic control devices, including signage and markings on trails.

Furthermore, FHWA's Recreational Trails Program suggests possible responses to addressing user-conflicts in the Conflicts on Multi-Use Trails report (1994). Metrics that help planners and managers control conflicts include the following:

- Speed differentials
- Sight distances
- Trail width
- Trail surface
- Congestion (e.g. number of users per mile)
- Trail difficulty (obstacles, terrain, condition, etc)

Guiding principles to reduce conflicts, as reported by FHWA's Bicycle and Pedestrian Program include the following:

- Safety – path should be designed for peak volumes and maintained throughout the year;
- Accommodation and comfort – separation of bicyclists and pedestrians as deemed necessary;
- Coherence – clear to each mode where and how they use the path;
- Predictability – design should encourage users to behave according to the path separation when necessary;
- Context sensitivity – support natural environment, land uses, community health, economic, and livability goals; and
- Experimentation – path lighting, user education, maintenance operations, and segregation techniques may be warranted to address conflicts.

RAILS TO TRAILS CONSERVANCY

Rail-trails are multi-use public paths converted from nonactive railroad corridors and are the mechanism through which most of Seminole County's trails received their funding. The Rails to Trails Conservancy's Trail-Building Toolbox draws from and expands the American Association of State Highway and Transportation Officials' (AASHTO) Guide for the Development of Bicycle Facilities. There are no maximum speeds for bicyclists along trails, but Rails to Trails recommends designing for the fastest common user. This means accommodating users at 18 MPH in long and flat segments of the trail. However, when designing for lower speeds, curvatures and centerline stripes should be utilized rather than merely reducing line of sight. Some examples of speed management tools are as follows:

- Speed bumps;
- Gravel or unpaved surfaces to reduce bicyclist speed;
- Clear signage: stop signs and warning signs when approaching intersections allow for appropriate stopping distances; and

- Education of who has the right of way.

EMERGING TRAIL USERS: PERSONAL (AND SHARED) ELECTRIC VEHICLES (PEVS)

The use of the PEVs (and shared micromobility fleets) along the trail were noted during field visits and interactions with Seminole County staff. These PEVs come in a large variety of vehicles and were once a fringe market item. The use of these vehicles have made a sharp increase ridership due to a number of contributing factors and have posed significant challenges to multiple right-of-way owning agencies in the United States.

The largest challenge is the speed differential between traditional pedal powered bicycles and pedestrians. The table below shows a comparison of relative top speeds of trail users.

User	Expected Speed
Pedestrian or Recreational Runner	2.5 - 6.0 MPH[2]
Low-Stress Cyclist	8.5 - 14.0 MPH[3]
Road Cyclist	15.0 – 20 MPH[3]
E-Scooter or E-Bike (Micromobility Fleet)*	Top Speed 15 MPH[4]
Electric Bicycle	Top Speed 20 MPH for Class 2 E-bike[5]
Electric Skateboard, Electric Unicycle, or Similar	Top Speed 30 MPH, depending on model[6]

*Can be regulated in speed and geographic area based on agency

Regulations related to the operation and use of PEVs is primarily focused on the unit itself and the limits to its operational speed and stopping distance, while the operators of PEVs must comply with local regulations concerning the speed limit and facility on which they permitted to ride in. Similar to traffic calming, an uninterrupted and low volume trails likely result in the increased speed of all users, with the exception of those on foot or in a wheelchair. The mixing of this type of traffic, though minimal in Seminole County, adds to the complexity of trail design features and the need to increase safety for all modes. Part of the peer agency interviews conducted was to gather strategies address a growing use of the trail system

[2] CDC Physical Activity Recommendations
[3] Level of Traffic Stress Methodology
[4] Average speed among Lime, Spin, and Bird branded e-scooters
[5] Class 2 is the highest speed an E-bike can reach before being considered a moped
[6] Top speed averaged from the premium models of electric skateboards

PEER AGENCY INTERVIEWS

Five peer organizations were interviewed to identify common best practices and design guidelines for trails and greenways related to the issues of speed differential and conflict avoidance that Seminole County is experiencing. The following peer agencies were interviewed for this purpose:

- City of Orlando
- Bike/Walk Central Florida (BWCF)
- Colorado Department of Transportation (CDOT)
- City of Boulder
- City of Denver

These interviews asked an informal series of open-ended questions to yield candid and informative answers. The questions asked are listed below:

- Do you have a design guide that your agency follows for trail safety and trail crossings?
- What are some of the best practices for bicycle and pedestrian safety along trails?
- How is user-conflict due to speed differentials on the trail minimized?

Each peer interview started with these questions but other information was collected during the discussions and memorialized below.

CITY OF ORLANDO

Interview Date: November 22nd, 2021
Michelle Robinson, Transportation Planning Manager
Jenn Rhodes, AICP, Bicycle, Pedestrian & Micromobility Program Manager

The City of Orlando has constructed and maintained several recreational trails and urban greenways, including the Cady Way Trail, Orlando Urban Trail, Shingle Creek Trail, the Downtown Loop, Orlando Southeast Trail, and the Lake Underhill Path. The Bicycle and Pedestrian Count Program allows the City to monitor ridership on the trail network, with a current average of 250,000 trips per month. The City of Orlando also has a Vision Zero Action plan and aims to eliminate traffic fatalities and serious injuries by 2040, with a priority placed on areas with high numbers of pedestrians, cyclists, and transit riders.

KEY TAKEAWAYS

- Speed and safety issues have caught the eye of City Commissioners, particularly in the more urban districts. The City is looking to establish a formal speed limit but is concerned about its enforcement.

- The City does use a series of bollards, flexposts, and slow zones for shared micro-mobility for traffic calming, but there are no established guidelines.
- The Dinky Line Trail in Orlando exhibits organized wayfinding signage and infrastructure that could be aspirational to Seminole County. One such piece of equipment is improved bike bars at major intersections.
- The Dinky Line Trail also provides bulbouts on certain streets in combination with RRFBs to stop traffic when actuated.
- The City has implemented high-visibility crosswalks in certain areas/trail crossings to highlight the crossing area, seen in Figure 1.

Figure 1 Dinky Line Intersection

BIKE WALK CENTRAL FLORIDA (BWCF)

Interview Date: December 16, 2021
Emily Hanna, AICP, Executive Director

Bike/Walk Central Florida is a nonprofit regional advocacy organization for bicyclists and pedestrians. BWCF has worked with several cities to adopt and implement Complete Streets policies, advocated for $15 million in state funding for the Coast to Coast Connector trail network and the passage of House Bill 2514-A for the Florida Shared-Use Non-motorized Trail Network (SunTrail). Ongoing programs and initiatives of BWCF include their Best Foot Forward program and Bike 5 Cities. As part of their Best Foot Forward program, BWCF conducted a Seminole County crosswalk study from March 10th, 2021 to May 7th, 2021. Advanced countermeasures combined with the program's strategies of educating citizens, enforcing driver yield laws, and evaluating yield rates at crosswalks are utilized in the crosswalk recommendations.

KEY TAKEAWAYS

- One metric to utilize when assessing the success of crosswalk interventions is driver yield rate. The Best Foot Forward program updates driver yield rate data in the Crosswalk Recommendations report for Seminole County
- Florida State Statutes require vehicles to yield to pedestrians in crosswalks (Title XXIII, 316.130). Although the statute language does not specify vehicles to yield to bicyclists, the treatment of bicyclists is different when on a trail or sidewalk than when the bicyclist is using the roadway. BWCF emphasizes that signage and striping inform motorists to yield to the trail crossing, and therefore should yield to bicyclists and pedestrians alike.
- Landscaping conflicts should be considered when designing recommendations for trail intersections. Landscaping can provide more separation of the trail and roadway but can also obscure the line of sight for motorists crossing the intersection.
- Consistency is important across signage and striping for trail crossings.

COLORADO DEPARTMENT OF TRANSPORTATION (CDOT)

Interview Date: November 22nd, 2021
Nathan Vander Broek, Bicycle and Pedestrian Program Manager

The Colorado Department of Transportation conducts three primary services to ensure the state builds and maintains its interstates, U.S. highways, and state highways – snow and ice operations, roadway maintenance and preservation, and construction management. CDOT adopted its Statewide Bicycle and Pedestrian Plan in 2012 with goals of increasing bicycle and walking activity, expanding recreational opportunities, and enhancing quality of life, and enhance safety. CDOT offers bicycle and pedestrian best practices and alternatives in their design guidelines.

KEY TAKEAWAYS

- CDOT have received several complaints about the speed differential among users on their trail system, with those on PEVs and cyclists exceeding the 15 MPH speed limit. E-bikes have increasingly problematic because trails that cross federal lands prohibit their usage.
- The CDOT follows AASHTO guidance closely in terms of signing its trails. Its guidelines are listed in the CDOT Bike Guide.[7]
- While the state does not use green paint in its bicycle lane markings, they heavily encourage local agencies to do so. They have seen agencies use thermoplastic or epoxy with glass to add reflective properties to the lane markings.
- Enforcement of rules is quite difficult as the trails are not policed.
- Traffic calming measures for both motor vehicles and bicycles used have included a standard toolbox of treatments:
  - RRFBs
  - Median Refuge
  - Raised Crosswalks
  - Speed feedback signs (flash 'SLOW DOWN' instead of speed)
  - Wayfinding signage

CITY OF BOULDER

Interview Date: November 22nd, 2021
David Kemp, Senior Transportation Planner

[7] Seen here https://www.codot.gov/programs/bikeped/information-for-bicyclists/bicycling-manual

The City of Boulder features more than 150 miles of bike-friendly infrastructure and ranks as one of the most bike- and pedestrian-friendly cities in the country. Boulder is also a Vision Zero city and joins other cities in the effort to eliminate all serious injuries and fatalities through safe street design.

KEY TAKEAWAYS

- The City relies primarily on peer enforcement to ensure those using the trail are complying with the rules. Named ***The Way of the Path***, these rules are expressed in a series of wayfinding signs- seen in Figure 2.
- The City does not have a codified standard for trail design, but they do adhere to certain design standards:
  - Splitting walk and bike modes at major intersections and activity centers;
  - Rectangular Rapid Flashing Beacons (RRFBs) for all mid-block crossings;
  - Soft-scaping and hardscaping color differentiation;
  - Differing standards for residential vs. commercial areas; and
  - Dismount zones for skateboarders and cyclists.

Figure 2 Boulder Trail Sign

- It was also emphasized that the effectiveness of communication should be center to any signage used (i.e. stating what to do vs. what not to do)

CITY OF DENVER

Interview Date: November 22nd, 2021
Brett Boncore, Multimodal Engineer
Adam Lind, Trails Planner

The City of Denver was cited by both the City of Boulder and CDOT as aspirational for trail planning in the State. Within City limits there are more than 80 miles of off-street, multi-use trails that follow the City's urban waterways. Trail planning in the City is guided by ***Denver Moves***, the City's long-term plan for recreational and active travel.

KEY TAKEAWAYS

- Similar to Boulder, Denver depends on those on the trail to self and peer enforce the rules that are posted regularly. Both cities have worked diligently with advocacy organizations to establish this culture;

- The City stated that some of the topography and even crack in the trail pavement have been helpful in regulating speed on the longer stretches of trail. In slowing trail traffic down, pseudo rumble strips have been created out of thermoplastic;
- Jug Handle intersections have been piloted in the City to divert trail traffic at intersection corners to avoid crowding and improve cyclist movements. The example in is in Figure 3 from Cambridge, MA;
- In terms of design standards, the City uses a codified toolbox of treatments
  - Speed humps/lumps on neighborhood bikeways;
  - Geofencing of rented e-scooters and e-bikes to limit speed in slow-zones, limiting potential harm in pedestrian and PEV users;
  - Strategic widenings (bulbouts) and lane markings at complex intersections and high-volume trail crossings; and
  - Context-sensitive design that changes the geometric configuration of the facility based on residential and commercial land uses. Below is an example of a separated sidewalk and bike path on a commercial thoroughfare.

Figure 3 Jug Handle Intersection

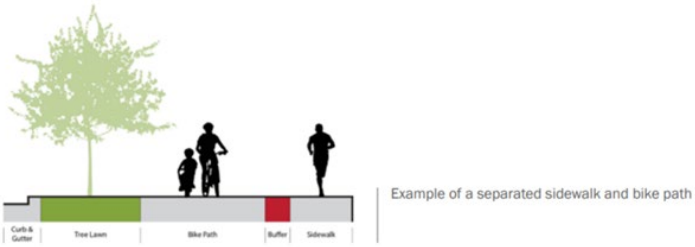


Figure 4 Bike Path Typical Section

PILOT SEGMENTS: EXISTING CONDITIONS AND FIELD REVIEW

FIELD REVIEW

To better understand the safety conditions and conflicts along the trail, the project team alongside Seminole County staff performed in-field reviews of nine pilot areas that exemplified the issues presented by the public and through crashes or complaints. These field review took place at the following locations:

1. Cross Seminole Trail – Aloma Avenue & Red Bug Lake Road (Home Depot Entrance, Oviedo)
2. Cross Seminole Trail – Lake Jessup Avenue Intersection, Oviedo
3. Cross Seminole Trail – Tuscora Drive Intersection, Winter Springs
4. Cross Seminole Trail – SR 434 Pedestrian Bridge, Winter Springs
5. Cross Seminole Trail – SR 46 & Rinehart Road Intersection, Sanford
6. Cross Seminole Trail – Longwood Lake Mary Road Intersection, Longwood
7. Seminole Wekiva Trail – Trail segment south of Lake Mary Boulevard, Lake Mary
8. Seminole Wekiva Trail – Long Pond Road Intersection, Longwood
9. Seminole Wekiva Trail – Dixon Road Intersection, Longwood

For summarization purposes, the observations made at these geographic locations can be classified into three distinct problem area contexts:

1. Non-Signalized Trail Crossings and Vehicle Conflicts
2. Trail User Traffic Calming/Speed Management
3. Signalized Trail Crossings

Each problem area experienced situational conflicts unique to the geometry and operations of the trail and are grouped in such a way that they may benefit from common solutions. The findings from the trail study are summarized in the sections below.

1. Non-Signalized Trail Crossings and Vehicle Conflicts

This problem area is defined as a trail crossing of a residential street or commercial driveway without the protection of an actuated signal to stop motor vehicles. Noted concerns at these intersections included failure of the trail users and motorists to slow down or stop where signed and speed of trail users particularly while traveling down a bridge ramp. The following trail locations were observed and reviewed:

- Seminole Wekiva Trail – Long Pond Road Intersection
- Seminole Wekiva Trail – Dixon Road Intersection
- Cross Seminole Trail – Lake Jessup Avenue Intersection
- Cross Seminole Trail – Tuscora Drive Intersection
- Cross Seminole Trail – Aloma Avenue & Red Bug Lake Road (Home Depot Entrance)

Trail User Speeding Conditions

At certain locations, trail users are expected to stop at the stop bar located at the trail stop sign prior to entering into an intersection. A bike bar, featured in Figure 6, is provided to encourage cyclists to stop without dismounting, using the bike bar as support.

Figure 6 Bike Bar for Cyclists near Stop Sign

Figure 5 Trail Conditions at Bridge Terminus

User speed at this location was of particular concern as cyclists will naturally gain speed as they exit the bridge ramp. **Error! Reference source not found.** is illustrative of the stopping distance the user must react to when approaching the stop bar. Based on trail counts provided by the County, usage on this portion of the trail is higher compared to other areas.

The remaining intersections in this category cross at heavily used residential streets where the primary safety concerns are visibility of the trail crossing to motorists and stop compliance among trail users. Conditions at these intersections are shown in Figure 3.

Figure 7 A Pair of Trail Crossings at Tuscora (left) and Lake Jessup (right)

2. TRAIL USER TRAFFIC CALMING

This problem area reflects trail conditions that contribute to dangerous behavior by trail users such as using excessive speed will on a bicycle or personal electric vehicle (PEV), potentially causing conflict with other users or elements along the trail. Trail location exemplary of this include:

- Cross Seminole Trail – SR 434 Pedestrian Bridge
- Seminole Wekiva Trail – Trail segment south of Lake Mary Boulevard

Trail Conditions

The pedestrian bridge exhibits unique conditions due to the placement of an equestrian segment through the center of the platform, effectively separating horseback traffic from other users. However, due to lack of demand, those walking along the trail often use this center portion of the bridge deck while others tend to use the outside sections for riding a bike. A cross-section photo of this bridge is provided inFigure 9.

Figure 9 SR 434 Bridge Section

Figure 8 SR 434 Bridge Center Walkway/Equestrian Trail

Severe and fatal crashes have occurred at this location with speed and the configuration of the bridge and its deck infrastructure being significant factors. While in the field it was discovered that the tiling in the center portion of trail is in disrepair and present tripping hazards. It was noted by Seminole County staff that they are amenable to phasing out the equestrian use of the trail, possible removing the railings. The railings were noted as direct contributors to a cyclist fatality.

South of Lake Mary Boulevard on the Seminole Wekiva Trail, conditions that contribute to undesirable biking speed and operation were found to be due to the topography and curvature of the trail (a slight slope, but enough to gain speed), seen in Figures 6 and 7. Compounding these issues is the overgrowth of shrubbery from the adjacent residential areas that obscures sight lines around the curves.

Figure 11 Blind Corner South of Lake Mary Boulevard

Figure 10 Shrubbery Encroaching onto the Trail

3. SIGNALIZED TRAIL CROSSINGS

Finally, there were two signalized intersections that were studied during the field reviews:

- Cross Seminole Trail – SR 46 & Rinehart Road Intersection
- Cross Seminole Trail – Longwood Lake Mary Road Intersection

The trail conditions at these intersections are cited to cause difficulty and confusion in crossing the intersection to continue onto the trail, and the associated user conflict and comfort among motorists.

The SR 46 and Rinehart Road intersection has a lengthy crossing distance across SR 46 (roughly 160ft) from the southeast corner to the northeast corner where the trail continues. Traffic is also heavy along both roadways, with SR 46 experiencing an AADT of 35,000 and Rinehart Road at 18,000.[8] Noise, truck traffic, and speed experienced firsthand at this intersection make it difficult to cross without the aid of the pedestrian phase. Notably, the median nose on SR 46 is extended to provide refuge for crossing trail users (Figure 13).

[8] https://tdaappsprod.dot.state.fl.us/fto/

Figure 13 Intersection of SR 46 and Rinehart Road

Figure 12 Conditions Approaching the Intersection

The area of the trail leading up to the intersection was noted to have water and debris from drainage, creating a slipping hazard for those approaching the intersection. Additionally, it is not apparent to the trail user that the continuation of the trail is across the intersection as signage and visual cues are limited to reinforce the trail continuity.

At the Longwood Lake Mary (LLM) Road intersection, conditions and conflicts were due to a lack of wayfinding, which would determine the safest path to cross the intersection and on which legs. In the aerial shown in Figure 14, trail users are meant to cross where there are marked crosswalks.

Figure 14 LM Boulevard Intersection

In the field it was observed that those using the trail chose their own path when approaching the intersection. One cyclist took the full outside left lane to reach the northeast corner where the trail

continues. Another cyclist rode north to the intersection of General Hutchinson Parkway, and then crossed where there was not a marked crosswalk.

MISCELLANEOUS OBSERVATIONS FROM THE FIELD

Wayfinding on the trail was present at most trail heads and major intersections, but often failed the attention of the user or the motorist. However, recently added wayfinding has been updated with appropriate safety information and directions.

Figure 15 Lake Mary Boulevard and Seminole Wekiva Trail

Additionally, there are underutilized pieces of infrastructure in the residential sections that once housed shrubs or plants that have been since paved over or perished due to climate conditions. These medians were still effective at splitting directional traffic and providing an area for cyclists to rest a foot without needing to dismount.

Figure 17 Medians at Tuscora Intersection

Figure 16 Illuminated Stop Sign

Finally, areas of the trail that are in established neighborhoods have added safety features at the request of the residents. Seen in **Error! Reference source not found.**, solar powered lights around the stop sign at the Tuscora Drive intersection to provide added awareness at the crossing.

The noted observations were instrumental in information the following approach to recommended solutions and steps to implementation. Each area of observation were understood to have applicable solutions to become a kit-of-parts through which County may apply to other areas with similar conditions. The following sections explains in detail the approach to this study's recommendations.

RECOMMENDATIONS

The recommendations housed in this section are inclusive of the explanation of recommendation Tiers, a list of policy recommendations, and a set of standard details for the design elements presented. The application to the trail system is intended to be phased in accordance to the County's fiscal and planning timelines.

TIERED APPROACH

Overall, both the Cross Seminole Trail and the Seminole Wekiva trails provide a scenic and safe option for users, truly living up to the nomenclature of "signature trails." Areas of concern are primarily where standards of safety are not carried through the entirety of the trail system. When approaching the needed improvements and recommendations for both the areas of the field review and the trail system as a whole, the project team chose to categorize the solutions in two tiers:

- Tier I: Immediate or short-term improvements to the current alignment and configurations to the trail. These treatments are intended to be lower in cost relative to Tier II, and will achieve a high degree of safety if implemented
- Tier II: Long-term solutions that are higher in cost and effort, but provide the maximum outcome of safety to all users

The intent for each of the locations would be to execute the Tier I enhancements and to monitor behavior to determine effectiveness; if the behavior is not sufficiently modified, then Tier II elements could be implemented at a later date. Inclusive in these two Tiers are spot treatments that aid in specific situations and global improvements that can be placed at standardized locations for maximum effectiveness. The following sections describe at a high level the recommendations that are being suggested at various locations. While the organization of recommendations is separated into two Tiers, they are not intended to conflict or override one another. Elements from Tier I or Tier II can be executed in tandem, and Tier II elements may be inclusive of all Tier I elements. Each treatment has been categorized to address the specific concerns encountered in the field and those discussed with County staff members. They are organized within each respective Tier according to their function:

- Signage and Wayfinding: treatments related to the post of regulatory and awareness signage;
- Conflict Mitigation Between Modes: treatments meant to lower the risk of negative user conflicts among all modes;
- Traffic (Trail User and Motorist) Calming and Speed Management: treatments intended to slow or separate modes for the purpose of awareness and safety; and
- Amenities and Furnishings: treatments meant to improve the comfort of the trail experience and encourage compliance with signage and trail rules.

While all locations exhibited needs related to all these elements, each location required treatments specific to the unique conditions of the trail segment or intersection and are discussed at a high level. A complete book of plansets, estimates of probable costs by Tier, standard details, and a comprehensive list of recommendations are found in the Appendix.

TIER I RECOMMENDATIONS

This Tier of recommendations should be deployed swiftly to mitigate the current safety conflicts observed and discussed. Treatments such as, high visibility crossings, wayfinding signage, and rumble strips. This first Tier is intended to be the starting point of the suggested solutions. An example is shown in Figure 14, with the full planset for all location with a comprehensive visualization of elements is located in the Appendix.

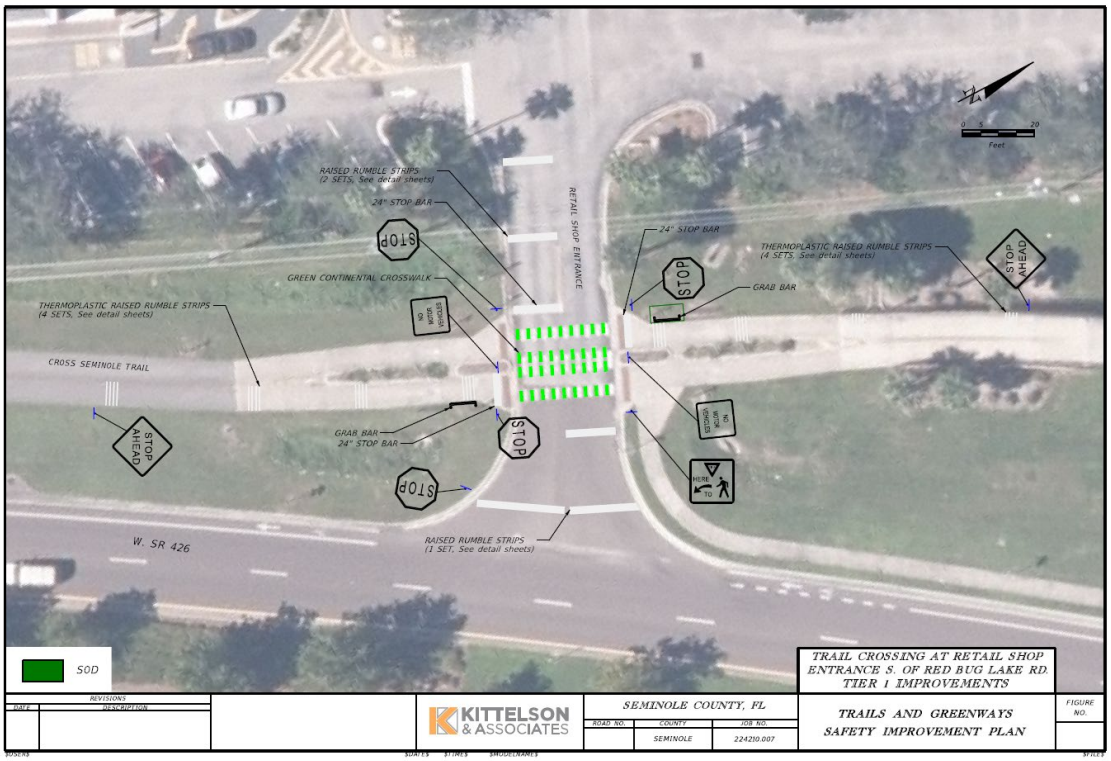


Figure 18 Tier I Improvements at Red Bug Lake Road Retail Center

Signage and Wayfinding

Signage was found to be consistent along the trail for trail users, but inconsistent for motorists crossing the trails. The signage was also in many cases set back away from the sight line of trail users or obstructed by vegetation. Signage being recommended in Tier I includes advanced warning signage, appropriate stop signs, and yield signage. Signage is also not limited to wayfinding and may work to improve the overall sense of place along the trail and general awareness that users of other modes are in the area. An example from Orlando's Urban Trail is shown in Figure 19. Locations where modes may need to branch off to their own designated areas of the trail are also inclusive in this category. The County is currently exploring comprehensive wayfinding updates through an ongoing planning effort.

Figure 19 Orlando Urban Trail Signage

Conflict Mitigation Between Modes

Where trail meets street is a contentious space in most areas of any trail system and are the most dangerous points of conflict for users. Tier I recommendations aim to warn both the motorist and the trail user of a potential conflict before they

advance into the crossing area. This conflict mitigation is meant to be accomplished primarily through high visibility crosswalks and RRFBs at the crossing, seen in Figure 21 and Figure 20. These elements are particularly important at the Longwood Lake Mary Road intersection in addition to unsignalized crossings throughout the trail system.

Figure 21 High Visibility Crosswalk with Artistic Notes, Orlando, FL

Figure 20 RRFB Location at Lake Underhill

Artistic stylings of crosswalk striping are dependent upon the desire and budget of the agency. Without artistic notes, these crossings are standard crosswalk markings in bright green, with the intention of alerting the motorist of the crosswalk space. In addition, these colored markings convey a sense of continuity such as where the trail crosses one leg of a signalized intersection. By following a consistent colored marking theme, users can rest assured they are continuing along the trail when they cross a street. Other elements within this categorized tier includes expand landing pads for crossing trail users, especially at signalized intersections such as Longwood Lake Mary Road.

Mentioned previously, the splitting of modes is also conveyed in Tier I and II for the Lake Mary Boulevard and SR 434 Trail bridge sections. These are areas where the speed differential between bicyclists/PEVs and those walking pose a significant risk in mixed traffic.

Traffic (Trail User and Motorist) Calming/Speed Management

This element is poignant in reviewing the conditions at the SR 434 trail bridge and the Aloma Avenue & Red Bug Lake Road retail entrance. The purpose of these treatments is to slow all users down to achieve a desired and safe travel speed and to grab their attention for potential conflicts ahead. In Tier I, these elements include a proposed mini-roundabout for trail users (particularly at the bottom of the SR 434 bridge) to terminate the vista as users look ahead and allow them to slow down before reaching unsafe travel speeds. This element is seen in Figure 23. Also included as the base for this tier are rumble strips for both the trail users and motorists to be used as audible and tactile cues to increase awareness and slow down as they approach a conflict point, shown in Figure 22. Similar in effect to roadway rumble strips, trail strips are thinner and constructed out of multiple strips of thermoplastic striping to remain bike and rollerblade-friendly.

Figure 23 Pedestrian Bridge Terminus Roundabout, Virginia

Figure 22 Example of Roadway Rumble Strips

Amenities and Furnishings

Amenities such as park benches and bicycle parking are often considered indicators for trail users that an approaching context is changing or there is opportunity or necessity to dismount or stop from their bike or PEV (if applicable). Standard for all intersections where the trail user will be required to stop are improved Bike Grab bars so the cyclist may stop without dismounting and grab onto the bar for balance, shown in Figure 24. The positioning and styling would replace the existing grab bars on the trail system.

Figure 24 Example of Grab Bar

TIER II RECOMMENDATIONS

Tier II recommendations are intended to be secondary and/or complimentary to the Tier I recommendations, with a higher degree of effort, planning, and costs associated with their implementation. Tier II recommendations may include instances where additional right-of-way will need to be purchased, where curb and gutter will need to be moved to accommodate sidewalk space, and full realignments of the trail right-of-way. An example from the intersection of SR 46 and Rinehart Road is shown below. Amenities and Furnishings did not change from Tier I to Tier II, and are not included in this section.

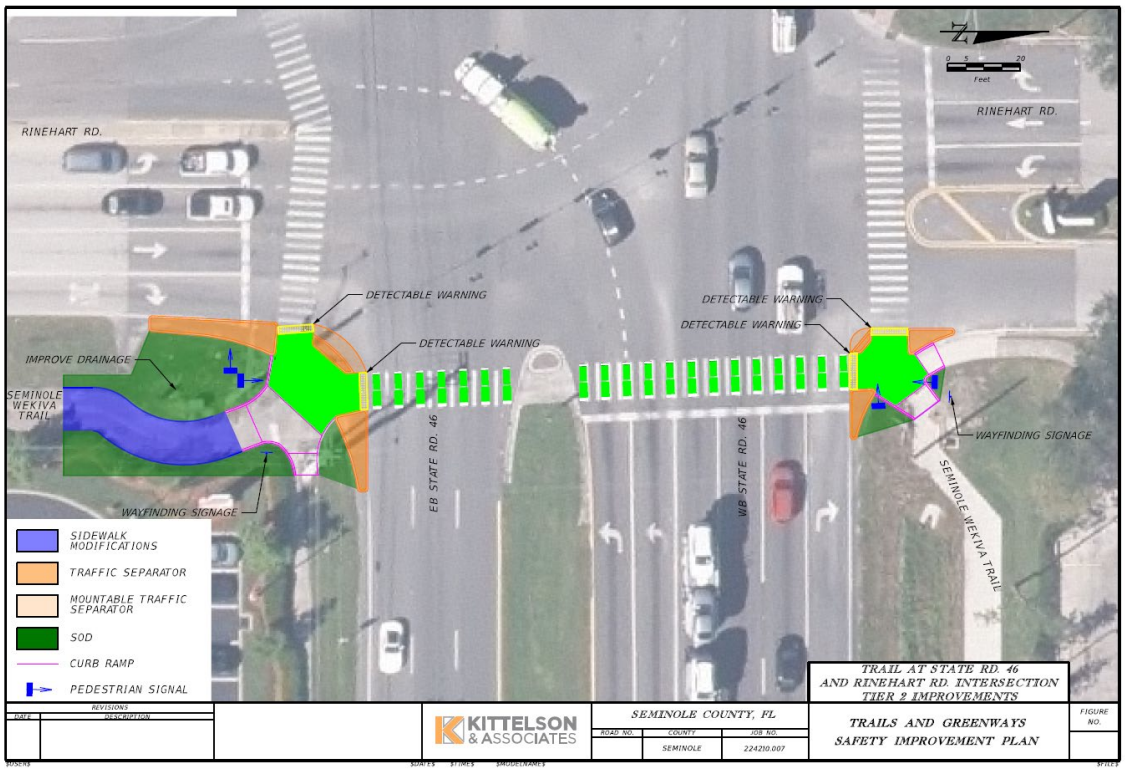


Figure 25 Tier II Example from SR 46 and Rinehart Road

Signage and Wayfinding

Across all locations, signage and wayfinding remained standard across all field site locations unless a major change to the trail configuration necessitated a change in signage or user travel needed to be directed to a specific direction. Instances where modes needed to be separated between bicycle/PEVs and pedestrians, trail signs were recommended to alert the trail user to navigate to the portion of the segment appropriate for their mode of travel, seen in Figure 26. A concurrent study of wayfinding is being conducted for Seminole County Leisure Services; this effort has coordinated with that study team and the focus of this study remains signage that is more regulatory in nature.

Figure 26 Mode Split Sign Example

Conflict Mitigation Between Modes

Discussed in Tier I, these treatments are meant to change the physical conditions of the roadway to ensure less risky conflicts between modes. This is particularly true for the Longwood Lake Mary Road intersection. The example recommendation here is inclusive of creating an alternate route for users to cross

Ronald Reagan Boulevard at General Hutchinson Parkway, as shown in Figure 27. Larger scale advanced warning signals in the form of an actuated or thermal detection pedestrian signal that stops motorist traffic when a trail user approaches the crossing is also recommended in this Tier. Example is show in Figure 28.

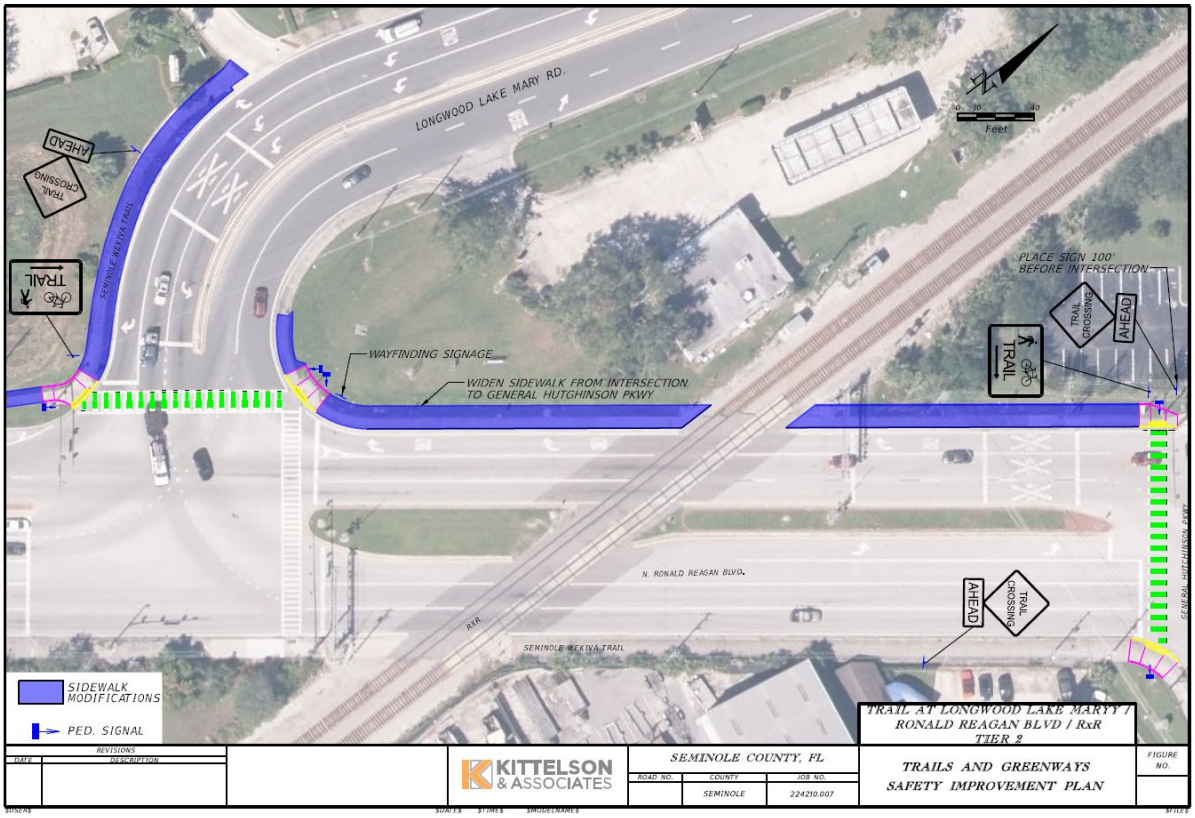


Figure 27 Longwood Lake Mary Road Intersection

Figure 28 Automated Pedestrian Hybrid Beacon (HAWK) in Sarasota, FL

Traffic (Trail User and Motorist) Calming

The primary change in traffic calming from Tier I to Tier II is the addition of hardscaping to various elements, particularly at intersections. Raised crosswalks are being recommended at most intersections to slow the travel in the approach and through the intersection, in combination with high visibility striping. Trail users would also need to traverse over the raised crosswalk to ensure they are also slowing down as they enter the intersection. An example from Safe Routes to School is illustrated in Figure 29. Equally, where splitting modes is recommended, the addition of plastic delineators are suggested for additional reinforcement to travel in the appropriate lane and at a reasonable speed. The recommended traffic delineators are also easy to install and remove as needed.

Figure 29 Raised Crosswalk Example

Speed feedback signs are recommended for those areas where the user on wheels is found to be traveling at a dangerous speed while traveling back down to grade on a bridge deck. This sign would be automated and begin to flash if the user is detected at 10 MPH and will read "SLOW DOWN."

Figure 30 Example of Mode Delineators

OTHER CONSIDERATIONS

While Seminole County staff did not indicate the desire to bar any PEV or specific user-type from the trails, it is also recommended in this study to establish a desirable speed as user trends change. As indicated in the peer agency interviews, many agencies have established areas where all PEV users and cyclists must dismount, and have established specific, enforceable rules to ensure that mixed traffic is safe and efficient. While this document is not making specific policy recommendations related to this, it does encourage that a broader, blanket policy related to the planning for future needs is considered in the future.

IMPLEMENTATION STEPS

This study has presented a set of best practices with regard to trail design to address issues that Seminole County is experiencing with regard to conflicts where trail users intersect with streets and where speed differentials among trail users causes conflicts on the trails. The literature search and interviews of peer agencies has yielded information on best practices that have been used in practice to address these issues, and an in-depth study of nine pilot trail segments within the County that exhibit these issues provided the ability to test these best practices on real situations that the County is experiencing.

As Seminole County considers these recommendations to enhance safety on their trails and related street crossings, a strategy to incorporate the measures contained herein is presented below.

1. Amend the existing Trail Design Guidelines to incorporate the measures contained in this study. By including the standard drawings of the measures contained in the pilot segment within the context of the Public Works Engineering Manual, Section 1.13, the ability to retrofit existing trails and to design in these best practices on new trail segments will become standard practice.
2. Prioritize the pilot locations for implementation of Tier I enhancements and identify funding. For the nine pilot segments studied, develop a priority implementation plan to execute the Tier I enhancements at each of the locations. The County should also identify
3. Develop a monitoring system to evaluate effectiveness of Tier I enhancements. The County should document the effectiveness of the Tier I enhancements at the pilot locations quantitatively through speed checks and crash reduction. In addition, the County should actively seek user feedback through online surveys or even through QR codes on signs to ask how users feel about the implemented measures.
4. Determine additional locations where the measures contained in this study could be implemented and develop retrofit priorities and funding. The measures shown in the standard details in the Appendix could be transferrable to other location; modifications to specific locations would need to be made, but each of the specific measures could be used at other trail and intersection locations as new issues are identified.

Funding for these and any trail enhancements would need to be identified to implement these recommendations. New safety funds on the federal level coming available through the bipartisan infrastructure legislation could be sought through grants or other streams. County funding could also be allocated through capital, maintenance, or safety funds. Where measures are on state roads such as the intersection of Rinehart Road and SR 46, coordination with FDOT District 5 will be required. Finally, measures would be included in new trail projects, and could be incorporated into locations of existing trail where the new project may intersect.

The following Appendix contains specific concept plans and estimates of probable costs for each of the nine pilot locations studied. In addition, the standard details contained after the concept plans are intended to be incorporated into the existing trail design guidelines to expand the toolbox of measures to address these specific issues related to safety.

APPENDIX

PILOT SEGMENT PLANSETS, ESTIMATES OF PROBABLE COST, AND STANDARD DETAILS