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DEPARTMENT OF TRANSPORTATION

Developing a Methodology to Incorporate Transit, Pedestrian and Bicycle Design Features into Highway and Bridge Projects during the Planning and Design Phases of Project Development in Pennsylvania (TPB Guidelines)

FINAL REPORT

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By Mark J. Magalotti, Ph.D., P.E.
University of Pittsburgh

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16. Abstract
The objective of this research was to develop a more qualitative means of assessing the need for bicycle, pedestrian, and transit facilities early in the design process. Based upon this evaluation, the researchers recommend consideration of the Georgia DOT method to replace the current checklist with several modifications.

These modifications included revising the project development process to require use of the method during the programming phase, adopting the AASHTO criteria for bicycle facilities and the Georgia standards for sidewalks, elimination or modification of the guidelines for bicycle, pedestrian and transit facilities and adding criteria for both the pedestrian and bicycle standards that require direct data collection to establish current levels of usage.

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Summary of Project Goals

PennDOT's current method of project development only evaluates multi-modal design features relative to their function as accessory uses, subservient to the primary function of a highway or bridge project. The current bicycle and pedestrian checklist process relies on user input, which does not have a validation system behind it; the process is largely qualitative. Anecdotally, this evaluation process has resulted in projects that were devoid of, or inadequately provided with, adjacent transit, pedestrian and bicycle facilities. While this outcome may be appropriate, no quantitative methodology is available to make, validate, or assist in this determination.

The goal of the project was to develop a more quantitative means of assessing the need for bicycle, pedestrian, and transit facilities early in the design process. This new process will determine several key project details, including the following:

- An appropriate project scope, based on land use and demand for various transportation modes;
- The extent to which various modes of transportation should be accommodated and the value of such accommodations; and
- An accurate project cost estimate.

A review of current research indicates that some attempts are being made to quantify the need and benefit of incorporating transit, pedestrian and bicycle features into highway projects by other states, metropolitan planning organizations (MPO) and cities.

The tasks of the project included a review of the current PennDOT practice and a summary of how other planning organizations accommodate alternative modes. The research team also wanted to obtain a better understanding of how the current checklist is being used. This goal was achieved by evaluating current PennDOT projects to determine the benefit of the checklist.

The research report's ultimate goal was to improve the implementation of multi-modal design features into PennDOT projects through an evaluation of other practices and adapt a methodology to Pennsylvania.

Overview of PennDOT Process

The bicycle and pedestrian checklist is a planning and design directive created by PennDOT to ensure that appropriate multi-modal features are considered during the planning and design process.

The current checklist created by PennDOT in 2000 was to be used during the design for all highway and bridge projects. The checklist was updated in 2007 to include the first page, "How to Use the Bicycle and Pedestrian Checklist" and was subsequently incorporated in the Design Manual Part 1X Appendix S, to provide direction to PennDOT personnel involved in the transportation program development and project delivery process. However, as part of the design manual, this also provides design guidance on the implementation of these measures.

The development of the checklist grew from the federal legislation at the time, The Transportation Equity Act for the 21st Century (TEA-21) and its predecessor legislation, the

Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). One component of both these acts was the call for mainstreaming of bicycle and pedestrian projects into the planning, design, and operation of our nation's transportation system.

The intention of the checklist was to have the three separate components incorporated into the appropriate PennDOT publications, relevant to the transportation development process. However, because the concept of bicycle and pedestrian mainstreaming was considered new at the time, it was felt all three stages should be introduced together. Therefore, a single checklist was developed with three distinct sections. These sections include:

- Planning and Programming;
- Scoping; and
- Final Design.

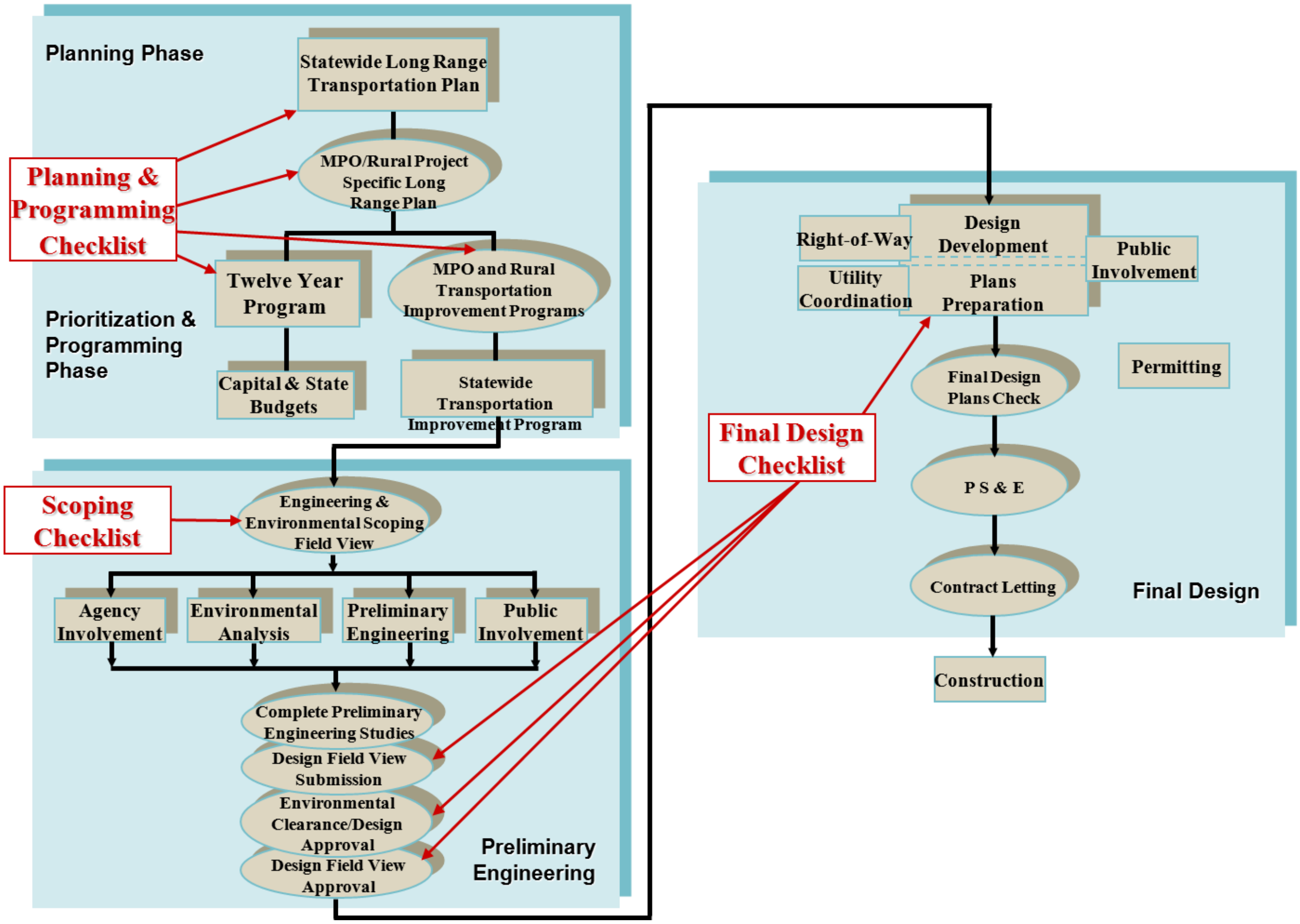
The original design of the checklist's purpose was as a data gathering tool. It was not proposed as a strict evaluation method to determine what bicycle and pedestrian facilities or attributes should be incorporated into a transportation project. Rather, it identifies components of the existing and proposed transportation system that should be considered.

Variations on the checklists have been created by PennDOT District personnel to aid in incorporation of scoping documentation throughout the years. This is considered acceptable by PennDOT, because the use of the actual checklist is a planning tool.

Relationship to the Project Development Process

Figure 1 illustrates the application stages of the three checklist sections to the Project Development Process. It was developed in a training course by PennDOT for application of the checklist.

Figure 1



The Planning and Programming section is utilized during the Long Range Planning stages at the local and state level, as well as the Twelve Year Program (TYP) and Transportation Improvement Program (TIP) levels. From a PennDOT Design Manual standpoint, this section of the checklist is referenced in DM-1, Chapters 2, 6 and 16.

The Scoping section is utilized at the Engineering and Environmental Scoping Field View stage of a project and is referenced in DM-1C, Chapter 2.

The Final Design section is utilized during various preliminary engineering stages and plan preparation in Final Design. DM-2, Chapters 1, 2, 6, and 16 refer to the checklist for this area of the process.

Need for Updated Process

Based upon discussions with PennDOT, the primary purpose of the current checklist is as a data gathering tool; it was not designed to evaluate if and how bicycle or pedestrian facilities should be incorporated. This idea, however, is the next logical step. There has been discussion, at PennDOT, that the next revision should evolve the checklist to more of a decision making tool.

Review of PennDOT Use of Checklist

In order to determine the current benefit and use of the checklist, the research team conducted a review of five projects, selected by PennDOT, that utilized the checklist. A data gathering list was developed for this review to obtain relevant information to evaluate the use and assist in the development of a potential new process to improve or replace the checklist.

The research team requested projects that varied in their location (urban and rural), the scale of the project and type of project (bridge and highway). Based upon this request, PennDOT provided five projects for review by the research team:

- Union County, District 3: SR 3005 – Pleasant Grove Road over Buffalo Creek, MPMS# 88029;
- York County, District 8: I-83 Exit 18, MPMS# 62880;
- Lebanon County, District 8: Schaeffer Road, MPMS# 82597;
- Allegheny County, District 11: Marshall Interchange Phase 3, MPMS# 28143; and
- Allegheny County, District 11: Carrie Furnace Redevelopment/Rankin Bridge, MPMS# 27727.

The research team met with District staff to review the overall project and to discover how the bicycle and pedestrian checklist was used. Regardless of whether the checklist was used or not, the research team learned which features (or lack thereof), were incorporated into the planning and design of the project.

When checklists were used, the research team obtained copies of the checklists for review. The goal was to obtain and review the checklists for the planning/programming, scoping and design phases of the project and determine how each section of the checklist was used to develop the project scope and design.

None of the projects reviewed had checklists completed or available for the design phase. Some projects did not have checklists completed for various reasons. For projects that checklists were not used, discussion ensued to determine how the project was scoped and is reflected in the project process.

Based upon the review of the five projects selected, it appears that the checklist is not being used to its full extent or intended function. The checklist is being used in the early stages of project development during planning and programming phases, but not during later stages of design. Also, some districts have the bicycle and pedestrian coordinator take the lead in completing the checklist for all projects, while others are making it the responsibility of the district program manager, project manager or consultant.

The issues of ADA compliance and safety also appear to be taking precedent over the incorporation of pedestrian and bicycle features. Coordination with the MPO or RPO appears to be limited during the planning and programming phase.

Based upon this review of the current process, improvements can be made to better address the issues identified. These issues include: not completing the checklist during the design phase of the project; not having the project manager be responsible for completion of the checklist; and having ADA compliance and safety take precedent over incorporating pedestrian and bicycle features.

Addressing these issues, during the early stages of project development, rather than during design is important for preparing an accurate project scope and project cost estimate. The current checklist also needs a better defined process that provides complete, accurate information to inform the decision on incorporating these nonmotorized modes into a project. The scoping field view section of the checklist could be used by designers to make decisions on the basic design features, but many designers are already predisposed by the design manual, which does not require the incorporation of pedestrian and bicycle features.

Summary of Literature Review and Current Standards and Practices

An extensive review of current standards and practices used at the national, state, regional, and local areas was conducted. PennDOT requested the research team also evaluate the current Geographic Information System (GIS) and Roadway Management System (RMS) maintained by PennDOT to determine if these systems could support processes similar to those identified in the literature research. The following is a summary of this review.

I. Federal Highway Administration (FHWA)

Several sources from FHWA were reviewed for guidance. The sources included the Manual on Uniform Traffic Control Devices, 2009 Edition (MUTCD) and FHWA sponsored research on accommodating bike, ped, and transit features.

The Manual on Uniform Traffic Control Devices (MUTCD)

The MUTCD is a publication by the Federal Highway Administration (FHWA), American Traffic Safety Services Association (ATSSA), American Association of State Highway and Transportation Officials (AASHTO), and The Institute of Transportation Engineers (ITE) that defines the national standard for traffic control devices, including signs and pavement markings. The MUTCD provides standardized markings and signs for roadways, including those used for cyclists and pedestrians. The MUTCD, in addition to state-specific references, is a repository of the common and legal street signs and markings. Consistent use of readily-understood markings aids in the safe use of all roadways.

Additionally, guidance on usage of devices and related factors may be found in the MUTCD. The MUTCD provides implementation guidance for bicycle and pedestrian facilities, but not guidance on when and how to implement these features into transportation projects.

Bicycle Compatibility Index

The Bicycle Compatibility Index (BCI) [FHWA, 1998] is a methodology developed by FHWA to rate how "friendly" a particular segment of mid-block, i.e., non-intersection, roadway is to bicycles. A conversion chart from BCI to (Bicycle) Level of Service is also given.

The research that supports the BCI was developed by videotaping segments of roadway with a stationary, curb-resident camera and then asking study participants to rate how comfortable they would feel riding a bicycle on it on a scale of 1 (very comfortable) to 6 (not comfortable at all). A linear regression model was done on these scores to apply weights for factors such as bicycle lane or shoulder widths, parking, 85th percentile speeds, and traffic volumes. The data used, and the published BCI equation, has an R-squared value of .89 with the study participants ratings.

The BCI has been criticized [Pein, 2007] for being biased towards bicycle lanes due to the study methodology. Pein claims that the cameras used to create the videos shown to study participants were not placed in the lane, as a bicyclist would have been, otherwise, a large left-shift in vehicle position would have been seen. Additionally, Pein cites other sources to claim that the perception of motorist speed by a bicyclist is not accurate, and the methodology used to determine the BCI is flawed. Pein concludes, by forcefully asserting, that comfort level is not the end-all-be-all in facility design, and therefore the BCI is fatally flawed.

While Pein is overly harsh in his critique, he does bring up some valid criticisms of the BCI. However, the BCI is a starting point for analyzing how "friendly" a roadway is to a bicyclist, especially inexperienced ones that rely on perception of the roadway as usage guides.

The BCI is used by some MPOs and state DOTs. There are few other metrics that have been established by research to ascertain the same types of metrics that the BCI provides. As guidance for project development, the BCI is a methodology that is rarely used. However, it does hold some promise as a methodology and should be further explored by researchers.

II. The Transportation Research Board - The Highway Capacity Manual

The 2010 edition of the Highway Capacity Manual is the first edition of the manual to provide an integrated multimodal approach to the analysis and evaluation of urban streets. Level of service analysis for the automobile, bicycle, pedestrian and transit modes are available at the intersection, segment and arterial facility level simultaneously. Also, the analysis takes into account the effects of automobiles on the bicycle or pedestrian operations.

III. American Association of State Highway and Transportation Officials (AASHTO)

Several AASHTO publications on the research topic were reviewed including the following.

Guide for the Planning, Design, and Operation of Pedestrian Facilities

The AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities (GPF) is a publication from AASHTO to aid in the planning and design of pedestrian facilities. The guide contains many traffic calming methods as well as a survey of the needs of pedestrians. The guide discusses ADA compliance as well as additional ideas of how to make sidewalks and walkways more pleasant and accessible. Criteria or thresholds for the incorporation of pedestrian facilities into highway or bridge projects are not provided in the GPF.

Guide for the Development of Bicycle Facilities, 4th Edition

The AASHTO Guide for the Development of Bicycle Facilities (GBF) is a publication by AASHTO to aid in the planning and design of bicycle facilities. The Guide contains comparisons of different facility types and their appropriate uses and refers the reader to many tools to aid in planning facilities, including methods to determine demand, cost, and Level of Service. In addition to planning guidance, the guide also offers preliminary engineering and final engineering standards and advice.

A Policy on Geometric Design of Highways and Streets, 6th Edition

AASHTO's A Policy on Geometric Design of Highways and Streets (Green Book) contains extensive data and guidance on the proper construction of a roadway. The Green Book briefly touches upon pedestrian and bicycle facilitates, but defers to the GPF and GBF for a more complete treatment of the topic.

Summary of AASHTO Guidance for Planning and Design

The AASHTO books provide a wealth of information for planning complete streets. The three books mentioned, in addition to the rest of their collection for specific needs, provide a good introduction and reference to the majority of the ideas found in the state DOTs, MPOs, and cities surveyed in this review.

IV. State Departments of Transportation (DOTs), Metropolitan Planning Organizations (MPO) and Cities

Many state DOTs', MPOs', and cities' Bicycle and Pedestrian Master Plans, policies and procedures were reviewed and analyzed to determine how other planning organizations plan and assess need for facility upgrades. Master Plans were found by web searches or contacting agencies directly. Plans were found that ranged from a declarative of the overarching goals with minimal practical guidance to detailed descriptions of the methods used.

The overall tone of the majority of the agencies surveyed is one of ranking need and facility-type determination, not determining if a facility is necessary or not.

The methods identified by the agencies, and the factors considered, in making decisions, were compiled for comparison purposes. The following provides a description of the wide variety of factors used by these agencies when making decisions on the incorporation of bicycle, pedestrian and transit facilities.

Connectivity

One of the most universal themes was connectivity. Emphasis was placed on having highly connected networks, be it bike paths, bike lanes, or sidewalks. Additionally, many agencies placed emphasis on connecting intermodal facilities such as transit stations and park-and-rides. Most agencies also found it important to provide connections to inter- and intra- state trails, to provide recreation for the residents as well as to attract bicycle tourism.

Public Input

Another common theme was gathering public input on where facilities should be as well as what the public looks for in such facilities. Collection methods ranged from online surveys to public meetings. The public input on nonmotorized facilities was used to develop Master Plans. Additionally, agencies also looked to local municipalities, advocacy groups, school districts, transit agencies, and park services for input and guidance on what facilities are appropriate for the community. Input is also requested on where facilities should be placed and how they can be incorporated into existing networks of trails, transit lines and park-and-rides.

Latent Demand Analysis

Most agencies use some form of latent demand analysis that, along with current demand, is used to determine what types of facilities will be adequate over their planning period. Some agencies use sophisticated methods based on GIS and Census information (Richmond Area MPO), while others use simpler techniques such as identifying trip sources and sinks. Schools are usually given special attention and the area around them is typically recommended to have bicycle and pedestrian facilities, where appropriate.

Level of Service Determination

A few of the surveyed agencies use the BCI or similar metric to assess roadway need. The following is a summary of the metrics used by these agencies.

New York City uses a “stress level” metric that reflects how experienced a bicyclist would need to be to safely use a facility. The Stress Level takes into account many of the same factors as the FHWA BCI.

Tennessee uses the FHWA BCI to grade its routes and select candidates for improvements. A scoring process that includes many project factors from the BCI is being developed to prioritize projects in Tennessee.

Oakland, California suggests testing the BCI against the current system to assess its applicability to future projects as part of a method of determining cost-benefit ratios. Oakland includes in its testing data from GIS direct data collection and MUTCD requirements.

Richmond, Virginia uses the method laid out in Transportation Research Record 1578 to evaluate Bicycle LOS (BLOS) and the method in Transportation Research Record 1773 to evaluate Pedestrian LOS (PLOS). Richmond then found that only 20% of the surveyed bike routes were LOS C or better and only 10% of pedestrian routes were LOS C or better. This realization caused Richmond to then seek out other methods, such as latent demand analysis, to help prioritize routes to be upgraded. Additionally, the LOS calculations aided planners in identifying the specific features that lead to low LOS grades for a route.

Colorado uses LOS as a determination if a project makes an improvement in a route. The percent of routes at each LOS is also used as a performance metric for the system overall.

Safety History

Agencies are also concerned with improving the safety of their bicycle networks. As such, historical data relating to crashes and their causes were analyzed to determine where facility upgrades would also improve safety.

Demographics

Approximately half of the agencies reviewed take demographics into consideration when ranking facility need. Colorado uses population densities as a metric to scale need. They also attempt to place bicycle and/or pedestrian facilities in low-income areas and senior populations. The Richmond Area MPO also places facilities in low-income areas or those with school-aged children. Additionally, the MPO also takes into account the number of bicycle and pedestrian commuters in an area when planning facilities. Colorado takes into account obesity rates in an effort to provide easy access to facilities to increase physical activity.

Land Use/Zoning

Similar to demographics usage, many agencies use broad land-use (i.e.: urban, suburban, and rural) as well as specific zoning codes to help rank the need for facilities. Often it is stated that mixed-use and multiple-use zoning areas are more desirable as they increase the usage of facilities within an area.

Public Education

While not used for facility and project development, approximately half of the agencies specified that funds should be allocated, in whole or pooled from per-project allocations, to maintain up-to-date maps and outreach material. This was determined, by said agencies, to be important to safe and high utilization of the facilities being built.

Average Daily Traffic (ADT) and 85th Percentile Speed

Oregon uses an 85th-percentile speed vs. ADT chart to aid in determining how separated a bicycle or pedestrian facility needs to be. The various combinations of speed and utilization range from traffic calming for low-speed, low utilization roads to bike lanes and sharrows being separated, or at least buffered to construction of bike lanes for high-utilization, high-speed lanes.

Benefit-Cost-Ratio

Colorado uses a Benefit-to-Cost ratio that considers modal shifts, safety improvements, health benefits, and economic improvements effects that a project will have. The scores for the various categories are relative ranks.

V. Academic Research

A search was conducted through the Transportation Research Data Base TRID, which is maintained by the Transportation Research Board. The following is a summary of relevant research conducted recently or in progress.

Bicycle Safety

There are very few studies that examine why motor vehicle-bicyclist crashes occur. F. Wegman *et al.* were unable to find data correlating specific policies to incident rates. They conclude by observing that there are two ways to increase cyclist safety: decrease the encounters between modes or decrease motor vehicle speed.

Zegeer *et al.* found that nearly half of all vehicle-bicyclist crashes were caused by motor vehicles overtaking bicycles or bicycles making a left turn or merging. Possible solutions given include lowering speed limits in bicycle heavy areas, better education of motorists and bicyclists, reducing conflicts at intersections via bike boxes, marked lanes through intersections, restricted right turns, and advanced bicycle phases.

Multiple studies, including M. Ehrgott *et al.* indicate that an increase in bike lanes or paths correlates positively with increased bicycle ridership, possible due to an increase bicyclist comfort level. Additionally, the Ehrgott study found that the total number of motor vehicle-bicyclist collisions decreases in areas with bike lanes. While volume data was not available to determine crash rates, given established trends, the incident-per-ride rate more than likely went down more than the overall crash rate decrease.

Bike boxes at intersections have been found to increase bicyclist safety. The boxes are placed ahead of the motor vehicle stop-bar and colored. The number of incidents decreased despite an increase in the number of right turning motor-vehicles and bicycles. Additionally, both drivers and cyclists thought that the bike boxes improved safety overall.

These studies and the AASHTO guidelines can help planners and designers make better decisions about facility types to both boost ridership and decrease incident rates.

Bicycle Route Determination

The major factors that go into bicycle route determination, from the studies reviewed, seem to revolve around distance and comfort. Motor vehicle volumes on mixed-use lanes play a large role in deciding to use one street versus another. Bike lanes tend to have a negative impact on busy roads by reducing roadway capacity. Bicycle commuters also look for the short path to their destination. After low-volume roads or separated lanes, roadway grade is an important issue to cyclists; since they are under their own power, level is ideal. These ideas play into latent demand analysis models and can be used to understand how much traffic a facility can expect if built.

Pedestrian Safety and Routes

Fewer studies have been done regarding pedestrian safety and route planning in general. Zegeer *et al* analyzed crash data for motor vehicle-pedestrian incidents and found many causes, conditions, and locations. That research team follows up with suggestions to decrease motor vehicle-pedestrian incidents, including updating the AASHTO GPF to discuss geometries found to increase safe pedestrian travel, update the MUTCD with current best-practices, develop national bus stop guidelines, and lighting enhancements.

Z. Asadi-Shkari *et al* discuss existing pedestrian LOS determinations (PLOS) and provides one that defines LOS from a person with a disability's perspective. A LOS determination, like the BCI and Bicycle LOS ratings, can be used to identify corridors of need and rank competing projects.

Transit

Transit studies were limited to stop accommodations and not stop placement, as stop placement is under control of the agency using the stop. The best reference the research team was able to find was TCRP Report 19 "Guidelines for the Location and Design of Bus Stops." The report gives criteria that can be used to identify when certain facilities should be included, *e.g.,* stopping lanes and bus shelters.

Bicycle and Pedestrian Latent Demand Analysis

Walking and bicycling are modes that have different impediments than cars when determining latent demand. Most methods of latent demand analysis consist of finding sources, sinks, volumes between the sources and sinks, and a map of facilities available. Most use gravity models to predict volumes over given routes. These models, given projected facilities, are able to ascertain how the new facility would be used.

VI. Use of Geographic Information Systems (GIS) and the Roadway Management Systems (RMS) in Processes

The research team contacted PennDOT GIS and RMS managers to obtain background data on the GIS and RMS systems.

The Roadway Management System (RMS) is a mainframe based system that houses all the physical roadway attribute information, such as locations of bridges, average daily traffic, pavement conditions and guiderail locations. A fixed linear reference system is used to identify the roadways, as well as attributes based on roadway segments and offsets. Currently, there is an effort through the Bureau of Planning and Research to incorporate local roadway information into the RMS system. There currently isn't any information related to separate bike lanes, or sidewalks in the RMS system, as it only has captured roadway data from shoulder edge to shoulder edge. Curbs are indicated in RMS, however. The system is capable of having this type of bike lane or sidewalk information added and that information then being extracted for GIS mapping and other uses.

The PennDOT's Geographic Information System (GIS) pulls information from the RMS system, but it uses a latitude/longitude referencing system. The GIS information is capable of being shared with MPOs and RPOs. From a planning perspective, some of the MPOs are more restrictive with what information can be shared due to computer virus concerns. PennDOT staff indicated that they do not receive much information from any of the MPOs; generally, PennDOT sends information to the MPOs.

PennDOT's MPMS system, used for managing projects, links to the GIS system and locations are displayed on a GIS map. RMS output is used by designers to identify roadway attributes as part of the existing conditions. If transit, bicycle and pedestrian facility data were added to the GIS or RMS system, it would be able to be extracted via GIS. The dilemma is the gathering of the data to be entered.

One of the possibilities for adding data to the systems would be through the linking Planning and NEPA process. The data and information that are currently being used on new projects through the linking planning and NEPA process could be incorporated into the GIS/RMS systems for future use.

Five (5) Current Methodologies Incorporating Alternative Modes into the Project Development Process

Based upon the literature review, the research team identified five potential methodologies that could be used by PennDOT. These five methodologies would require some adaption for use and are summarized. Four DOT processes and one MPO process were reviewed and include Arizona DOT, Colorado DOT, Georgia DOT, Oregon DOT and Richmond MPO.

I. Five Methodologies Evaluated

The following is a summary of the five methodologies evaluated:

Arizona DOT

The Arizona DOT approach has identified general guidance as to where pedestrian and bicycle facilities are to be located and specific routes through a statewide master plan. However, it also acknowledges that more detailed policies are needed to guide specific project decisions and acknowledge funding constraints for such facilities.

Colorado DOT

In 2012, the Colorado DOT adopted a statewide bicycle and pedestrian plan. This plan established a vision and goals for the state but did not identify specific facilities for improvements. The plan provided a tool to evaluate specific projects and rank them for suitability to meet these goals.

The Colorado DOT approach considers both statewide goals and project specific performance. They have adopted investment decision criteria to evaluate projects relative to each other for implementation. Some of the criteria established are very broad, including creating recreational opportunities, improving the environment and economic impacts. More specific criteria include the level of service for bicycles, pedestrians and vehicles.

Georgia DOT

The state of Georgia policy is based upon the complete street approach to accommodating bicycles, pedestrians and transit. Their goals and vision are similar to other states. The Georgia DOT policy provides very specific threshold criteria in addition to a statewide plan for bicycles. By adopting warrants, the approach is very prescriptive but does provide flexibility based on project costs and other factors, such as environmental impacts and right-of-way needs.

Oregon DOT

The Oregon approach to bicycles and pedestrians is to accommodate all modes where possible. Little guidance is provided on specific criteria and more emphasis is given on how to accommodate bicycles and pedestrians at different levels and methods of design. The Oregon Bicycle and Pedestrian Design Guide from 2011 provides very specific design guidelines for accommodations.

The Oregon DOT guidelines do not present any information relative to the planning process, but rely on a policy of all accommodation and using local jurisdiction bicycle and pedestrian plans.

Richmond MPO

The Richmond MPO approach, while a regional rather than statewide approach, was explored because of its unique approach to estimating latent demand for bicycle and pedestrian facilities. A central issue in the planning for facilities is the future demand. In many locations, existing usage may be non-existent or minimal due to the lack of accommodations for bicycles and pedestrians, however latent demand may exist. The prediction of such latent demand has been generalized in many policies, primarily based upon the spatial relationships of complimentary land uses that may generate bicycle or pedestrian trips.

Richmond MPO approach resulted in a specific plan for locations of bicycle and pedestrian facilities, however the approach to determining the highest priorities was unique in that it used the highway capacity manual method (the method was not adopted at the time of the plan but currently is used). Also, Richmond estimated relative latent demand based upon land use projections from the MPO travel demand model.

II. Potential Methods of Analysis for Three Recommended Methodologies

Three methodologies of the five initially identified were recommended for further development of analysis procedures and identification of specific data requirements as part of the research. The following is a brief preliminary summary of how the three methodologies could be applied for testing of PennDOT projects. Information is presented on the basic approach to determine the need for the facilities and the design guidance that was used. Once this preliminary evaluation was completed, more detailed procedures were developed for testing purposes.

Arizona Methodology

The Arizona Methodology has an approach in which guidance regarding incorporation of bicycle, pedestrian or transit facilities is based on the access classifications of the highway and locations of the facilities within defined urban and rural areas. This approach is similar to PennDOT’s use of Smart Transportation Guidelines.

In Arizona, the primary objective of the project is identified as well as the community character of the study area and roadway classification. In addition, information such as bicycle facilities and master plans, transit routes, walking routes and pedestrian facilities is gathered. Accommodations for pedestrians, cyclists and transit users are determined based on context and location of trip generators.

<u>Arizona Bicycle Accommodations</u>

As part of major new construction and major reconstruction in urban areas, ADOT requires that the design provide a minimum 4-foot wide shoulder regardless of the presence of a shared use path. In rural areas, paved shoulders are often the best way to accommodate bicyclists, according to ADOT. The AASHTO recommendation of 4-foot shoulders (not including rumble strips) to accommodate bicycle travel is used.

When bicycles are expected to be present, a bicycle buffer lane (4-5 feet) is required between through lanes and right turn lanes at intersections. There is a proposed change to the existing

ADOT policies to omit the statement "when bicycles are expected to be present", which would make the bicycle buffer lane a standard typical section for right turn bays/lanes.

Bike lanes are to be installed on any major new construction or major reconstruction in Arizona when:

- The bike lane is part of a bicycle facilities plan adopted by a local agency; and
- The incremental costs for construction and maintenance are funded by a local agency (note that the requirement this item proposed to be removed in the 2013 Bicycle Plan Update).

Arizona Pedestrian Accommodations

Sidewalks should be provided if origin/destinations are within 1.5 miles walking distance from one another, per ADOT. Five foot clear width sidewalks should usually be placed on both sides of the highway. Shared use paths (for pedestrians, skaters, joggers, wheelchair users) can be installed when they are funded and maintained by a local agency. These facilities are designed and located in accordance with accepted criteria for safe facility.

Colorado Methodology

The Colorado Methodology uses a rating system to evaluate projects that is similar to the FHWA bicycle compatibility index. This methodology is geared towards evaluating competing bicycle and pedestrian projects. For purposes of this testing, this methodology has been adapted to look at individual projects.

Variables such as bicycle/walking level of service, county obesity rates, minority/low income populations surrounding project area, and senior populations, are examples of some variables that are incorporated into the review, in addition to traditional connectivity evaluation criteria. The information is then rated and ranked to determine an overall threshold rating to determine if accommodations are warranted, and to rank projects as part of their programming process.

Candidate Project Evaluator Calculator – Rating Chart		
VARIABLE	**RATING TYPE**	**RATING**
Bicycle/Walking LOS Before Project	LOS	1-5 (F=1)
Bicycle/Walking LOS After Project	LOS	1-10 (F=1, D=3 etc.)
Crash Rate Reduction Potential	0 - 10	1-5 based upon guidance from the highway safety manual
Motor Vehicle LOS after Project	LOS	1-5 (F=1)
Roadway Functional Class	Classification Type	0 - Limited Access 1 - Regional Arterial 2 - Community Arterial 3 - Community Collector 4 - Neighborhood Collector 5 - Local Street
Corridor Aesthetics	0 - 5	5 - High Value Aesthetics, Street Furniture, Public Art, Landscaping, Scenic Views 4 - Potential to make Corridor a showcase for high value Aesthetics with incorporation of additional features. 3 - Medium Value Aesthetics, Landscaping, Blending of Surroundings 2 - Potential for Aesthetic Improvements in form of landscaping & material selection to enhance surroundings 1 - Some aesthetic elements exist 0 - No aesthetics
Count Devices installed	Yes/No	1 - Yes 0 - No
Designated Scenic Byway	Yes/No	10 -Yes 0 - No
Direct Access to Scenic Byway	Yes/No	5 - Yes 0 - No
Direct Access to Public Lands	Yes/No	5 - Yes 0 - No
Shared Use Path	Yes/No	10 -Yes 0 - No
Designated Downtown Area	Yes/No	5 - Yes 0 - No
County Obesity Rate	0 - 5	5 - Higher than statewide average for county 3 – At County Avg. 0 – Lower than County Avg.

Candidate Project Evaluator Calculator – Rating Chart		
VARIABLE	**RATING TYPE**	**RATING**
Minority/Low Income Population in Area	0 - 5	5 – 100%-75% 4 - 74% - 50% 3- 49%- 25% 2- 24%-10% 1 – 9% - 0%
Access to Schools	Yes/No	10 – Yes 0 - No
Senior Population in Surrounding Area	0 - 5	5 – 100%-75% 4 - 74% - 50% 3- 49%- 25% 2- 24%-10% 1 – 9% - 0%
Closes Gap between 2 Existing Facilities	Yes/No	20- Yes 0 - No
Extends Existing Facility	Yes/No	20 - Yes 0 - No
Fixed Route Transit Service	Yes/No	10 - Yes 0 - No
Access to Park & Ride Facility	Yes/No	5 - Yes 0- No
Project contributes to County Tourism Revenue	0 - 5	5 - Data available that confirms facilities create revenue 0 – No data
Concerted Tourism Investment by County	Yes/No	5 - County has tourism investment revenue 0 - No tourism investment
Facility Construction Cost	Cost in $	10 – cost is < than 20% of project costs 0 – Cost is > 20% of project costs

Colorado Bicycle Accommodations:

In restricted urban area conditions, 14-foot wide curb lanes may be used in lieu of a four foot paved shoulder to accommodate bicycles in Colorado. CDOT also permits 5-foot dedicated bike lanes to accommodate bicyclists. Bicycle detection at intersections is required. Video detection is the preferred technology.

Colorado Pedestrian Accommodations:

For projects in urban areas, pedestrian accommodations will most often be addressed with 5-foot width sidewalks in Colorado. In constrained areas, a 3 to 4-foot width may be used with passing spaces being provided at 200-foot intervals.

Separated shared used paths are another class of facility, which may be provided for pedestrians by CDOT. In more rural areas, where pedestrian traffic is expected to be light, paved shoulders may accommodate pedestrians

Georgia Methodology

Georgia DOT has a policy that assumes new facilities and major reconstruction projects should anticipate bicycle and pedestrian traffic. They consider resurfacing, rehabilitation, and restoration (3R) projects as opportunities to enhance safety for pedestrians and bicyclists.

The Georgia Methodology is a warrant-based methodology, which has established both standards and guidelines for accommodations, based on type of project being undertaken. In general, new facilities, including intersections, should include bike and pedestrian facilities.

For purposes of this testing, the first step was to determine if the general criteria for the bicycle or pedestrian standards were met. If the standard was not met, then the approach would be to evaluate the guidelines. For this research project, all four projects met the standards criteria; therefore the guidelines were not utilized.

Standards for bicycle, pedestrian and transit accommodations that were used for project evaluation as part of the testing for the GDOT method were presented in Chapter 2. The following design criteria are used by GDOT.

Georgia Pedestrian Accommodations:

GDOT does not have specific information on what level of accommodations should be incorporated when standards are met. However, they reference the Accessible Public Right-of-Way Planning and Design Alternatives and PROWAG requirements for pedestrian accommodations in urban areas.

The minimum width for sidewalks by GDOT is a 5-foot of clear unobstructed space, while locations with higher pedestrian volumes may warrant wider sidewalks. At bridges, the typical sidewalk width in urban areas is 5 foot 6 inches without a buffer strip between the back of curb and sidewalk in Georgia.

Georgia Bicycle Accommodations:

Bicycle lanes on rural roadways are required by GDOT to be 4-foot bicycle lanes (or paved shoulders) that are incorporated into the overall width of the 6.5 foot wide paved shoulder (which includes rumble strip design). On urban roadways, the 4-foot bicycle lane is provided between the traveled way and gutter in Georgia. The bicycle lane does not include the gutter width. For areas that are less than 4-feet, they cannot be signed or marked as bicycle lanes in Georgia. Bicycle safe drop inlet grates are required for all urban roadways with on-road bicycle facilities.

Shared lanes are used where space constraints do not allow for the width required for a bicycle lane. Wide outside lanes with a 14-foot minimum width and marked as shared lanes per AASHTO standards are used where possible.

Data Collection Methods for Bicycles and Pedestrians

Background research on various methods for counting pedestrians and bicycles were reviewed to identify the ways to quantify existing users of a facility. The research included both new methods being developed and those commercially available currently. A recommendation is provided on the methods that would be best utilized with each of the analysis methods. Also, a recommendation is provided on the amount of data needed.

I. Literature Review of Developing Technologies

Collecting data, whether it is for motor vehicles, bicycles, or pedestrians needs to be accurate. Methods that are not permanent or that do not require major installations are needed for short-term counts, but permanent sensor technologies are useful for long-term counts and detection.

There is current research being performed to evaluate and improve most forms of detection. For example, loop detectors have difficulty distinguishing between bicycles and cars, which have led to their limited use on multi-modal use streets. However, there are some sensors that are commercially available that are capable of distinguishing between cars and bicycles [K. Nordback] et al.

Research is also being conducted on microwave detectors capable of detecting and distinguishing between cars, pedestrians, and bicycles. Microwave detectors work by bouncing microwaves off of moving objects and measuring the time that they take to return. Such systems are in use to detect users in specific scenarios, such as pedestrians in Pleasanton, California and the myriad of stop-bar detectors in use through the United States. [M. Volling] et al. described one system capable of distinguishing targets.

Video detection is also the subject of much research. Both visual and IR video systems are available for purchase, but currently have difficulty distinguishing the types of targets. [Malinovskiy] et al. describes an algorithm that they believe can distinguish the identities of multiple target identities.

Microwave and video detection are capable of multiple target identifications and directional information for each. These advanced technologies set them apart from many other detection methods.

II. Types of Detection Devices Available

The types of commercially available detection methods to count bicycles and pedestrians were reviewed. There are several types of methods currently being utilized for pedestrian and bicycle detection. Each method has certain advantages and disadvantages. The distinctions between the methods include the capability to distinguish between pedestrians and bicycles, the type of facility the method can be used on, and the capital / operational cost of the method. The following is a summary of available technologies:

<u>Manual Counts</u>

Manual counts have been the most popular means for quantifying pedestrian and bicycle usage. The advantages of manual counts are that they can be used for any type of facility, can distinguish between pedestrians and bicycles and can track direction of the users. The main disadvantage associated with manual counts is the hourly labor cost of providing field personnel to perform the count and limitation on the amount of data that can be collected over time.

Video (Manual or Computer Processing)

Video or video with computer processing has the same advantages of manual counts. The added advantage is video systems can be left in the field for extended periods (> 8 hours). The video is then processed manually or with computer image processing software that can distinguish between modes and direction. One company, Miovision, provides this service in the form of video equipment purchase or rental. The translation of the video into counts through processing could either be done manually by the user or electronically uploaded to Miovision for processing. The disadvantage with this method is the capital or rental cost of the video equipment and the processing cost of the video.

Active Infrared

Active infrared systems are used primarily with trails or exclusive, separated pedestrian / bicycle facilities. They are composed of a battery operated device that emits an invisible infrared beam of light across the trail / facility to a reflector. The reflector then returns the light beam back to the emitter. If the beam is broken, a count is registered. Because of this setup, there are a number of limitations. The device cannot detect direction or distinguish between the modes of pedestrians and bicycles. It also requires the mounting of both the emitter and the reflector. Accuracy can also be a problem when users are traveling in platoons, although field studies have shown this to be a minimal error. Advantages include the capability to be portable, use of extended periods of time or permanently, low capital costs and low labor costs for installation and processing of the data.

Passive Infrared

Passive infrared systems are similar to active infrared systems; however, they do not require a reflector device. They operate by detecting a moving object's infrared signature. Their use does require their sensor to be positioned in a way that adjacent traffic would not result in interference. An urban sidewalk with the unit mounted on a utility pole and the sensor aimed toward a sidewalk and adjacent building would be a preferred location. Some device setups do allow for directional counting. Similar to active infrared, passive infrared cannot distinguish between modes. These devices are also highly portable, can be left in the field over long periods of time, have low capital costs and low labor costs.

Inductive Loops (Bicycles Only)

Although considered more of a permanent detection method, inductive loops can be installed rather inexpensively. As with automotive inductive loop systems, it consists of an electrically conducting loop installed in the pavement. Manufacturers provide detectors calibrated to pick up aluminum bicycle wheels, while ignoring larger vehicles. This also provides for detection on either trails or shared bike roadways. This method does not collect data on pedestrians. As with the infrared systems, this method can be installed for long periods of data collection with minimal ongoing operational costs.

Pneumatic Tubes

As with automotive pneumatic tube counters, these counters can also be used for detecting bicycles on trail paths or shared use roadways. Pneumatic tubes are installed on top of the roadway and connected to a device that records "hits" of the tube. Multiple tubes are placed to detect direction and to distinguish between bicycles, motorcycles or automobiles. The tubes would not detect pedestrians and can create problems for skateboards or rollerblades on paths. Counters can be bought or rented, can provide long term counts, and have minimal ongoing operational costs.

The following Table 1 is a summary of the methods available and their attributes:

TABLE 1
TYPES OF DETECTION SUMMARY

Technology	Modes Detected/ Differentiate between modes?	Type of Facility	Directional?	Costs	Time Period	Portability
Manual	All / Yes	All	Yes	• Labor Costs ($12-$50 /hour depending on overhead costs)	• 0 to 8 hours	Yes
Video (Manual or Computer Processing)	All / Yes	All	Yes	• Equipment Cost (Purchase or Rental) • Labor Cost or Service Cost to process video • $1800 to $8000	• 0 to 24 hours • Multiple Days	Yes
Active Infrared	Pedestrian and Bicycles / No	Separated Path / Sidewalk	No	• Equipment /Software Cost • $800 to $7000	• Multiple Days	Yes
Passive Infrared	Pedestrian and Bicycles / No	Separated Path / Sidewalk	Can be with proper equipment	• Equipment/Software Cost • $2000-$3000	• Multiple Days	Yes
Inductive Loops	Bicycles only	Separated Path/ Shared Road	Can be with proper setup	• Equipment / Software Cost • Installation Cost • $2000-$3000	• Multiple Days • Permanent	No
Pneumatic Tubes	Bicycles only	Separated Path / Shared Road	Can be with proper setup	• Equipment Cost (Purchase or Rental) • $350-$1500	• Multiple Days	Yes

III. Recommendations

Several general conclusions can be reached for the detection methods researched:

- Manual counting provides the greatest flexibility for quantifying users. Its only limitation is a limited time frame for counting due to the hourly labor costs associated with it.
- In general, advanced technology methods have higher capital costs but can be more cost effective, if data is collected over a long period of time.
- The passive infrared systems are popular for sidewalk and other exclusive pedestrian/bicycle facilities where overall use is desired and directional and mode information is not needed.
- Inductive loops may be a viable long term counting solution for shared use lanes.
- The type of facility being analyzed is a major determining factor on the technology to be used.

Based on the six detection methodologies being evaluated, manual, video and passive infrared systems provide the best detection methods.

The Colorado DOT methodology requires directional pedestrian and bicycle data for peak periods. In this situation, manual counts would serve this purpose best. The other two methods require usage information in a general form. When possible, passive infrared systems could provide 24 hour count information at a minimal cost for the proper type of facility (exclusive pedestrian and bicycle facilities). A video system could also provide this, but at a higher cost.

With respect to the amount of data required to establish current conditions, it is recommended that hourly data as needed to support the highway capacity manual methods be collected during the highway peak hour analysis periods. Additional data could be collected on daily, peak days or peak months of activity. For this type of data collection, detection systems would be required.

Levels of Accommodation for Bicycles and Pedestrians

Determining the need for and appropriate level of accommodation for alternative modes is a goal of the planning, scoping field view and final design sections of the current PennDOT checklist. Since the current bicycle/pedestrian checklist process is largely qualitative, PennDOT seeks other ways to determine the appropriate level of accommodation (such as sidewalk widths, need for bike lanes vs. shared use lanes, use of medians, etc.,) as well as the estimated cost of the recommended accommodations. The selected method or methods must also fit into the PennDOT project development process. To get a better perspective on the PennDOT process as it relates to other existing methods, a literature review of the current PennDOT design manual requirements, other state DOT standards, and AASHTO guidelines and recommendations was conducted.

I. Current PennDOT Design Manual Requirements

The PennDOT design manual provides some guidance on design features. The following is a summary of the current requirements.

Bicycle Facilities

Current design manual requirements for bicycle facilities are located in Chapter 16 of Design Manual part 2 (DM-2). This chapter provides for 16 general factors to be considered for bicycle facilities. However, these factors do not indicate a method or guidelines to determine what type of a facility should be considered. The only statement pertaining to determining the consideration of bike lanes vs. shared lanes is the following:

Bike lanes should be considered when it is desirable to delineate available roadway space for preferential use by bicyclists and motorists and to provide for more predictable movements by each.

Typical bike lane cross sections indicating 5-foot minimum bike lane widths are provided in Chapter 16 of DM-2.

Pedestrian Facilities

Pedestrian requirements are located in Chapter 6 - Pedestrian Facilities and the Americans with Disabilities Act of Design Manual 2. As with the Bicycle Facilities Chapter, the pedestrian guidelines for accommodation of pedestrian facilities (i.e., sidewalks) are general. Below is the statement regarding accommodation:

Sidewalks are an essential part of the urban street cross section. In rural and suburban areas, community development such as schools, local businesses, industrial plants and recreation areas may result in pedestrian concentrations that make sidewalks a necessity. In many cases, the absence of roadway lighting and higher traffic speeds in rural areas increases the potential for vehicle and pedestrian conflicts.

In general, wherever roadside and land development conditions affect regular pedestrian movement along a highway, sidewalks should be considered. As a general practice, sidewalks should be constructed along any roadway without shoulders where there is a need to provide pedestrian accommodation. Where sidewalks are built along a high-speed highway, buffer areas should be established to separate pedestrians from the travel way.

Sidewalk minimum and desirable width dimensions are given in relation to ADA requirements:

Sidewalks must meet the following criteria:

1. See PAR requirements in Section 6.5.

2. Minimum sidewalk width of 1525 mm (60 in). The sidewalk width may be reduced to 1220 mm (48 in) if 1525 mm × 1525 mm (60 in × 60 in) passing areas are provided every 61 m (200 ft). Consider pedestrian volume in determining required sidewalk width. Minimum accessible path width may not be less than 1220 mm (48 in). These widths exceed the 2010 ADA Standards minimum clear width of 915 mm (36 in) for a single wheelchair due to the probability of multiple pedestrians. See Figure 6.1 for the 2010 ADA Standards minimum clear width dimensions associated with wheelchair accessibility.

3. Handrails are not required on sidewalks.

4. Sidewalks must be separated from vehicular travel lanes by curbs, planting strips or other barriers which will be continuous except where interrupted by driveways, alleys or connections to accessible elements.

In summary, the current design manual provides little guidance on the level of accommodation required but does specify design standards.

II. AASHTO Bicycle Accommodation Guidelines

The 2012, Fourth Edition of AASHTO's Guide for the Development of Bicycle Facilities provides a General Considerations Table, which outlines attributes of different bikeway types. These considerations have been adopted and modified by several DOTs.

TABLE 2-3 OF THE AASHTO GUIDE, PAGES 2-17 THROUGH 2-20

Type of Bikeway	Best Use	Motor Vehicle Design Speed	Traffic Volume	Classification or Intended Use	Other Considerations
Paved shoulders	Rural highways that connect town centers and other major attractors.	Variable. Typical posted rural highway speeds (generally 40–55 mph).	Variable.	Rural road-ways; inter-city highways.	Provides more shoulder width for roadway stability. Shoulder width should be dependent on characteristics of the adjacent motor vehicle traffic, i.e. wid-er shoulders on higher-speed and/or higher-volume roads.
Bike lanes	Major roads that pro-vide direct, convenient, quick access to major land uses. Also can be used on collector roads and busy urban streets with slower speeds.	Generally, any road where the design speed is more than 25 mph.	Variable. Speed dif-ferential is generally a more impor-tant factor in the decision to provide bike lanes than traffic volumes.	Arterials and collectors intended for major motor vehicle traffic movements.	Where motor vehicles are allowed to park adjacent to bike lane, provide a bike lane of sufficient width to reduce probability of conflicts due to opening vehicle doors and objects in the road. Ana-lyze intersec-tions to reduce bicyclist/ motor vehicle conflicts.

Type of Bikeway	Best Use	Motor Vehicle Design Speed	Traffic Volume	Classification or Intended Use	Other Considerations
Bicycle boulevards	Local roads with low volumes and speeds, offering an alternative to, but running parallel to, major roads. Still should offer convenient access to land use destinations.	Use where the speed differential between motorists and bicyclists is typically 15 mph or less. Generally, posted limits of 25 mph or less.	Generally less than 3,000 vehicles per day.	Residential roadways.	Typically only an option for gridded street networks. Avoid making bicyclists stop frequently. Use signs, diverters, and other treatments so that motor vehicle traffic is not attracted from arterials to bicycle boulevards.
Shared use path: independent right-of-way	Linear corridors in greenways, or along waterways, freeways, active or abandoned rail lines, utility rights-of-way, unused rights-of-way. May be a short connection, such as a connector between two cul-de-sacs, or a longer connection between cities.	N/A	N/A	Provides a separated path for non-motorized users. Intended to supplement a network of on-road bike lanes, shared lanes, bicycle boulevards, and paved shoulders.	Analyze intersections to anticipate and mitigate conflicts between path and roadway users. Design path with all users in mind, wide enough to accommodate expected usage. On-road alternatives may be desired for advanced riders who desire a more direct facility that accommodates higher speeds and minimizes conflicts with intersection and driveway traffic, pedestrians, and young bicyclists.

Type of Bikeway	Best Use	Motor Vehicle Design Speed	Traffic Volume	Classification or Intended Use	Other Considerations
Shared use path: adjacent to roadways (i.e., sidepath)	Adjacent to roadways with no or very few intersections or driveways. The path is used for a short distance to provide continuity between sections of path on independent rights-of-way.	The adjacent roadway has high-speed motor vehicle traffic such that bicyclists might be discouraged from riding on the roadway.	The adjacent roadway has very high motor vehicle traffic volumes such that bicyclists might be discouraged from riding on the roadway.	Provides a separated path for nonmotorized users. Intended to supplement a network of on-road bike lanes, shared lanes, bicycle boulevards, and paved shoulders. Not intended to substitute or replace on-road accommodations for bicyclists, unless bicycle use is prohibited.	Several serious operational issues are associated with this facility type. See Sections 5.2.2 and 5.3.4 for additional details.

III. AASHTO Guidelines Utilized by Other DOTs

Accommodation guidelines from other Departments of Transportation were researched. These guidelines were the result of recent research papers, as well as incorporation of the AASHTO Guide for the Development of Bicycle Facilities. These guidelines can be broken into the following components:

- Accommodation Exceptions
- Warrants
- Specific Guidelines for Facility Types

The purpose of this research is to identify specific guidelines for facility types; however, the accommodation exceptions and warrants are also presented. It is noted that this information is presented for reference only and does not represent the recommended methods, which are presented in the next section of the chapter.

Below is a summary of guidelines identified from the research:

Accommodation Exceptions

Illinois DOT - Illinois DOT identifies two types of projects that can be immediately excluded from consideration of bicycle and pedestrian accommodation:

1) Projects along fully access controlled highway facilities on which bicycle and pedestrian access is prohibited; and

2) Existing pavement resurfacing projects that neither widen the existing traveled way nor provide stabilized shoulders.

Colorado DOT - Colorado DOT (CDOT) exemption policy is as follows:

1) Bicyclists and pedestrians are prohibited by law from using the roadway;

2) The cost of establishing bikeways or walkways would be excessively disproportionate to the need or probable use (excessively disproportionate is defined as exceeding twenty percent of the cost of the larger transportation project); and

3) Where scarcity of population or other factors indicate an absence of need.

Georgia DOT - Georgia DOT's Design Policy Manual outlines the following accommodation exemptions conditions:

1) For very low speed (i.e., < 35mph) residential roadways where pedestrians and bicyclists can safely share the roadway with motor vehicles;

2) On side road tie-ins where there is no existing sidewalk or bicycle accommodation and widening of construction limits for sidewalk or bicycle accommodation would result in disproportionate impacts to adjacent property (as decided by the project development team on a case-by-case basis);

3) Sidewalks are not required in rural areas where curb and gutter is placed at the back of the useable shoulder solely for the purpose of reducing construction limits; and

4) Required accommodations (i.e., where a Standard Warrant is met) may only be omitted, after approval of a Design Variance, where the cost of providing the required accommodations is excessively disproportionate to the need or probable use. Excessively disproportionate may be defined as exceeding 20% of the total project cost. This cost should consider construction, required right-of-way, environmental impacts, and in some cases operation and maintenance. Where accommodations provide safety benefits to address bicycle and/or pedestrian crash history, these benefits must be considered.

Virginia DOT - Virginia DOT has established a Bicycle and Pedestrian Exceptions List, which include the following criteria:

1) Scarcity of population, travel, and attractors, both existing and future, indicate an absence of need for such accommodations.

    a. The project is not on a designated bicycle/pedestrian facility, and

        i. Is the road expected to carry less than 400 VPD in the design year or;

        ii. The locality does not want bicycle/pedestrian accommodations.

    b. There is no obvious bicycle/pedestrian activity (no cyclists or pedestrians observed, no worn paths present) and existing development is only industrial, agricultural, or large lot residential and Comprehensive Plan does not propose uses/densities that can be expected to generate bicycle/pedestrian activity.

2) Environmental or social impacts outweigh the need for these accommodations

a. Would right-of-way be needed for accommodation or require displacement of homes, businesses, or places of worship?

b. Would provision of accommodation create impact to cultural, historic, or other sensitive environmental resources?

3) Safety would be compromised

a. Would accommodation require a reduction in the current lane width below acceptable standards?

b. Would accommodation termini encourage unsafe bicycle/ pedestrian activity?

4) Total cost of bicycle and pedestrian accommodations to the appropriate fund (i.e., Interstate, primary, secondary, or urban system) would be excessively disproportionate to the need for the facility (not applicable for bicycle/pedestrian specific projects)

a. Does the accommodation cost more than 10% of total project cost if not a designated bicycle/pedestrian facility or 20% of total project cost if a designated bike/ped facility?

b. In the case of major projects (over $500 million), does accommodation cost more than 10% of total project cost?

5) Purpose and scope of the specific project do not facilitate the provision of such accommodations (e.g., projects for the Rural Rustic Road Program are defined as paving unpaved (gravel) roads, which are considered to be a bicycle accommodation)

a. Is the project a Rural Rustic Road project?

b. Is the project an Industrial Access project?

c. Is the project for minor changes that should not directly affect bike/ped activities (such as drainage or turn lane storage extension projects)?

d. Is the project of such short length that provision of bike/ped facility would be inappropriate?

e. Is the project a bridge superstructure replacement that does not impact bridge substructure?

6) Bicycle and pedestrian travel is prohibited by state or federal laws

a. Is the proposed accommodation parallel to and within interstate right-of-way and not separated by a physical barrier?

b. Is the proposed accommodation parallel to and within limited access right of way where Commonwealth Transportation Board (CTB) action prohibits bicycle/pedestrian traffic?

Warrants

Both Illinois and Georgia DOT were identified as having adopted both bicycle and pedestrian facility warrants. Georgia DOT also identified "Transit Warrants", which identify the need for bicycle or pedestrian facilities when certain transit attributes are in an area.

Illinois DOT - Bicycle Warrants

1) The highway or street is designated as a bikeway in a regionally or locally adopted bike plan or is published in a regionally or locally adopted map as a recommended bike route.

2) The projected two-way bicycle traffic volume will approximate 25 ADT or more during the peak three months of the bicycling season five years after completion of the project.

3) The route provides primary access to a park, recreational area, school, or other significant destination.

4) The route provides unique access across a natural or man-made barrier (e.g., bridges over rivers, bridges over railroad yards, bridges over freeways or expressways, highways through a National Forest). Bicyclists will be accommodated on the bridge unless bicycles are otherwise prohibited to operate on the roadway approaches.

5) The highway project will negatively affect the recreational or transportation utility of an independent bikeway or trail. Highway projects will negatively affect at-grade paths and trails when they are severed, when the projected roadway traffic volumes increase to a level that prohibits safe crossings at-grade, or when the widening of the roadway prohibits sufficient time for safe crossing.

Illinois DOT - Pedestrian Warrants

1) There is current evidence of frequent pedestrian activity;

2) There is a history of pedestrian-related crashes;

3) The roadway improvement will create a safety impediment to existing or anticipated pedestrian travel (e.g., adding lanes so that the improvement itself acts as a barrier to pedestrian traffic);

4) There is urban or suburban development that would attract pedestrian travel along the route to be improved;

5) Pedestrian-attracting development is expected along the route within five years of project completion, either as documented in a local plan or anticipated as a factor of similar development history; and/or

6) The roadway provides primary access to a park, recreation area or other significant destination, or across a natural or man-made barrier;

7) Overpasses and underpasses will be evaluated on a case-by-case basis considering the type of pedestrian travel, travel generators (e.g., schools, factories, stadiums, parks, transit terminals, shopping districts), the amount of anticipated non-motorized traffic, and

the safety impacts of not providing the accommodations. Anticipated pedestrian trip length to generators should be 1 mile (2 km) or less and the adverse travel distance alleviated by construction to the facility should be greater than 0.5 miles (1 km).

Georgia DOT - Bicycle Warrants

Standards – Bicycle accommodations shall be considered in all planning studies and be included in all reconstruction, new construction, and capacity-adding projects that are located in areas with any of the following conditions:

- If the project is on a designated (i.e., adopted) U.S., State, regional, or local bicycle route;
- where there is an existing bikeway along or linking to the end of the project corridor (e.g., shared lane, paved shoulder, bike lane, bike boulevard, or shared-use path);
- along corridors with bicycle travel generators and destinations (i.e. residential neighborhoods, commercial centers, schools, colleges, scenic byways, public parks, transit stops/stations, etc.);
- on projects where a *bridge deck* is being replaced or rehabilitated and the existing bridge width allows for the addition of a bikeway without eliminating (or precluding) needed pedestrian accommodations – reference Title 23 United States Code, Chapter 2, Section 217, Part (e); and
- where there is an occurrence of reported bicycle crashes which equals or exceeds a rate of five for a 1-mile segment of roadway, over the most recent three years for which crash data is available.

Guidelines – Bicycle accommodations should be considered on projects that are located in areas with any of the following conditions:

- Within close proximity (i.e., 3 miles) of a school, college, university, or major public institution (e.g., hospital, major park, etc.);
- where a project will provide connectivity between two or more existing bikeways or connects to an existing bikeway;
- where there is an occurrence of bicycle crashes;
- along a corridor where bicycle travel generators and destinations can be expected prior to the design year of the project; and
- any location where engineering judgment, planning analysis, or the public involvement process indicates a need.

Georgia DOT - Pedestrian Warrants

Standards – Pedestrian accommodations shall be considered in all planning studies, and be included in all reconstruction, new construction, and capacity-adding projects which include curb and gutter as part of an urban border area or are located in areas with any of the following conditions:

- Along corridors with pedestrian travel generators and destinations (i.e. residential neighborhoods, commercial areas, schools, public parks, transit stops and stations, etc.), or areas where such generators and destinations can be expected prior to the design year of the project;
- where there is evidence of pedestrian traffic (e.g., a worn path along roadside);
- where pedestrian crashes equal or exceed a rate of ten for a ½-mile segment of roadway, over the most recent three years for which crash data is available; and
- where a need is identified by a local government, MPO or regional commission through an adopted planning study.

Guidelines – Pedestrian accommodations should be considered on projects that are located in areas with any of the following conditions:

- Within close proximity (i.e., 1 mile) of a school, college, university, or major public institution (e.g., hospital, major park, etc.,);
- within an urbanized area; or area projected to be urbanized by an MPO, regional commission, or local government prior to the design year of the project;
- where there is an occurrence of pedestrian crashes; and
- any location where engineering judgment, planning analysis, or the public involvement process indicates a need.

<u>Georgia DOT - Transit Warrants</u>

Standards – Transit accommodations shall be considered in all planning studies and be included in all reconstruction, new construction, and capacity-adding projects that are located in areas with any of the following conditions:

- For transit vehicles: on corridors served by fixed-route transit; and
- For pedestrian transit users: within the ½-mile pedestrian catchment area of an existing fixed-route transit facility (i.e., stop/station, or park-and-ride lot). A catchment area is defined by a radial distance from a transit facility per Federal Transit Administration (FTA) guidelines - this includes crossing and intersecting streets.

Guidelines – Transit accommodations should be considered on projects that are located in areas with any of the following conditions:

- For bicycle transit users: within the 3-mile bicycle catchment area of an existing fixed-route transit facility;

- along a corridor programmed (and funded) to begin construction of high-capacity transit before the roadway project design year; and

- For all transit users: between transit stops/stations and local destinations.

Where a warrant is met, the need for accommodations should be validated through coordination with the transit service provider (and MPO, regional planning commission and/or local government, where applicable). This coordination is necessary for existing as well as planned transit facilities. It should be recognized that although classified as fixed route transit, local and express bus routes are periodically changed in order to improve services to riders.

Specific Guidelines for Facility Types

In determining the need for bicycle or pedestrian facilities, several DOTs identified guidelines for determining the type of facility for accommodation.

Illinois DOT has established bicycle facility selection using urban/rural roadway and ADT thresholds. Along with these thresholds, they provided required widths for bicycle accommodations. Below is the facility accommodation guideline Selection Table from their design manual:

	Bicycle Accommodation Required			
Roadway Characteristics	Paved Shoulders (inclusive of rumble strip)	Outside Curb-lane Width	Bicycle Lane (includes gutter pan)	Side Path Bidirectional
Rural Roadways < 30 mph Posted				
Design Year ADT under 2000	None			
Design Year ADT 2000 – 8000	4 ft (1.2 m)			optional
Design Year ADT > 8000	4 ft (1.2 m)			optional
Rural Roadways 30 – 35 mph Posted				
Design Year ADT under 2000	4 ft (1.2 m)			optional
Design Year ADT 2000 – 8000	4 ft (1.2 m)			optional
Design Year ADT > 8000	6 ft (1.8 m)			optional
Rural Roadways 36 – 44 mph Posted				
Design Year ADT under 2000	6 ft (1.8 m)			optional
Design Year ADT 2000 – 8000	6 ft (1.8 m)			optional
Design Year ADT > 8000	6 ft (1.8 m)			optional
Rural Roadways > 44 mph Posted				
Design Year ADT under 2000	6 ft (1.8 m)			optional
Design Year ADT 2000 – 8000	8 ft (2.4 m)			optional
Design Year ADT >8000				10–12 ft (3.0 m – 3.6 m)
Urban Roadways < 30 mph Posted				
Design Year ADT under 2000		None		optional
Design Year ADT 2000 – 8000		13 ft – 14 ft (4.0 m – 4.3 m)		optional
Design Year ADT > 8000			5 ft (1.5 m)	optional
Design Year ADT > 15,000			optional 6 ft (1.8 m)	10–12 ft (3.0 m – 3.6 m)
Urban Roadways 30 - 35 mph Posted				
Design Year ADT under 2000			5 ft (1.5 m)	optional
Design Year ADT 2000 – 8000			5 ft (1.5 m)	optional
Design Year > 8000			6 ft (1.8 m)	optional
Design Year ADT > 15,000			optional 6 ft (1.8 m)	10–12 ft (3.0 m – 3.6 m)
Urban Roadways 36 - 44 mph Posted				
Design Year ADT under 2000			5 ft (1.5 m)	optional
Design Year ADT 2000 – 8000			6 ft (1.8 m)	optional
Design Year ADT > 8000				10–12 ft (3.0 m – 3.6 m)
Design Year ADT > 15,000				10–12 ft (3.0 m – 3.6 m)
Urban Roadways > 44 mph Posted				
Design Year ADT under 2000			6 ft (1.8 m)	optional
Design Year ADT 2000 – 8000			6 ft (1.8 m)	optional
Design Year ADT > 8000				10–12 ft (3.0 m – 3.6 m)
Design Year ADT > 15,000				10–12 ft (3.0 m – 3.6 m)

Georgia DOT (GDOT) adopts the guidance published in the 2012 AASHTO *Guide for the Development of Bicycle Facilities* (AASHTO Guide) for the selection and design of bicycle accommodations. Design consistency with local or regional bicycle design guidelines should be considered. Where these local guidelines are consistent with the AASHTO Guide they should be used.

GDOT recognizes the eight types of bikeways presented in Table 2-3 of the AASHTO Guide. An appropriate bikeway type should be selected from this table based on the type and conditions of the street or corridor involved. For on-road bikeways in urban areas, bicycle lanes are generally preferred over shared lanes because they provide a separate and more visible network of bikeways, which increases user safety and comfort. If an existing bicycle facility is present in the form of a shared lane, consideration should be given to upgrading the facility to a bicycle lane.

1. **Bicycle Lanes (including paved shoulders)** – A bicycle lane is preferred by GDOT, where appropriate in accordance with Table 2-3 of the AASHTO Guide. A bicycle lane consists of an

on-road bikeway commonly designated for one-way travel, in the same direction as the adjacent travel lane, for preferential or exclusive use by bicyclists. GDOT has defined 4-feet as the minimum width for bicycle lanes for both rural and urban type roadways. A width greater than 4-feet may be appropriate in some cases, such as where on-street parking is permitted (refer to Section 4.6.4 and 4.6.5 of the AASHTO Guide).

- *Rural Roadways*: the 4-feet bicycle lane (or “paved shoulder”) is incorporated into the overall width of a 6.5-foot wide paved shoulder, which includes a 16-inch rumble strip offset 12-inch from the traveled way. The shoulders are designed with a skip pattern rumble strip to allow bicyclists to smoothly enter and exit the bicycle lane.

- *Urban Roadways* (with curb & gutter): the 4-feet bicycle lane is developed between the traveled way and gutter. The bicycle lane does not include the gutter width. A 2-feet additional width should be provided for bicycle lanes located adjacent to on-street parking, where practical. The designer should note, if the space to the right of the traveled way stripe is less than 4-feet wide, the route cannot be signed or marked as a “bicycle lane”.

A 2-foot to 4-foot wide pavement marking buffer (i.e., buffered bicycle lane – refer to the NATCO Urban Bikeway Design Guide) between the travel lanes and the bicycle lane may be considered for roadways with posted or operating speeds of greater than 35 mph. Bicycle safe drop-inlet grates are required for all urban roadways (i.e., curb and gutter) with on-road bicycle facilities.

2. **Shared Lanes** – shared lanes should be used where space constraints or other limitations do not allow for the width required for a bicycle lane. A shared lane bikeway requires that motorized vehicles and bicycles share the outside travel lane of the roadway. Shared lanes may take the form of either a wide outside lane or a marked shared lane (refer to Table 2-3 of the AASHTO Guide for the Development of Bicycle Facilities).

The minimum width for a wide outside lane is 14feet. This allows motor vehicles to pass a bicyclist with a 3-foot clearance between the bicycle and the motor vehicle. This 14-foot width does not include the width of a gutter pan and generally is appropriate for use on arterials and collectors with traffic volumes which exceed 3,000 vehicles per day – a bicycle lane is still preferred where adequate width is available. Shared lanes should be signed in accordance with the 2009 MUTCD.

Where posted speeds do not exceed 35 mph and it is desirable to provide a higher level of guidance to bicyclists and motorists, shared lanes may be marked with a shared-lane marking symbol – i.e., “marked shared lanes” (refer to the 2009 MUTCD Section 9C.07). Marked shared lanes should be used along a corridor where bicycle lanes are the prevailing facility, but space constraints or other limitations do not permit continuous bicycle lanes. Proper striping transitions should be provided between the two types of bikeways.

3. **Shared-Use Paths** – A shared-use path is defined as a bikeway within an independent right-of-way or that is physically separated from motor vehicle traffic by an open space or barrier, located within the roadway right-of-way (i.e., a sidepath). Most shared-use paths are designated for two-way travel and are designed for both transportation and recreation purposes. Shared-use paths are intended to supplement a network of on-road bicycle facilities and should not be used as an alternate for an on-road bikeway. Also, shared-use

path design is similar to roadway design, but on a smaller scale and with typically lower design speeds (refer to Chapter 5 of the AASHTO Guide).

Shared-use paths may also be used by pedestrians, skaters, equestrians, and other non-motorized users and should be designed accordingly. Since nearly all shared use paths are used by pedestrians, these facilities must meet all applicable ADA requirements (refer to Section 5.1.1 of the AASHTO Guide).

Sidepaths are a specific type of shared-use path that run adjacent to the roadway and should only be used after considering potential conflicts associated with sidepaths (refer to Section 5.2.2 of the AASHTO Guide). Sidepaths may be considered where one or more of the following conditions exist (Page 5-10 of the AASHTO Guide):

- The adjacent roadway has relatively high-volume and high-speed motor vehicle traffic that might discourage bicyclists from riding on the roadway, potentially increasing sidewalk riding, and there are no practical alternatives for either improving the roadway or accommodating bicyclists on nearby parallel streets.
- The sidepath is used for a short distance to provide continuity between sections of path in independent rights-of-way, or to connect local streets that are used as bicycle routes.
- The sidepath can be built where there are few roadway and driveway crossings. (A pair of sidepaths – one on each side of the roadway - may be considered for roadways with frequent cross-streets and driveways. Each sidepath would be signed for one-way bicycle traffic.).
- The sidepath can be terminated (at each end) onto streets that accommodate bicyclists, onto another path, or in a location that is otherwise bicycle compatible.

The design of bikeways should give particular attention to providing connections between on-road and off-road bikeways and reducing bicyclist/motorized vehicle conflicts at cross-streets, driveways and other intersections (refer to Sections 4.8 and 5.3 of the AASHTO Guide).

Colorado DOT - Colorado DOT embraces the concept of bicycles being vehicles, thus the accommodation of bicycles should be based upon a Level of Service (LOS) criteria. For bike lanes / shared use facilities, they have developed LOS tables based on vehicle service volumes to determine the width of the paved shoulder/bike lane. Below are their LOS tables.

Adopted Bicycle Level of Service = B

	Speed Limit (or Design Speed) 35						Speed Limit (or Design Speed) 45					
	Percent Heavy Vehicles						Percent Heavy Vehicles					
Shoulder width, ft	2	4	6	8	10	12	2	4	6	8	10	12
4	13300	7500	4500	3600	3100	2700	11200	6200	3900	3400	3000	2500
6		26400	10100	4800	3700	3200		16400	6600	4200	3500	3000
8				27000	8100	3700				12200	3900	3400

	Speed Limit (or Design Speed) 55						Speed Limit (or Design Speed) 65					
	Percent Heavy Vehicles						Percent Heavy Vehicles					
Shoulder width, ft	2	4	6	8	10	12	2	4	6	8	10	12
4	9900	5600	3800	3300	2800	2400	8900	5200	3700	3200	2700	2300
6		12200	6100	3900	3400	2800	29900	10300	5600	3800	3300	2800
8			29900	7600	3800	3300			22400	5200	3800	3200

Adopted Bicycle Level of Service = C

	Speed Limit (or Design Speed) 35						Speed Limit (or Design Speed) 45					
	Percent Heavy Vehicles						Percent Heavy Vehicles					
Shoulder width, ft	2	4	6	8	10	12	2	4	6	8	10	12
4			12700	5100	3700	3100		21200	7100	4400	3500	2900
6				24900	7300	3700				11600	3900	3400
8											22400	4700

	Speed Limit (or Design Speed) 55						Speed Limit (or Design Speed) 65					
	Percent Heavy Vehicles						Percent Heavy Vehicles					
Shoulder width, ft	2	4	6	8	10	12	2	4	6	8	10	12
4		15800	6500	4100	3400	2800		12700	6100	3900	3200	2700
6			27600	7100	3800	3200				5200	3700	3100
8					12000	3800					7600	3600

Adopted Bicycle Level of Service = D

	Speed Limit (or Design Speed) 35						Speed Limit (or Design Speed) 45					
	Percent Heavy Vehicles						Percent Heavy Vehicles					
Shoulder width, ft	2	4	6	8	10	12	2	4	6	8	10	12
4					9300	3700				14700	4100	2900
6						13900					20700	4400
8						15100						

	Speed Limit (or Design Speed) 55						Speed Limit (or Design Speed) 65					
	Percent Heavy Vehicles						Percent Heavy Vehicles					
Shoulder width, ft	2	4	6	8	10	12	2	4	6	8	10	12
4				9000	3900	3200			26200	6200	3800	3100
6					11300	3700					7100	3500
8						16600						9500

CalTrans - CalTrans has developed the following guidelines in determining bicycle facilities:

Bicycle Facility	Where to use
Bicycle Lanes	• Urban arterials and major collector roadways • Average Vehicle Speeds>30 mph • Vehicle mix includes significant heavy trucks and/or buses
Wide Outside / Curb Lane (14 foot minimum outside lane)	• Average Vehicle Speeds<30 mph • ADT < 10,000 • In urban areas on major streets where experienced cyclists will likely be operating
Shared Lane Marking	• Average Vehicle Speeds < 30mph • ADT< 10,000 • On urban roadways with width constraints due to on-street parking and/or limited right-of-way. • On suburban/rural roadways to indicate usage
Paved Shoulders	• On designated bicycle routes and/or popular bicycling roadways • ADT > 2,000 • Average vehicle speeds > 35 mph) • When there is inadequate sight distance (e.g. corners and hills)
Separated Bicycle Paths	• In corridors along rivers, lakes, greenbelts, power lines, railroad tracks, or limited access freeways that link parks, schools, shopping, and/or public transportation • Where there are fewer than 2 driveway/ intersection/road crossings per 1 mi with a combined ADT of less than 500 • In areas of poor connectivity – to link neighborhoods to schools, parks, shopping and community centers

IV. Recommendations

Adopting a three tier set of accommodation guidelines (Exceptions, Warrants and Specific Guidelines) would be one approach to provide planners and designers with the best guidance on determining the type of facility to pursue.

It is recommended that PennDOT consider adoption of the AASHTO General Considerations table (Table 2-3 of the AASHTO Guide, pages 2-17 through 2-20). The Georgia DOT guidelines are much more specific; however, they favor the implementation of bicycle lanes.

Currently, many local municipalities in Pennsylvania are concerned about the required maintenance and liability associated with placing bicycle lanes on state roads. PennDOT may wish to consider the AASHTO general guidelines because they are more flexible to these concerns, yet allow guidance to planners and designers.

Methods of Analysis for the Three Methodologies

The three methodologies, Arizona, Colorado, and Georgia DOT, were further reviewed in more detail and procedures were developed for their application. These procedures were intended to be detailed enough for application but generalized enough for modifications in the final recommendations, dependent upon the results of the testing.

Some of these procedures, if adopted, may require adaptations because of the conditions in Pennsylvania. This is because the Arizona and Colorado methods begin with a statewide plan or assessment for these modes. The PennDOT and MPO methods of project development currently assess these needs on an individual project basis.

A list of data that could assist in the development of any methodology and an alternative method is also presented. The alternative method considers a more global approach that many states have taken that establishes a statewide plan specific to project areas. The following is a summary of the recommended procedures to be applied.

I. Arizona Method (Smart Functional Classifications)

The Arizona Department of Transportation (ADOT) ranked as the 3rd highest in the nation for pedestrian fatalities and 6th for bicycle related fatalities, according to the National Highway Safety and Traffic Administration 2010 data. As part of the bicycle and pedestrian plan, they have various surveys and inventories that were completed to make improvements to their bike and pedestrian facilities that will improve bicycle and pedestrian safety. ADOT's approach is to provide guidance based upon the access classification of the highways and location of facilities within defined urban and rural areas. This approach is similar to PennDOT's approach and the use of Smart Transportation Guidelines.

ADOT has identified locations on their state highway system that have needs related to alternative modes of transportation, including bicyclists and pedestrians. This methodology does not provide any quantitative analysis regarding the selection of level of accommodations to provide for bicycles, pedestrian or transit. However, they have made general decisions such as standard shoulder width to be provided and the provision of bicycle buffers as part of design guidelines.

The following are some of the initiatives and strategies used or being initiated by ADOT.

Using GIS and the ADOT photo log, ADOT completed an inventory of sidewalk along the State Highway System (SHS), as well as an inventory of shared use paths, and pedestrian grade separations to determine where sidewalks may be needed.

A paved shoulder inventory was also completed to determine how many miles of shoulder ADOT has that are greater than 4 feet (measurement without rumble strip); these locations that are less than 4 feet have been identified as priority state highway segments where improved shoulders are needed. ADOT policy states that all new construction and major reconstruction projects have a minimum 4-foot paved shoulder, regardless of the presence of shared use paths. ADOT also has a bicycle buffer (4-5 foot lane) requirement between through lanes and right turn lanes as part of their design guidelines.

As part of their Evaluation Program strategies, ADOT also has a strategy to develop and implement a statewide program for collecting and analyzing bicycle and pedestrian count data.

Washington State Department of Transportation was benchmarked, as they have an annual Bike/Pedestrian Documentation Project, during which volunteers conduct nonmotorized traffic counts in 30 cities across Washington. ADOT is looking to do something similar, so they have data to aid decision making about future bicycle and pedestrian facilities. To assist in this data collection, ADOT has installed a permanent bicycle counting station on SR 179; it is not clear if there are intentions of installing counting stations at other locations.

Using crash data, ADOT has also identified high priority bicycle and pedestrian crash locations on the state highway system. Modifications to their crash reporting forms are also underway to improve data collection for bicycle and pedestrian crashes.

ADOT is developing a policy for construction of sidewalks in urban areas as part of major construction. It should be noted that ADOT removes snow from sidewalks, bike lanes and shared use paths. This is not the policy in Pennsylvania.

As part of their Bicycle and Pedestrian Plan educational plan, ADOT recommends hosting bicycle/pedestrian facility design courses at different locations throughout the state on an annual or biannual basis that focus on design, as part of Complete Streets/Smart Transportation program.

Based on the aforementioned information, ADOT has incorporated these procedures into their planning and design of bicycle and pedestrian facilities. ADOT typically prioritizes overall highway segments to address bicycle/pedestrian needs. However, to evaluate individual projects, the following information is needed to use the ADOT method. It should be noted that this method is not going to provide a robust quantitative analysis needed to make determinations of what level of accommodation is needed.

1) <u>The project analysis process and required project information</u>

    a. Identify primary objective of project. (Full reconstruction, rehabilitation, preventative maintenance)

    b. Determine community character of study area. (Rural, Suburban Neighborhood, Suburban Corridor, Suburban Center, Town/Village Neighborhood, Town/Village Center, Urban Core) See Table 2 below:

TABLE 2
COMMUNITY CHARACTER CLASSIFICATIONS

Rural	Few houses and structures. Small markets/gas stations are often seen at intersections. The area between intersections is predominately natural woodlands, cultivated land, etc.
Suburban Neighborhood	Low density residential communities. Lot sizes typically 1/4-2 acres. Community facilities such as schools, churches, offices etc.
Suburban Corridor	Big box stores, commercial strip centers, auto dealerships, office parks, gas stations are in area. There may be natural areas interspersed and occasional clusters of homes. Buildings are usually set back from roadway behind surface parking.
Suburban Center	Mixed used, cohesive collection of land uses that may include residential, office, retail, and restaurants. Typically designed to be accessible by car and include large parking areas/garages. Less accommodating to pedestrians than town centers.
Town/Village Neighborhood	Predominately residential neighborhoods, sometimes mixed with retail, residential and offices. In urban paces residential buildings tend to be close to the street. Small retail establishments sometimes occupy principal corners. Large majority of the neighborhoods have sidewalks.
Town/Village Center	Mixed use, high density area with buildings adjacent to sidewalk, typically two to four stories tall with commercial operations on ground floor. Parallel parking is usually on both sides of the street.
Urban Core	Downtown area consisting of blocks of higher density mixed use buildings. Buildings vary from 3 to +60 stories high.

c. Review crash data. Identify bicycle and pedestrian crash data and consider run off roadway/hit fixed object crash data results.

d. Identify roadway classification based on Smart Transportation classifications (i.e. Regional Arterial, Community Arterial, Community Collector, Neighborhood Collector, Local Road). MPOs and RPOs should be involved with this classification. It is noted that as part of the PennDOT design process, this type of information is supposed to be used as guidelines for designers to address project needs and established at the beginning of each project.

e. Conduct an inventory of the bicycle facilities for project area such as bike lanes, shared use paths, etc.

f. Identify (through the MPO/RPOs) any bicycle master plans in the vicinity of project. Identify any connector routes that interact with local bicycle master plans. In addition, have each MPO/RPO assist in prioritizing if any roadways in study area should be considered a priority for bicycle/pedestrian usage for future inventory and evaluation.

g. Identify transit routes in project vicinity. Projects that include transit stops should have priority for pedestrian/bicycle improvements as nearly all transit trips begin with walking or bicycle trips.

h. Conduct shoulder width inventory for project. Determine based on functional classification if an effective four-foot shoulder (minus bicycle friendly rumble strip dimensions) should be considered.

i. Determine if school walking routes, schools, or other pedestrian/bicycle generators are within study area.

j. Inventory the pedestrian facilities/sidewalks in study area. Review ADA ramps, as well as crossing locations and connectivity concerns. Consider future connectivity.

2) Determine accommodations to be provided for pedestrians/bikes/transit

a. For complete reconstruction and rehabilitation projects, it is assumed that pedestrian and bicycle accommodations will be considered. If project is of a preventative maintenance type, then bicycle, pedestrian, or transit accommodations will not be considered as part of the project unless the project is still in the planning stage and funding has not been established.

b. Use Smart Transportation Guidelines (Table 3) for pedestrian or bicycle facilities. It is noted that currently PennDOT designers use this information in the design process. This approach does not provide quantitative analysis for the level of accommodation to be provided for bicycles, pedestrians or transit; however, it does provide guidelines for consideration.

TABLE 3
ROADWAY CLASSIFICATION TYPES

Roadway Type	Bike Lane	Sidewalk
Regional Arterial ADT 10,000-40,000	Suburban/Urban Context – Recommended	Suburban or Urban - Recommended
Community Arterial ADT 5,000-25,000	Urban Context – Recommended Suburban - evaluate shared roadway conditions	Suburban or Urban - Recommended
Community Collector ADT 5,000-15,000	Urban Context – Recommended Suburban Context – Consider shared roadway accommodations	Suburban or Urban - Recommended
Neighborhood Collector ADT <6,000	Not Recommended, Consider shared roadway accommodations	Suburban or Urban - Recommended
Local ADT <3,000	Typically not needed	Suburban or Urban - Recommended

c. Determine if a sidewalk is needed based on context and location of pedestrian generators and existing sidewalk. In suburban or urban areas, sidewalk should be installed.

    i. Exceptions: In urban/suburban areas, sidewalks may be omitted from design if there is no obvious pedestrian activity and existing development is industrial, agricultural in nature and there are no existing or future pedestrian generators within a ½ mile of the project. (it is noted that "future pedestrian generators" are not defined in the Arizona Method)

d. Determine if a bike lane or shared roadway accommodations are needed. It is recommended that if there is an existing bike lane/bike path to connect to it or if the route were identified as part of a Master Bike Plan, then a separate bike lane shall be warranted. (More research is needed to determine the number of bikes or number of pedestrian types for quantitative thresholds.)

e. Review shoulder inventory. It is acknowledged that bike lanes, or shared use paths outside the roadway, may be appropriate for some locations, but most bicycle trips take place on the shoulder, which allows bicyclists to share the roadway with motorists. Regional Arterials, Community Arterials and Community Collectors should all have a minimum 4-foot effective shoulder width. Neighborhood Collectors and Local Roads may warrant installation of shoulder through retrofit of wider lanes to accommodate bicyclists.

II. Colorado Method (Compatibility Index)

Colorado is viewed nationwide as a destination for biking and hiking. In 2013, Colorado was ranked 2nd by the League of American Bicyclists in their annual Bicycle Friendly State Program.

Colorado DOTs approach evaluated facilities with a rating system similar to FHWA's bicycle compatibility index, which ranks each location as a candidate. Their methodology is geared toward evaluating competing bicycle and pedestrian projects in a way that is consistent and defensible. The method has been adapted for use in Pennsylvania to look at projects individually and then potentially assign a threshold to the index to determine if the projects should be implemented.

Following are criteria Colorado DOT (CDOT), as presently developed, uses components of the index to evaluate candidate bicycle/pedestrian projects.

Candidate Project Evaluator Calculator - Colorado DOT		
VARIABLE	**RATING TYPE**	**RATING**
Bicycle/Walking LOS Before Project	LOS	
Bicycle/Walking LOS After Project	LOS	
Crash Rate Reduction Potential	0-10	
Motor Vehicle LOS	LOS	
Roadway Functional Class	Classification Type	
Population Employment in Surrounding Area	0-5	
Corridor Aesthetics	0-5	
Count Devices Included in Project	Yes/No	
Designated Scenic Byway	Yes/No	
Direct Access to Scenic Byway	Yes/No	
Direct Access to Public Lands	Yes/No	
Shared Use Path	Yes/No	
Located in Designated Downtown Area	Yes/No	
County Obesity Rate	0-5	
Minority/Low Income Population in Surrounding Area	0-5	
Access to Schools	Yes/No	
Senior Population in Surrounding Area	0-5	
Closes Gap between 2 Existing Facilities	Yes/No	
Extends Existing Facility	Yes/No	
Fixed Route Transit Service	Yes/No	
Access to Park and Ride Facility	Yes/No	
County Tourism Revenue	0-5	
Concerted Tourism Investment	Yes/No	
Facility Construction Cost	Cost in $	

As shown in the list, CDOT has not yet assigned rating or weighting numbers to this method. The method is still in the development phase; however, the researchers have used this as a basis for potential use in Pennsylvania.

Based on their methodology, CDOT has incorporated this policy into their planning and design of bicycle and pedestrian facilities. The following is a summary of information that would be needed on sample projects to complete the individual project evaluations for PennDOT:

1) Volume data (cars, trucks, bicycles, pedestrians) and geometric data to conduct Level of Service Analysis for before and after scenario.

2) Detailed Crash Analysis. Number of bicycle/pedestrian crashes per number miles traveled. (Note, PennDOT does not have any method established to determine the number of pedestrian or bike miles traveled, so crashes are based on total number of crashes, not based on miles traveled).

3) Roadway Functional Class.

4) Population Data (+65 population; minority; low income).

5) Corridor Aesthetics.

6) Permanent Count Devices on project.

7) Surrounding land use (Scenic Byway or Public Byway access; downtown area, Park and Ride facilities, access to schools).

8) Network Connectivity (other facilities).

9) Shared Use Path in study area?

10) Transit Route located in study area?

11) County Tourism Revenue.

12) Is project a Tourism Investment? Does Community have a dedicated marketing campaign?

13) County Obesity Rate.

14) Project Construction Cost.

The threshold requirements for each assessment area are recommended to be developed by a stakeholder group to determine weighting factors if this methodology is adopted.

For purposes of this method's application, rating scales were developed by the research team to be used for an index as follows:

Candidate Project Evaluator Calculator - Colorado DOT		
VARIABLE	**RATING TYPE**	**RATING**
Bicycle/Walking LOS Before Project	LOS	1-5 (F=1)
Bicycle/Walking LOS After Project	LOS	1-10 (F=1, D=3 etc.)
Crash Rate Reduction Potential	0-10	1-5 based upon guidance from the highway safety manual
Motor Vehicle LOS	LOS	1-5 (F=1)
Roadway Functional Class	Classification Type	1-5 (limited access=0)
Population Employment in Surrounding Area	0-5	Based on census track data, higher density = 5
Corridor Aesthetics	0-5	Subjective
Count Devices Included in Project	Yes/No	Yes=1
Designated Scenic Byway	Yes/No	Yes=10
Direct Access to Scenic Byway	Yes/No	Yes=5
Direct Access to Public Lands	Yes/No	Yes=5
Shared Use Path	Yes/No	Yes=10
Located in Designated Downtown Area	Yes/No	Yes, if designated as urban are = 5
County Obesity Rate	0-5	Higher than statewide average for county = 5
Minority/Low Income Population in Surrounding Area	0-5	Higher than statewide average for census track = 5
Access to Schools	Yes/No	Yes=10
Senior Population in Surrounding Area	0-5	Higher than statewide average for census track = 5
Closes Gap between 2 Existing Facilities	Yes/No	Yes=20
Extends Existing Facility	Yes/No	Yes=20
Fixed Route Transit Service	Yes/No	Yes=10
Access to Park and Ride Facility	Yes/No	Yes=5
County Tourism Revenue	0-5	Data available that confirms facilities create revenue = 5
Concerted Tourism Investment	Yes/No	County has tourism investment revenue = 5
Facility Construction Cost	Cost in $	< than 20% of project costs = 10

III. Georgia Method (Standards and Guidelines)

As part of the Georgia Department of Transportation (GDOT) Design Policy Manual, bicycles, pedestrians and transit are routinely incorporated into project design as part of their Complete Streets approach.

GDOT's basic assumptions are that new facilities should anticipate bicycle and pedestrian uses, and therefore bicycle/pedestrian facilities, intersections and interchanges should accommodate bicyclists and pedestrians in a manner that allows them to safety cross the roadway and travel along them.

GDOT does acknowledge that resurfacing/restoration/rehabilitation (3R) projects are not intended to expand existing facilities, but they do provide opportunities to enhance safety for pedestrians and bicyclists and additional accommodations should be considered during the programming phase of 3R projects.

GDOT has useful tools on a statewide basis related to bicycle/pedestrian/transit. They have developed a Bicycle Route Network that has linked together the local/regional bicycle networks. GDOT has also developed an overall state map that shows which counties have fixed route transit systems, as well as links to the actual transit service providers.

GDOT has established standard and guideline warrants, ensuring appropriate bicycle and pedestrian accommodations are included in transportation infrastructure projects. It is recommended that the warrants and guidelines be adopted as currently utilized by GDOT.

<u>Bicycle Accommodation Warrants</u>

Standards **–** Bicycle accommodations shall be included in all reconstruction, new construction, and capacity-adding projects that are located in areas with any of the following conditions:

- If the project is on a designated (i.e., adopted) U.S., State, regional, or local bicycle route;
- Where there is an existing bikeway along or linking to the end of the project corridor (e.g., shared lane, paved shoulder, bike lane, bike boulevard, or shared-use path);
- Along corridors with 2-3 types of bicycle travel generators and destinations on the corridor (i.e. residential neighborhoods, commercial centers, schools, colleges, scenic byways, public parks, transit stops/stations, etc.);
- On projects where a bridge deck is being replaced or rehabilitated and the existing bridge width allows for the addition of a bikeway without eliminating (or precluding) needed pedestrian accommodations; and
- Where there is an occurrence of reported bicycle crashes which equals or exceeds a rate of five for a 1-mile segment of roadway, over the most recent three years for which crash data is available.

Guidelines **–** Bicycle accommodations should be considered on projects that are located in areas with any of the following conditions:

- Within close proximity (i.e., 3 miles) of a school, college, university, or major public institution (e.g., hospital, major park, etc.);
- Where a project will provide connectivity between two or more existing bikeways or connects to an existing bikeway;
- Where there is an occurrence of bicycle crashes;
- Along a corridor where bicycle travel generators and destinations can be expected prior to the design year of the project;
- Any location where engineering judgment, planning analysis, or the public involvement process indicates a need.

<u>Pedestrian Accommodation Warrants</u>

Standards – Pedestrian accommodations shall be considered in all planning studies, and be included in all reconstruction, new construction, and capacity-adding projects which include curb and gutter as part of an urban border area or are located in areas with any of the following conditions:

- Along corridors with 2-3 types pedestrian travel generators and destinations along the corridor (i.e. residential neighborhoods, commercial areas, schools, public parks, transit stops and stations, etc.), or areas where such generators and destinations can be expected prior to the design year of the project;
- Where there is evidence of pedestrian traffic (e.g., a worn path along roadside);
- Where pedestrian crashes equal or exceed a rate of ten for a ½-mile segment of roadway, over the most recent three years for which crash data is available; and
- Where a need has been identified by a local government, MPO or regional commission through an adopted planning study.

Guidelines – Pedestrian accommodations should be considered on projects that are located in areas with any of the following conditions:

- Within close proximity (i.e., 1 mile) of a school, college, university, or major public institution (e.g., hospital, major park, etc.)
- Within an urbanized area; or area projected to be urbanized by an MPO, regional commission, or local government prior to the design year of the project;
- Where there is an occurrence of pedestrian crashes; and
- Any location where engineering judgment, planning analysis, or the public involvement process indicates a need.

Transit Accommodation Warrants

Standards – Transit accommodations shall be considered in all planning studies and be included in all reconstruction, new construction, and capacity-adding projects that are located in areas with any of the following conditions:

- For transit vehicles: on corridors served by fixed-route transit; and
- For pedestrian transit users: within the ½-mile pedestrian catchment area of an existing fixed-route transit facility (i.e., stop/station, or park-and-ride lot). A catchment area is defined by a radial distance from a transit facility per Federal Transit Administration (FTA) guidelines - this includes crossing and intersecting streets.

Guidelines – Transit accommodations should be considered on projects that are located in areas with any of the following conditions:

- For bicycle transit users: within the 3-mile bicycle catchment area of an existing fixed-route transit facility;
- Along a corridor programmed (and funded) to begin construction of high-capacity transit before the roadway project design year; and
- For all transit users: between transit stops/stations and local destinations
- Where a warrant is met, the need for accommodations should be validated through coordination with the transit service provider (and MPO, regional planning commission and/or local government, where applicable). This coordination is necessary for existing as well as planned transit facilities. It should be recognized that although classified as fixed route transit, local and express bus routes are periodically changed in order to improve services to riders.

Based on the methodology that GDOT adopted for these warrants, the following is a summary of information that would needed on sample projects to complete the individual project evaluations for PennDOT:

1) Pedestrian and/or bicycle generators and destinations in the study area
2) Pedestrian and/or bicycle generators and destinations that are proposed prior to project design year
3) Evidence of pedestrian traffic (such as worn path along roadside)
4) Pedestrian crash rate (based on ½ mile segments of roadway over past 3 years)
5) Bicycle crash rate (based on a one mile segment over past 3 years)
6) Does the sideswipe crash rate for project corridor exceed statewide average?
7) Is need for pedestrian accommodation identified through an adopted planning study by the MPO or local municipality?

8) 1-Mile and 3-Mile Radius inventory of school, college/university, hospital, major park

9) Identification of study area as urbanized

10) Is study area part of any designated bicycle route (US, State, Regional, local)?

11) Bikeways exist in study area? Do they link to the project corridor? (i.e. shared lanes, paved shoulders, bike lane, shared use paths)

12) Sidewalks exist in the study area? Do side road tie-ins have sidewalk/bike paths?

13) Bridge deck replacement /rehabilitation projects. What is the existing bridge width, and can a bikeway be accommodated?

14) Has local municipality requested bicycle lanes?

15) Does fixed route transit exist in study area/corridor, or within ½ mile or 3 miles of study area?

16) Are there transit facilities, stops or local destinations within the study area?

17) Is construction of transit scheduled to begin prior to the roadway project design year?

18) Roadway speed (less than 35 mph?)

19) Roadway classification/Urban/Rural

IV. Alternate Method and Data Needs

The current process used to identify bicycle, pedestrian and transit needs in Pennsylvania is based upon local decisions and local data on an individual project basis. The checklist attempts to broaden the view of the project scope to evaluate more global considerations beyond the limits of the project.

Currently, the project development process in Pennsylvania identifies project scopes and definitions prior to the programming process and after a project is funded. Once a project is funded on the Transportation Improvement Plan (TIP), a scoping field view is conducted. This field view identifies potential alternatives that are supposed to meet project need and purpose and fit the type of roadway, community and land use.

It appears that, from the projects evaluated, the bicycle/pedestrian checklist is not being completed by the MPOs prior to funding of the project on the TIP. When the project field view is held, the bicycle/pedestrian requirement isn’t clearly identified as part of project need because the checklist was not completed. The research team also noted that very few projects had bicycle/pedestrian count data available to make these decisions during any step of the project development process.

An alternative to this process would be the development of a statewide database and plan for bicycles, pedestrians and transit. The MPOs could use these resources during the project development process to guide project selection and ensure that proposed improvements meet the statewide plan. Such a database would require statewide bicycle, pedestrian, and transit data collection. Use of this database and methodology at the MPO level could prevent changes in project scope or funding shortfalls that occur when a decision on these types of facilities is made.

Accurate and comprehensive statewide inventory of bicycling and walking facilities and the existing conditions for those facilities do not exist as a baseline for measurement in Pennsylvania. PennDOT should consider moving towards a statewide inventory to provide a baseline to assist in development of quantitative thresholds or create a statewide plan.

Based on experience gained in developing the three methodologies and a review of other states policies on planning and design of bicycle and pedestrian facilities, the following is a list of data that would assist with any methodology approach and potentially lead to a statewide plan that could be used in Pennsylvania:

<u>Inventory of the State Highway System involving Bicycle Routes and the Scenic Byways to determine potential needs:</u>

a. Consider providing official PennDOT classification of state Bicycle and Scenic Byway Routes based on Smart Transportation classifications and incorporating it into the GIS /RMS system. Identify roadways as Regional Arterial, Community Arterial, Community Collector, Neighborhood Collector, and Local Road. MPO/RPOs should be involved with classification. It is noted that as part of the PennDOT design process, this type of information is supposed to be used as guidelines for designers to address project needs and established at the beginning of each project.

b. Conduct an inventory of the bicycle facilities on the Bicycle PA Routes, Scenic Byways and other trails, bike lanes, shared use paths, etc. Include this information into the PennDOT GIS/RMS system so it can be cross referenced with future crash data and used for project needs planning.

c. Identify, through the MPO/RPOs, any bicycle master plans in the areas of the routes. Identify routes or potential missing links to the routes that would connect with local bicycle master plans. In addition, have each MPO/RPO assist in prioritizing which roadways should be considered a priority for bicycle/pedestrian linkage for future inventory and evaluation.

d. Conduct an inventory of transit routes and stops throughout the state in concert with the MPOs and RPOs. This information could be addressed on a county basis with information on transit organizations to contact for specific route information. Incorporate this information into GIS/RMS. It should be noted that state routes that include transit stops should have priority for pedestrian/bicycle improvements because many transit trips begin with walking or bicycle trips in urban areas.

e. Conduct shoulder width inventory for routes. Bicycle PA Routes and Scenic Byways identified throughout the state should be given higher priority for review and inventory of shoulder conditions to ensure that effective 4-foot shoulders (minus bicycle friendly rumble strip dimensions) are present.

f. PennDOT already has bicycle and pedestrian crash data available and it is used as part of the design process as applicable. In order to better analyze crash data key factors should be evaluated. Bike and pedestrian crash reports should be analyzed to include lighting conditions and age of crash victims. This will permit better targeting of mitigating actions and educational programs. Corridors in which bicycle and pedestrian crash rates are higher should be analyzed to identify problematic roadway designs or human behavioral factors. For roadways that have been identified as bicycle routes, review run off roadway/hit fixed object crash results. Note that crash data is currently not summarized based on million miles of bicycle or pedestrian miles traveled. The researchers recommend use of 10 pedestrian crashes per ½ mile segment and 5 bicycle crashes per 1-mile as a threshold. As an alternative, crash data for bicycle/pedestrians could be plotted on a bell curve and an average threshold could be determined based on roadway type.

g. Consider a statewide inventory of pedestrian facilities/sidewalks along state highways. An inventory of pedestrian facilities and crossings would be helpful in determining missing links. It is understood that as part of the planning and design process, evaluation of pedestrian needs and existing facilities should occur.

h. Incorporate School Walking Routes into the PennDOT GIS system. This should then be cross referenced with future crash data and used for planning purposes.

i. Consider incorporating ADA ramps/pedestrian sidewalk information obtained from signal permits into the GIS/RMS system to begin inventory of crossing locations and future connectivity evaluation.

j. Consider an annual Pedestrian/Bicycle Documentation Day project using Community Grant projects and volunteers to begin obtaining statewide bicycle and pedestrian data. The National Bicycle and Pedestrian Documentation Project is a joint effort of Alta Planning and Design and the Institute of Transportation Engineers (ITE) Pedestrian and Bicycle Council.

Testing of the Three Methodologies

PennDOT provided four projects for the testing that were selected by PennDOT Central Office in conjunction with the regional planning agency for Southwestern Pennsylvania, The Southwestern Pennsylvania Commission (SPC), and PennDOT Engineering Districts 10-0, 11-0 and 12-0. The goal in selecting the projects for testing was to evaluate:

- One highway project in planning (HP)
- One highway project in design (HD)
- One bridge in planning (BP)
- One bridge in design (BD)

After a review and discussion of potential projects, which are currently in the planning, design or construction phases of the project development process, four projects were selected. The projects selected, their current project status and type of project were the following:

- Kenmawr Bridge - Planning Phase for a Bridge Replacement
- Freeport Road – Planning Phase for Traffic Signal Coordination Project
- Derry Bridge – Preliminary Design for a Bridge Replacement
- Freeport Bridge – In Construction as a Bridge Rehabilitation

The following is a description of each project and its current status, at the time of the testing, in project development.

I. Kenmawr Bridge

The Kenmawr Bridge is located in PennDOT District 11-0. The project is a replacement of a local two lane short span bridge over a railroad located on the border of two municipalities. The municipalities are the Boroughs of Rankin and Swissvale located in Allegheny County.

This bridge was selected because the project development process has not yet begun and the transit, pedestrian or bicycle features needed to be determined. Although the project only involves the replacement of the bridge, the need for alternative mode facilities is being considered, based upon the environs of the project including approach roadways and adjacent intersections. Because the project is in the beginning of the project development process, the bicycle/pedestrian checklist was not completed. The bridge currently has a 6 ton weight limit as shown in Figure 2.

Figure 2 Kenmawr Bridge Southbound Approach

The existing bridge is located immediately adjacent to the eastern terminus of the Port Authority of Allegheny County (PAT) East Busway. This busway facility terminates approximately 300 feet north of the bridge on Braddock Avenue. There is a busway station with a 163 space park and ride lot located adjacent to the busway access intersection as shown in Figure 3.

Figure 3 Port Authority East Busway Entrance

There are two signalized intersections immediately north and south of the bridge on Kenmawr Avenue. These two signalized intersections are Kenmawr Avenue with Braddock Avenue/Hawkins Village Drive and Braddock Avenue with Woodstock Avenue. Both traffic signals provide pedestrian accommodations. The access intersection to the East Busway is an unsignalized intersection. Pedestrian access to the busway station is provided via the intersection on Braddock Avenue with sidewalk accommodations. At both signalized intersections there are ADA ramps provided. There are no bicycle facilities currently on the roadways in the project area; however, there are bicycle racks at the busway station.

II. Freeport Road

Freeport Road (S.R 1001) is a state-owned arterial roadway located along the Allegheny River, traveling through several communities. The section of the roadway, in which the project is located, includes Blawnox Borough, The City of Pittsburgh and Aspinwall Borough in Allegheny County. The corridor is being studied by PennDOT District 11-0 for the installation of a coordinated traffic signal system through the Congestion Mitigation and Air Quality (CMAQ) program. The project was selected for this type of improvement because the traffic signals are older and are not coordinated in their operation.

The project was selected for the testing because it represents an arterial highway that acts at the main street of several smaller business districts in the area. It currently has some alternative mode features such as sidewalks and transit service.

Although the purpose of the project is traffic signal coordination, the testing of the need for alternative mode features was conducted for the corridor as part of this evaluation. This was based upon the need to potentially expand the project type to include these features. This evaluation included the whole corridor length of 2.0 miles. There are 13 traffic signals in the corridor. PennDOT District 11-0 provided traffic and pedestrian traffic counts at three intersections for the corridor. These three intersections were selected by the researchers to be representative of conditions in each segment of the corridor. The three intersections included:

- Freeport Road with Blawnox Avenue;
- Freeport Road with Fox Chapel Road; and
- Freeport Road with Center Avenue.

The following photos in Figures 4, 5 and 6 are representative conditions in the corridor. As shown, travel lanes vary from 2 to 3 in number. Sidewalks are present in some locations on one or both sides and on-street parking is present in the northern and southern business districts of Blawnox and Aspinwall.

Figure 4 Freeport Road in Blawnox Business District

Figure 5 City of Pittsburgh section of Freeport Road

Figure 6 Blawnox section of Freeport Road

III. Derry Bridge

The Derry Bridge is a state owned bridge (S.R. 217) located in Westmoreland County PennDOT District 12-0 in the Borough of Derry. The bridge crosses a main railroad track and provides a connection within the Borough of Derry. It is the primary roadway connection between the two sections of the borough, which is divided by railroad tracks. It is both a major vehicular and pedestrian connection for the borough.

The bridge is scheduled to be replaced by a new structure. Currently, alignment studies to construct the new structure adjacent to the existing structure are being conducted. The existing bridge has two travel lanes with sidewalks on both sides of the bridge. On the northern end of the bridge, there is a closed pedestrian connection to a staircase that appeared to provide a walking connection to an industrial plant. On the southern side of the bridge approach, there is a pedestrian staircase that connects the bridge approach to the business district of Derry at 1st Street. It was observed that pedestrians currently cross the railroad tracks below the bridge at grade to avoid walking up and down the bridge to cross the tracks.

At the southern end of the bridge there is a signalized intersection with Second Avenue. This intersection has pedestrian crosswalks with a traffic signal installation. The northern approach to the bridge intersects with Owens Avenue, which is a stop sign controlled intersection without crosswalks. A bicycle/pedestrian checklist was completed and provided for this project.

As shown in Figures 7, 8 and 9, there are several pedestrian features on the current bridge.

Figure 7 Pedestrian Staircase at Northern Portion of Bridge

Figure 8 Current Bridge lane and sidewalk configuration

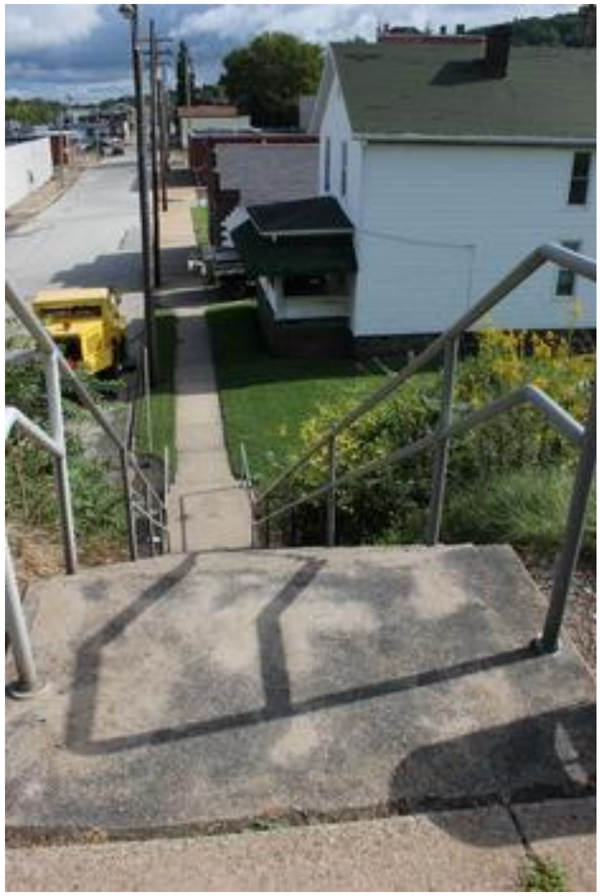


Figure 9 Steps from current bridge to 1st Avenue

IV. Freeport Bridge

The Freeport Bridge is a major river crossing of the Allegheny River connecting Westmoreland County to Armstrong County. The bridge is state owned (S.R. 356) and connects Allegheny Township in Westmoreland County to Freeport Borough in Armstrong County. Currently the bridge is being reconstructed. All of the data provided for the evaluation was based upon pre-construction conditions.

The previous bridge deck had four travel lanes with two lanes in each direction. There was a narrow sidewalk on one side of the old bridge. The reconstruction project involved the repair of the bridge superstructure and installation of a new deck with four lanes and bicycle/pedestrian separated path. Also, as part of the bridge reconstruction, the northern bridge approach interchange with Freeport Road (S.R. 0128) was reconfigured. This interchange between the bridge and Freeport Road is being replaced with an at grade signalized intersection as part of the construction project.

Data from the traffic counts in the interchange area was used to evaluate the nonmotorized mode needs. All of the information used for the testing of this project was based upon information collected in 2001 when the project development process began. A pedestrian needs accommodation checklist for the signalized intersections was provided at the northern end of the bridge. A bicycle and pedestrian checklist was not provided for the bridge. No data was available on pedestrian or bicycle volumes in the project area.

The following Figures 10 and 11 provides some views of the current bridge construction.

Figure 10 Current Freeport Road Bridge Construction

Figure 11 Superstructure Reconstruction on Freeport Bridge

V. Testing Summary

The testing of the three methodologies revealed many positive and negative aspects of each procedure. The testing provided an evaluation of the data requirements of each method as compared to available data sources. These findings were also compared to information typically gather as part of the project development process by PennDOT or an MPO/RPO. Comparing the test results and conclusions for the three methods, when applied to the four projects, was another benchmark of the potential applicability of each method to the PennDOT project development process.

The following provides a critique of each methodology relative to the data collection, analysis methods, applicability of the results and potential application of the method in Pennsylvania. A comparison of the test results to the current checklist method and actual project decisions is also provided. Finally, a recommendation on a potential implementation strategy for a methodology to replace the checklist is provided.

VI. Arizona Methodology

The Arizona methodology provides a planning level method that can be applied based upon basic information available to an MPO/RPO or PennDOT. The data requirements are straightforward and are available from secondary sources such as roadway classification systems, community characters, crash data and inventories of project area land use characteristics.

The analysis uses the planning level data and applies the following criteria:

- For complete reconstruction and rehabilitation projects, it is assumed that pedestrian and bicycle accommodations will be considered.
- For other types of projects, such as maintenance projects, the following criteria are used:
  - A sidewalk is needed based on context and location of pedestrian generators and existing sidewalks. In suburban or urban areas a sidewalk should be installed.
  - A bike lane or shared roadway accommodations are needed if there is an existing bike lane/bike path to connect to it. If the routes were identified as part of a master bike plan, then a separate bike lane shall be warranted.
  - Regional arterials, community arterials and community collectors should all have a minimum 4-foot effective shoulder width.
  - Neighborhood collectors and local roads may warrant installation of shoulders through retrofit of wider lanes to accommodate bicyclists.
- Design criteria are also specified in general terms. There are criteria such as sidewalk, shoulder and bikeway widths, which are all sufficient for project programming purposes.

When this method was applied to the four projects, the results and recommendations were similar for three of the four projects, relative to pedestrian facilities. Sidewalks were recommended in three of the cases because the criteria require sidewalks where complete reconstructions are being performed in urban or suburban areas. All of the projects tested were bridge reconstructions except the Freeport Road project. This project met the criteria based upon the land use context of the project.

For bicycle facilities, none of the projects qualified for a separate bicycle facility because a four-foot shoulder can be incorporated into the roadway section of all projects. Finally, transit facilities, other than sidewalks, were only required for the Freeport Road project because there is currently transit service in the corridor.

The Arizona methodology appears to be applicable for a planning level screening analysis that may be performed early in the project development process. This type of method could be used by an MPO/RPO during the programming process to determine the need for such facilities and estimate additional project costs for alternative mode features.

VII. Colorado Methodology

The Colorado method considers a very wide range of criteria when establishing a ranking for the construction alternative mode features into highway and bridge projects. The method, as currently developed, is used to rank the relative benefit for projects to incorporate pedestrian, bicycle and transit features. The testing considered how this method could be adapted for the evaluation of a single project.

The criteria include many measures of the benefit of these facilities. Generally, the criteria fall into these types of categories:

- Measurement of Current and Future Transportation Conditions – Levels of service, volumes and crash history
- Community Characteristics – demographics and adjacent land uses
- Recreational Features – tourism, scenic byways and public lands

There are 29 criteria needed for this evaluation. The criteria are used to calculate an index, which describes the relative benefit for alternative mode facilities in the project. The index weighs each characteristic on a scale that was selected for this testing. The current Colorado method did not select weighting factors, but anticipated their use. The method also evaluates the economics of the project. The cost of the alternative mode enhancements are compared to the index.

The data collection for this method is extensive. It requires the collection of site specific information from primary sources such as traffic, bicycle and pedestrian counts. Extensive secondary source data is needed to describe community characteristics and recreation facilities. All of the data needed was found to be available.

One different feature of this method is that specific pedestrian, bicycle and transit features must be assumed for the project in order to use the method. Specific assumptions on the level of accommodation and costs must be determined first and then the criteria applied. Calculation of the pedestrian and bicycle levels of service must be performed for the before and after project implementation conditions.

Once the data is collected, the analysis is very simple. The index is calculated based upon the criteria results and the weighting factors. As summarized in the results section of this report, an index was reported for each of the four projects.

Because no threshold index has been developed, the relative ranking of the four projects can only be reported. The cost criteria are based upon the assumed features and costs that may be incorporated into the project. For the purpose of the testing, the researchers developed conceptual alternative mode features for each project to calculate the index. Costs for these features were also assumed.

Based upon these test results, it appears that this method may be most applicable when a specific funding source is being used to add costs to a project for alternative mode enhancements. This method would apply when a ranking system is needed to program funds. If a specific program, such as transportation alternatives, was being used to increase funding for a typical highway or bridge project, this method could be used. It could help to determine which project areas may benefit the most by incorporation of the features as part of a regional or statewide plan.

The method could be modified by developing a threshold requirement for the index to evaluate individual projects and the benefit of such features. The key to developing a threshold requirement would be to determine the appropriate weighting factors used for the index.

To use the Colorado method as a threshold test will be difficult, because it lacks any guidance on how to make an initial decision for the level of accommodation that must be assumed for the testing.

VIII. Georgia Methodology

The Georgia method is very similar to a warrant analysis that is used for the installation of traffic control devices. This method establishes specific objective and subjective criteria for the installation of pedestrian, bicycle and transit features separately. The standards and guidelines are a screening method. If a project meets the standards criteria, then the features are incorporated into the project. If the standard is not met, then the guidelines are utilized to make the decision. It is a two-tier decision process.

The data required for this method is transportation planning type information along with crash data. Geographic information on the proximity of generators of bicycle or pedestrian trips is also a major part of the data required.

The analysis method evaluates several standards for each of the mode areas and, if one of the standards is met, the feature is incorporated into the project. The crash analysis does require statewide crash rates for bicycles, which is not currently available in Pennsylvania. There are very specific crash criteria for both pedestrian and bicycles modes as part of the analysis. The transit analysis is based upon current types of service in the project area and the need to provide better bicycle and pedestrian links to the transit stops.

The testing results revealed that bicycle and pedestrian accommodations met the standards for all projects. The transit standard was met for the Freeport Road project only. The Georgia method also provides specific guidance as to the level of accommodation for the features, including specific sidewalk width and buffer standards. Bicycle accommodation features refer to the AASHTO standards.

The Georgia methodology generally fits well within the current PennDOT project development process during the programming or design phases. It could be used by either an MPO/RPO or PennDOT to determine the need for accommodations on a project basis with specific criteria. The criteria are both safety and land use context based.

IX. Comparison to Checklist Results

One of the projects, the Derry Bridge, had the bicycle and pedestrian checklist completed. One other project, the Freeport Bridge, is in construction and has incorporated bicycle and pedestrian features. Both of these projects were reviewed relative to the data provided and the project development decisions made on incorporation of the features. The following is a summary of this comparison for each project.

Derry Bridge

The Derry Bridge project had an extensive bicycle and pedestrian evaluation conducted. This was due to a public concern about safety of the existing setting of the bridge, which crosses a major railroad line. The study report and checklist evaluation resulted in a recommendation to install both bicycle and pedestrian features into the bridge replacement. However, the report identified six different levels of accommodation. The report did not conclude what level of accommodation would be incorporated.

All the methodologies tested recommended both bicycle and pedestrian accommodations for this project. The Arizona method recommended 5-foot sidewalks on both sides of the bridge and a four-foot shoulder to accommodate bicycles on the bridge. These conclusions are consistent with the PennDOT project development process recommendations.

Freeport Bridge

This project is currently in construction and is incorporating a 6 to 8-foot bicycle and pedestrian separated path on the bridge. This will be a dual use path separated from the travel lanes. The testing of this project recommended bicycle and pedestrian features using both the Arizona and Georgia Methods. The Arizona method recommended a 5-foot sidewalk and a four-foot shoulder for bicycles on the bridge. The Georgia method recommended a sidewalk of 5-feet and a four-foot shoulder to accommodate bicycles. The method testing results were similar to the decisions made in the PennDOT project development process. However, a combined facility was recommended by the PennDOT method instead of separate bicycle and pedestrian facilities, which is currently being constructed.

Analysis Results Summary

Based upon the analysis results, the following is a summary of the testing outcomes for the four projects and the three methodologies. As shown, results are similar for the Arizona and Georgia methods for each of the projects. As reported, the Colorado method does not provide a specific recommendation but tests an assumption for bicycle or pedestrian improvement in the project area and calculates a rating. The highest rating of the projects was the Kenmawr Bridge. Based upon the information collected for the methodology and review of the other methods' results, it appears logical that this project would rate the highest and the Freeport Bridge would rate the lowest.

PROJECT	ARIZONA METHODOLOGY	COLORADO METHODOLOGY	GEORGIA METHODOLOGY
Kenmawr Bridge	5 Ft Sidewalks 4 Ft Shoulder for Bicycles	Rating 94	5.5 Ft Sidewalks 14 Ft Shared Bicycle Lane
Freeport Road	6-8 Ft Sidewalks 4 Ft Shoulder for Bicycles Transit Enhancements	Rating 57	4-5 Ft Sidewalks 14-Foot Shared Bicycle Lane Transit Enhancements
Derry Bridge	5.5 Ft Sidewalks 4 Ft Shoulder for Bicycles Transit connection via Stairs	Rating 53	5 Ft Sidewalks 14-Foot Shared Lane Transit connection via Stairs
Freeport Bridge	8-10 Ft Shoulder for Pedestrians and Bicycles	Rating 41	5-Foot Sidewalks 4-Foot Shoulder (Less Rumble Strip Width) for Bike Travel

Research Findings

The testing of the three methodologies, for the four projects, revealed the advantages and disadvantages of each method. The methods were evaluated based upon the data requirements, analysis methods and context of application. While all of the projects tested were in the design phase of project development, this research has also considered the need for a methodology that is applicable during the programing phase of project development.

The stage of project development and the need for a more defined methodology was a major consideration in the development of a recommendation. During the programming phase of the project development process, the Arizona or Georgia method would appear to be adaptable to Pennsylvania. Both methods use available data that is contextual based for the project environs and safety related. One negative aspect of both of these methods is that no direct data is collected on existing pedestrian or bicycle users in the project environs. Only the Colorado method requires this type of data to be collected and analyzed.

The Georgia method provides a more prescriptive methodology and incorporates crash criteria, specifically for pedestrians and bicycles. It also has specific criteria for transit, which is lacking in the other two methods tested.

Based upon this evaluation, the researchers recommend consideration of the Georgia method to replace the current checklist with the following modifications:

- Revise the project development process to require use of the method during the programming process to determine the need for the facilities and programming level cost estimates;
- Adopt the AASHTO criteria for bicycle facilities and the Georgia standards for sidewalks to be used during the design phase of the project development process;
- Consider elimination or modification of the guidelines for bicycle, pedestrian and transit facilities due to their qualitative criteria and the potential for many different interpretations of their application; and
- Add criteria for both the pedestrian and bicycle standards that require direct data collection to establish current levels of usage. This information could be used to reinforce the criterion that establishes current use of the project area.

Implementation Plan

In order to implement the research findings, several documents and processes need to be modified. These include:

- Design Manual Part 1X, Appendix S – This appendix to the design manual provides the checklist for use by the designer.
- PennDOT Design Manual DM-1, Chapters 2, 6 and 16 – All of these sections of the design manual refer to the checklist, the most critical one is Chapter 2, which is used during the planning and programming stage of project development. This section will have to be modified to implement a new process.
- Development of the Transportation Improvement Plan (TIP) – Guidance for MPOs and RPOs will be needed. During the updates of the TIP, revised procedures to develop project concepts and cost estimates need to be modified to ensure that the new methodology is used.

Future Areas for Improvements

The development of a method to determine the needs for alternative transportation features into highway and bridge projects is based upon an analysis of existing features of the highway and adjacent community. However, no data is analyzed relative to the latent demand for such facilities. This is a future area of improvement that can refine the methodology recommended.

Bicycles and pedestrians are modes separate from cars and hence have different impediments to consider when determining latent demand. Most current methods of latent demand analysis consist of finding sources, sinks, volumes between the sources and sinks, and a map of facilities available. Most use gravity models to predict volumes over given routes. These models, given projected facilities, are needed to determine how the new facility would be used.

Development of these models is a future area of improvement that is needed to advance the methodology beyond analysis of existing conditions. Also, latent demand is important to predict how future users may be attracted to an enhanced bicycle or pedestrian environment once the features are in place.

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