GEOGRAPHIC INFORMATION SYSTEMS APPLICATIONS FOR BICYCLE AND PEDESTRIAN DECISION-MAKING

Peer Exchange Summary Report

Miami, Florida
May 11-12, 2009

Prepared for:
Office of Interstate and Border Planning
Federal Highway Administration
U.S. Department of Transportation

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I. Summary

On May 11–12, 2009, during National Bike Month and National Bike to Work Week, the Federal Highway Administration's (FHWA) Office of Interstate and Border Planning sponsored a 1.5-day peer exchange to promote the advancement of bicycling and walking as healthy, efficient, and safe transportation modes. The purpose of the peer exchange, which focused on select transportation agencies' applications of geographic information systems (GIS) to accomplish various bicycle and pedestrian objectives, was to allow participants with notable GIS applications for bicycle and pedestrian planning the opportunity to share knowledge and experiences. Lessons learned and challenges faced in using GIS for bicycle and pedestrian considerations were also discussed.

This report provides a summary of the presentations made and discussions held at the peer exchange. It should serve as a resource for state Departments of Transportation (DOTs) and transportation agencies looking to learn more about the implementation of GIS for bicycle and pedestrian planning. The report concludes with a section on the lessons participants stated as having learned and recommendations they made for moving forward.

The City of Miami hosted the peer exchange at the offices of the Miami-Dade County Metropolitan Planning Organization (MPO). Participants included staff from FHWA, the Broward MPO, the Martin MPO, the Michigan DOT, the New Jersey DOT, the City of Seattle DOT, the Two Rivers-Ottauquechee Regional Commission (TRORC), and the U.S. Department of Transportation (USDOT), Research and Innovative Technology Administration/Volpe National Transportation Systems Center (Volpe Center). Other observers included staff from the City of Miami Mayor's Office, the City of Miami Public Works Department, and the Street Plans Collaborative.[1]

II. Background

In communities across the world, there is a growing need to provide options that give people the opportunity to walk and bicycle more often, to more places, and to feel safe while doing so. There are nine million bike trips daily in the U.S.[2] Additionally, walking comprises about nine percent of all trips in the U.S. and over 35 billion trips annually.[3] The benefits of using non-motorized means of transportation include improved environmental and personal health, reduced traffic congestion, and enhanced quality of life, equity, and community livability.

GIS can be an important tool to help reach these and other goals related to developing a safer, more efficient, and multi-modal transportation system. The use of geospatial software to collect and analyze bicycling and pedestrian data can help planners better understand where needs exist for project development and how those needs should be prioritized. Additionally, GIS can help identify gaps along non-motorized pathways where new or better linkages could be created to build a more robust transportation network.

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[1] Candidate participants voluntarily submitted responses to an electronic questionnaire that FHWA developed. The questionnaire asked for information on the ways that transportation agencies use GIS for supporting and improving bicycle and pedestrian planning decision-making. The questionnaire also solicited information on outcomes from this decision-making process and challenges encountered. There were 37 respondents to the questionnaire representing state and city DOTs, MPOs, other county and local government agencies, and the private sector. Peer exchange participants were selected based on several criteria, including demonstration of innovative or unique application of GIS and the extent to which GIS use had resulted in documented outcomes. See Appendix A for a complete list of participants and attendees.

[2] National Household Travel Survey. www.bts.gov/programs/national_household_travel_survey/

[3] National Bicycle and Walking Study: Ten-Year Status Report. www.fhwa.dot.gov/environment/bikeped/study/index.htm

III. Presentations and Discussion

Day 1 – Monday, May 11, 2009
During the first day of the peer exchange, participants from the City of Miami, the TRORC, the New Jersey DOT, the Michigan DOT, and the City of Seattle DOT discussed applications of GIS for bicycle and pedestrian facility/asset management, project prioritization, and development of bicycle and pedestrian master plans. This report summarizes the presentations and comments made, as well as questions and answers for each agency.

Welcome, Introductions, and Background
Mark Sarmiento, FHWA Office of Interstate and Border Planning

As an introduction, Mr. Sarmiento welcomed participants to the peer exchange and thanked the City of Miami and Miami-Dade MPO for hosting the event. Mr. Sarmiento noted several national geospatial trends at transportation agencies nationwide, including an increasing emphasis on enterprise data integration, asset management, and the development of public information web-based portals. These trends and others are captured in a state survey presented at the American Association of State Highway and Transportation Officials' (AASHTO) 2009 GIS in Transportation Symposium.[4]

FHWA recognizes GIS as an important decision-making tool. In 2005-2006, FHWA sponsored a scan of transportation agency executives regarding uses of geospatial technology for transportation decision-making. A recommendation from this scan was to develop peer exchanges to facilitate knowledge-sharing. FHWA implemented the recommendation by developing this workshop on applications of GIS for bicycle and pedestrian planning. Other peer exchanges have focused on uses of GIS for right-of-way planning and for the FHWA Planning and Environment Linkages initiative,[5] an approach to transportation decision-making that considers various environmental, community, and economic goals early in the planning process to reduce project implementation delays.

Finally, Mr. Sarmiento noted that FHWA continues to disseminate state-of-the-practice information on uses of GIS through the GIS in Transportation website.[6] The website features quarterly newsletters and summaries from a webcast series on GIS applications. In addition, the website features a database of transportation-focused GIS applications submitted by agencies nationwide.

Overview of the FHWA Pedestrian and Bicycle Program
Carson Poe, Volpe Center

Presenting on behalf of Gabe Rousseau, FHWA's Pedestrian and Bicycle Coordinator who was unable to join the peer exchange, Mr. Poe gave an overview of the Federal perspective on walking and bicycling. The snapshot discussed four primary topics:

1. How the USDOT Secretary's new "Livability Initiative" includes improvements for walking and bicycling
2. Current walking and bicycling trip and safety trends
3. Growth in Federal funds for walking and biking
4. Existing data needs for these modes and how the peer exchange can help address these needs

Livability Initiative. Based on his recent testimony, press releases, speeches, and web postings, it is clear that USDOT Secretary LaHood plans to focus on improving community livability. Part of this initiative will involve developing better facilities for walking and bicycling. For example, in a statement to the Committee on Appropriations Subcommittee on Transportation, Housing and Urban Development, the Secretary commented that:

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[4] The state survey is available at www.gis-t.org/files/chmos.pdf
[5] FHWA Planning and Environment Linkages: www.environment.fhwa.dot.gov/integ/index.asp
[6] FHWA GIS in Transportation Website: www.gis.fhwa.dot.gov

How a community is designed, including the layout of its roads, transit systems, and walkways, has a huge impact on its residents. For instance, nearly one-third of Americans live in neighborhoods without sidewalks and almost one-half of households say they lack access to public transportation. Improving the livability of our Nation's communities will help raise living standards (March 18, 2009).[7]

Regarding bicycling, Secretary LaHood commented on Fast Lane: The Official Blog of the USDOT Secretary (http://fastlane.dot.gov/2009/04/index.html) that:

The upcoming reauthorization of DOT's surface transportation programs provides an opportunity for us to feature bicycling as part of a new American mobility within livable communities. As I said today in testimony before the House Energy and Commerce Committee, this includes fostering communities where bicyclists feel both safe and welcome on the roadways. Bike-friendly development also has the potential to contribute significantly to the revitalization of downtown districts and offer an alternative to sprawl and automobile-focused commuting (April 22, 2009).

Current walking and cycling trends. According to the most recent National Household Travel Survey (NHTS) survey (2001),[8] walking and bicycling trips nationally accounted for almost 10 percent of all trips made in the U.S. Over 38 billion trips were made walking. The 2008 NHTS is nearly complete and, in addition to those reported in the table below, more recent non-motorized trip data are expected to be available soon.

	Walking Trips (% of all trips)	Bicycling Trips (% of all trips)	Combined Trips (billion)	Combined (% of all trips)
1990 NPTS	7.2	0.7	19.7	7.9
1995 NPTS	5.3	0.9	23.6	6.2
2001 NHTS	8.7	0.8	38.6	9.5

In safety terms, there are over 5,000 pedestrian and bicyclist fatalities annually. These figures represent 14 percent of annual roadway fatalities.

Growth in Federal funding. Unprecedented levels of Federal aid funds are being used for walking and bicycling facilities. In 2008, the most recent year for which data are available, roughly $540 million was devoted to walking and bicycling infrastructure. This is a substantial increase from 15 years ago when the amount of Federal funding devoted to walking and bicycling activities was approximately $34 million.

Data needs. While the outlook for walking and bicycling as transportation modes is bright, there are many improvements that could be made to non-motorized data collection, including:

- Better travel data. The NHTS is conducted roughly every 7 years. More frequently collected data are necessary to be able to track and report trends in precise detail.
- Better methods to incorporate non-motorized trips into travel demand models. In particular, bicycling is poorly factored into transportation travel demand models.
- Better safety data. Walking and bicycling crashes that only involve injuries and not fatalities are likely substantially underreported.

GIS can play a key part in addressing several of these data gaps. The peer exchange offered an opportunity for participants to describe to broader audiences what accomplishments are being made and how challenges are being overcome. This information can inform others' efforts to develop and implement similar decision-supporting geospatial applications.

For more information, contact Gabe Rousseau at gabe.rousseau@dot.gov or 202-366-8044. FHWA's Pedestrian and Bicycle Program website is another resource: www.fhwa.dot.gov/environment/bikeped/index.htm.

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[7] http://appropriations.house.gov/Witness_testimony/TH/Honorable_Ray_%20Lahood_03_18_09.pdf
[8] http://nhts.ornl.gov/

Demonstrations and Presentations

City of Miami (Florida)
Collin Worth, City of Miami Bicycle Coordinator/Special Projects Assistant

Overview

Until recently, the City of Miami had no bicycle facilities on city-owned streets, and cyclists were generally dissatisfied with the cycling conditions in the city. To address this gap and to enhance the overall bicycling environment of the city, a significant planning effort to design and implement bicycle-friendly projects has been occurring. Specifically, as a part of his Green Initiatives,[9] the mayor of Miami established a bicycle action committee consisting of a variety of bicycle advocates, including staff from a number of city government departments who were identified to participate and provide input. During 2008, the committee drafted a Bicycle Action Plan[10] that included goals for infrastructure development, public education, interdepartmental coordination, and monitoring and evaluation. The plan also called for the creation of a bicycle action map that showed existing and potential bicycle projects, such as those for greenways, shared routes, bicycle lanes, and neighborhood routes.

To accomplish the latter, the City of Miami initiated a two-phased effort:

- A public outreach campaign to learn more about cyclists' behavior and needs, and
- The development of a GIS data layer for existing and planned bicycle infrastructure so that relationship and interaction of these facilities with the existing street network could be analyzed. The data layer was based on information collected during the public outreach campaign.

Outreach, which was conducted primarily through advocacy groups involved with the bicycle action committee, consisted of online and paper surveys that requested input on a number of bicycling factors. Maps showing the existing transportation network and planned bike projects were provided, and the public was asked to identify where they typically ride and where they would like to see bicycle infrastructure. Survey questions sought to determine how frequently cyclist rode their bikes (e.g., constantly, daily, weekly, monthly), the purpose of the trips (e.g., exercise, recreation, fuel economy, commute), and where in the street they rode (e.g., street or sidewalk). Other questions included:

- Where do you ride most frequently?
- Where do you want to see bicycle parking?
- What do you consider to be an impediment to riding?
- Where would you want to see bike lanes? Specify roads and routes.

A challenge with the survey was many respondents gave vague answers even when questions requiring specific answers or data were asked, For example, when asked "Where would you like to see bike lanes? Specify routes and roads," some respondents indicated "downtown Miami" or "everywhere." Nevertheless, in some cases, the survey did help identify several locations for potential bicycle improvements that had not been previously considered.

To find roadways that could be compatible with bicycle facilities and the publically-identified needs, the City of Miami used high-resolution aerial images to examine street right-of-way (ROW) measurements. The effort started with streets that could provide connections to the existing bicycle network; the city and county have a partnership to fly the city for aerial imagery every year. Roads with widths less than 25 feet and with speed limits of 45 miles per hour or higher were excluded from the outset. In addition to their connectivity to existing facilities, important aspects for determining locations of future bicycle infrastructure included opportunities for potential connections to parks, schools, libraries, community

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[9] Mayor Diaz and the City have taken a series of steps to ensure that Miami's efforts to curb the impact of global warming and protect South Florida's environment are coordinated and are held accountable. For more information, see www.ci.miami.fl.us/cms/mayor/4060.asp.
[10] Bicycle Action Plan for the City of Miami: http://miamigov.com/cms/Files/Bicycle_Action_Plan_Approved_by_Commission_10-16-08.pdf

buildings, and transit stations. Locations where traffic calming and controlling features were desirable were also higher priorities.

Streets deemed compatible are planned to be incorporated into future capital improvement projects, some of which are planned through 2014. Although this approach can limit the ability to make quick bicycle facility improvements, it allows planners to integrate these improvements with other, already approved infrastructure projects to phase in bicycle network enhancements over time. This approach also helps to ensure close coordination with county and state officials. Figure 1 illustrates the City of Miami's approved Bicycle Action Plan map.

Figure 1. Approved Bicycle Action Plan Map for the City of Miami
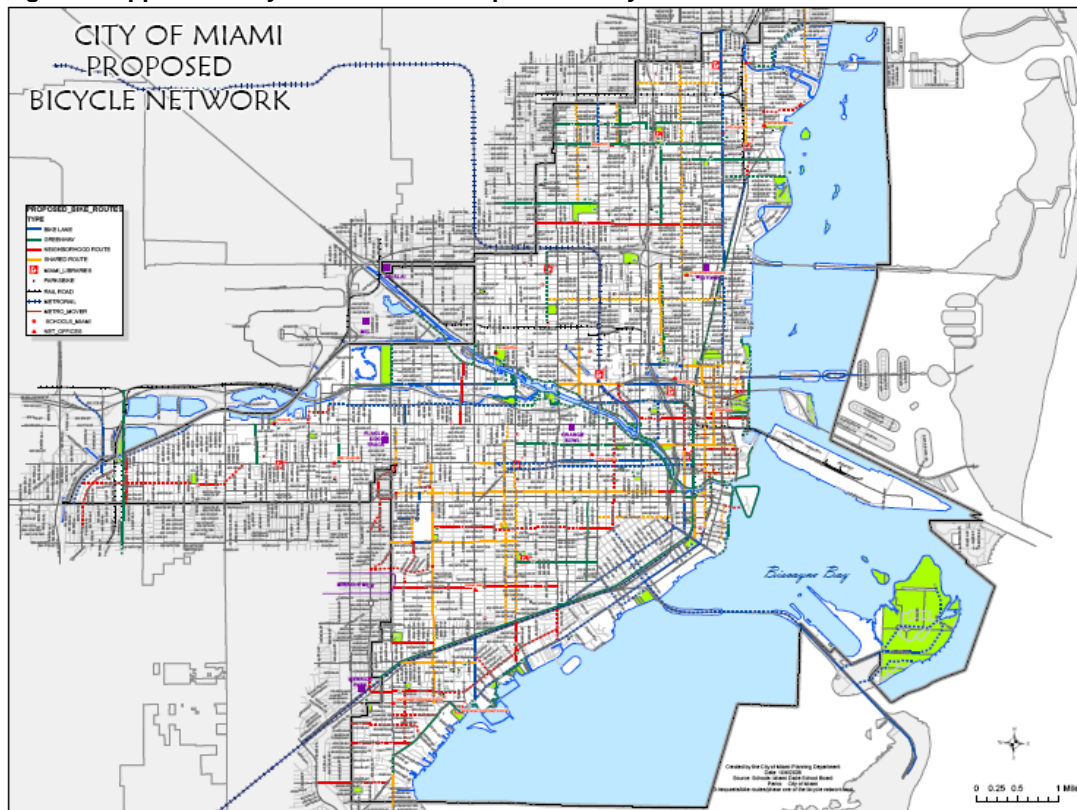
Moving Forward

The public involvement approach used to draft the Bicycle Action Plan helped identify the need for a bicycle master plan. To address this need, the City of Miami intends to develop a bicycle master plan based on a more robust citywide approach that has adequate and ample support from several of the city's agencies. The city expects to schedule workshops aimed at gathering as much stakeholder input as possible.

The City of Miami also anticipates continuing its Bike Miami Days program, another component of the Bicycle Action Plan. Through Bike Miami Days, the city set out to create greater community involvement and an exploration of the downtown community through a monthly, family-friendly day of open streets. Bike Miami Days incorporates bike safety and education, as well as food entertainment, free bike rentals, and children's events. Recently ending its first season of implementation, Bike Miami Days have been enthusiastically received by the public. Law enforcement personnel have also indicated that city crime rates improve during these events. The first season of Bike Miami Days occurred from November through May and will begin again in October.

Other Related Efforts in Miami

- **City of Miami GIS team**. The City of Miami Information Technology Department has an enterprise GIS database maintained by the GIS team. The database is currently five years old. GIS data from various city departments is housed and maintained by GIS users in those departments. The Miami Public Works Department maintains the street layer, which includes attribute data on features such as direction of streets, one-way street locations, roadway ownership (e.g., county, city, state DOT), and pedestrian pathways. A street closures layer helps the office determine the effects of closing sidewalks on pedestrians, fire hydrants, and parking. Recently, the GIS team began meeting monthly with GIS users from each department to form a GIS Users' Group. The purpose of the group is to facilitate a regular flow of information and ensure standards and practices.

- **The Street Plans Collaborative (TSPC)**. TSPC is an urban planning and design firm focused on improving the public realm and increasing the effectiveness of alternative transportation. TSPC worked closely with the City of Miami to develop the Bicycle Action Plan and is currently working with the HNTB Corporation to complete the City of Miami Bicycle Master Plan. TSPC is currently in collaboration with The Open Planning Project in Manhattan, New York. TSPC is helping to develop a suite of tools called the "Bike Planner," which will use open-source GIS software tools to improve public participation process and project implementation. The tool will allow users to view a map of their city and log the bicycle routes they take. Pop-up bubbles will indicate the location of dangerous intersections along the routes. The real-world usage patterns the tool can illustrate are expected to help inform the bicycle planning and project prioritization process.

Comments, Questions, and Answers

- **Question**: Does the City of Miami have "sharrows" (pavement markings that improve the positioning of both bicyclists and motorists)? If so, how did the city accomplish this given the Manual on Uniform Traffic Control Devices standards?
  Answer: Sharrows are recommended in the Miami Bicycle Action Plan. A challenge with sharrows is that few people know what the markings mean. Currently, Miami does not have sharrows.
  Comment: In Seattle, a number of outreach activities were conducted on sharrows, including announcements in newspapers and interactive, electronic newsletters. Seattle decided that reaching out to communities rather than "hard-core cyclists" would be a valuable public education activity.

- **Question**: Has the City of Miami considered web-based bicycle route mapping and/or how it might go about making that happen?
  Answer: Negotiations with a sub-consultant to develop a bicycling website for the city are ongoing.

- **Question**: Did having the GIS help establish more traction with county officials on pedestrian and bicycle issues?
  Answer: The City of Miami's street guidelines for transportation improvements are generally the least restrictive when compared to the county's and state's guidelines. Where the city will say "yes," the county and/or state will sometimes disagree. The ability to show how pedestrian and bicycle facilities are part of the transportation network and interact with vehicular traffic has given significant weight to these issues in discussions with both the county and the state. GIS illustrates how various transportation modes connect, as well as the potential consequences of not adding certain pedestrian and bicycle facilities.

- **Question**: Does the GIS include ridership and incident data? Are higher ridership and reduced occurrences of incidents expected with more bicycle lanes?
  Answer: Ridership is expected to increase and incidents to be minimized with additional bicycle lanes. Greater ridership is observed where there are bicycle lanes. The concept of planning these additional facilities began in March 2008. The GIS does not yet incorporate ridership and incidents data. The city's latest bicycle/pedestrian crash statistics are from 2007 and are managed by the county.

- **Question**: Some counties have very few roads with speed limits lower than 45 miles per hour – the speed threshold over which the City of Miami excluded streets for potential bicycle lanes. These roads could be the ones in most need of bicycle facilities. How many streets were excluded from the GIS analysis due to the speed requirement?
  Answer: Only a few roads were excluded due to not meeting the speed requirement. While posted speeds on many roadways is below 45 miles per hour, actual speeds may vary.

- **Question**: What challenges does the City of Miami face in terms of land use and pedestrian/bicyclist movement? Are industrial buffers becoming more residential, for instance?
  Answer: The volume of freight trucks in downtown Miami is not conducive to pedestrian movement. Since there are relatively few alleys in the downtown area, trucks are often forced to park in the road. This means that bicycle lanes, if they are even there, can become obstructed by parked trucks.

- **Question**: How aware is the City of Miami of other cities' bicycle and pedestrian efforts?
  Answer: The City of Miami does not currently have many connections to other cities across the Nation. During the development of the Bicycle Action Plan, a number of other cities' bicycle master plans were reviewed and that process is continuing. The possibilities are nearly endless since little has been established to date. The peer exchange can help point out what is and is not working.

- **Question**: Has there been any work towards developing a ROW GIS layer?
  Answer: Historically, there have not been easily obtainable ROW measurements in GIS format. Ideally, ROW data would be available, allowing for easier analysis. The city has a land management steering committee that votes on the priority of data layer development. The committee recommends a ranked list of layers to develop, which will be given to agency decision-makers. A few years ago, ROW was suggested as a priority, but the decision-makers did not agree due to the expense associated with obtaining ROW accurate enough for engineers' work. With bicycle issues coming into prominence, the case for making a ROW layer important could be strengthened.

Two Rivers-Ottauquechee Regional Commission (Vermont)
Chuck Wise, Senior Transportation Planner
Peter Fellows, GIS Manager

Overview

The Two Rivers-Ottauquechee Regional Commission (TRORC) covers 30 municipalities in rural east-central Vermont and includes a population of 57,000. The agency has a staff of eight and functions as a rural planning organization. TRORC's regulatory structures rest with the state and its 255 towns; the agency primarily functions in an advisory capacity. In bicycle and pedestrian terms, projects in the region range from $300K—$500K and the projects are usually small in scope. Inflation and funding challenges have made it difficult to implement more expensive, complex projects.

TRORC's primary GIS uses for bicycle and pedestrian planning are to assess the suitability of existing roadways for making non-motorized improvements. In addition, use of GIS has helped TRORC prioritize bicycle and pedestrian projects. As a hypothetical example, two bridges might have identical sufficiency ratings but have different non-motorized capacities (e.g., one bridge has a bicycle lane and a sidewalk; the other bridge does not). TRORC might use GIS to identify the first bridge's non-motorized capacities and strategically "count" them when assessing and prioritizing all transportation projects.

In addition to facilitating more strategic prioritization, GIS has helped TRORC breach a gap between system-wide transportation planning and neighborhood planning. Since local constituencies have historically tended to motivate most bicycle and pedestrian project implementation in the region, GIS can help to "level the playing field" by making prioritization a more objective process.

However, modeling the transportation system as part of bicycle and pedestrian planning is a difficult process. The challenge is developing objective criteria to comprehend and assess a complex system. To achieve a level of consistency and objectivity when assessing road conditions for long-range planning,

TRORC uses the Road Surface Management System (RSMS). The RSMS involves scoring different road attributes, such as the extent of roadway edge cracking, roughness, or rutting. Although the scoring is inherently subjective, planners can be trained on how to use the RSMS to achieve more predictable evaluation results. In combination with TRORC's capital project prioritization system, the RSMS set the framework for adapting a bicycle and pedestrian evaluation process.

While the state DOT focuses on engineering-related factors to prioritize projects, TRORC focuses on planning factors. Except for stimulus-related project solicitations, TRORC uses planning factors to prioritize and evaluate approximately 60 Federally funded transportation projects each year. Examples of these planning factors include the extent to which projects contribute to:

- System preservation (repair/rehabilitation projects promoted over replacement)
- Safety benefits (project addresses known safety deficiencies)
- Economic development (project reduces single vehicle occupancy), and
- Alternative routes (project helps maintain linkages between communities and within the region).

Using GIS to Develop a Bicycle and Pedestrian Plan

TRORC's draft bicycle and pedestrian plan has been completed. To develop the draft plan, TRORC took a number of steps, including:

Public Involvement Process. TRORC worked with a citizens' advisory group to identify important bicycle and pedestrian considerations. These considerations were divided into two categories: land use and transportation factors. Land use factors included existing land use densities, proximity to businesses and schools, and development growth centers. Transportation factors included RSMS road conditions, traffic volumes, and traffic speeds. TRORC then translated these factors into a GIS map to model potential areas for project implementation. Data were also organized by management segments, which comprised groups of towns and districts.

Prioritizing Projects. To prioritize bicycle and pedestrian projects for inclusion in the plan, TRORC used GIS to identify those projects that were located within a half mile of bus services. TRORC coded roads that received transit service and designated half mile "buffer zones" along these roads. TRORC then coded the roads that fell within the half mile buffer zones; roads that were within the zones or within walking distance of the zones received a certain number of points. Management segments then were drawn on top of the potential roads to designate areas for potential non-motorized projects. Points were totaled to determine the priority areas for these projects. Mr. Wise noted that this coding process sometimes yielded roads that could fit into a number of potential management segments. In these cases, roads had to be manually designated as part of a specific management segment.

Assessing Road Conditions and Suitability. TRORC used GIS to assess road conditions and suitability for bicycle and pedestrian activities. Elected officials helped define the final project prioritization methodology that was then used to evaluate every public road. The prioritization methodology was determined before any roads were formally evaluated. Elected officials had to contribute their planning priorities before seeing how these priorities might impact specific projects. Elected and appointed officials from the selectboard, planning commission, and conservation commission worked for months to finalize a ranking methodology that professional staff and citizen volunteers then used to evaluate the road system.

As part of this evaluation, traffic speeds were coded for road segments and then summarized into three speed limit categories (40 miles per hour and higher, 30-35 miles per hour, and 25 miles per hour). Higher points were assigned to roads with traffic speeds that compromised actual and perceived safety.

To further assess potential roads for bicycle and pedestrian facility development/improvements, TRORC used a three-step process to identify a road condition priority score. First, traffic volumes and land use densities were added to the number of walking and biking routes to produce a planning priority score. Second, special situations (e.g., political contexts) were considered to further rank potential roads. Finally, the quality of walking and biking conditions (including issues such as the vertical grade of biking routes or

other types of topography that affect walking and biking) were considered as "tie-breakers" for those projects that received identical planning priority scores.

Additional variables such as statewide planning priorities (e.g., support of Vermont tourism) may be considered in future assessment processes. While these types of variables can help to focus and narrow a list of priority projects, they can also be subjective and difficult to translate into a GIS.

Public Feedback. As a final step, TRORC input priority road segments into the GIS and downloaded the data into an Excel spreadsheet for public distribution. Feedback was solicited by distributing surveys at local bike shops. The surveys asked the public to comment on those road segments recommended as priorities for non-motorized planning activities. The public agreed to approximately 20 percent of the planned improvements/developments. The public also unanimously supported the bicycle/pedestrian ranking system; there were no negative comments about the ranking process.

Lessons Learned

Lessons TRORC learned from the process of using GIS to develop the draft bicycle and pedestrian plan are:

- It is important to know what data are in hand and where gaps exist so preparations for any necessary data collection efforts can be made.

- To disseminate findings more broadly, put GIS data into more user-friendly formats, such as Excel spreadsheets, and avoid technical jargon. GIS data can always be imported back into GIS after public review.

- Contextualize data so that information becomes more meaningful. For example, TRORC decided to organize roads into speed limit categories to better address the varying degrees of severity of vehicle-bicycle collisions at different speeds (i.e., likelihood of bicyclist fatality increases with vehicle speed).

- GIS allows for the analysis of most criteria. However, too many criteria or planning factors can make information become unwieldy. Similarly, too few planning factors may increase project ties. To break ties between identically scored projects, it is important to have additional, more specific planning factors to apply.

- GIS cannot easily model general or subjective variables such as "support of tourism." Translate variables into more specific language to make information more conducive to GIS mapping.

- GIS can help to display three-dimensional views, which is particularly important for bicycle and pedestrian planning in Vermont given the broad range of cyclists' abilities and the hilly topography.
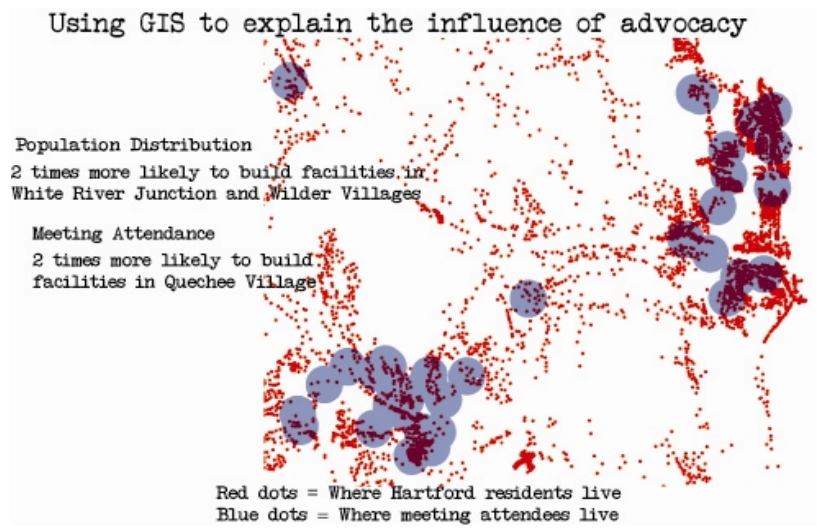

Figure 2. An example of TRORC's use of GIS to explore spatial relationships between meeting attendance and project implementation.

Ongoing GIS Uses

While finalization of the draft bicycle and pedestrian plan is on hold while other municipal priorities are addressed, GIS has been adapted to other transportation and recreation projects at TRORC. For example, GIS is being used as part of the Safe Routes to School program to depict origins and destinations for students walking to school. GIS can be used to explain corridor-level priorities while helping people better understand spatial relationships. GIS can also help show the relationship between attendance at public meetings and project implementation (see Figure 2).

Comments, Questions, and Answers

- **Question**: What kind of mass transit does the region have?
  Answer: The region has a minimal fixed-route bus system. Transit systems are useful as proxy measures for land use densities.

- **Question**: Why did TRORC prioritize roads with speed limits above 40 miles per hour?
  Answer: TRORC's prioritization focused on roads with speed limits of 35 miles per hour or higher. Bicyclists and pedestrians need more help on roads with higher speed limits. Separate bicycle and pedestrian facilities are often not needed on local roads and streets; in fact, in some cases it can be beneficial to integrate non-motorized activities with vehicular traffic.

- **Question**: Does TRORC encounter any challenges related to achieving intra-agency concurrence, and how does the agency use GIS to address these challenges?
  Answer: That is a difficult issue. TRORC's perspective is that GIS can help make more transparent decisions because people can interact with GIS products and can more easily understand the potential impacts of specific projects. For example, GIS was recently used to plot the location of 560 streetlights and identify lights that were in consideration of being eliminated. After viewing the map, bicycle and pedestrian advocates could more clearly understand how the elimination of these lights might impact cyclists and walkers. To ensure the safety of cyclists and walkers, advocates recommended that certain lights remain in place.

- **Comment**: Some agencies' cultures are more quantitatively oriented and bicycle and pedestrian activities are somewhat difficult to quantify. In agencies that have strong quantitative cultures, planners might have to work hard to develop or use quantitative measures to justify bike and pedestrian project funding. Quantitative measures can also help define benefits when weighing different projects against each other.
  Answer: That can be the case. TRORC believes that GIS can help make more democratic decisions and can support the business missions of agencies even if they have different organizational cultures.

- **Question**: Did the public request the GIS data that had been downloaded into Excel files?
  Answer: Yes, they did. Because the information was in Excel, it could be emailed quickly and easily. Some recipients of the information provided corrections to the data as well.

- **Question**: Is TRORC's Safe Routes to School process difficult?
  Answer: Sometimes there are challenges to implementing this program. However, GIS has helped to justify and explain the need for program funding.

- **Question**: What type of state-level support for GIS exists?
  Answer: Vermont has very good state-level support for GIS. TRORC collects most data but there is an extensive state GIS network where certain data, such as natural resources, can be obtained. In most cases, TRORC does not have to "start from scratch" but simply adds lower-resolution data to what already exists. New data has to be constructed about one-third of the time. Currently, TRORC is trying to collect data from automatic pedestrian counters, but the technology is quite new; and there are sometimes problems, such as counting both a vehicle and its tail pipe as pedestrians (the pedestrian counters are heat-sensitive). The pedestrian counters are a proxy; these data are not as informative as direct data about where people are going.

- **Question**: Has TRORC found that elected officials helped TRORC corroborate the prioritization methodology?
  Answer: The bicycle/pedestrian prioritization methodology was universally accepted by all town officials and citizens although some groups still strongly argued for particular sidewalks and bicycle or pedestrian projects. Some exceptions had to be made, and these projects were added into the top-ranked project priorities with an explanation about why they were made priorities. The project's original prioritization score was kept for reference.

New Jersey DOT
Robert d'Abadie, Michael Baker Jr., Inc.

The New Jersey Department of Transportation (NJDOT), in cooperation with New Jersey's three MPOs, developed an update to its Bicycle and Pedestrian Master Plan. The Master Plan provides a framework for estimating bicycle and pedestrian demand and analyzing demand and roadway suitability, along with additional methodologies for identifying priority corridors. The metrics in the Master Plan also provide a comparative framework for ranking projects at the statewide level. The update to the plan was unique in that it quantified bicycle and pedestrian needs at the statewide level, providing guidance to decision-makers on the best locations for future bicycle and pedestrian investment. GIS data inventories on both bike/pedestrian facilities and on trip attractors, such as schools, commercial areas, and transit stations, were critical in performing the analysis that led to the project priorities described in the Bicycle and Pedestrian Master Plan. The resulting list of priority locations for bicycle and pedestrian facilities across New Jersey are expected to help evaluate the need for bicycle and/or pedestrian improvements on existing and new infrastructure projects.[11]
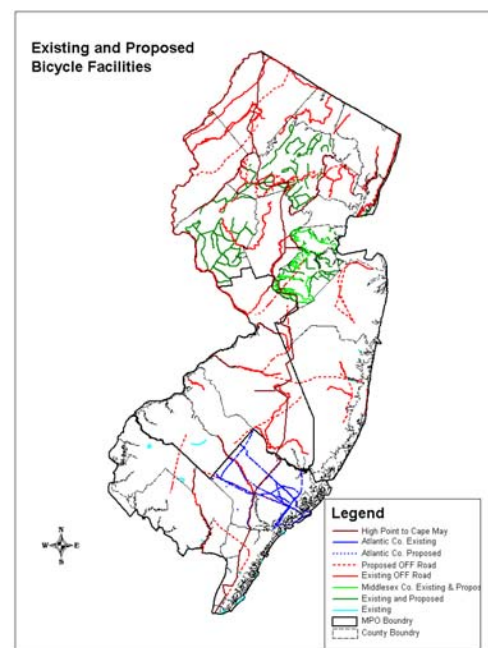
To conduct the GIS analysis, the bicycle and pedestrian network first was inventoried. NJDOT and its consultant held three workshops across the state aimed at identifying what geospatial data for bicycle and pedestrian facilities existed for counties. A few counties were able to offer electronic data layers, while others gave paper maps or nothing at all. After completing the inventory, existing, programmed, and proposed bicycle and pedestrian facilities were mapped and then shown to the counties (see Figure 3). With the map in hand, the counties realized that they may have had more relevant data than first thought, motivating them to become more involved and provide additional data for the analysis. Additional data collected included information on trip attractors, inactive and active rail lines, the location of transit-oriented development, and Federal, state, and local funding opportunities.

Figure 3. Existing and proposed bicycle facilities in New Jersey

Bicycle Suitability and Demand

As part of the Bicycle and Pedestrian Master Plan, both bicycle and pedestrian travel demand and suitability were modeled to investigate priorities for the consideration of capital investments. Wanting to use the state of the practice at the time, several potential models were evaluated. For example, the Bike Demand Model (BDM) identifies potential demand based assuming no facility constraints, while the Bicycle Compatibility Index (BCI) looks at existing roadway and traffic

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[11] Paraphrased from Swords, Andrew R., et al, *An Analytical Framework for Prioritizing Bicycle & Pedestrian Investments: New Jersey's Statewide Bicycle & Pedestrian Master Plan Update, Phase 2*, TRB 2004 Annual Meeting. The final report includes all technical information related to developing the prioritization models.

characteristics to assess suitability for bicycle use. It was intended that the model used would have some of the following characteristics:

- Data would be available
- It would be nationally accepted
- It could easily be updated
- It could easily be applied at local levels

The resulting model used a combination of several interdependent methods in conjunction with facilities and trip attractor inventories at the statewide level. After the analysis, areas where bicycling demand was high and suitability was low were determined to be priorities.

Pedestrian Demand and Suitability

To help quantify the potential demand for infrastructure improvements, a pedestrian analysis was also undertaken. The model used in the Bicycle and Pedestrian Master Plan to quantify pedestrian demand was the Pedestrian Compatibility Index (PCI). The PCI was based in part on the North Jersey Transportation Planning Authority's Pedestrian Potential Index, which uses census tract level data, roadway density, and other factors to identify the areas with the greatest likelihood of significant pedestrian demand. The PCI index scores were created by multiplying 2000 census tract boundary scores for input indices:[12]

- Activity Balance Index
- Transit Service Index
- Pedestrian Facilities Index
- Road Density Index

PCI values calculated were used to identify locations with the greatest current and potential pedestrian demand.

Due to the limited data available at the statewide level—in particular, the absence of sidewalk data— an alternate approach was developed to grade pedestrian accommodation on a roadway. A crossability index was created as a surrogate to the actual compatibility of a roadway. A methodology to estimate the time needed to cross the road (wait time plus crossing time) was based on average walking speed, step-off time, roadway width, number of lanes, and presence of a median. Using traffic volumes and a Poisson arrival pattern, the percent of the time that the road is crossable was then estimated. This estimate was used to identify those roadways that were in greatest need of pedestrian facilities.[13]

Challenges and Opportunities

A challenge in conducting the analyses was that counties did not always have the GIS capabilities necessary to recreate the analyses performed for NJDOT. Although a series of spreadsheets intended for these counties was developed, only about 25 percent of the counties were able to do the analysis themselves.

Training to the counties on how to apply the measures is ongoing. At a basic level, counties are being shown how to overlay bicycle and pedestrian demand layers with facilities and compatibility layers so that a four-mile buffer and all attractor data can be added. At the end of the process, counties have maps that illustrate the presence of high demand areas for bicycle and pedestrian use, as well as roadways where existing facilities are insufficient. This process is expected to help them justify investment in bicycle and pedestrian improvements.

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[12] Metropark Rail Station Pedestrian Enhancement Study.

[13] *ibid.*

In the future, NJDOT anticipates updating the model to have the latest census boundaries, better roadway, sidewalk, and facilities databases, and an enhanced approach for analyzing dense urban areas. With these data, it is expected that the calculation of model values in the GIS will be automated so that manual data input is no longer necessary.

Comments, Questions, and Answers

- **Comment**: Qualitative analysis, such as local input, provides the foundation of any evaluation or plan. Models do not provide definitive approaches on their own nor do they supersede past, qualitative work.

Michigan DOT
Debra Alfonso

Overview

The Michigan DOT (MDOT) was an early adopter of non-motorized facilities. Section 10K of Michigan's Public Act of 1951 demonstrates the state's early commitment to these activities. The act governs state appropriations for highway and transportation funds and requires that at least one percent of the Michigan transportation fund be expended on non-motorized services or facilities, as calculated on a 10-year running average. The act provided impetus for several non-motorized projects, such as MDOT's construction of a paved 40-mile path running adjacent to the I-275 freeway.

As part of a broad MDOT initiative to improve the non-motorized landscape, MDOT developed a series of 10 regional bicycle maps that cover the entire state. The initial prototype took several years to develop with full stakeholder input. The effort to obtain extensive input from system users when developing the prototype helped highlight issues of importance to users, such as the best size for the maps.

The prototype was developed with an early insistence on the use of GIS as an important, integral tool to the process. The prototype laid out the scale and format for all the maps to follow, down to the detail of inset layouts. From earliest conception to completion, developing the entire series of bike maps took 10 years; almost all of the bike maps have now been published, and several have already been updated.

The maps are printed on quality water-resistant paper designed for outdoor use and each printing is intended to last three years. While being well-received by users, the map revenue goes into the general fund for MDOT and is not recycled into the non-motorized program. Maps are distributed with a suggested $5.00 value but each agency involved is allotted a supply to distribute as suits its needs. MDOT contracts with the League of Michigan Bicyclists to handle map orders, shipping, and maintain a customer database. Maps can be ordered from the MDOT bicycling homepage at www.michigan.gov/mdot-biking.

Data Collection for the Regional Bicycle Maps

To gather information for the regional bike maps, MDOT drew on existing data and collected new data when necessary. Some geospatial information was available from MDOT's transportation management system, especially for features such as ferries, rail, bridges, and carpool lots.

The Center for Shared Solutions and Technology Partnerships, a part of the Michigan state government Department of Information Technology, maintains a statewide GIS framework. The framework uses a physical road linear referencing system (LRS) to organize geographic data, which is updated on an annual basis. The state framework was an integral resource when developing the regional bicycle maps. The regional bike maps use the physical road LRS data from the state framework to produce attribute-rich road layers; MDOT does not yet have a LRS for off-road data. Framework files provided to each area included all trunkline information (i.e., road type, surface, shoulder type and width, and average daily traffic (AADT) counts), hydrology layers, county, city, and urban boundaries, parks, rail, and a local road layer.

While some shared-use path and shoulder data were available from MDOT's internal departments and from the state GIS framework, MDOT found that this area has typically been a lower priority for statewide data collection. To augment existing information, MDOT partnered externally with regional entities and MPOs to collect trail, road shoulder data, and other information on the local system in addition to general amenities (such as restaurants/public restroom facilities). A private consulting firm, the Greenways Collaborative, assisted in creating three of the regional maps.

MDOT contracted with three of the state's 15 MPOs and six of the 14 state planning and development regions for data collection. These agencies were required to provide specific types of data for the regional bike maps, such as pavement type on non-trunkline roads, rail trails, and local road AADT counts. In addition, the agencies can customize the maps with information pertinent to their area, such as adding information about wineries in southwestern Michigan or elevation data for parts of northern Michigan. In the future, agencies will be requested to collect a total of 29 attributes for trail, road, and bridge layers for a proposed MDOT master non-motorized database.

Building the Regional Bike Maps

The regional bike maps identify roadways with shoulders exceeding four or more feet as well as existing regional, county, local, and state bicycle facilities, multi-use trails, points of interest, trailheads, services, and road surface type (e.g., gravel or paved). In addition, the maps include color codes that designate annual AADT. To allow map users to make more informed decisions about what types of roads to travel on, the AADT figures were "translated" into ranges relevant for a bicyclist, such as "light" traffic volume (under 2,500 cars a day), "medium" (2,500 to 10,000 cars a day), and "heavy" (over 10,000 cars a day). An excerpt from a regional bike map is depicted below in Figure 4.

The maps also show that shoreline routes and abandoned rail corridors have received more attention as potential destinations for bicycle and pedestrian activities. MDOT's next step is to identify projects at the local and regional levels with potential for including non-motorized facilities.

Figure 4. Excerpt from a regional bike map in Michigan.

Regional Non-Motorized Plans

The regional bike maps served as a base for developing regional non-motorized plans.

The plans identify the locations of paths, trails, potential rail-trail corridors, roads with paved shoulders, and priority corridors. MDOT uses the plans to identify opportunities for potential bicycle and pedestrian projects and to guide where and how to invest in non-motorized networks. These opportunities, as identified in the plan, might include:

- "Spot treatments" like locations for making shoulder improvements on hills and curves with poor sight lines or areas for way-finding signage improvements.
- New areas for bike parking.
- Areas to implement road diets—techniques to reduce the number of travel lanes and/or road width—to add bike lanes and paved shoulders. Road diets and restriping efforts can be more
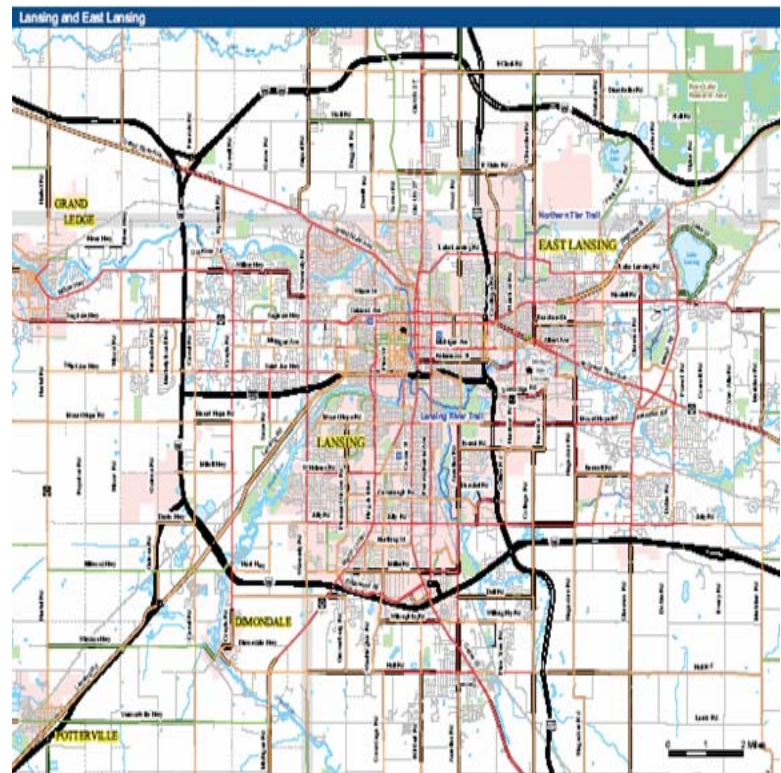
acceptable to communities that have difficulty obtaining the necessary ROW to construct a bike lane. Road diets can also have traffic calming effects.

- Increasing road networks to address gaps (see Figure 5 below, which displays an excerpt from one of the regional non-motorized plans).
- Identifying roads with shoulders less than four feet where restriping efforts or other changes could occur.

Figure 5. Excerpt from a regional non-motorized plan in Michigan.
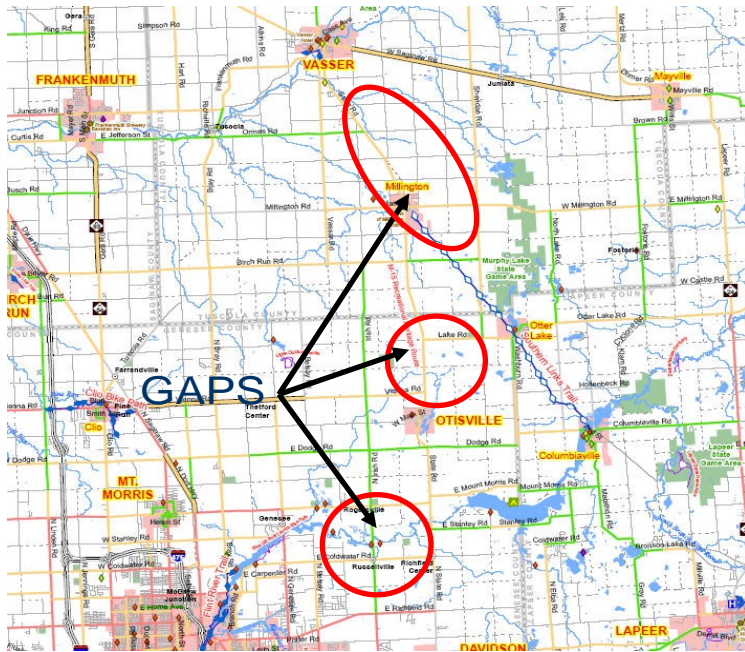
To increase connections between rural areas, MDOT focused on coordination with on-road projects or linking existing non-motorized paths to major traffic generators.

To address opportunities for non-motorized planning in urban areas, MDOT assumed a need for bike lanes on urban thoroughfares and collectors and emphasized building a usable network of bike lanes. In many areas, particularly local neighborhoods, there may not be a high demand for bike facilities. In many areas, particularly local neighborhoods, traffic volumes are low enough that no special accommodations are needed.

In Michigan, there have often been many opportunities to add non-motorized elements to existing projects.

In particular, the Context Sensitive Solutions (CSS) initiative, which encourages development of transportation facilities suited to their physical and/or environmental settings with local input on priorities and needs, can help further non-motorized activities.

Since 2003, Michigan has had a CSS policy that requires MDOT to incorporate this approach into transportation decision-making when possible. The policy has facilitated bicycle and pedestrian infrastructure development. For example, engineers developed a context-sensitive tunnel under a roadway to allow bicyclists and pedestrians continuous access to a rail-trail corridor. The tunnel, which was built without the need for extensive advocacy from MDOT's bike and pedestrian planners, demonstrates that both context-sensitive planning and non-motorized planning can fit well together.

Current and Future Efforts

MDOT is moving into the second phase of the regional mapping project to update existing bike maps and identify critical elements to include in the next generation of map updates. In addition, MDOT is working to create a non-motorized transportation database for collected trail data. This geodatabase will potentially allow MDOT to create a rich interactive web application of the Michigan non-motorized network.

Work has also started on Connecting Michigan: Planning for the Future of Michigan's Trail System: A State Trails Planning Partnership,[14] a state visioning plan to assess opportunities for building an interconnected trail system to link all areas of the state.

MDOT reported that an increased emphasis on bicycle and pedestrian planning has led to a changing organizational culture. For example, part of the department's project development "checklist" is to look at

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[14] The Connecting Michigan website is available at: http://michigantrails.org/connectingmichigan/

the potential incorporation of bicycle and pedestrian facilities. MDOT's CSS policy has also increased the focus on bicycle and pedestrian projects; likewise, a new departmental policy on sidewalks has emphasized constructing sidewalks to fill obvious gaps or otherwise meet needs. Both policies represent significant changes from several years ago.

Challenges

It has sometimes been difficult for MDOT to integrate one-time data collection efforts with other departmental needs. For example, MDOT underwent an extensive state effort to collect an inventory for ramps constructed to meet requirements of the Americans with Disabilities (ADA) Act. The inventory comprised information on the location and slope of the ramp. The effort did not involve collecting information on pedestrian signal location and sidewalks, although these data could have been obtained relatively easily while capturing the ramp information. It is important to consider opportunities to integrate data collection efforts to ensure that robust information is available for more comprehensive bicycle and pedestrian planning.

MDOT also found it challenging to address inter-agency data compatibility issues when building the regional bike maps. Each MPO used a different type of GIS database to collect attributes for the maps. Once received, MDOT had to spend extra time translating these data into a format usable for the agency. Additionally, obtaining data for the rural parts of the state not covered by MPOs was difficult. To do this work, MDOT had to negotiate with several agencies to collect information from outside their boundaries. Despite these difficulties with inter-agency collaboration, however, MDOT found that the data collection partnerships with external entities helped to generate significant support, awareness, and enthusiasm for bicycle and pedestrian planning. Overall these partnerships were significant assets to the bike mapping effort.

Comments, Questions, and Answers

- **Question**: Was a global positioning system (GPS) used to complete the ADA inventory?
  Answer: Yes, a GPS was used for the sidewalk ramp inventory and for some of the rail-trail data.

- **Question**: Are there initiatives related to Complete Streets in Michigan?
  Answer: There is a Healthy Kids, Healthy Michigan initiative that is recommending Complete Streets as one part of the solution to combat childhood obesity. The governor-appointed Climate Action Council has also indicated support for policies or programs that support bicycling and walking. Complete Streets is also on the legislative agenda of the League of Michigan Bicyclists.
  .
- **Question**: Was there an underlying assumption that GIS would be used for the regional bike maps or was this a conscious decision?
  Answer: MDOT believed that GIS was an essential tool and was not optional. The agency's prototype included the use of the Michigan geographic framework system before the first version of the framework became available in 2001.
  Comment: NJDOT also believed that using GIS was essential to bike and pedestrian planning. One challenge that NJDOT faced was in addressing data compatibility issues. Dynamic segmentation, a process that allows all attributes in a GIS to update simultaneously, has been integral to making data compatibility less of an issue.

- **Question**: What were some of the challenges related to collecting geospatially referenced bicycle and pedestrian data?
  Answer: MDOT wanted to collect bicycle and pedestrian data several years ago but encountered a major barrier when determining the appropriate physical referencing standards. While the road and physical referencing system is considered a priority, MDOT is now working to establish the need for bicycle and pedestrian data to be elevated as priority attributes for the Center for Shared Solutions to maintain. MPO and Regional Planning Agency staff turnover has made it difficult to maintain data once they have been collected. Although certain attributes were required to be collected, standards

for database fields and naming conventions were not agreed upon in advance due to varying software implementation.

- **Question**: Are all bicycle and pedestrian data considered roadway data?
  Answer: Yes, if they are on or adjacent to a road. For example, shoulder information is not always considered roadway data, but it is very relevant to bicycle and pedestrian activities. The ramp inventory is considered roadway data, but it could be considered relevant to bicycle and pedestrian data as well. Currently, MDOT is discussing how to integrate bicycle and pedestrian data into the roadway system and make the information available to the department.

- **Question**: Did MDOT contract out bike route data collection to the MPOs when building the regional bike maps?
  Answer: Yes, but MDOT retained ownership and approval authority of the data after the MPOs collected them. As part of the agreement, the MPOs/regions are required to turn the data files over to MDOT. MDOT developed data standards (such as a standard symbology) to achieve a level of consistency in how the MPOs reported data. However, in some cases, data compatibility issues meant that information had to be translated into a format usable for MDOT. There were some color variations between each of the regional maps submitted by MPOs, but these differences were small and will not confuse map users.

- **Question**: Is MDOT developing a web-based version of the paper bike maps?
  Answer: MDOT has PDF copies of the maps available for downloading from its website. In the future, MDOT may consider developing an interactive web-based application to provide on-demand bicycle routing information.

- **Question**: Does MDOT have standardized street data?
  Answer: Yes, the agency has very strict standards set by the Center for Shared Solutions, the statewide geospatial framework. The state collects aerial imagery for the state. Some counties also share higher-resolution imagery as well.

- **Question**: Does MDOT provide any incentives to municipalities to develop GIS bike and pedestrian data?
  Answer: Michigan has a statewide GIS framework that provides this kind of incentive already. Some counties have their own GIS applications and prefer to use them.

City of Seattle DOT (Washington)
Chad Lynch, Seattle DOT and Amalia Leighton, SvR Design Co.

Seattle's Bicycle Master Plan

Thirty-six percent of Seattle residents bicycle recreationally, and approximately 4,000-8,000 individuals daily use their bicycles to commute to work. Given these ridership levels along with the city's climate, topography, and diverse demography, pedestrian and bicycle planning has become an important component of the city's overall transportation planning effort. GIS has played an increasingly significant role in assisting planners in the prioritization of bicycle and pedestrian improvements as the city moves to be less "auto-centric."

The earliest GIS for the city began in 1990, evolving from work being done in the City of Seattle's former Engineering Department. Early on, the city's GIS was used to improve the way utility infrastructure was managed and operated. Now GIS has permeated many of Seattle's business areas with at least six of the city's departments formally conducting some type of geospatial analysis.

The long and varied GIS history has contributed to a complex corporate geospatial architecture in Seattle. Eight offices subscribe to the city's primary geospatial database, and development of new databases and layers occurs on an ongoing basis. At Seattle DOT, staff members maintain and can access and update an abundance of GIS data. For example, through the Hansen asset management system, street

maintenance and traffic management staff can view and update data on capital projects and roadway structures. Major projects, street use, and urban forestry staff can edit permitting data, while personnel in the policy and planning office can change data in an ArcSDE database. All of these data are referenced to the city's centerline file.

Approved in 2006 and completed in 2007, the Seattle Bicycle Master Plan capitalized on all of these geospatial data resources. Defining a set of actions to be completed within 10 years, the Bicycle Master Plan envisions a 450-mile network of on-and off-street bicycle facilities connecting Seattle and providing cyclists convenient access to transit stations, workplaces, parks, commercial areas, and other destinations throughout the city. Its goals are to increase the number of bicycle trips while reducing the number of crashes involving bicyclists.

In developing the plan, the City of Seattle compiled a field inventory of all existing bicycle facilities in the city along with a list of the facilities needed to complete the network, including bicycle lanes, sharrows, climbing lanes, and signed routes. GIS analysts then worked to prioritize potential projects based on criteria established by the Seattle Bicycle Advisory Board and Seattle DOT staff. Prioritization criteria were based on links, barriers, safety, land use, and destinations. It is anticipated that using these criteria will help ensure that the completed bicycle facility network will offer at least one bicycle facility within a quarter mile of 95 percent of Seattle homes.

Since the plan was implemented, much progress has been made, including the addition of 56 new miles of bike lanes or sharrows, 15 new signed routes, 16 green lanes, and 429 bike racks, among other improvements.

The master plan and latest progress report (February 2009) are available at www.seattle.gov/Transportation/bikemaster.htm.

Seattle's Pedestrian Master Plan

Currently, about 25 percent of Seattle does not have sidewalks. The city's recently completed draft Pedestrian Master Plan aims to improve this and other characteristics of Seattle's walking environment. The plan, which is entirely Internet-based, defines the steps necessary to make Seattle a more walkable, livable, and healthy city. The goals of the plan are safety, equity, vibrancy, and health so that access in all Seattle's neighborhoods is enhanced.

An interagency advisory team provided pedestrian-related data and input on an in-depth review of the policies and practices related to the pedestrian environment. This helped to inform the plan's objectives and strategies. To begin, the team compiled and analyzed data related to the plan goals. The current quality of the pedestrian environment and anticipated pedestrian activity levels were evaluated. The analysis also considered socioeconomic and health factors, such as lower rates of automobile ownership and higher rates of diabetes and obesity. In doing so, all streets were viewed as having some improvement opportunity; no streets were considered perfect.

Figure 6. Composite pedestrian priority map for Seattle. The map combines the outputs of a Demand Map, Equity Map, and Corridor Function Map developed as a part of the Pedestrian Master Plan development process.

Using the centerline as the reference point, Seattle DOT completed a sidewalk inventory, identifying where sidewalks were and how their existing conditions could be characterized throughout the city. Opportunities for improvement were estimated using variables that contribute to the pedestrian environment, such as:
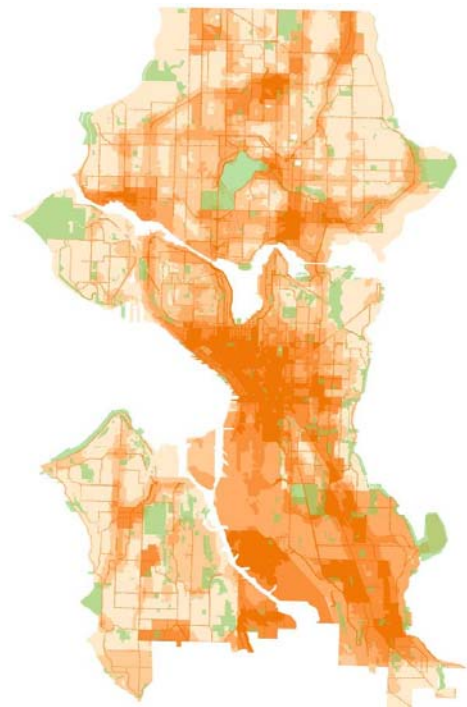
- Vehicle speed limit
- Road width
- Presence of traffic signals and distance between them
- Presence of curb ramps and crosswalks, which were used as proxies for a street's crossability.

Using this approach, an area with wide roads, no sidewalks, and no traffic signals was assumed to be more challenging for pedestrians than an area with sidewalks, traffic signals, lower traffic speed, and curb ramps on every corner. All roads and intersections were then scored, allowing for an overall comparison of the city's streets' pedestrian potential.

In order to prioritize potential projects, the scores were first entered into a GIS and combined with other prioritization criteria to generate three maps: a Demand Map, an Equity Map, and a Corridor Function Map. The Demand Map was based on "demand generators" intended to help planners further understand where people walk. High generators included universities or colleges, major destinations, and major transit stops. Medium generators were major retail and grocery stores, hospitals, community centers, and parks. Low generators included minor retail stores and bus stops. The Equity Map identified where pedestrian improvements would serve people with the greatest needs. Neighborhoods with low incomes and low auto ownership rates and people with disabilities, obesity, chronic disease, and low levels of physical activity were considered higher priorities in the Equity Map. Finally, the Corridor Function Map balanced street classification and land use in auto-oriented corridors with the needs of pedestrians based on their destinations. For example, Seattle's port facilities area, which produces significant economic activity for the city, was considered as an important pedestrian priority area in the Corridor Function Map.

The three maps were then combined to establish pedestrian priorities (see Figure 6). The Demand Map contributed 40 percent to the final prioritization, while the Equity Map and Corridor Function Map contributed 35 percent and 25 percent, respectively. The highest scoring priority areas were overlaid with the initial data collected on improvement opportunities.

Building in performance measures and reporting and tracking requirements, the resulting Pedestrian Master Plan makes a commitment to work on making improvements in the priority areas over the next five years. The plan also informs future data gathering efforts, planning level cost estimates, and interagency and project development coordination. Funding for pedestrian improvements for 2009-2014 is approximately $60-72 million, or $10-12 million per year.

The draft Seattle Pedestrian Plan is available at www.seattle.gov/transportation/pedestrian_masterplan/. More details regarding the implementation of the plan, as well as links to the GIS-based project prioritization assessment, are available at www.seattle.gov/transportation/pedestrian_masterplan/pmp_implementation.htm.

Comments, Questions, and Answers

- **Question**: Is "My Neighborhood Map" available to the public?
  Answer: Yes. My Neighborhood Map can be accessed at http://web1.seattle.gov/MNM/.

- **Question**: How dynamic is the Bicycle Master Plan prioritization process, and what is the schedule for updating the plan? Is the prioritization process available anywhere online?
  Answer: Right now, the plan is to be updated every five years. It is expected that the framework will be applied to many more business functions in the future. The prioritization process is described online at www.seattle.gov/Transportation/bikemaster.htm. The City of Seattle is working to automate the prioritization process more so that five-year periods modeled can be generated multiple times using different factors.
  Comment: It is impressive that the model clearly furthers the goals of Seattle's Bicycle Master Plan.

- **Question**: How are the bicycle improvements funded?

Answer: Typically, the city pays for the improvements, unless or they are funded through a grant program like CMAQ. It is getting more difficult, however, to justify bike rack projects through the CMAQ grant process. The executive level of the Seattle DOT understands the importance and need for improved bike facilities; securing funding has not been difficult.

Broward MPO (Florida)
Mark Horowitz

The Broward MPO, established in 1977, is the lead agency responsible for developing and administering plans and programs to maintain eligibility and receive Federal funds for the transportation systems in Broward County, FL. The MPO has five districts and 19 member municipalities. There are approximately 4,000 miles of roads in Broward County, of which 700-800 are arterials and collectors.

To enhance the availability of bicycling information in the county, the MPO has funded two state universities—Florida International University (FIU) and the University of Florida—to develop an interactive, web-based bicycle route-planning tool. Using specially developed algorithms, the tool calculates a variety of routes for the same origin and destination based on bicycle facility locations, bicycle suitability ratings, traffic signal locations, signal timing, and bicyclists speed (see Figure 7). It also allows the user to view a variety of transportation related information as static layers. The tool uses these factors to help bicyclists to choose a bicycle route based on the following optimization criteria:

Figure 7. Map of bicycle facility and signal information in Broward County .

- Shortest route – the criterion is based on road segment distance (see Figure 8).
- Fastest route – the criterion is based on road segment distance, turns at controlled intersections, and signal timing. Travel time is computed as segment length over travel speed, where a default travel speed of 16 kilometers per hour was assumed.
- Safest route – the criterion is based on Broward County's roadway condition index and minimizes a route's exposure to roads with higher average daily traffic volumes, number of traffic lanes, and speed limits. Other location factors such as type of street parking and presence of raised median are also included in the algorithm.
- Simplest route – the criterion minimizes the number of total turns along a route.
- Most scenic route – the criterion choose optimal routes by increasing the perceived cost of bicycling along arterial roads and reducing the perceived costs of travel within water or park buffers and travel on bike-only segments.
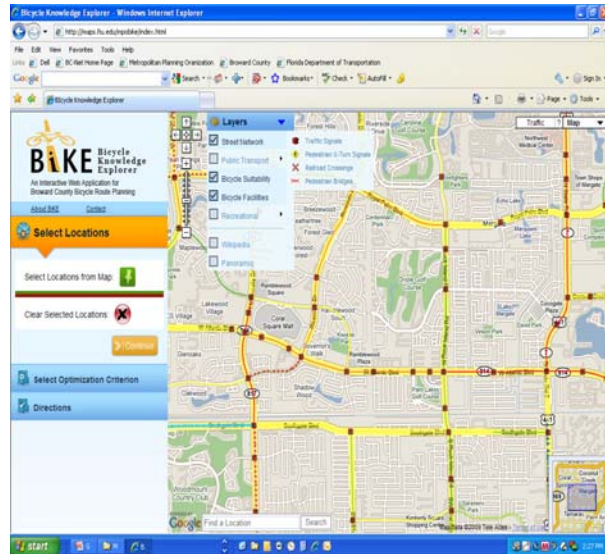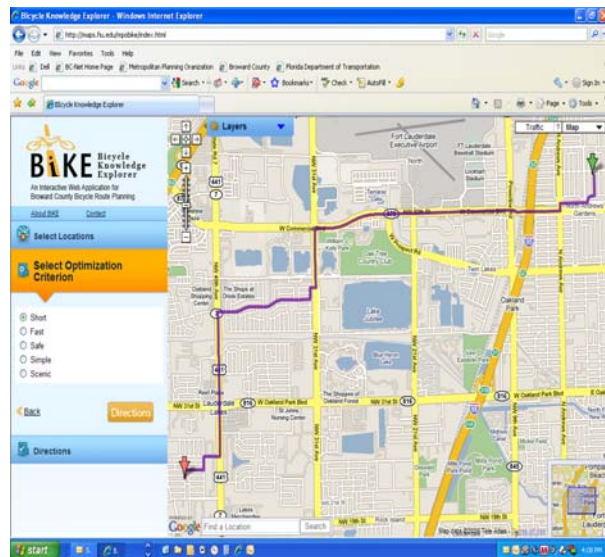

Figure 8. Example shortest bike route map generated by the Bike Knowledge Explorer.

The planner provides users with printer-ready, turn-by-turn directions indicating time and distance. Development of the tool is expected to be completed in August 2009.

Comments, Questions, and Answers

- **Question**: Has Broward MPO faced any licensing issues in developing the interactive tool?
  Answer: No. Google offered the mapping software for free as part of its Application Programmable Interface (API). The Google Maps Streetview feature is not currently included in the tool.

- **Question**: Are the number of site visits tracked?
  Answer: The application is not live yet. It is still in beta version and is approximately 80 percent complete. Site visits are not yet tracked. To aid in prioritization the MPO will be able to track origin and destinations.

- **Question**: Will the application track whether riders are choosing to map safe rides versus, for example, scenic rides?
  Answer: At this point, the purpose of the ride is not viewed as important. It is stated in the Broward MPO Bicycle Facilities Network Plan that all members of the public have a right to safe travel from their homes regardless of their mode of travel or trip purpose.

- **Question**: Does the application map any designated bike lanes as "unsuitable"?
  Answer: Yes. A stripe of paint signifying a bike lane does not mean that the road will reduce a high ADT volume, presence of numerous driveways, or other factors that contribute to a rating of high interaction with traffic. The suitability index number does change over time with changes in ADT, but it may not be enough to change the rating for the interaction with traffic. For example, if there is a drastic change to a roadway section, such as access management, and there is a significant drop in ADT, then the suitability rating is likely to improve. If the only change is to ADT, its numerical value will change but it is unlikely that the overall suitability rating will change.

- **Question**: Will the application be made available for the public to test?
  Answer: FIU is expected to finish developing the application by August. The link to the development site has already been sent to bicyclists inquiring about places to cycle. It is a good idea to continue to give the public the opportunity to provide input on what they encounter. For example, bicyclists might be able to point out routing connections that were not previously identified or areas to increase continuity such as routing to provide roads through a gated community.

- **Question**: How long did it take to input all of the data on lane width, pavement condition, etc?
  Answer: It took around 80 hours to input all the data. Initially, MPO staff spent about 80 hours driving the area while speaking into a tape recorder to collect feature data. The bicycle facility and suitability data is updated approximately every two years.

- **Comment**: One of the issues that needed to be resolved was adding data that indicates location of median breaks to allow for left-hand turns. The original data set indicated only where medians were located but not what kind of movement was allowed. These data are being entered and aerial imagery is being used to identify locations and allowable movements through the medians.

Martin MPO (Florida)
Boyd Lawrence

Overview

The Martin MPO was established in 1993 and is Florida's second-smallest MPO, serving a population of 140,000 that has significant seasonal fluctuations. Martin County is located north of Miami along Florida's eastern coast. While the county experiences some growth demands, it is generally a slower growing area. There is strong support for open space and environmental preservation as well as greenways and trails. For example, county residents voted for a half-cent sales tax to fund park development and necessary

land purchases under the Comprehensive Everglades Restoration Plan, a framework for Federal restoration of the South Florida ecosystem.

Bicycle and pedestrian advocacy is also growing, as evidenced by the increasing activity of organizations like the Bicycle and Pedestrian Advisory Committee (BPAC) and the Treasure Coast Cycling Association (TCCA), a non-profit promoting cycling in Martin County and neighboring St. Lucie county. The MPO has involved BPAC and other advocacy organizations in planning for bicycle and pedestrian activities.

Current Conditions and Challenges

Martin County has a fairly well-developed sidewalk network although there are significant network gaps in older neighborhoods. The county also has strong land development standards that are conducive to bicycle and pedestrian activities; for example, all new sidewalks must be at least six feet in width and located at least one foot from the outside edge of the ROW. In addition, new county and state DOT expansion projects must include bicycle and pedestrian enhancements, such as bicycle lanes and sidewalks on bridges. These facilities are heavily used.

There are several challenges to planning for bicycle and pedestrian activities in the area. Florida has the highest bicycle fatality rate in the Nation and bicycle facilities are lacking and inconsistent overall. While bike lanes exist on newer or reconstructed roadways, there are narrow or no shoulders on older roadways. Obtaining ROW to construct bike facilities is the biggest challenge for the Martin MPO.

Using GIS to Identify Multi-Modal Needs and Priorities

The Martin MPO has several goals of upgrading biking facilities, improving linkages, and addressing gaps in the sidewalk/path network.

To meet these goals, the Martin MPO is in the process of building a GIS database. Data sources for the database include the Florida DOT, cities, developer site plans (particularly for sidewalk data), aerial imagery, and the Martin County Hansen asset management database. The Martin MPO also conducted fieldwork to collect additional data and update current data.

Using this information, the Martin MPO produced working internal GIS maps to identify gaps in the existing bicycle and pedestrian network and prioritize project needs according to proximity to schools, parks, residential areas, and other public areas. Three roadway segments were identified where there were significant opportunities for bicycle and pedestrian enhancements, including the Seabranch Greenway project near the Seabranch Preserve State Park in eastern Martin County. This project will provide multi-modal path connectivity from the Port Salerno Community Redevelopment Area to the park entrance. The path will be an important segment of the East Coast Greenway, a 2,500-mile developing trail network linking Canada to Key West, Florida. GIS was used to identify the appropriate alignment for the multi-modal path. The first phase of path construction is planned for late 2009. This phase will be funded with transportation enhancement monies made available through the American Recovery and Reinvestment Act.

Kanner Highway (SR-76) was another segment identified as a significant opportunity for multi-modal enhancements. The highway passes a regional park but is also a heavily traveled access route to Interstate 95. The Martin MPO recommended SR-76 as a priority location for developing a multi-modal path to provide increased connectivity to the park and nearby schools. This multi-modal recommendation was incorporated into the Florida DOT's Project Development and Environment study for the future expansion of the highway.

In addition to using GIS to develop a needs/priority list for bicycle and pedestrian projects, the Martin MPO is using GIS for several other projects, including:

- Creating bicycle and pedestrian maps and plans. These plans were incorporated into the 2030 regional long-range transportation plan.

- Mapping the 10 most frequent bicycle and pedestrian accident sites to analyze potential locations for sidewalk and intersection improvements. The Martin County Engineering Department assisted the MPO with this project.
- Developing a bicycle conditions map. This map will be replaced by an updated facilities map in late summer 2009. The facilities map will display bicycle lanes, paved shoulders, and multi-modal paths.
- Identifying areas of connectivity with the Regional Greenways and Trails Plan, a plan developed by the Treasure Coast Regional Planning Council. The regional plan involves the input and collaboration of Indian River, St. Lucie, Martin, and Palm Beach counties.

Comments, Questions, and Answers

- **Comment**: Like the Martin MPO, the Seattle DOT has taken steps to improve and expand uses of GIS for bicycle and pedestrian planning. However, the Seattle DOT has found it difficult to determine data maintenance policies, particularly regarding data collected by consultants. Seattle has many bicycle and pedestrian facilities in place, including street cars, light rails, sidewalk improvements, and bike lanes, but the agency is still working to expand its use of GIS for prioritizing, managing, and assessing bicycle and pedestrian projects.

IV. Observations, Lessons Learned, and Conclusions

All Participants

To conclude the peer exchange, participants were given the opportunity to discuss observations made during the meeting. Participants also noted some of the lessons their organizations had learned in their efforts to develop and enhance ways to use GIS for supporting bicycle and pedestrian decisions.

Observations

- There are many different ways to determine bicycle and pedestrian suitability. Some approaches include studying crash locations, the physical environment, roadway speed, and/or bicycle compatibility indices. An important first step in developing geospatial applications to support bicycle and pedestrian decision-making is determining what and how factors should be considered and whether to incorporate them into long-term planning documents like bicycle master plans. As a next step, data needs should be identified as well as sources of existing data that could be used to populate geospatial applications.

- There was a broad range of agencies selected to participate in the peer exchange in terms of size, GIS sophistication, and progress. By allowing both smaller and larger organizations to see how their efforts and direction compared and contrasted to those of agencies nationwide, the workshop helped peers better understand the state of the practice. The peer-to-peer nature of the meeting allowed participants to have a depth of discussion and interaction that would not likely have been possible in a conference environment.

- Some agencies have considered using other data collection efforts to add to bicycle and pedestrian inventories. For example, in Florida, funding from the Federal Emergency Management Agency (FEMA) was made available after Hurricanes Katrina and Rita for inventorying objects such as trees or feet of sidewalks. The funding allowed several municipalities in Florida to compile data inventories. The data collected on sidewalks can be used for other purposes, including bicycle and pedestrian planning.

Lessons Learned

- *Use quantitative data to back recommendations*. These data can give additional credence to proposed projects and help meet goals.

- ***Send out draft products to those impacted for their early review***. Feedback can be gathered by allowing those who will use or be affected by the application or process to refine the end product. Early input can help ensure useful outputs.

- ***Consider alternatives to standard GIS packages***. Open-source software options may provide cost-effective and useful alternatives for agencies—especially smaller ones—seeking to develop their own GIS applications for making bicycle and pedestrian considerations.

- ***Geospatially enable ROW data where possible***. There may be many non-traditional places from which ROW data and/or knowledge can be acquired. Similarly, there may be more end users of these data than first expected. An often overlooked benefit of geospatially enabling ROW data and information systems is the improved ability to respond quickly to management needs and business goals.

- ***Integrate data collection efforts.*** Some municipalities might have difficulty finding the resources to compile data inventories. To address this challenge, it can be useful to explore all opportunities to build a more robust, comprehensive bicycle and pedestrian database. For example, there may be ongoing projects to collect certain roadway data that could also be useful for bicycle and pedestrian planning*.*

- ***Involve the public in data collection as much as possible***. The walking and cycling public are the users of bicycling and pedestrian facilities. The public can be valuable resources to collect roadway data since they are on the streets each day. Although publically collected data would need to be verified, working collaboratively with the public to do so is another way to include their voices in the planning process while accomplishing an often labor-intensive task. In return, municipalities might consider creating public information databases. Many cities have great places to walk and cycle, but the public may not be aware of them. Often, the public has limited awareness that bicycle lanes and/or pedestrian improvements are being constructed. In some cases, raising public awareness (about facilities' locations, bicycle safety, etc.) may be more difficult than building the network itself. GIS itself can help to make the decision-making process more transparent and democratic: GIS maps and other products can illustrate proposed projects, allowing the public a better understanding of what changes might occur in the future.

Conclusions

Due to the range of peer agencies' experiences with bicycle and pedestrian planning, the workshop participants were introduced to many different issues, some of which they may not have previously considered. Participants shared ideas on addressing challenges to data collection and maintenance, obtaining funding for development of bicycle and pedestrian facilities, and determining what factors to consider when assessing the need for multi-modal facilities and enhancements. Overall, the workshop was one step to help build a stronger peer network and bicycle, pedestrian, and GIS practitioner community.

Appendix A. Participants and Other Attendees

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Appendix B. Agenda

Goal: *Share lessons and challenges in using GIS to accomplish various bike/pedestrian objectives.*

<u>**Monday, May 11**</u>

8:00   Meet in hotel lobby to travel to the Stephen P. Clark Government Center
              111 NW 1st St, Miami, FL

8:30 – 8:45   **Welcome, Introductions, and Background** *FHWA*

8:45 – 9:00   **Overview of FHWA's Pedestrian and Bicycle Program** *USDOT Volpe Center*

9:00– 10:00   **Roundtable** *Summary of GIS and bicycle/pedestrian activities. What would you like to learn?*

Break

10:15 – 11:45   **Demonstrations/Presentations**

- *City of Miami (Florida)*. Spatial data are used to support preliminary plans for future bicycle facilities. Existing bicycle lanes and greenways data were used as a starting point to demonstrate how the current bicycle network could be improved.

- *Two Rivers-Ottauquechee Regional Commission (Vermont)*. GIS is used to evaluate the entire road system to facilitate condition assessment and project prioritization.

Lunch

1:00 – 4:30   **Demonstrations/Presentations**

- *New Jersey DOT*. GIS is used to prioritize bicycle/pedestrian projects and support projects' compatibility and crossability.

- *Michigan DOT*. MDOT partnered with regional planning agencies to create regional bike maps covering the entire state. The maps serve as a base for developing regional non-motorized plans. MDOT is also exploring options for building a non-motorized geodatabase. This geodatabase will potentially allow MDOT to create a rich interactive web application of the Michigan non-motorized network (bike trail, mixed-use, on-road, etc.).

- *Seattle DOT (Washington)*. GIS has been a valuable tool for analyses performed for the city's Bicycle Master Plan and Pedestrian Master Plan, which help ensure proper priority is placed on bicycle and pedestrian related projects.

<u>**Tuesday, May 12**</u>

8:00   Meet in hotel lobby to travel to the Stephen P. Clark Government Center

8:30 – 8:45   **Day 1 Re-cap**

8:45 – 10:15   **Demonstrations/Presentations**

- *Broward County (Florida) Department of Environmental Protection and Growth*. Spatial data are being used to develop the Bike Knowledge Explorer, an innovative, bicycle route-planning tool.

- *Martin MPO (Florida)*. Used GIS to update map data for bicycle and pedestrian facilities along arterial roadways. The analysis identified future locations for multimodal paths, filling gaps in the bicycle and pedestrian network. A Bicycle Conditions Map that highlights ideal bike routes and key destinations has also been developed.

10:15 – 10:45   **Roundtable**

10:45   **Peer Exchange Key Points and Wrap-Up** *FHWA*

Appendix C. Useful Links

The following list comprises the links included in the report.

AASHTO 2009 GIS in Transportation Symposium State Survey
www.gis-t.org/files/chmos.pdf

City of Miami, Bicycle Action Plan
http://miamigov.com/cms/Files/Bicycle_Action_Plan_Approved_by_Commission_10-16-08.pdf

City of Miami, Office of the Mayor, Miami Green Commission
www.ci.miami.fl.us/cms/mayor/4060.asp

City of Seattle Draft Pedestrian Plan and Implementation Strategy
www.seattle.gov/transportation/pedestrian_masterplan/
hwww.seattle.gov/transportation/pedestrian_masterplan/pmp_implementation.htm.

City of Seattle Master Bicycle Plan and progress report
www.seattle.gov/Transportation/bikemaster.htm.

City of Seattle, "My Neighborhood Map"
web1.seattle.gov/MNM/.

Fast Lane: The Official Blog of the USDOT Secretary
fastlane.dot.gov/2009/04/index.html

FHWA GIS in Transportation
www.gis.fhwa.dot.gov

FHWA's Pedestrian and Bicycle Program
www.fhwa.dot.gov/environment/bikeped/index.htm.

FHWA Planning and Environment Linkages
www.environment.fhwa.dot.gov/integ/index.asp

Michigan DOT bicycle home page
www.michigan.gov/mdot-biking

Michigan Trails and Greenways Alliance – Connecting Michigan: Planning for the Future of Michigan's Trail System: A State Trails Planning Partnership
http://michigantrails.org/connectingmichigan/

National Bicycle and Walking Study: Ten-Year Status Report
www.fhwa.dot.gov/environment/bikeped/study/index.htm

National Household Travel Survey
www.bts.gov/programs/national_household_travel_survey/