

Planning the Mississippi River Trail in Iowa Using Geographic Information Systems

Jamie L. Luedtke and David J. Plazak

Center for Transportation Research and Education

Iowa State University

2901 South Loop Drive, Suite 3100

Ames, IA 50010-8634

jtunnell@iastate.edu, dplazak@iastate.edu

ABSTRACT

Bicycle transportation in the U.S. has been increasingly supported through cooperation for new bicycle facilities among all levels of government. A prime example is Millennium Trails, a federal program devoted to trail development to recognize America's history and future. The Mississippi River Trail (MRT) is a Millennium Trail, envisioned to begin at the Mississippi headwaters in Minnesota and to end at the Gulf of Mexico. Iowa's rural MRT portion is being planned to provide economic and recreation opportunities, but also presents potential planning issues. The MRT includes urban and regional trails over varied terrain, includes off-road bicycle trails and on-road bicycle lanes, currently planned or programmed bicycle facilities, and must be aligned to maximize use of Iowa's riverside amenities while providing safe cycling conditions. Geographic information systems (GIS) were used to effectively analyze the trail planning factors of the Iowa MRT. GIS allow many levels of information to be simultaneously analyzed, and may process large datasets required for the bicycle level of service analysis used to determine safe trail routings. The bicycle level of service analysis outlined safe MRT on-road bicycle lanes, and also directed where off-road trails should be used instead. Verification of results with public officials and the public is key to validate the trail planning effectiveness with GIS. This process to develop the MRT has proven effective for Iowa and may be applicable to analyze trail development feasibility in other states.

Key words: bicycle facilities—bicycle level of service analysis—bicycle trails planning—geographic information systems—multimodal, alternative transportation

INTRODUCTION

Bicycling has grown in recent years as both a rewarding recreational activity and a viable mode of personal transportation alternative to the automobile. The United States is working to develop and maintain bicycle policies to increase both bicycle facilities and the level of bicycle use in the nation. One notable step towards welcoming alternative modes of transportation, such as the bicycle, onto U.S. transportation systems was the introduction of the Intermodal Surface Transportation Efficiency Act (ISTEA), which required states and metropolitan planning organizations (MPOs) to integrate bicycle and pedestrian planning into their long-range plans (1). This federal requirement urged cities and states to expand their bicycle and pedestrian facilities in a move to promote modes of transportation alternative to the automobile in urban and state plans.

In these transportation planning efforts, bicycle facility needs for all levels of cyclists have been taken under consideration. Generally, there are three types of cyclists: Level A, or advanced, Level B, or basic, and Level C, children (2). While there are advanced cyclists are accustomed to sharing facilities with automobiles, there are many more basic cyclists and children that are not comfortable with sharing roadways with bicycles. Because there are more basic cyclists and children than advanced cyclists, separately designated bicycle facilities are needed to better serve these populations (2). In this, the designation of public funds, time, and efforts towards adding designated bicycle facilities such as bicycle trails or lanes to our current transportation system will allow the majority of cyclists more access to more places in the United States.

The Millennium Trails represent an idea formed by the Clinton administration in the 1990s to honor U.S. history through trails and natural areas to “honor the past and imagine the future” of the United States (3). There are many planned or existing Millennium Trail projects in the United States at this time, but the Mississippi River Trail (MRT) represents a unique opportunity to connect the communities along the approximately 2000 miles of the Mississippi River by bicycle. From the Mississippi headwaters in Lake Itasca in Minnesota to its convergence with the Gulf of Mexico, the MRT can serve short-distance as well as long-distance cyclists, connecting people and places by this alternative mode of transportation. In addition, the trail will be composed of both bicycle trails and lanes; the different facilities along the route will cater to different levels of cyclists, from advanced and basic cyclists on the on-road bicycle lanes, to children on the off-road bicycle trails.

The rural Iowa portion of the Mississippi River Trail will provide connections by bicycle between communities along the river, through both existing bicycle facilities and facilities that will be designed and constructed expressly for the MRT. The urban sections of the MRT in Iowa are being planned and constructed by local groups using a combination of on-street and off-street bicycle facilities. To ensure a well-rounded trail plan, the Iowa Mississippi River Trail Advisory Committee was formed to brainstorm as well as to review potential plans for the rural segment of the trail. The advisory committee provided support from numerous organizations, clubs, and state, regional, and local agencies as well as give input on trail design from local cyclist perspectives. The advisory committee contributed to the geographic information systems (GIS) trail development effort by providing insights on future bicycle facilities to incorporate, amenities that could interest cyclists, and other information pertinent to the development process.

This paper will document the use of GIS to develop a recommended alignment for the rural portion of the Mississippi River Trail in the state of Iowa. The use of GIS in this process allows for simultaneous analysis of physical land attributes such as topography and hydrology, roadway attributes such as average daily traffic counts and lane widths, political attributes such as county and city borders, and trail amenities and potential development problems.

A current problem in bicycle facility planning is that no standardized methods of bicycle trail or lane planning in GIS exist. Because no standardized methods of bicycle facility planning in GIS currently exist, undertaking this task at any jurisdictional level can be daunting. While documenting the process used to develop the MRT in Iowa, this paper will introduce a method to develop trails with GIS that can be replicated by state, regional, and local agencies to better develop bicycle facilities. The use of GIS for trail development will be compared to previous methods of trail development used by statewide agencies. In addition, the bicycle level of service (BLOS) and bicycle compatibility index (BCI) will be introduced as methods to create safer bicycle facilities. Then, the BLOS study will be combined with area amenities, trail development concerns, existing or planned bicycle facilities, as well as other factors, to determine the best routing of the MRT.

The MRT plan created through this process is for the rural segments of the MRT between communities along the Mississippi River. The Mississippi River Trail Advisory Committee wished to create a trail plan for rural areas that also provides a precedent and recommendations for cities to follow when developing their own segments of the MRT. Therefore, the resulting MRT plan for Iowa only shows rural trails that end at cities' political boundaries. By knowing where the rural trail is recommended to terminate at their borders, cities are better equipped to create their own bicycle facility programs.

BACKGROUND

There are five basic types of bicycle facilities used in the United States today: shared lanes, wide outside lanes, bicycle lanes, shoulders, and separate bicycle trails (2). Out of these facilities, bicycle lanes and bicycle trails are specifically designated as bicycle facilities separate from automobile facilities. Because these facilities do not require cyclists to share the same facilities as automobiles, they are more suitable for B level cyclists than shared-roadway bicycle facilities. Because of this, the MRT in Iowa will use both bicycle lanes and trails; because the MRT will be a dynamically developed facility, a move from initially building bicycle lanes to the development of off-road bicycle trails is encouraged. C level cyclists, children, are not recommended to use MRT bicycle lanes even though they are designated separate lanes from those of automobiles; children may not have full control of their bicycles at all times, and could swerve into automobile traffic. However, children are encouraged to instead use the bicycle trail sections of the MRT. Because the MRT is recommended to be both bicycle lanes and trails, a method to build proper facilities along the routing is essential.

Previous methods of bicycle facility planning that have not used GIS technologies could be user-based or project-based. User-based methods analyze which levels of cyclist the facility would be planned for, and recommend appropriate facilities based on its users. In addition to this, bicycle planners decided where facilities should go, what type of facilities should be used, and how their jurisdictions could pay for the improvements. To better determine how user needs compared to bicycle facility type, cost, and feasibility, many bicycle planners used the BLOS or BCI methods to analyze bicycle suitability in their regions (4). These models include roadway variables that affect cyclist comfort and safety, including: average annual daily traffic counts, traffic speed, width of the right-hand motor vehicle lane, percentage of heavy vehicles, on-street parking types, and condition of the pavement surface (4). The BLOS model measures cyclists' perceived comfort and safety while riding, and is rated much like the roadway level of service method, on an A–F scale.

While these previous methods of bicycle facility planning have produced reliable, well-matched bicycle facilities to satisfy user needs and project feasibility, methods like BLOS are more difficult to apply on a regional or statewide level. BLOS requires calculations involving detailed roadway data on individual road segments, and the sheer volume of road segments that could be involved in a regional or statewide bicycle facility make the manual application of BLOS a daunting task. An answer to this problem is found

in GIS technologies, which, as outlined in the next section, were used to produce reliable and fast results for the MRT BLOS analysis.

METHODOLOGY

The MRT in Iowa is planned to be a combination of both bicycle lanes and trails to better service all levels of cyclists along the routing. Because cyclist safety and efficient use of public resources are of utmost importance in creating the MRT, the methodology used to create a trail routing must reflect these factors. The BLOS was used to ultimately create a trail routing that reflected these factors, and this analysis was conducted in a GIS for reliable, visual, and fast results.

Route Evaluation and Mapping Using GIS

GIS were used to compile all information about the MRT to create the interim route. First, inventories of project area maps were made using base geographic information for the ten counties. After this, attribute maps of trail amenities and trail concern areas were created. Then, the BLOS analysis was performed within GIS to graphically display the BLOS rankings of individual corridors to make safe decisions on trail placement. To further analyze the safety of the potential routing, a shoulder improvements analysis was performed to determine each corridor's feasibility to carry a bicycle lane after adding paved shoulders. The interim route was determined by comparing results for the above listed analyses.

The ten Iowa counties along the Mississippi River represent a range of topographic, social, cultural, and physical differences that needed to be accounted for during MRT planning. First, an inventory of these counties included a collection of their amenities, potential trail development problems, existing bicycle facilities, programmed or planned bicycle facilities, and paved roads within 10 miles of the river for potential MRT bicycle lanes. This inventory of trail amenities or possible trail development concerns along the river was essential to identify areas where trail building is feasible and would highlight amenities. An example of an inventory map is seen in Figure 1, a trail amenities map for Scott County.

After the inventory of existing, programmed, and planned bicycle facilities along the Mississippi River in Iowa, gaps where no existing, programmed, or planned bicycle facilities were apparent. These gaps are where bicycle lanes or trails must be constructed in order to complete the MRT in Iowa. However, because existing facilities were not available in these gaps in the MRT, two issues made bicycle lane or trail planning complex here. First, cyclist safety was of utmost importance to the MRT, so all recommended trail routings must be located either on off-road trails or on roads deemed to be safe for cyclists through the BLOS scale. Second, while off-road trails separated cyclists from almost all instance of conflicts with motor vehicles, the cost of building all off-road trails for the MRT all at once would be much more money than the state, counties, or cities along the route could afford. In order to get the MRT started, the majority of the MRT needed to be placed on less-expensive six-foot wide bicycle lanes, or on-road designated bicycle facilities. However, the recommended bicycle lanes did not have to be included in the permanent routing of the trail; in recommending the MRT first be routed on bicycle lanes, MRT planners also recommended that off-road bicycle trails be built to replace the bicycle lanes as funding becomes available. In addition to being less expensive per mile to construct, paving roadway shoulders for bicycle lanes also provides an important safety benefit for motorized vehicles that continues even if the bicycle lanes are abandoned for off-road trails in the future.

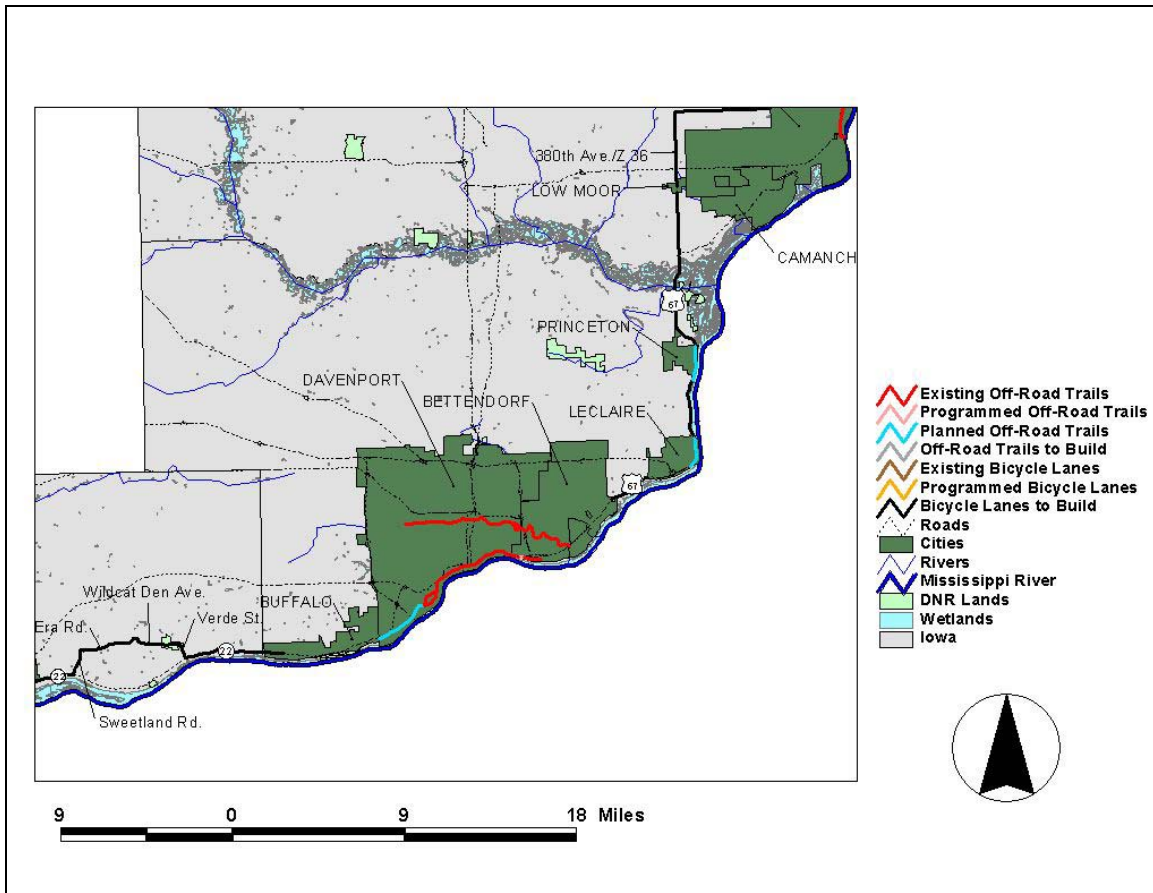


FIGURE 1. Scott County Trail Amenities

The development of bicycle lanes for the MRT will extend benefits to motorists as well as cyclists. Providing bicycle lanes for cyclists takes cyclists off the same travel path as automobiles and trucks. Also, the paved shoulders required for bicycle lanes provide safety benefits to motorists. A study to measure motorist safety benefits of paved shoulders by the Iowa Department of Transportation and the Center for Transportation Research and Education concluded that paved shoulders of at least 3 feet have been nationally shown to reduce associated motor vehicle crashes (5). In addition, the study recommends 6-foot wide shoulders for bicycle use, which is consistent with the recommendations of the Iowa Mississippi River Trail Advisory Committee and the bicycle level of service analysis used for the Iowa MRT.

In the context of the MRT in Iowa, BLOS represented a data-driven effort to design the Iowa portion of the MRT with the concept of bicyclist comfort and safety. While both provide a good measure for bicycle lanes, the MRT planners and advisors chose to use Bicycle Level of Service rather than the Bicycle Compatibility Index because BLOS contained variables that were relevant for rural roads. The League of Illinois Bicyclists and the Chicagoland Bicyclist Association derived the BLOS used for MRT planning (6). BLOS is used to estimate the safety and comfort of the cyclist. The BLOS scale ranges from A (extremely high compatibility) to F (extremely low compatibility); however, MRT trail planners and advisors decided the lowest acceptable BLOS for the MRT could be a level of C.

BLOS uses roadway data to determine if a paved corridor is suitable for an on-road bicycle lane. Important roadway data used in the BLOS calculation includes number of lanes, lane width, paved shoulder width (where the bicycle lane would be placed), annual average daily traffic counts, percentage of heavy vehicles, and speed limit.

On-road bicycle lanes were preferred for the MRT in Iowa over the more expensive off-road trails, so each corridor was analyzed for its suitability for a bicycle lane. This was done through three methods: Bicycle Level of Service analysis, a shoulder improvements study, and field studies with public input. To fully assess each roadway's current potential for bicycle lanes, an initial BLOS analysis was performed in GIS using current roadway conditions for all roads in the ten counties within ten miles of the Mississippi River. The result of this analysis showed roads that would be adequate for bicycle lanes in their current states; no additional shoulder paving would be required to create bicycle lanes. However, the majority of roads did require additional shoulder paving in order to create safer bicycle lanes. To assess the remaining roads' viability to be converted into bicycle lanes after additional paved shoulder width is constructed, another BLOS analysis, the shoulder improvements study, was performed. This study used the current roadway traffic conditions in addition to a hypothetical shoulder width of 6 feet, the shoulder width that would be used if there were a bicycle lane on the road. The result of the shoulder improvements analysis showed the roads within the project area that could have bicycle lanes safely after additional widths of paved shoulders were constructed.

The two BLOS analyses resulted in a disjointed MRT routing of existing, programmed, and planned bicycle facilities and roadway segments that scored at least a C on either BLOS analysis. There were different routing alternatives to choose from, and there were still areas along the recommended route that did not yet connect to make a complete trail. At this point, the recommended routing was chosen by comparing route alternatives to the previously made maps of trail amenities and trail development concerns to the two BLOS analyses. The trail routing was chosen from the alternatives by determining which routing could best serve cyclists by the highest levels of amenities, aesthetics, and safety. An example of a shoulder improvements analysis map is seen in Figure 2, the shoulder improvements analysis map for Scott County.

After the trail alternatives were chosen, however, there remained three small gaps on the trail network between bicycle facilities where the nearest roadway was not found to be adequate to safely have bicycle lanes. At these points, the construction of off-road trails were recommended to finish the complete recommended MRT routing in Iowa.

To verify the accuracy of the trail development procedure in GIS, and in the interest of time for this process, planners went on site visits and drove the recommended routes for the MRT. The observed routes were considered adequate for the MRT, and with the construction of needed road improvements or off-road trails the MRT planning process in GIS seemed a success. Although the trail development process in GIS was deemed reliable through site visits and driving the recommended routes, public input was necessary to gain local opinions and insights on trail development and its impacts. Public meetings were held at three points along the recommended route: Lansing, Davenport, and Fort Madison, Iowa. In addition to public meetings, the draft MRT plan was posted on the Internet for public comment. These two methods of public comment generated new ideas about the MRT through Iowa. Some communities along the MRT recommended routing did not approve of the interim routing on bicycle lanes, for some of the on-road facilities were routed away from certain community amenities and river views for safety reasons. To solve this problem, these communities have decided to skip the interim routing of the MRT on bicycle lanes and have instead committed to building off-road bicycle trails to take advantage of amenities each community had to offer the MRT cyclists.

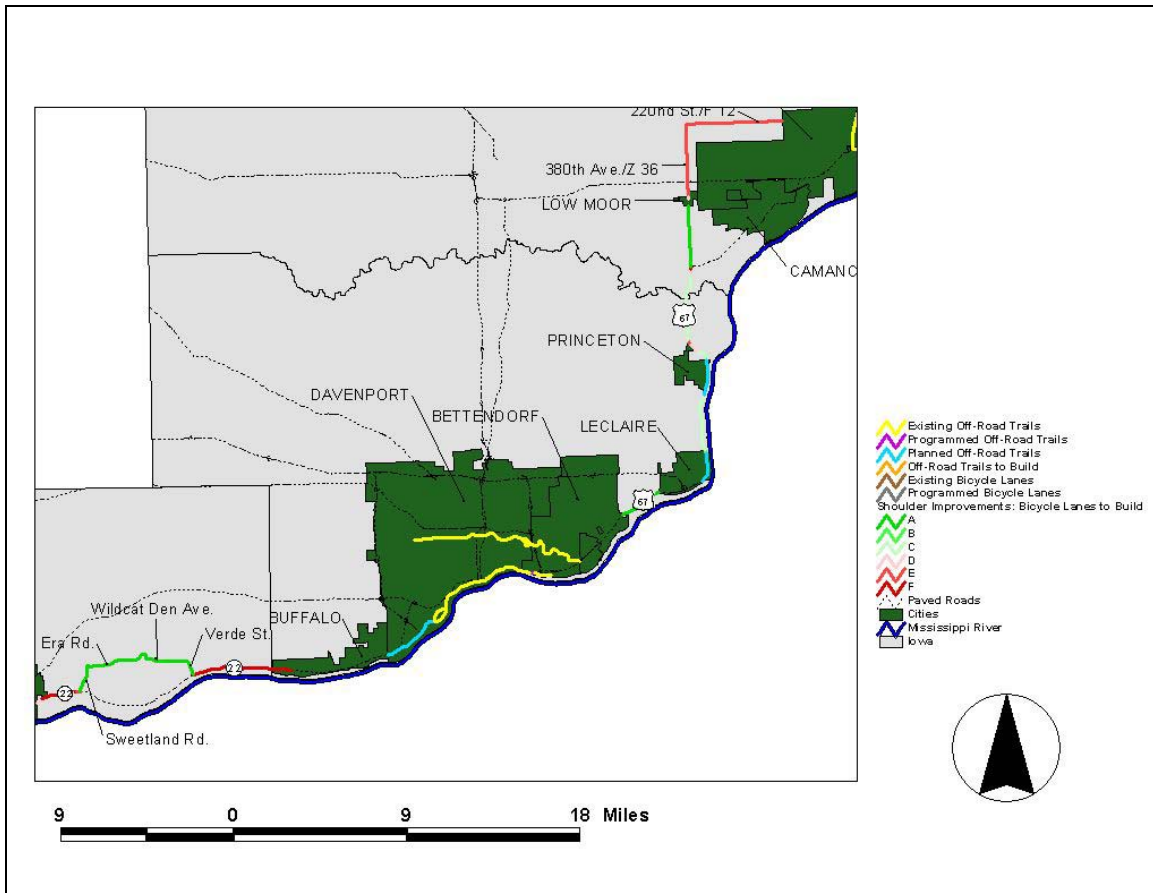


FIGURE 2. Scott County Shoulder Improvements Analysis

Cost Estimates

The costs of creating the Mississippi River Trail in Iowa are dependent upon construction projects required for each bicycle lane or trail to meet MRT standards. Bicycle lanes for the MRT will be created on roads by constructing six-foot asphalt shoulders at a cost of approximately \$107,000 per mile (7). Non-motorized asphalt off-road bicycle trails 10 feet wide may be constructed at a cost of approximately \$85,344 per mile. In addition to these costs, structural improvements may be necessary for the roadway to accommodate bicycle trails. Narrow structures on roadways may need to be redecked to include bicycle lanes at a cost of \$50 per square foot, assuming a six-foot wide bicycle lane.

Because either county or state government will complete portions of the rural MRT, both county and state agencies need to be aware of their jurisdiction’s unique responsibilities in MRT development. The state of Iowa will be responsible for an estimated 99 miles of state roadway to be improved for bicycle lanes, while individual counties will be responsible for approximately 125 miles of the Iowa MRT on county roads. There are also county jurisdiction off-road trails that will need to be funded. In addition, individual municipalities have jurisdiction over approximately 54 miles of the Iowa MRT, and each is responsible for developing their own MRT routing. Altogether, these mileages add up to approximately 278 miles of bicycle facilities in both rural and urban areas that will be created by the Iowa Mississippi River Trail. In this recommended rural trail mileage, 15.19 miles will be off-road bicycle trails, while 205.45 miles will be on-road bicycle lanes. The approximate cost, without the major expenses of land acquisition, trail

design, and other costs, to create the off-road trails is approximately \$740,000, while the cost to build the bicycle lanes, without striping and other costs, is approximately \$22 million.

CONCLUSIONS

The plan for the MRT in Iowa outlines many individual bicycle facility projects that make up the complete trail. The trail plan should direct state and county bicycle facility programs, but should be used as a guideline for city bicycle facility programs. Trail planners, advisors, and others have deemed this routing safe through the BLOS analysis, shoulder improvements analysis, field reviews, and public input. However, because the trail routing has been recommended and analyzed for safety, there are no guarantees that it will be developed as outlined in the MRT plan. Some cities along the MRT route are concerned that bicycle lanes rather than trails are being recommended; some of these areas are taking the initiative to plan for off-road trails immediately, rather than first building bicycle lanes. Although the trail routing is not always agreed upon, the idea of the MRT has been positively received in all levels of government in the project area.

Planning for the Iowa portion of the Mississippi River Trail in geographic information systems not only allowed for data to be spatially displayed with ease, but also enabled planners to quickly analyze existing conditions for bicycle facilities in the large project area. GIS was especially beneficial to use for the MRT because it is a long distance rural trail; many road segments, existing facilities, and other data were incorporated into analysis, which would have been very time consuming if calculated manually. The results of all analyses for the MRT were spatially displayed easily, which allowed for better decision-making based on all levels of analysis. Another important benefit of using GIS in bicycle facility planning is that the process used to plan for the MRT can be easily replicated for other areas. The trail amenities, trail development concerns, bicycle level of service, and shoulder improvement analysis helped to develop the trail digitally to be a safe facility, but the accompanying field reviews and public input verified the accuracy of the GIS analysis. A combination of GIS analysis with field reviews and public input for verification can be easily replicated in other areas for bicycle facility planning.

ACKNOWLEDGMENTS

This research was sponsored by the Iowa Department of Transportation Office of Systems Planning. The authors would like to thank the Iowa Mississippi River Trail Advisory Committee, Project Monitor Kathy Ridnour, Mississippi River Trail, Inc., and all who attended the Mississippi River Trail public meetings in Lansing, Davenport, and Fort Madison, Iowa.

REFERENCES

1. Bicycle Federation of America. *Bicycle and Pedestrian Planning Under the Intermodal Surface Transportation Efficiency Act: A Synthesis of the State of the Practice*. FHWA-PD-97-053. Federal Highway Administration, U.S. Department of Transportation, Washington, D.C., 1997.
2. Federal Highway Administration. *Selecting Roadway Design Treatments to Accommodate Bicycles*. FHWA-RD-92-073. Turner-Fairbank Highway Research Center, McLean, Virginia, 1994.
3. U.S. Department of Transportation. Millennium Trails. <http://www.dot.gov/mtp/>.
4. Edwards, John D., ed. *Transportation Planning Handbook*. Institute of Transportation Engineers, Washington, D.C., 1999.
5. Souleyrette, R., T. McDonald, Z. Hans, and A. Kamyab. *Paved Shoulders on Primary Highways in Iowa: An Analysis of Shoulder Surfacing Criteria, Costs, and Benefits*. Center for Transportation Research and Education, Iowa State University, Ames, Iowa, November 2001.
6. Chicagoland Bicycle Federation. BLOS/BCI Calculator. <http://www.bikelib.org>.
7. Iowa Department of Transportation. Iowa Trails 2000. 2000. <http://www.dot.state.ia.us/trails/index.html>.