

Evaluation of Planning and Design Issues for Multiuse Trail and Highway Crossings

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Across the country a network of multiuse trails is evolving from abandoned rail corridors. This phenomenon creates a new set of demands on public highway and transportation agencies. These demands are most evident at public highway crossings of rail-trail projects. These demands raise new policy, planning, and engineering issues. The most difficult and controversial of the engineering issues is whether to retain or remove grade-separating rail structures. The issue often pits trail advocates against public highway and transportation engineers in a debate over whether safety is enhanced or degraded by the removal of the structure. Decisions on structures rely on a variety of factors, including the physical condition of the structure; the alignment, clearance, and sightlines at the crossing; the quality of trail plans; and the magnitude and division of responsibility for current and future costs. To effectively resolve trail and highway crossing issues, it is important to recognize that, in matters related to the crossings, the highway or transportation agency's customer base includes trail users as well as motor vehicle drivers and passengers. Decisions on crossing issues should evolve from a balanced appraisal of the sometimes differing safety and operating needs of trail as well as highway users. The process of reaching balanced, multimodal design decisions begins with better public planning before rail line abandonment. The state highway or transportation agency can enhance its decision making through better communication, coordination, and encouragement of trail planning with sister state agencies, local government(s), regional planning agencies, and trail development organizations.

The public desire for nonmotorized transport alternatives coupled with the rising popularity of outdoor recreation has stimulated a nationwide movement within the United States to convert abandoned railroad lines into trails for bicycling, hiking, walking, in-line skating, and similar activities. Popularly known as rail-trails, the first such conversion occurred in the 1960s, and federal funding first became available for rail-trails in 1976. By mid-1995, largely resulting from local volunteer initiatives, 684 rail-trail projects totaling nearly 11 300 km had been completed, with proposals for many more projects pending (1).

Rail-trails are popular; for example, Virginia's Washington and Old Dominion Railroad Trail annually attracts nearly 2 million users (2). In some cases, rail-trails serve as valuable recreational facilities, whereas in others, they are also useful transportation corridors. Studies also indicate that rail-trails can stimulate economic activity in neighboring communities (3,4).

The rails-to-trails movement received a significant boost from the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) (5). ISTEA's emphasis on intermodalism, right-of-way preservation

planning, and broadened funding eligibility for bicycle and pedestrian facilities is cited as a rationale for more proactive state and metropolitan planning for rail-trails (6). Federal transportation funding for bicycle and pedestrian facilities skyrocketed from \$40.7 million in the 1973 to 1991 pre-ISTEA period to \$676.9 million in the 1992 to 1995 ISTEA years (7). The latter figure includes only enhancement program funding and not funds that might be used from nine other eligible ISTEA programs.

ISTEA's stimulus and the accelerating popularity of existing rail-trails has created a new set of demands for state and local highway and transportation agencies. These new demands are most acute near the intersections of rail-trails and public highways. When planning and designing a trail or highway crossing, the various skill levels, experiences, and characteristics of the various trail users (bicyclists, pedestrians, joggers, skaters, etc.) must be taken into account along with the needs of motorists. This presents engineers with difficult decisions on appropriate tradeoffs between a range of safety and operational requirements for the crossings.

PURPOSE

The purpose of this paper is to present research initiated by the Pennsylvania Department of Transportation (PennDOT) to address public concern for providing safe, operational trail and highway crossings. The research, sponsored by PennDOT and the Mid-Atlantic Universities Transportation Center, was conducted by the Pennsylvania Transportation Institute at The Pennsylvania State University. Pennsylvania is among the states with the most rail-trails; yet as of late 1994, PennDOT did not have statewide policies for issues related to trail and highway crossings. Thus, the primary purpose of the research was to gather information and make recommendations useful for PennDOT's efforts to formulate policies on trail and highway crossings. Although the research focuses on Pennsylvania and PennDOT, many of the recommendations are applicable to public highway and transportation agencies in general.

Objectives

The objectives of this research were

- To identify the key engineering and public planning issues associated with the conversion of a railroad and highway crossing to a trail and highway crossing;
- To identify points in the transportation planning process in which consideration for future trails should be addressed;

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- To determine current practice, including lessons learned in addressing crossing issues on rail-trail projects; and
- To make recommendations on the key crossing issues on the basis of a review of current practice, existing guidelines or standards, and published research.

RESEARCH METHODOLOGY

The research approach included in-person interviews in selected state agencies, surveys of various states and metropolitan planning organizations, and an international literature review. A questionnaire structured around key engineering and planning issues, but flexible and open-ended in format, was used as an interview guide. Interviews were conducted in 7 of the 11 PennDOT engineering districts and the central administrative office to learn staff experiences and perspectives on the issues. The individuals interviewed represent a wide range of responsibilities and program areas, including grade-crossing operations, traffic safety, environmental issues, design, programming, right-of-way, location liaison, and bicycling.

Representatives from local and metropolitan planning organizations also attended several of the district meetings. Interviews were also held with the Department of Conservation and Natural Resources (DCNR) (formerly part of the Department of Environmental Resources, which was reorganized in 1995), the Public Utility Commission (PUC), and the Rails-to-Trails Conservancy. In total, 44 people were personally interviewed.

In addition to the in-person interviews, telephone interviews were conducted with 10 of Pennsylvania's metropolitan planning organizations and with 5 other state DOTs to determine their state of practice with rail-trail conversions. Finally, a review of engineering and planning research literature was conducted to gain more insight into the state of the art and practice in the United States and other countries.

The next section of this paper presents some background material on the rail line abandonment process in general and on the rail and highway crossing abolition process in Pennsylvania. The latter is particularly relevant for the types of constraints it imposes on agencies responsible for the safety of rail and highway and trail and highway crossings. The abandonment section is then followed by sections covering research findings and recommendations.

RAIL LINE ABANDONMENTS

The Abandonment Process

Rail-trail conversions depend upon the availability of contiguous rail rights-of-way. Under current federal regulations, a railroad may abandon a line with as little as 50 days' notice, depending on the type of abandonment (8). This situation creates extreme time pressures on attempts to preserve rail corridors for trail or other public uses.

One way to preserve desirable corridors for public use is to intervene when a railroad files an abandonment petition with the Interstate Commerce Commission (ICC). The two major requests that can be made in this process are the "public use condition" request and the request for "interim trail use," also known as a railbanking request (8). If the ICC grants a "public use condition" request, it notifies the railroad not to dispose of any real estate in the corridor and to keep intact all of the structures suitable for trail use.

The public use condition allows a 6-month period to negotiate a purchase agreement for the right-of-way. Often, this is a difficult undertaking. Adjacent property owners may have reversionary property rights to portions of the right-of-way that mature upon official abandonment.

The "interim use" request is made by certifying to the ICC that an entity is willing to accept financial and legal responsibility for an about-to-be-abandoned corridor. If the railroad agrees to negotiate the railbanking of the line, the ICC will grant a "notice of interim trail use." This notice also allows 6 months to negotiate the terms for use of the corridor as a trail. The important feature of railbanking is that the abandonment does not legally occur, thus avoiding the property reversion problems of the public use condition.

Abolition Proceedings in Pennsylvania

In Pennsylvania, ICC abandonment approval triggers a state administrative process called the abolition proceeding. This process determines the disposition of all bridges and tunnels along the railroad line and is administered by the Pennsylvania PUC, which has jurisdiction over all Pennsylvania rail-public highway crossings.

The initiation of an abolition proceeding includes the notification of many parties: the railroad, PennDOT, local government(s), DCNR, utilities, neighboring property owners, and interested trail groups. All parties are invited to a state inspection to discuss plans and responsibilities for matters such as removing, maintaining, or modifying structures, removing tracks, realigning the roadway, and restoring the pavement. All issues unresolved at this field conference are sent to a formal administrative hearing where interested parties may present testimony and make recommendations. The commission's ruling covers the scope of the engineering work required and identifies those parties financially responsible. Following the execution of the commission's decisions, the crossing is officially "abolished," and the commission has no further enforcement powers at the site.

RESEARCH ANALYSIS AND FINDINGS

PennDOT and the research team developed a preliminary list of trail and highway crossing engineering and planning issues. This list was pared during the course of the research to the set of most significant issues shown in Table 1. Following are the research findings for most of the issues presented in Table 1.

At-Grade or Grade-Separated Crossings?

The most controversial engineering issue in rail-trail projects is the decision whether to retain or to remove existing grade separations at highway-trail crossings. This issue often pits trail advocates against public highway and transportation engineers in an argument over whether safety is enhanced or degraded by the removal of the structure. The issue also usually includes debate over the magnitude and division of responsibility for current and future costs.

PennDOT Policy and Practice

PennDOT does not have a formal written policy on the matter of bridge structure removal at grade-separated highway crossings on

TABLE 1 Topics and Issues Addressed in the Research

ISSUE	TOPICS TO ADDRESS
1. Currently at-grade crossings	<ul style="list-style-type: none"> • What criteria should be used to trigger consideration of a grade-separated crossing? • What is the nature of any warrants that may be involved?
2. Currently grade-separated crossings	<ul style="list-style-type: none"> • What criteria should be used to trigger consideration of an at-grade crossing? • What steps might be necessary to bring a structure up to trail standards? • Should an existing structure be rebuilt or rehabilitated? • What if an existing structure creates a sight distance problem now?
3. Sight distance	<ul style="list-style-type: none"> • What process should be used for ensuring that adequate consideration is being given to sight distance and for documentation on the factors considered and the decisions made?
4. Signing	<ul style="list-style-type: none"> • What signing is necessary for the highway, and who is responsible for installation and maintenance? • What type of signing is necessary along the trail in advance of the intersection, and who is responsible for installation and maintenance?
5. Rail corridor preservation	<ul style="list-style-type: none"> • What steps need to be taken to increase awareness regarding the potential value of preserving the integrity of a rail corridor? • What criteria should be considered regarding the potential of a trail project? • Whose responsibility is it to be aware of the potential?
6. Conversion process	<ul style="list-style-type: none"> • What is the process and where do responsibilities lie? • What are some of the alternative levels of involvement that PennDOT might have during the rails-to-trails planning and conversion process? • What are the nature of PennDOT responsibilities during planning for rail/trail conversions?

abandoned rail lines. PennDOT engineers are expected to use sound engineering judgment in choosing and weighing a variety of factors in their evaluations of such structures. A general concern is the overall statewide cost of bridge construction, reconstruction, and maintenance. This cost is particularly acute in Pennsylvania because of the many bridges necessitated by rolling and mountainous terrain, numerous rivers, and large highway and rail networks. There are more than 23,100 bridges on the state-owned highway network alone; the cost of rehabilitating these structures and constructing new ones where necessary currently consumes 20 to 25 percent of PennDOT's annual \$1 billion construction/reconstruction budget. Thus, in an era of tight fiscal constraints, each opportunity to remove a structure from state responsibility is carefully weighed.

When asked what factors they consider in a choice to retain or to remove existing grade separations, all seven PennDOT engineering districts interviewed indicated that their primary concern is motor-ing public safety. Although the emphasis differs depending on whether the grade separation is rail over highway or vice versa, the specific factors most important to the districts are

- Physical condition of the bridge, such as loose masonry or concrete or rusting steel components;
- Limiting design elements or geometrics, principally alignment and horizontal and vertical clearances;
- Motor vehicle accident history at the site;
- Mix and volume of the motor vehicle traffic; and
- Financial considerations.

The first three factors relate directly to motor vehicle safety. Loose bridge masonry or other components falling on roadway surfaces

creates a strong motivation among the districts to remove rail structures over highways. Design elements below current policies create the same incentive, especially when there is a history of motor vehicle accidents at the site. Many rail structures over highways were constructed in the early decades of this century, at a time when roadway design policies were considerably lower than they are today. The roadways at these sites typically have 2.4- or 2.7-m lanes and little or no shoulders and are frequently in poor alignment with the structure. In most such cases, PennDOT pushes for the elimination of grade-separating structures as part of geometric safety improvement projects.

The last two factors in the above list are not associated with motor vehicle safety and may need some elaboration. Routes that carry a high volume of commercial or agricultural traffic have a high priority in Pennsylvania. In some regions, the opportunity to remove a bridge is also seen as an opportunity to enhance the movement of this type of traffic.

Beyond the general financial pressure to eliminate structures, an additional fiscal consideration relates to the crossing abolition ruling. Abolition proceedings provide an opportunity for Pennsylvania to hold railroads financially responsible for removal of rail structures. However, if a crossing is abolished without removing the structure, the Commonwealth has no further recourse to the railroad to help finance removal costs at a future date. This adds more pressure to the argument that PennDOT should press for railroad bridge removal during the abolition proceedings.

The engineering district interviews clearly indicate that PennDOT's decisions about whether to retain or remove grade-separating structures on abandoned rail lines have been dominated by motor vehicle safety and financial concerns. However, individuals in a couple of the district offices and others in PennDOT's central office questioned the department's traditional perspective that virtually ignores trail user safety. Given the multimodal mandates of ISTEA, these individuals suggested that a broader array of factors should be considered. These additional factors are discussed in a later section of this paper.

Even if a common set of factors that accounts for trail user safety can be agreed on, the PennDOT interviews revealed mixed opinions about how trail advocate demands for retaining structures should be factored into structure fate decision making. Some cite a shortage of credible trail plans, which casts doubt on whether a trail will ever be developed, as a reason for PennDOT not having more concern for trail user safety. Others state that even when a responsible organization develops a well-reasoned and publicly supported plan, it is difficult for PennDOT to objectively weigh existing highway user needs, which are well known, with potential trail user needs, which are largely uncertain.

PUC Policy and Practice

Another state agency with a high degree of interest in rail-trail conversions is the Pennsylvania PUC. The PUC staff position on crossing abolitions tends to be similar to PennDOT's traditional focus on motor vehicle safety. Although the state Rails-to-Trails Act directs the PUC to consider the effects of crossing abolishments on the future development of rail-trails, the commission's long-standing mandate is to prevent accidents and preserve safety at the crossings. Motor vehicle safety dominates the execution of this mandate; safety from a trail user standpoint is not currently given much weight. In addition, as at PennDOT, the PUC views the

abolition proceedings as an opportunity to assign due costs to railroads while the PUC still has some regulatory control over the crossings.

A necessary condition for the PUC to allow a rail structure to remain at a highway crossing is the availability of a responsible agency that can be held accountable for the structure. According to the PUC, a responsible agency is one that is relatively permanent and has sufficient resources to maintain the structure over the long term. Most nongovernmental trail sponsors do not meet this PUC standard largely because their funding base is not sufficiently stable and because many are relatively new organizations staffed by volunteers. The failure of such sponsors to present expert engineering testimony in abolition proceedings further lessens their credibility in the PUC's eyes. Furthermore, the PUC is reluctant to entrust the care of structures to nongovernmental trail sponsors because the PUC has no authority to order such sponsors to do or pay for future maintenance or reconstruction costs. On the other hand, the PUC does have jurisdiction over municipal governments, state agencies, and railroads. These organizations have relatively reliable sources of funding and have sufficient permanence to qualify as responsible agencies.

DCNR Policy and Practice

The Pennsylvania DCNR is responsible for implementing Act 188, the Pennsylvania Rails to Trails Act, passed in late 1990 (9). The Act established the Pennsylvania Rails to Trails Program. Among DCNR's mandates are the identification of existing and potentially available railroad corridors that may be suitable for trail use and the updating of listings of abandoned lines in Pennsylvania. The Act authorizes, but does not require, DCNR to acquire land for the purpose of trail development. Unfortunately, the Act did not provide a funding source for implementation.

DCNR has been supportive of sponsors' efforts to develop trails but, because of limited funds, its efforts generally have been in reaction to local initiatives. DCNR has provided testimony in support of nonprofit trail groups in abolition proceedings before the PUC. On structures, DCNR's position is that if engineers determine the structure to be structurally sound, then consideration should be given to leaving the structure in place for trail use.

Viewpoints of Trail Sponsors and Advocates

Most trail organizations planning to develop abandoned rail corridors tend to argue against the removal of grade-separating structures along the rights-of-way. The foundation of their position rests primarily on safety, economic, and financial grounds. They are critical of the PennDOT and PUC viewpoint on crossing safety, believing it to be unbalanced in the direction of motor vehicle safety while failing to consider the consequences of at-grade crossings on trail user safety. This failure is a significant omission in light of the inherently safer nature of grade-separated crossings for trail users.

For trail advocates, rail structures left in place become symbolic of commitment to a complete trail corridor. On the other hand, a structure removed severs the corridor, reducing the corridor's economic value as a public asset and decreasing the likelihood of trail development. From a transportation perspective, the value lost from severing a trail on a potential commuting route may be especially high. Speed is important on commuter trails; at-grade

intersections significantly reduce trail user speeds and thus the value of the route as a commuting corridor, unless stop controls are placed on the crossing roadway.

From a financial perspective, most nongovernmental trail-sponsoring organizations do not have the financial ability to replace structures. Thus, if a structure of any considerable length is removed, the probability of these organizations replacing it is remote, forcing an at-grade crossing with all of the attendant risks to trail users.

Balancing Viewpoints

In light of the concern for more balanced safety assessments, PennDOT personnel were asked which factors should be used to determine the appropriate type of trail/highway crossing if the needs of both motorists and trail users are to be considered. The factors mentioned included

- Type of trail user;
- Average daily traffic (ADT) of roadway and trail;
- Mix of vehicular traffic;
- Type of roadway to be crossed (limited access, arterial, etc.);
- Number of lanes to be crossed;
- Speed of the roadway;
- Sight distance;
- Percent grade; and
- Drainage.

Although this list is a start on a more balanced set of factors, few quantitative thresholds were provided and no guidance was given on how to integrate the factors into a decision-making framework.

Survey of States and Literature Review

In an effort to uncover more definitive guidance for choosing the appropriate type of crossing, five other states and several local jurisdictions were contacted by telephone and a comprehensive literature search was conducted. After talking to state and local agencies generally regarded as leaders in bicycle transportation, it was evident that not much engineering guidance for choosing crossing types has been developed in the United States.

The literature review produced more information but fell far short of providing a comprehensive set of engineering guidelines. Although summarized in this paper, the literature review is addressed in detail in a research report (10). Several documents provide guidance on the design of trail/highway crossings for bicyclists. Guidelines developed in California during the 1970s present warrants for stop control and signalization (or grade separation) on the basis of peak-hour motor vehicle volume and peak-hour bicycle volume (11). The Finns have assembled guidelines to distinguish between marked crossings, marked crossings with traffic islands, signalization, and grade separation. The guidelines employ an integrating matrix containing quantitative thresholds for motor vehicle ADT and the roadway speed limit, plus certain characteristics of the trail, such as user type and trip purpose. These guidelines are under consideration for use in Minnesota (12). Guidelines developed in the Netherlands determine the type of crossing (intersections with or without right-of-way ruling, signalized intersections, roundabouts, and grade separation) on the basis of a framework that

integrates the functional class of the bicycle trail, the design speed of the roadway, and the type of roadway to be crossed (13). Unfortunately, the nature of the research supporting the guidelines supported by the Dutch and the Finns could not be determined.

Other literature provided general guidance on the appropriate type of trail/highway crossing for pedestrian traffic. Zegeer and Zegeer developed criteria on the basis of pedestrian demand, user type, and roadway conditions to help determine where grade separation would be most beneficial to pedestrians crossing roadways (14). Axler developed guidelines to justify grade separation for pedestrians crossing freeways, taking into consideration criteria such as pedestrian volume, vehicular speeds on the roadway, vehicle volume, and location of the crossing (15). On the basis of pedestrian delay time, the width of the crossing, and pedestrian volume (16), the Institute of Transportation Engineers developed guidelines that indicate the need to protect children near school crossings. The *Manual on Uniform Traffic Control Devices* (MUTCD) also provides a warrant for signalization of a crossing on the basis of minimum pedestrian volume (17).

The literature review indicates that additional research is required. The existing guidelines are limited in scope, incorporating only a few of the factors that should be evaluated in determining the appropriate type of trail or highway crossing. For example, the guidelines do not account for factors such as sight distance and geometric conditions. Many of the guidelines were also developed for different types of facilities, not trail and highway crossings. Consequently, future research should identify the needs of trail users at highway crossings and develop a unified assessment methodology that incorporates all relevant factors while balancing the needs of road and trail users. As it currently stands, decisions on the type of crossing that best fulfills the needs of trail users and motorists given the site's physical characteristics must be made using primarily engineering judgment.

Sight Distance

Another related issue that highway and transportation agencies must address is sight distance requirements for safe operation near a crossing. Near any intersection, sight distance is critical for the safety of all users. It is especially critical when the conflict potential is between motorized vehicles and bicyclists or pedestrians. The latter do not have any physical protection, so conflicts often result in serious injuries.

Generally consistent responses were received during the PennDOT interviews; the primary concern of highway officials is providing at least the minimum stopping sight distance along the roadway for the motorists. By providing this minimum, a vehicle traveling at or near the roadway design speed should be able to stop before reaching a trail user in its path (18).

The literature review provided another viewpoint. It illustrated that additional types of sight distance should be considered near the crossing. One type is stopping sight distance from the trail user's perspective (11–13, 19, 20). Trail users, primarily bicyclists, should be provided adequate sight distance along the trail to react and come to a controlled stop before reaching the roadway (19). This is important for two reasons. To cross vehicular traffic safely, trail users should stop before proceeding across the roadway. In addition, many crossings are designed with measures, such as gates, to keep motorized vehicles off the trail. Therefore, trail users must be given sufficient sight distance to see these measures so the measures themselves do not become a hazard to the trail users.

Another form of sight distance that should be considered near a trail/highway crossing is intersection sight distance for trail users (13, 20). Sufficient sight distance should be available for a trail user, starting from a stopped position, to avoid a conflict with a vehicle that appears after the trail user's crossing maneuver has begun. The required sight distance is a function of the approach speed of motor vehicles, the width of the roadway, and the acceleration capabilities of trail users. The latter is a complicating factor because different types of trail users have varying acceleration capabilities.

Signs and Pavement Markings

A third issue facing highway and transportation agencies concerns trail and highway crossing signs and pavement markings. In many instances, signs or pavement markings or both, on or along the roadway and along the trail are the only safety measure implemented near a crossing. In this respect, signs and pavement markings are a important issue. In Pennsylvania, trail sponsors are usually responsible for financing, installing, and maintaining all trail-related signing near a crossing, both along the trail and along the highway. Typically, PennDOT incorporates all necessary permits for signs and pavement markings into agreements with trail organizations. This arrangement raises more some concerns, however. If standard warning signs and pavement markings are missing, conveying the wrong message, or not installed, the public highway or transportation agency is exposed to tort claims if an accident occurs involving a trail user and a motorist. This circumstance raises the question, If a public agency risks the liability exposure, should the agency take a more active role in the installation and maintenance of signs and pavement markings on the highway?

Another concern relates to the effectiveness of trail-related warning signs and markings. Although warning signs often are used in advance of the point where the trail actually crosses the roadway, rarely are signs or pavement markings placed at the immediate location of the crossing. Consequently, motorists can drive right by the trail crossing and not ever see it. In these situations, motorists have no information on where specifically to expect bicyclists or pedestrians. Furthermore, over time, motorists probably become less sensitive to warning signs.

Several alternatives for marking actual trail crossing locations were suggested during the interviews. One simple solution is marking the trail or highway crossing with crosswalks. Whether marked crosswalks improve, reduce, or have little impact on pedestrian safety is uncertain, however (21, 22). This ambivalence can be explained in some instances by the effect of the environment and by beliefs on driver expectations, as demonstrated by the practices of two engineering districts in Pennsylvania. Pennsylvania law, with one principal exception, grants right-of-way to pedestrians in marked crosswalks or at unmarked intersection crosswalks; the major exception occurs at intersections controlled by operating traffic signals (23). One rural engineering district discourages the placement of crosswalk markings where trails intersect roadways at non-intersection locations, preferring that pedestrians and bicyclists yield the right-of-way to the motorized traffic. Their rationale is that when drivers traveling at high speeds on rural highways encounter pedestrians and bicyclists, drivers do not expect to yield the right-of-way. In contrast, one primarily urban district marks all of its trail crossings with crosswalks because the district believes this helps to promote behavior consistent with driver expectations in urban areas.

Several suggested alternatives to crosswalk pavement markings included reflectorized panels or bicycle crossing signs. Reflectorized panels or vertical bars could be placed at all four corners of the crossing. This would distinguish the exact location of the crossing in both daylight and nighttime conditions. The MUTCD contains a crossing sign (W11A series) that is distinguished from the advance warning crossing sign (W11 series) by the addition of crossing lines on the sign face (17). The former would complement the latter by identifying the specific location where the highest level of motorist caution is necessary.

Importance of Public Planning to Trail Development Efforts

PennDOT and the PUC have been criticized during the course of abolition proceedings for giving too little consideration to the potential for trail development. Both agencies countered that they do assess whether a given structure is likely to be part of a future trail when formulating their respective positions for abolition proceedings. The agencies indicated that their perceptions of the feasibility of a trail sponsor's proposal and of the trail sponsor's credibility played a major role in the agency's judgment of whether there would be a trail developed or not. PennDOT and PUC interviews consistently indicated that the relative importance of a trail sponsor's argument for retaining a structure rose if the proposed trail was part of an official local or regional transportation, land use, or open space plan. A few examples of such plans, either already completed or in the process of being developed, were found in the same districts that appeared to have the strongest working relationships with local trail sponsors and planning agencies. Most of the districts, however, were generally not aware of whether their respective municipalities, counties, or regional planning agencies had or were contemplating any trail planning or development activities.

Interviews in PennDOT's central administrative office highlighted opinions on the need for a statewide bicycle trail plan to help guide department decisions on structures. Such a plan needs to identify a trail network; one suggestion was that this network should consist of a primary and secondary system and that every effort should be made to retain grade separations on the primary network. Another individual within DCNR emphasized the need for a line-specific statewide plan because of the nature of the abandonment process. Without a line-specific plan, the significance of an abandonment notice for a specific line segment is difficult to judge. As a result, little effort may be given to preserving structures along the line. After several years, additional abandonments in the area may be requested. When these additional notices and the prior abandonments are pieced together, the picture of a potential trail network emerges. However, if structures on the first few lines abandoned have already been removed, the opportunity to develop the network may be gone. Thus, from a policy perspective, this individual emphasized the need to develop a line-specific master plan because the potential of a trail system may not be seen otherwise.

RESEARCH RECOMMENDATIONS

Treat Trail Users as Transportation Customers

Not unlike many other public agencies, one of PennDOT's core values is commitment to providing the best possible service to the

agency's customers (24). A current issue for the agency, though, is whether rail-trail users are PennDOT customers. With regard to trail and highway crossings, the recommendations made in this paper evolve from the belief that PennDOT's customer base includes trail users as well as motor vehicle drivers and passengers. The authors view PennDOT's acceptance of this broader customer mix as critical to effective resolution of trail and highway crossing issues. Public decisions on rail bridge structures, trail and highway crossing design, signs and markings, and other trail and highway crossing matters should evolve from a balanced appraisal of sometimes differing safety and operating needs of both highway and trail users.

Encourage Development of Local Bicycle and Trail Plans

The process of reaching balanced decisions on engineering issues at trail and highway crossings begins with a strong commitment to better planning, communication, and cooperation among relevant stakeholders well in advance of rail line abandonment. Currently, public decision making on crossing issues is hampered by a lack of public planning for trails or other uses of abandoned corridors. Indeed, local or regional planning for right-of-way preservation, even for highways, is rarely done in Pennsylvania (25). However, if a proposed trail is part of a local or regional government transportation or land use plan, then the trail sponsor's request to preserve a particular grade-separating rail bridge structure can be given significantly more weight because some of the uncertainty over future trail development is reduced.

Formal public plans for trails can also serve as the basis for implementing land use ordinances that a local government may use to preserve right-of-way for future public purposes. The planning process itself can be beneficial if it encourages a high degree of stakeholder and general public involvement and if it produces a community consensus about public reuses of abandoned rail corridors. This consensus may not necessarily produce more trails. However, in those communities choosing to encourage trail development, an inclusive consensus development process provides planners and trail sponsors with a good forum for identifying stakeholder concerns and addressing potential stakeholder conflicts. If initiated sufficiently in advance of abandonment, community consensus building may be pursued without the time pressures governing the rail line abandonment process.

PennDOT and DCNR should encourage consideration of trail planning and development through the transportation plan and land use plan elements of municipal comprehensive planning. All counties in Pennsylvania are legally required to develop comprehensive plans (26). Many municipalities, although not required by law, also have municipal comprehensive plans and planning commissions. Comprehensive planning is also conducted by multijurisdiction councils of government. Multijurisdiction cooperative planning is frequently useful to the development of longer trails.

Among the required elements of comprehensive plans is a land use plan and a plan for the movement of people and goods, including pedestrian and bikeway systems (26). As part of the land use and transportation plan elements, state agencies should encourage local comprehensive planning efforts to address potential public reuses of abandoned and active rail lines. Although state and local priority may be to retain or to restore rail service, local and regional comprehensive planning should carefully weigh and prepare to implement alternative public uses that are in the public interest when rail service is not financially viable.

Enhance Communications and Cooperative Intergovernmental Efforts To Preserve Potential Trail Corridors

PennDOT must determine means of obtaining better advance warning of abandonments and, through cooperation with sister state agencies, develop a more effective process for preserving important abandoned rail corridors. PennDOT can facilitate this change through better communication, coordination, and encouragement of trail planning with other state agencies, local governments, regional planning agencies, and bicycle and trail development organizations. PennDOT’s district engineering offices are the important communications links with local governments, including county and regional planning agencies, and trail sponsors. While in a few districts these links are very strong, other districts need significant improvement. PennDOT should adopt a statewide policy directing the districts to regularly seek out and work cooperatively with local and regional trail planning efforts.

Encourage Identification of Bikeway and Trail Networks in Statewide Bikeway and Pedestrian Plans

Both states and MPOs are to include bicycle and pedestrian elements in their long-range transportation plans mandated by ISTEA (5). Although not a requirement for these plans, identifying specific facilities or corridors on a statewide bikeway and trail network guides future public priorities on abandoned rail line preservation and structure retention. Ideally, the plan functionally classifies the bikeway and trail network, furnishing one important indicator of the relative need for grade-separated crossings. Those geographic portions of the network where actual biking facilities do not already exist may have to be shown at a corridor level. Active rail lines in the corridor could then assume a higher priority as preservation candidates if abandoned. The development of a statewide bikeway and trail network should be a cooperative state and local government effort with a high degree of stakeholder input.

Decide Whether To Retain or Remove Bridge Structures

The following recommendations on the decision to retain or remove structures place a high degree of importance on the existence of credible public trail plans. Table 2 summarizes these recommendations by outlining several scenarios for a railroad structure over a roadway. These scenarios differ in whether there are geometric problems or accident histories at the site and whether a responsible agency is willing to assume ownership responsibilities for the structure.

To assess these scenarios properly, the highway or transportation agency must weigh the risks, from both the motorists’ and trail users’ perspective, of retaining, modifying, or removing the structure. This involves considering all of those factors listed previously in the findings. The intent behind the final decision, though, is to balance the needs of the motoring public and trail users while providing for safe operation of two intersecting modes of transportation.

Given the existence of a public plan for a trail, the risk to motorists in Scenario 1 is minimal. Therefore, as long as a responsible agency comes forward and is willing to accept all respon-

TABLE 2 Structure Removal or Retention Decision

Scenario	Recommended Decision ¹
1. No alignment or clearance problem. No accident history. Responsible agency willing to accept responsibility for structure.	Retain
2. No alignment or clearance problem. No accident history. No responsible agency willing to accept responsibility for structure.	Case by Case
3. Alignment, clearance, or both are substandard. No accident history.	Remove
4. Alignment, clearance, or both are substandard. Accident history at site.	Remove

¹ These recommendations assume the existence of public plans for the trail in question. If such plans do not exist, then it is recommended that the structure be removed.

sibilities for the structure, it is recommended that the structure be allowed to remain. In Scenario 2, the risk to motorists is again minimal if the structure remains, but if no responsible agency steps forward to assume ownership of the structures, joint ownership arrangements should be made between the highway or transportation agency, local government, local or state trail groups, and other state agencies, if appropriate. This spreads the ownership responsibilities and financial burdens while preserving the opportunity to develop a trail along the corridor.

In Scenarios 3 and 4, the risk to motorists has increased, and it is in their best interest to modify or remove the structure. However, if conditions warrant grade separation for trail use, the highway or transportation agency should assume some of the financial responsibility for replacing the structure when the trail is developed. The trail groups should not have to bear all the costs for replacing a structure when its removal is largely benefitting the motoring public.

A final scenario to consider is when the highway runs over the rail line. Once again the issue of planning is important, as a decision to remove the structure and rebuild the roadway on a fill reduces the attractiveness of a trail along that corridor. Therefore, the highway or transportation agency should become familiar with potential trail plans and work with other agencies to design a safe and secure overpass, if feasible and if needed for the trail.

In Scenarios 3 and 4, recommendations have called for increasing the financial responsibility of the highway or transportation agency. Some of these additional costs may be eligible under ISTEA programs. However, those who benefit from the rail structure preservation/substitution actions of the agency should bear some of the financial responsibility. Since individual trail organizations tend not to have significant financial resources relative to the costs associated with structure preservation/substitution, some alternative financing mechanisms should be developed. Alternatives that might be explored include some type of user fee that might come from annual trail use passes or from a fee on bicycle sales. Funds from such fees should be strictly dedicated to bicycle-related improvement efforts.

Determine Sight Distance

Traditionally, PennDOT has concerned itself only with motorists’ stopping sight distance near the intersection of a rail-trail and state

right-of-way. By considering only the minimum stopping sight distance for motorists, however, the department is ignoring in some cases the unique requirements of a major group of users at these crossings. The sight distance requirements of trail users should also be considered and, when appropriate, adequate sight distances should be provided so that trail users can decide when a safe crossing gap is available.

To determine the actual sight distance requirements at a crossing, the advantages and disadvantages of the various forms of sight distance were reviewed along with actual distances required for each form. The critical types of sight distance are minimum stopping sight distance for motorists and intersection sight distance for bicyclists and pedestrians. Sound engineering judgment would take the worst-case scenario for each type of sight distance and apply these requirements as a minimum in all situations. If this were done, intersection sight distance for pedestrians would be required at all trail-highway crossings. Theoretically this concept is based on similar principles as intersection sight distance for motor vehicles. However, this requirement may not be practical in all cases. The requirements for intersection sight distance are so great that, in some cases, it would be too expensive to provide and, in other cases, it may be impossible to provide the required sight lines. As a result, the proper form of sight distance must be decided on a case-by-case basis. Much of the final decision depends on where the crossing is located, if it is in an urban or rural area, and whether crosswalks are marked at the crossing. Sight distance recommendations considering each of these factors are given in Table 3.

Determine Responsibility for Signs and Pavement Markings

Highway and transportation agencies must address two issues about trail-related signs and pavement markings. The first deals with installation, inspection, and maintenance of trail-related signing along the roadway. The current practice in Pennsylvania has the trail groups responsible for these duties. It is recommended, though, that the state or local agency with ownership control over the roadway assume maintenance responsibilities for all trail-related signs along the roadway. Trail sponsors tend to be volunteer-based organizations; as such, they should not be relied on consistently to inspect and maintain roadway signing. The risk of a tort claim against the public agency is too great if a bicycle-motor vehicle accident occurs at a trail crossing where warning signs were not properly maintained. Although the public agency should take on sign-related inspection and maintenance responsibilities, all expenses for materials should be assumed by the trail sponsor.

The second issue addresses marking the location of trail crossings. It is recommended that some mechanism be used to indicate the immediate location of trail-highway crossings. One

approach is to mark the crosswalk at the location. However, crosswalks are not appropriate in all situations. Guidelines developed by Knoblauch et al. should be used to determine when marked crosswalks are appropriate (22). If marked crosswalks are not appropriate, then the public agency should provide for the installation of a crossing sign (W11A series of the MUTCD) immediately adjacent to the crossing to supplement the advance crossing warning signs (W11 series) (17).

Pursue Additional Research

This research addressed some of the issues surrounding conversion of rail and highway crossings into trail and highway crossings. Additional issues covering trails parallel to roadways, lighting, and several planning and policy matters, although not discussed in this paper, are presented in a research report (27). Additional research is needed to improve guidelines on the specific needs of trail users at crossings, the appropriate type of trail-highway crossing, trail user willingness to divert to safer crossing points, the safety consequences of midblock crossings, sight distance requirements for bicyclists, and the required signing or pavement markings, or both, at a trail-highway crossing.

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TABLE 3 Sight Distance Recommendations

	Marked Crosswalk	Unmarked Crosswalk
Urban Area	Stopping Sight Distance for Motorists	Intersection Sight Distance for Pedestrians
Rural Area	Intersection Sight Distance for Pedestrians	Intersection Sight Distance for Pedestrians

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