THE KANSAS GRADE CROSSING CONSOLIDATION STUDY

by

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SECTION I: INTRODUCTION

The Kansas Study

Background. The United States Department of Transportation (USDOT) has put renewed emphasis on closure of rail-highway grade crossings. In 1991, the Administrator of the Federal Railroad Administration (FRA) established a goal of closing 25 percent of all grade crossings in the USA. Several states are considering state legislation to mandate grade crossing closure and/or to make the process easier or more palatable to those affected. A few states are achieving success by making funds available to local communities as an incentive to close grade crossings. Some major railroads have expressed a willingness to also contribute funds to communities that close grade crossings. There are bills pending in Congress to provide federal funds as an incentive to close grade crossings. This is an ideal time for a study in Kansas to make recommendations for a state program that will take full advantage of the existing momentum for closure and be in a position to make use of the federal and railroad funds that may be available as an incentive to closure. Kansas State University (KSU) received a grant for such a study. This report documents the results.

Objectives of the Kansas Study.

The following objectives were initially set forth:

1. To find a model for Kansas that will enable the state to follow an orderly process that will have a high probability of success in closure of highway-rail grade crossings in the state of Kansas.
2. To ensure that the process is acceptable to a wide range of state and local agencies by obtaining their input and views on acceptable trade offs.
3. To ensure that the state is in a position to take advantage of any incentives that might be available through existing or future federal laws or state statutes.
4. To develop a final report that will be a resource document on a uniform and systematic procedure for identifying closure candidates, collecting and analyzing data, identifying effective incentives and documenting steps for getting crossings closed.

Scope of the Kansas Study. The scope was described as follows: "The study will do a review of literature on the subject of grade crossing closure, review reports of existing committees and task forces that are addressing this issue, review the recent Missouri study, identify key state agencies and personnel, survey these key persons by both mail and personal interview, review the current state statutes and closure process, review other states' programs, develop criteria for closure, recommend the level of incentives that could lead to success, develop a closure process and write a final report that will be a resource document on the process."

Specific Tasks.

The following specific tasks were specified:

1. Review the study work plan with the KDOT monitor and/or personnel in the railroad coordinating section of the Bureau of Design.

2. Form a study advisory committee of key state people with KDOT input.
3. Develop a survey and survey protocol to obtain input from a wide range of state agencies and local government.
4. Review literature on the national initiative, previous studies, and specific criteria developed by other states.
5. Conduct a survey of state and local personnel.
6. Analyze the survey data.
7. Write a final report that will be a resource document for achieving grade crossing closures in Kansas.

SECTION II: REVIEW OF LITERATURE

The National Initiative: Overview

Throughout this report, **grade crossing consolidation** will be used as the preferred, descriptive term for closure of unnecessary grade crossings. This terminology is in conformance with the national initiative to close unnecessary grade crossings in the USA as set forth in the *Guide to Crossing Consolidation and Closure.* (Guide) As stated in the guide: Terms such as "crossing closure" and "crossing elimination" have two shortcomings (USDOT 1994):

1. they convey an incomplete image of what is involved in closing a crossing; and,
2. they generate connotations of something being taken away.

The *Guide* sets forth the most important benefits of consolidating unnecessary grade crossings (USDOT 1994):

- fewer intersections at which collisions between motor vehicles and trains can occur;
- removal of a potential safety hazard at a cost that is often only a fraction of the cost of warning signals and gates;
- redirection of limited resources to the remaining crossings which have the greatest public necessity; and
- a reduction in the number of at-grade crossings which may need costly improvements or grade separation in the future to accommodate high speed rail operations.

A National Conference of State Railway Officials/Railroad Industry Ad Hoc Committee (NCSRO) report Highway-Rail Crossing Elimination and Consolidation: A Public Safety Issue(NCSRO) gives a more detailed list:

A. Safety, economic and societal benefits:
    - When a crossing is eliminated or closed, traffic can be rerouted to another crossing with a better warning device or a grade separation, reducing or eliminating the potential for train-vehicle collisions and casualties. The potential for derailments is also reduced.
    - The potential to upgrade warning devices or construct a grade separation at an adjacent crossing will often increase due to additional Average Daily Traffic (ADT) rerouted from the closed crossing.
    - As higher priority locations are addressed with improvements under the grade crossing improvement programs, it becomes more difficult to improve the remaining crossings.

With a smaller crossing inventory base, state program managers can more effectively utilize limited financial resources.

- Remaining street systems and crossing surfaces can be maintained at a higher level with limited financial resources.
- The sounding of train whistles or horns is no longer required, thereby reducing noise in the community.
- Crossing blockage can be reduced at the remaining crossings if switching and passing operations can be concentrated in areas with no crossings.

B. In addition to public and railroad safety and operating benefits, potential cost savings can be identified that can justify expenditures for crossing elimination and closure projects. These include improving adjacent crossings, constructing alternate accesses, and providing other incentives that may be negotiated. Following are some of these items that can be quantified in a cost-benefit analysis:

(1) Benefits to railroads:

- The railroad does not have to maintain as many crossing surfaces.
- Track/ballast/drainage problems at eliminated and closed crossings are eliminated.
- Expenses for maintenance of passive and active warning devices and whistle boards are eliminated.
- Facilities on the railroad right-of-way, such as culverts and ditches, can sometimes be retired, and vegetation control can be reduced to cover the track area only.
- Crossing elimination and closure can allow for full usage of railroad operating capacity, reducing crossing blockage and site restrictions and the need to break up trains. This is particularly true at multiple track locations.

(2) Benefits to highway agencies:

- Its responsibility to maintain traffic control devices, such as pavement markings, advance warning signs, and speed reduction measures, can be eliminated.
- Streets can be closed, turned into cul-de-sacs, or reduced in functional classification.
- Traffic is rerouted to major systems, reducing the adverse traffic and related impact on local streets.
- While difficult to quantify, noise emissions associated with crossings, including whistles and highway traffic, can be eliminated.
- The closed crossing can be removed from the statewide priority list, freeing up resources for other priorities.

SECTION III: BACKGROUND AND REVIEW OF RECENT FEDERAL INITIATIVES

The federal program of categorical grants to upgrade warning devices and improve safety at grade crossings began in 1973. From the beginning, states had to develop priority lists of grade crossings to ensure the money was spent on the most "hazardous" grade crossings. During the past 20 plus years, improved grade crossing signalization and public education programs have helped cut grade crossing accidents and casualties in half. The program has been one of the country's most successful highway safety programs.

In recent years, however, decreases in the accident rate and fatalities have ceased. In 1993, over 600 people died and over 1,800 sustained injuries in 4,892 grade crossing crashes. (NCSRO). About one-half of the fatalities occur on low-volume rural roads where traffic does not justify costly signal systems. More disturbing is that most of the other fatalities occured at those public grade crossings with automated warning devices. All of these statistics indicate that a different approach is needed. Consolidating and eliminating grade crossings is the logical next step.

Beyond highway safety there is another strong argument for consolidation and elimination of grade crossings. The country needs a strong railroad industry to maintain a healthy economy. Our infrastructure must accommodate faster, more sophisticated trains and higher train densities as the rail industry meets the public demand for faster, more efficient and more reliable transportation of goods and people. Consolidation and elimination of grade crossings will enhance national goals of having a safe and efficient intermodal transportation system. Both the rail and highway modes must play major roles. However, neither will reach their full potential unless significant strides are made in the area of grade crossing consolidation and elimination.

Nationwide, grade crossings average two per mile of railroad track, which may increase to 10 per mile in heavily congested areas. (NCSRO) Many of these grade crossings can be eliminated with little or no adverse effect on the motoring public.

The concept of consolidating or eliminating unnecessary and hazardous crossings is not new. (NCSRO)

> The *Manual on Uniform Traffic Control Devices* states that any highway grade crossing for which there is not a demonstrated need should be closed.
>
> The *Traffic Control Devices Handbook* states that the first alternative to be investigated for improvement of a grade crossing is whether or not the crossing can be eliminated by either removing the roadway or the railroad...
>
> The *Railroad-Highway Grade Crossing Handbook* states that the first alternative that should always be considered for a railroad-highway at-grade crossing is elimination.

There can also be benefits to local communities. However, it must be recognized that local residents generally respond negatively to any grade crossing elimination, and the benefits must be "sold" with good "public relations" techniques. To promote grade crossing consolidation, alternate routes must be improved to increase traffic flow and reduce accident potential. A subsidy or cash grant to the local government entity is often helpful. There may be many other benefits to specific communities beyond the two which are universal--safer alternate routes and improving the local economy--which tend to be community and/or site-specific. There is no sure fire formula for success. Russell has long pointed out that grade crossing consolidation is as much a public relations issue as a traffic engineering issue. (Russell, et. al.)

The Federal Railroad Administration is encouraging a 25 percent reduction in the approximately 280,000 public and private grade crossings. **However, accomplishing any significant reduction will take the combined and dedicated efforts of states, political subdivisions and railroads.**

Selection of Crossings

A corridor approach should be universal. When a recommendation to consolidate one or more grade crossings is one of several elements of a rail corridor grade crossing safety improvement project, the *consolidation* portion of the plan is often more acceptable to the political subdivision involved than targeting a single grade crossing for closure. The desirability of the corridor approach to achieve the most effective use of grade crossing safety funds, and as the most effective way to approach grade crossing consolidation has been recognized for years by several professionals(Russell, et al). Some states still have not adopted this approach, nevertheless, no opportunity should be missed. Several successful case studies have shown that consolidation projects can also come from the following sources: (Guide)

- review by a diagnostic team of a rail corridor,
- recommendation by federal or state safety inspectors,
- signalization of an adjacent crossing,
- response to a serious accident or series of accidents,
- planning of a track rehabilitation project,
- reports by train engineers of "near misses",
- suggestions from Operation Lifesaver volunteers,
- planning for high-speed passenger service,
- request by a town or city for crossing upgrades, and
- recommendation by railroad safety committees.

No matter how crossings or corridors are selected, a local traffic study is essential. **Proposals for grade crossing consolidation must include a highway, traffic flow and safety study by qualified professionals--preferably an experienced traffic engineer. This is essential to ensure that public safety is not compromised.**

Local governments have legitimate concerns regarding closure. These concerns must be recognized. The NCSRO report lists four concerns that are important and must be addressed:

- If alternate access is not available to handle the additional traffic adequately, countermeasures must be considered, such as improving an adjacent crossing, constructing an access road, or building a grade separation. (The costs associated with these countermeasures must be weighed against the potential benefits).

- Traffic patterns on other roads may be affected, and capacity or traffic control improvements may be required, especially if truck traffic is involved.
- The economic impact to roadway users must be considered, especially where commercial facilities are involved. If a business is adversely impacted, financial incentives may have to be considered to win support for the project. Additionally, restrictions on road access could lower property values.
- Emergency access may be the most important issue in some cases. Local fire, safety, enforcement, and planning officials should be consulted.

Authority for Closure and Local Approval

As presented in the NCSRO report: "Highway rail crossing safety responsibility is vested in a variety of agencies including state regulatory agencies, such as public service commissions and public utilities commissions, and state transportation departments. In some jurisdictions, authority to open and close crossings is vested in the local government."

Table 1 shows the specific entity responsible for opening and closing crossings in each state. The responsible entities may be regulatory commissions, administrative agencies, local road jurisdictions, or some mix of these three. The Federal government exercises no legal authority over grade crossings.

To help explain the process of closing public grade crossings, states can be divided into two groups: (Guide)

1. states that have broad authority to order a crossing closed on any public road; and
2. states that reserve for political subdivisions that exclusive authority to close crossings on locally maintained roads.

It must be kept in mind that authority to close grade crossings will not in itself result in closure. Even when arguments showing a grade crossing to be unnecessary are presented before an authority such as an administrative law judge or hearing officer at the state level, the outcome most often will favor the local government position. (Guide) **Thus, local approval is critical!**

Many states have authority over grade crossings on their state highway system. However, the majority of the opportunities to consolidate crossings are on local roads and streets over which many states have no jurisdiction. Nevertheless, case studies have shown that a strategy that includes securing local agreement will enhance opportunities to consolidate grade crossings regardless of their location.

As stated in the *Guide*: "*The reason is that even states that have the legal authority to close grade crossings on local streets seldom exercise this state power in the face of local opposition. Thus, to close a public grade crossing, the key is local agreement or absence of local opposition.*"

"***Based on the above knowledge, it is essential to recognize that the first step to an effective strategy to consolidate unnecessary grade crossings is to recognize that the approval process is a process of negotiation.***"

Table 1. State Responsibilities to Open and Close Public Crossings
(Source: NCSRO Report)

Regulatory Commissions	Administrative Agencies	Local Jurisdictions
Alabama	Alaska	Georgia
Arizona	Arkansas	Indiana[4]
California	Connecticut	Iowa
Colorado	Delaware	Kansas
Idaho[1]	District of Columbia	Louisiana
Illinois	Florida	Mississippi[3]
Minnesota[1]	Idaho[1]	Montana
Missouri	Indiana[4]	Nebraska
Nevada	Kentucky	North Carolina
New Mexico	Maine	South Carolina[4]
North Dakota	Maryland	Tennessee[4]
Ohio[2]	Massachusetts	Texas[4]
Oklahoma	Michigan	West Virginia
Oregon	Minnesota[1]	
Pennsylvania	Missouri	
Rhode Island	Mississippi[3]	
Washington	New Hampshire	
	New Jersey	
	New York	
	South Carolina[4]	
	South Dakota	
	Tennessee[4]	
	Texas[4]	
	Utah	
	Vermont	
	Virginia	
	Wisconsin	
	Wyoming	

[1] States whose regulatory commissions have authority to close crossings and whose administrative agencies have authority to open crossings.

[2] A state whose regulatory commission has authority to close crossings, but requires the approval of a local judicial court to open a new crossing.

[3] A state whose administrative agency has authority to close crossings and whose local jurisdictions have authority to open crossings.

[4] States whose administrative agencies and local jurisdictions have responsibility to close crossings.

Model Approach Recommended in the Federal Railroad Administration Guide

The *Guide* presents a model approach to grade crossing consolidation which is paraphrased below (USDOT 1994).

1. **Screen Projects**
   - *Safety and redundancy.* Considering both safety and redundancy is a good first test. The approval to close a grade crossing seldom is based solely on safety, i.e., eliminating hazards. The most successful also consider public necessity and convenience and provide viable alternate routes.
   - *Traffic safety.* It is important that the motoring public be diverted to a safer grade crossing via a safe connecting roadway with adequate capacity. A traffic engineering study is a critical element.

2. **Know the Local Community**
   - *Profile of the local community. Critical factors*:
     - the layout of local streets;
     - traffic patterns and amount of traffic;
     - emergency vehicle routes (fire, police, rescue);
     - the impact on neighborhoods, businesses, and schools;
     - community perception of the railroad (favorable, unfavorable, neutral);
     - warning devices at adjacent crossings;
     - the form of local government and administrative procedures;
     - local needs (incentives the railroad or state can offer in exchange);
     - alternative crossings for closure;
     - miscellaneous information, such as background of key decision-makers, local culture and practices (formal or informal), etc.

   Failure to address any of the above local concerns could result in rejection of an otherwise meritorious proposal.

3. **Use State and FHWA Guidelines.**
   Make local officials aware of state and federal guidelines for grade crossings that should be closed. Federal guidelines in place since 1986 are as follows: (*Grade Crossing Handbook*)
   - *Mainline.* More than 4 crossings within a 1 mile segment.
   - *Branchline.* Less than 2000 ADT; more than 2 trains per day; alternate crossing within 0.25 mile.

   Also, it is the position of the FRA that transportation planners should identify and consider the following types of crossings for possible elimination: (NCHRO)
   - crossings where a high number of collisions have occurred;
   - crossings that occur where the road crosses railroad tracks diagonally, or any crossing with reduced sight distance (e.g., where track is curved) or reduced visibility, even if only seasonally;
   - adjacent crossings when one is being upgraded or grade-separated;

- several adjacent crossings when a new one is being built;
- private crossings for which no responsible user can be identified;
- private crossings for which the user is unable or unwilling to fund improvements (and alternate access to the other side of the tracks is reasonably available);
- complex crossings where it is difficult to provide adequate warning devices or that have severe operating problems (e.g., multiple tracks, extensive switching operations, long periods of blocked crossings, etc.).

4. **Use Volunteers, Particularly Operation Lifesave Personnel**

An extensive list is presented by the NCSRO committee report and is presented below.

- Public Officials:

  (1) state highway personnel responsible for administering the grade crossing improvement programs;
  (2) state regulatory agency personnel (where applicable). In some states, the utilities commission has the authority to close crossings, and hold hearings, etc.;
  (3) local administrative officials, such as mayors, city councilmen, and county commissioners;
  (4) local public works and planning officials--e.g., directors of public works, city traffic engineers, and city planners;
  (5) state and local emergency officials, including enforcement and fire departments;
  (6) local school and school bus officials.
- Private Industry:
  (1) any industry or company in the area that relies on the crossing for customer or employee access.
- Railroad Personnel:
  (1) public projects personnel who coordinate Section 130 projects with the state;
  (2) local operating personnel, such as the trainmaster or railroad superintendent;
  (3) local maintenance personnel, such as the roadmaster or signal supervisor; and
  (4) safety committees, such as Operation Lifesaver (OL). Often, committee members, such as railroad officials and locomotive engineers, are aware of crossing elimination and closure candidates.
- Community Allies:
  Because community agencies often have the final decision, it is important to obtain public support for crossing closures. Those directly involved in the closure evaluation process are critical to the planning and implementation processes, but others can provide valuable support, particularly political, to these efforts. Potential allies may include:
  (1) Operation Lifesaver (OL) presenters and committees, who often have already contacted members in the community or area and are aware of strategic political contacts, closure candidates, and so on;
  (2) police agencies, particularly if they have been involved in a grade crossing collision investigation;
  (3) rail-served industries, such as grain elevator companies, that may improve their operations by closing a crossing;

(4) local groups, such as Mothers Against Drunk Driving (MADD), National Safety Council Chapters, etc., that have a common interest in safety matters;

(5) private citizens who may have a personal interest in closing a crossing to eliminate whistle noise or to reduce traffic through a neighborhood;

(6) school boards and school bus companies which have a vested interest in crossing safety and can be supportive of closure efforts.

Incentives

Railroads have more flexibility than states in offering incentives. The *Guide* lists the incentives that were offered in case study projects:

- cash payments that could be applied to any community project;
- upgrading of adjacent crossings without any cost to the town;
- transfer of land parcels from the railroad to the town;
- street improvements;
- construction of connecting roads to link remaining crossings;
- training for school and local public safety officials to give Operation Lifesaver presentations.

Some states have passed legislation allowing them to provide incentives. This will be discussed in a later section of the report.

SECTION IV: STATE PROGRAMS

The NCSRO study conducted a 50-state survey of laws, policies and practices relating to grade crossing consolidation. An appendix to the NCSRO study final report lists detailed closure, legislation and procedures from several states. A contact person for each state is listed. These will not be repeated here. A summary of significant findings, paraphrased from the NCSRO report follow (NCSRO).

State laws vary widely. Even those with vested authority to order the elimination of grade crossings can encounter difficulty unless there is local agreement. Some states, such as Kentucky (where the Kentucky Transportation Cabinet has authority to close all *public* grade crossings used by fewer than 4,000 highway vehicles per day), have used their authority as a negotiating tool to gain cooperation from railroads and locals. As of the writing of the NCSRO report, they had never found it necessary to exercise the authority.

Oregon. The Oregon Public Utilities Commission (PUC) has exclusive legal authority to close public grade crossings wherever possible. They have exercised this authority to close more than 250 grade crossings between 1974 and 1992.

Before selecting candidate grade crossings, Oregon PUC considers:

- the closure's potential impact on business;
- the availability of access for emergency services;
- the availability and convenience of alternate routes.

Oregon PUC also involves local officials in the decision-making process even though it doesn't have to do so.

In April 1994, the state of Oregon gave the PUC power to "alter, relocate or close farm or private grade crossings on railroad lines designated as high-speed rail systems." The same bill gave the Oregon Department of Transportation (ODOT) authority to use eminent domain to acquire private property related to grade crossings ordered closed by the PUC. Funds to cover the costs of consolidation will be paid by funds dedicated to high-speed rail systems. (The new legislation will not be implemented until the state receives high-speed rail funding.)

Missouri. Studies that include pilot grade crossing consolidation are being conducted. The Missouri Division of Transportation (DOT) in the Department of Economic Development has recommended a closure plan. This division has exclusive power to determine both the closure and opening of highway-rail grade crossings. They may order closure or alteration where they find that public convenience and necessity are not adversely affected. They also have the authority to determine if a private grade crossing has become public in its operation, and the authority to order a specific warning system. If the system is not installed, the division will order the grade crossing closed to the public.

Illinois. The Illinois Commerce Commission (ICC) currently has authority to close grade crossings and open new ones. In 1993 the Illinois Compiled Statutes (Chapter 625,5/18C-7401(3)) was amended and lists specific criteria for the ICC to consider for opening or abolishing grade crossings:

- the timetable speed of passenger trains;
- the distance to an alternate crossing;
- the accident history for the last five years;
- vehicular traffic and posted speed limits;
- the number of freight trains and their timetable speeds;
- the type of warning device present at the grade crossing;
- alignments of the roadway and railroad, and the angle of intersection of those alignments;
- the use of the grade crossing by trucks carrying hazardous materials, vehicles carrying passengers for hire, and school buses; and
- the use of the grade crossing by emergency vehicles.

The amended statutory language requires the ICC to close a crossing if it meets criteria established by the ICC. A hearing process is specified. Arguments at the hearing should be based upon the "facts" of the criteria.

Florida. Florida statutes give the Florida Department of Transportation (FDOT) sole authority to open or close public railroad-highway grade crossings. Applications for closure or opening a grade crossing may be made by a city, county, railroad or the FDOT. The FDOT has placed a moratorium on opening new at-grade crossings on Florida's Section 1010 high-speed rail corridor.

Kentucky. In 1992 the Kentucky state legislature directed the Kentucky Transportation Cabinet (State DOT) to develop regulations for highway-rail crossing closure decisions. The Kentucky program is based upon an annual list of grade crossing closure candidates that the state DOT develops from the following sources: (Richards, 1993)

- responses to a letter sent to each county or local government in the state that has rail service;
- responses to a letter sent to each railroad company operating in the state, requesting candidate grade crossings for closure;
- recommendations from other public or private agencies or individuals;
- railroad crossings which the state DOT considers candidates for closure (based on the following criteria):
  (1) in urban areas, alternate crossings within one-quarter track mile and a street ADT of 500 vehicles or less;
  (2) in rural areas, an alternate crossing within one track mile and a roadway ADT of 150 vehicles or less;
  (3) the crossing has sight distance or geometric conditions which create a hazard and closure is the economically preferable alternative to correcting deficiencies.

The Kentucky regulations imply that the state DOT may use a corridor approach. They also provide that a grade crossing closure may be evaluated in terms of economic costs and benefits, including: (Richards, 1993)

- the railroad crossing's effects on highway and rail operations safety;

- changes in highway capital and maintenance costs due to closure;
- effects on local business operations and property values;
- effects on rail and highway vehicle operating costs;
- other economic impacts.

The Kentucky grade crossing closure regulations specify that the state DOT recommendation to close a grade crossing include consideration of one or more of the following factors: (Richards, 1993)

- highway traffic flow through the crossing;
- highway operating speeds through the crossing;
- train traffic through the crossing;
- train speed through the crossing;
- character, function and type of highway traffic through the crossing;
- the necessity of the crossing for emergency vehicles;
- accident history for the past five years;
- crossing geometry, including sight distance and acute crossing angle;
- the type of warning device;
- the condition of alternate crossing;
- the distance and time to alternate crossing;
- the character of adjacent road network;
- reasonable access to public and private lands;
- the use of crossing for pedestrians and bicycles;
- the frequency of roadway blockage by trains;
- community impacts of train whistle;
- the economic importance of the crossing;
- development projections in the vicinity of the crossing.

An important aspect of the Kentucky program is that: (Richards, 1993)
"The burden of proof for the retention of the railroad crossing shall be the responsibility of the individuals, organizations or agencies that contested the closure decision."

Montana. The state of Montana uses the diagnostic team review process. The diagnostic team is given only limited, suggested guidelines to follow for preparation of a closure request. The suggested guidelines set forth the following terms to include: (Richards, 1993)

1. Study highway traffic flow, including;
    - capacity;
    - optimum route designation;
    - one or more crossings consolidated to move to a nearby crossing;
    - alternate route(s) in reasonable travel time and distance.
2. Positive and negative impacts, such as:
    - emergency vehicles;
    - engineering assessment (by diagnostic team);
    - economic assessment.

Minnesota. The Minnesota legislature enacted recent legislation, "to consider that the number of grade crossings in this state should be reduced and that public safety will be enhanced by reducing the number of grade crossings." The legislature directed the Transportation Commissioner to develop a list of candidates for closure. In response the Minnesota DOT developed the following criteria for closure: (Richards, 1993)

- A grade crossing at which there has been an accident involving a fatality or two property damage or personal injury accidents within the last five years;
- An alternate grade crossing or grade separation which provides access to the affected private properties or public lands is available within one-quarter mile in an urban area or one mile in a rural area;
- The grade crossing:
  - is located in an urban area within ADT of less than 750 vehicles;
  - is located in a rural area with ADT of less than 150 vehicles;
  - has sight distance obstructions or alignment which creates unsafe conditions.

California. In California, authority to close grade crossings is vested in the California Public Utilities Commission (CPUC). They have the authority to prevent new grade crossings, abolish existing grade crossings, or order a grade crossing abolished if it is "not maintained by a local agency." The authority of the CPUC is clear in the state's public utilities code. However, it is an example of a state where the authority exists but closing a grade crossing is difficult due to political pressure. It is only on rare occasions--about once in ten years--that a proposal for closure goes through the hearing process. (NCSRO, 1994)

The NCSRO report suggests the following factors must be considered:

- Volume of traffic (ADT);
- Type of vehicular use, e.g., school buses, hazardous materials carriers, etc.;
- Physical conditions, such as:
  - approach grades;
  - sight restrictions;
  - number and speed of trains;
  - accessibility of alternate crossings;
- Adequate alternate routes and upgraded crossings with improved approaches and surfaces and adequate vertical and horizontal clearances.

Incentive Programs

Nebraska. The state cannot close grade crossings without agreement from the local political subdivision. To facilitate negotiations, the state offers the following cash incentives: (NCSRO, 1994)

1. for loss of access, $5,000 (and a matching $5,000 from the railroad involved);

2. actual costs of closure, including related improvements such as road widening, not to exceed $12,000.

Between 1984 and 1994 the Nebraska Department of Roads closed 36 grade crossings using financial incentive payments.

Missouri. The Missouri DOT recently developed a policy that requires the agency to allocate 10 percent of the State's Grade Crossing Safety Account funds for incentive payments to local jurisdictions for crossing closure. (NCSRO, 1994)

The Missouri policy does not mandate a matching amount from the railroads but Union Pacific Railroad Company (UP) and Burlington Northern Railroad Company (BN) have agreed to participate, voluntarily. Their payment must not exceed $5,000 per grade crossing closed and incentives are allowed from the state fund only in cases where the project is not federally funded. (NCSRO, 1994)

American Association of State Highway and Transportation Officials (AASHTO): To encourage incentive programs nationwide, AASHTO recently approved a resolution to support changes in the United States Code of Federal Regulations (CFR). The proposed changes would allow the use of federal funds currently reserved for highway-rail improvements to provide incentive funds to local agencies for grade crossing consolidation. The United States Department of Transportation (USDOT) has proposed legislation to establish an incentive program. The proposed legislation is summarized below: (NCSRO, 1994)

- It includes crossing closure projects among those Surface Transportation Program (STP) projects eligible for 100 percent federal funding. (The current matching requirement acts as a financial disincentive to close crossings.).
- It allows use of federal funds to pay incentives, not to exceed $7,500, to local jurisdictions for each crossing closed. (Payment would be made at the discretion of the responsible state agency upon receipt of a matching share from the railroad owning the affected track.).
- It directs the secretary of transportation to establish guidelines to enable states to determine the public benefits and costs resulting from any new grade crossing.
- It provides a fiscal incentive for states to review and implement grade-crossing safety improvements on a corridor basis. (This incentive would be in addition to those funds available for the above programs.).
- It requires the secretary of transportation to set aside $15 million in STP funds annually to cover the fiscal incentive program.

The Missouri Study

It was the intention at the start of the Kansas study that it would basically follow the procedures of a study by Richards Associates (RA) for the state of Missouri. (Richards, 1993) There was an initial, tentative plan to coordinate effort with additional field work in a selected rail corridor by RA or one of the railroads operating in Kansas. This follow-on project was not funded; however, much good information was available from presentations and personal communication with Mr. Richards, and from the project final report. An overview will be presented in the following paragraphs. The Executive Summary is presented in Appendix A.

The Missouri study had the following 12 steps:

1. establish a study advisory committee;
2. develop a questionnaire;
3. identify data needs;
4. review other state programs;
5. review national initiative programs;
6. conduct interviews;
7. identify data necessary for crossing closure program;
8. develop a priority index;
9. develop crossing closure criteria;
10. compute priority index;
11. do a benefit/cost analysis;
12. study funding alternatives.

Of particular interest from the Missouri study is the list of data elements that should be considered in determining criteria. These were identified by the study advisory committee as follows: (Richards, 1993)

- the distance to an alternate crossing;
- accident history for the past five years;
- the number of motor vehicles using the crossing;
- the number of trains and timetable speed;
- the type of warning device installed at the crossing;
- the type of signal circuitry;
- the angle of roadway/rail intersection;
- the use of the crossing by special vehicles;
- the use of the crossing by emergency vehicles;
- rail passenger operation and speed;
- the number of traffic lanes;
- the number of tracks;
- sight distance on roadway approach to the crossing;
- urban or rural environment;
- crossing closure costs;
- crossing closure economic benefits.

To use the recommended corridor approach to grade crossing consolidation, the data used in the corridor analysis must be representative of the corridor and not just the individual grade crossings. The following corridor data elements were selected: (Richards, 1993)

Group 1: Corridor Considerations:

- the total number of crossings;
- the length of corridor;
- the average distance between crossings;
- the average AADT for the corridor.

Group 2: Roadway Considerations:

- the number of urban crossings with less than 750 AADT;
- the number of rural crossings with less than 150 AADT;
- active warning systems
  - -- with constant warning, and
  - -- with DC circuitry;
- the number of Passive crossings;
- the number of crossings with less than 60 degree angle;
- sight obstructions.

Group 3: Railroad Considerations:

- the number of through trains;
- the speed of one train;
- the number of passenger trains;
- the number of crossings with one track;
- the number of crossings with two-three tracks;
- the number of crossings with more than three tracks.

Group 4: Safety Considerations:

- average composite hazard index;
- the number of accidents past five years;
- the number of fatalities and injuries for the past five years.

Group 5: Crossing Use Characteristics:

- the number of school bus crossings;
- emergency vehicle use;
- special vehicle use (hazardous materials);
- the number of crossings with more than 15% truck use;
- railroad operating requirements.

These data elements can be weighted by groups and by individual elements. An example of how these were weighted is presented in Appendix B.

An important step in the Kansas study is to determine, with input from the advisory committee, a similar list. Consideration should be given to:

1. concerns of local government respondents to a survey (presented in the next section);
2. data availability, particularly from the Kansas "Highway-Railroad Grade Crossing Inventory";
3. lists suggested by the federal initiative (Section III);
4. lists used by other states with viable crossing consolidation programs (Section IV).

SECTION V: SURVEY RESULTS

A mail survey was sent to 674 officials from local highway agencies in the state. Surveyed officials included those from counties, large cities, townships, and small cities. The questionnaire shown in Appendix C comprised nine questions on improvement of grade crossing safety. A total of 324 questionnaires (48 percent) were returned, with large city and county officials showing higher response rates of 70 and 66 percent, respectively, compared to 33 and 42 percent by townships and small city officials respectively. The following sections discuss the results of the survey.

Number of Crossings

Counties have the largest number of grade crossings, with an average of 36 grade crossings per county and a maximum of 283. Large cities rank second, with an average of 17 and a maximum of 400 grade crossings. Townships have an average of 5.8 crossings and a maximum of 17 crossings, while small cities have the fewest crossings with an average value of 2.8 and a maximum of 25 crossings.

Concerns Regarding Safety

Overall, about 67 percent of respondents have safety concerns at railroad grade crossings on streets and roads in their jurisdictions. Only 25 percent do not perceive safety problems, while eight percent were undecided. County and township officials seem to be more concerned than city officials. This could be due to the different circumstances, with county and township roads being in rural areas where train speeds and accident severity are higher than in the cities. Figures 1a and Table 2 show the percentage of respondents having safety concerns, broken down by jurisdiction, while Figure 1b shows for the same for a combination of all jurisdictions.

Table 2: Jurisdictions in Kansas With Concerns Regarding Safety

Response/ Jurisdiction	Counties [N(%)]	Large Cities [N(%)]	Small Cities [N(%)]	Townships [N(%)]	All [N(%)]
Yes	60(86)	35(65)	108(60)	15(71)	218(67)
No	9(13)	14(26)	52(29)	5(24)	80(25)
No Response	1(1)	5(9)	19(11)	1(5)	26(8)
Total	70(100)	54(100)	179(100)	21(100)	324(100)

Figure 1a: Distribution of Concerns Regarding Safety Within Jurisdictions

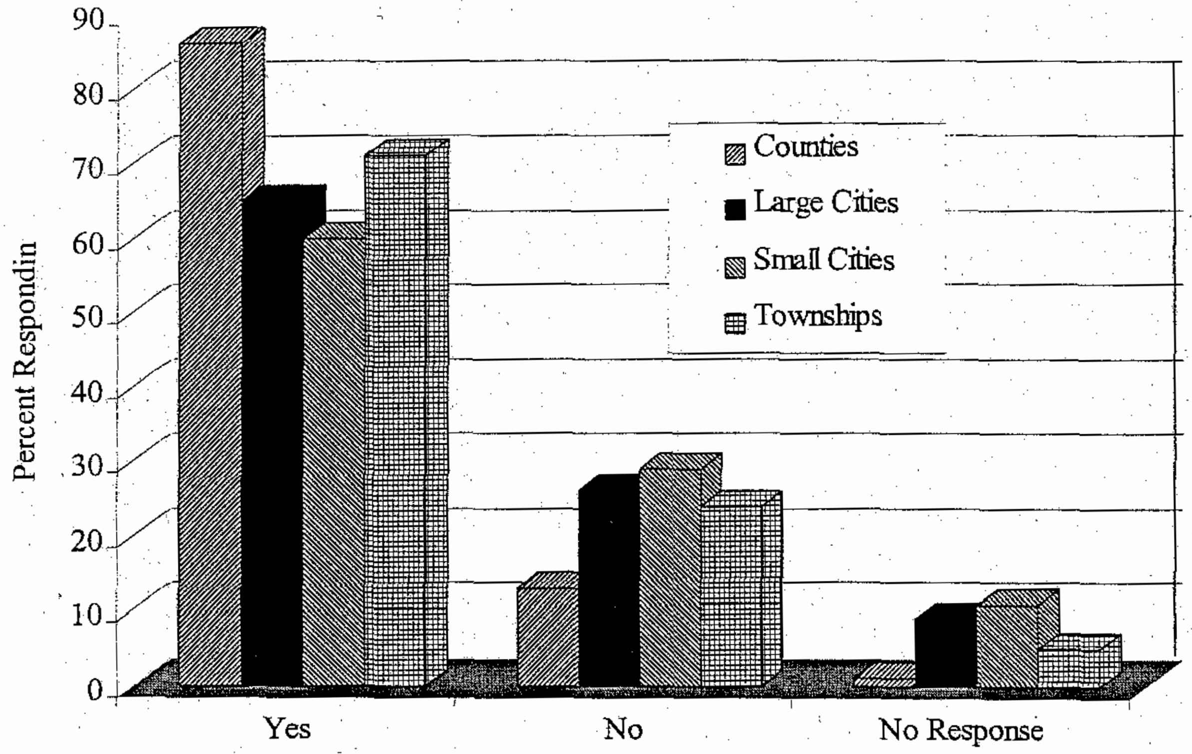
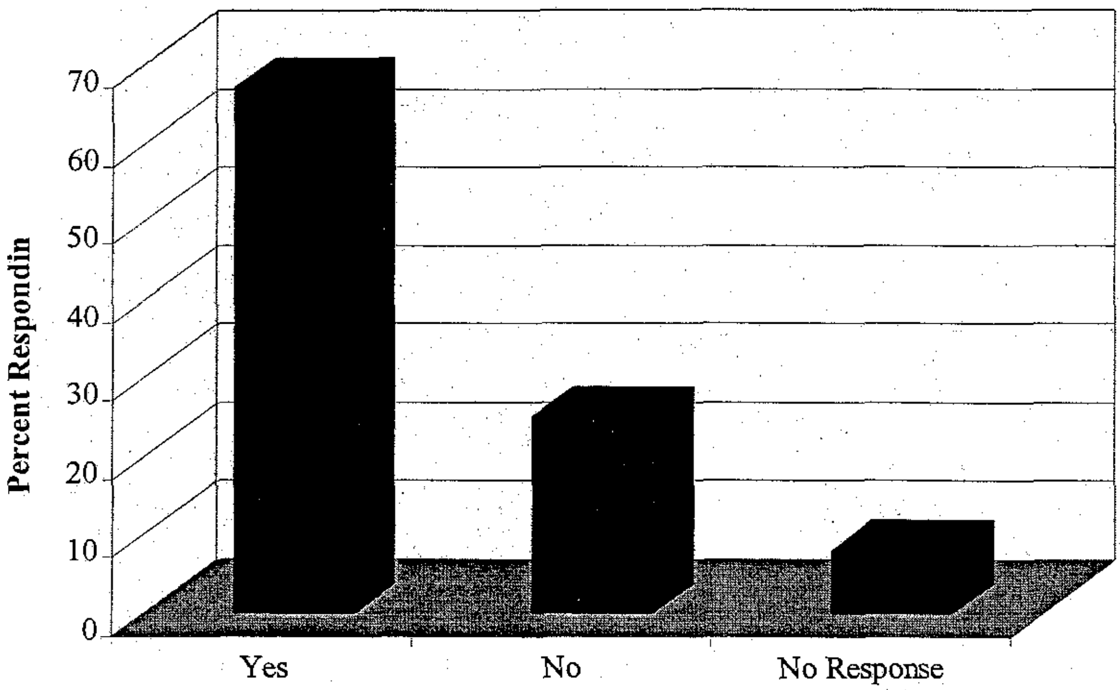


Figure 1b: Distribution of Concerns Regarding Safety (All Jurisdictions)



Type of Safety Concerns

As can be seen in table 3, county officials seem to be more concerned than city and township officials regarding safety of active warning devices, crossing surfaces, and train visibility. None of the respondents from counties and townships indicated train whistle noise to be a safety concern. "Crossing surface", "train visibility", "crossing blockage" and "need of active warning devices" are the four highest categories, in that order. Table 3 and figures 2a and 2b show the distribution of respondents' concerns. Under the "other"category the following concerns were expressed:

- high train speeds,
- skewed alignment,
- derailment of hazardous material trains,
- steep crossing approach grades,
- abandoned but not removed railroads,
- inattentive drivers,
- engine noises,
- emergency response vehicles, and
- inadequate railroad right of way maintenance.

Table 3: Type of Rail-Highway Crossings Concern Jurisdictions

Safety Concern / Jurisdiction	**Counties** [N(%)]	**Large Cities** [N(%)]	**Small Cities** [N(%)]	**Townships** [N(%)]	**All** [N(%)]
Need Active Warning Devices	29(41)	13(24)	40(22)	5(24)	87(27)
Train Visibility	47(67)	17(31)	39(22)	9(43)	112(35)
Crossing Surface	55(79)	31(57)	94(52)	11(52)	191(59)
Blockage of the Crossing by Train	17(24)	19(35)	46(25)	3(14)	85(26)
Signal Malfunctioning	9(13)	9(17)	22(12)	2(10)	42(13)
Noise from the Train Whistles	0(0)	7(13)	13(7)	0(0)	20(6)
Other	14(20)	5(9)	20(11)	1(5)	40(12)
No Response	4(6)	16(30)	55(31)	3(14)	78(24)

Figure 2a: Distribution of Rail-Highway Crossing Concerns Within Jurisdictions

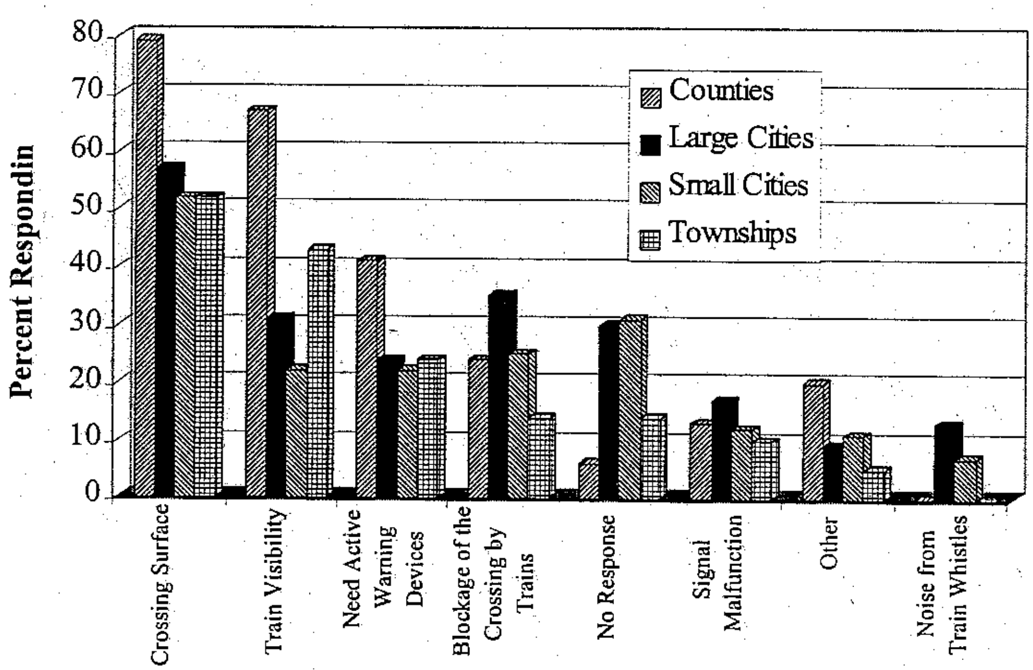
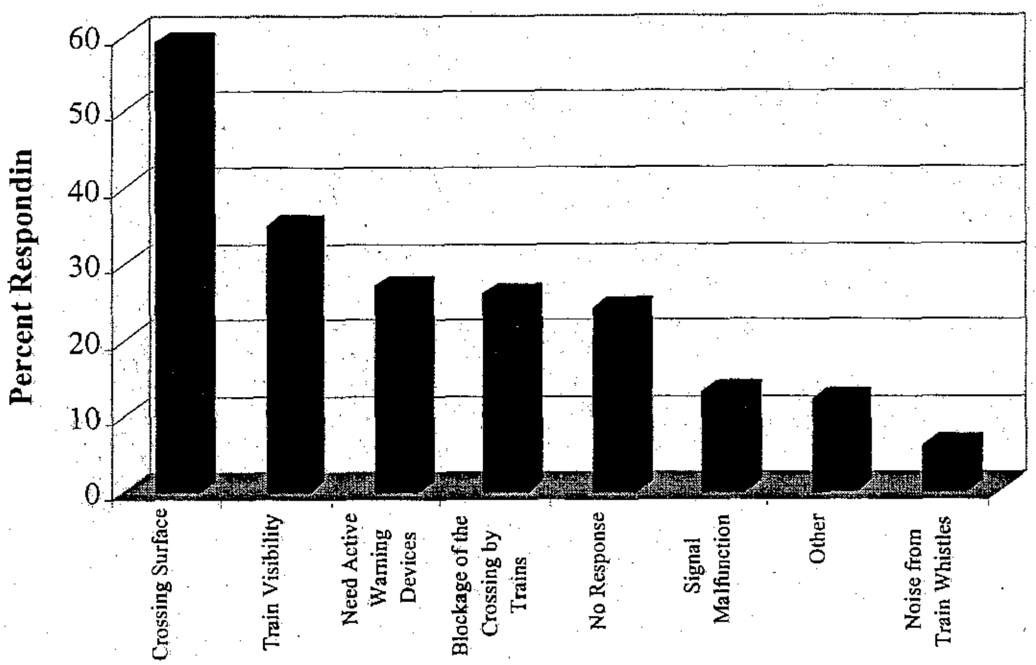


Figure 2b: Distribution of Highway-Rail Crossing Concerns (All Jurisdictions)



Essentiality of Crossings

Respondents were asked to mark the factors that their governing bodies would use to determine if the grade crossing were essential. "Access to businesses", "access to residential areas", "emergency vehicle blockage", "affect on major traffic flows", "traffic safety", and "public convenience" were marked by significant proportions of respondents (between 47 to 64 percent) as factors used to determine if the crossing were essential. "Access to new development" was the only factor marked by 28 percent of the respondents. Table 4 and Figures 3a and 3b summarizes the distribution of factors considered in the determination of the essentiality of the crossing. Other factors mentioned by respondents that were not included in questionnaire categories are:

- farm vehicle and industry access,
- potential traffic increase,
- school bus and pedestrian crossing,
- detour length if crossing is closed or blocked,
- cost, and
- public hearings.

Table 4: Factors Used to Determine Essential Crossings.

Factor Considered/ Jurisdiction	Counties [N(%)]	Large Cities [N(%)]	Small Cities [N(%)]	Townships [N(%)]	All [N(%)]
Access to Businesses	44(63)	37(69)	90(51)	14(67)	185(57)
Access to Residential Areas	41(59)	33(59)	88(49)	11(52)	173(53)
Access to New Development	22(31)	26(48)	40(22)	3(14)	91(28)
Emergency Vehicle Blockage	43(61)	43(78)	101(57)	8(38)	195(60)
Affect on Major Traffic Flows	41(59)	38(69)	66(37)	6(29)	151(47)
Traffic Safety	55(79)	40(72)	103(58)	11(52)	209(64)
Public Convenience	47(61)	30(56)	80(45)	12(57)	169(52)
Other	10(14)	6(11)	21(12)	1(5)	38(12)
No Response	2(3)	8(15)	43(24)	2(10)	55(17)

Figure 3a: Distribution of Factors Used to Determine if Crossing is Essential by Different Jurisdictions

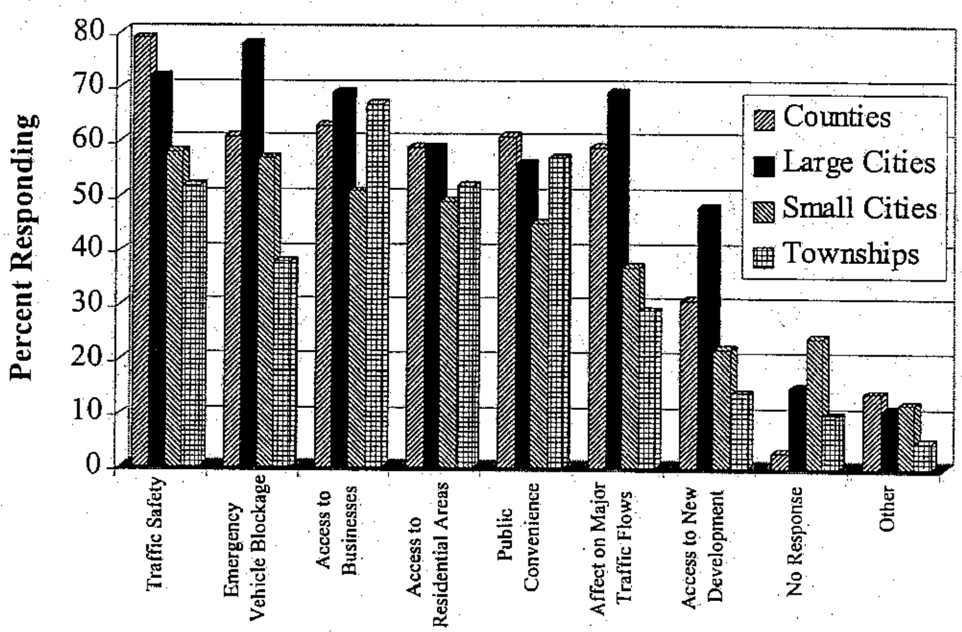
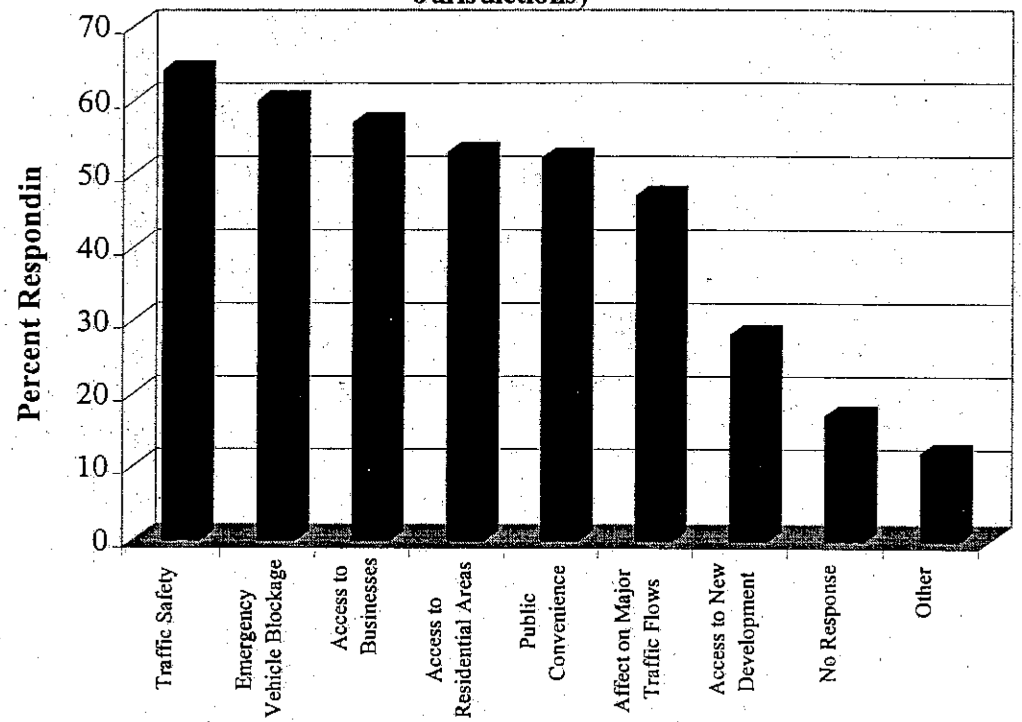


Figure 3b: Factors Used to Determine if Crossing is Essential (All Jurisdictions)



Crossing Closure

The questionnaire contained four questions to determine if the responding jurisdictions would consider closure of non-essential grade crossings under different conditions of improving safety, i.e., "no cost to the governing body", "safety improvements on essential crossings", and "financial incentive to offset the impact of crossing closure".

For all four questions, the "Yes" category was marked by a small proportion of respondents (13 to 17 percent) compared to "No" and "Maybe" (28 to 35 and 31 to 35 percent respectively). However, there is a great potential for converting the "Maybe" category to "Yes" through incentive programs, and education of local officials. Such conversion would make the closure of non-essential crossings widely accepted. It is worth noting that the option of "financial incentive" had the highest "Yes" and lowest "No" categories. Tables 5 through 8 and figures 4a through 7b shows the distribution of response on these questions.

Table 5: Opinions of the Closure on Non-Essential Crossings to Improve Safety

Response / Jurisdiction	Counties [N(%)]	Large Cities [N(%)]	Small Cities [N(%)]	Township s [N(%)]	All [N(%)]
Yes	14(20)	7(13)	19(11)	2(10)	42(13)
No	20(29)	11(20)	74(41)	10(48)	114(35)
Maybe	33(47)	32(59)	36(20)	6(28)	107(33)
No Response	3(4)	4(8)	50(28)	3(14)	60(19)
(Yes + Maybe)	*47(67)*	*39(72)*	*55(31)*	*8(38)*	*149(46)*

Table 6: Opinions on the Closure of Non-Essential Crossings at no Cost

Response / Jurisdiction	Counties [N(%)]	Large Cities [N(%)]	Small Cities [N(%)]	Township s [N(%)]	All [N(%)]
Yes	19(27)	10(19)	23(13)	2(10)	54(16)
No	15(23)	8(15)	72(40)	11(52)	106(33)
Maybe	32(46)	32(59)	32(18)	4(19)	100(31)
No Response	4(4)	4(7)	52(29)	4(19)	64(20)
(Yes + Maybe)	*51(73)*	*42(78)*	*55(31)*	*6(29)*	*154(37)*

Table 7: Opinions on the Closure of Non-Essential Crossings by Safety Improvements of Essential Crossings

Response / Jurisdiction	Counties [N(%)]	Large Cities [N(%)]	Small Cities [N(%)]	Township s [N(%)]	All [N(%)]
Yes	16(23)	8(15)	23(13)	0(0)	47(14)
No	19(27)	7(13)	63(35)	10(48)	99(31)
Maybe	31(44)	35(65)	39(22)	8(38)	113(35)
No Response	4(6)	4(7)	54(30)	3(14)	65(20)
(Yes + Maybe)	*47(67)*	*43(80)*	*62(35)*	*8(38)*	*160(49)*

Table 8: Opinions on the Closure of Non-Essential Crossings if Financial Incentive is Available

Response / Jurisdiction	**Counties [N(%)]**	**Large Cities [N(%)]**	**Small Cities [N(%)]**	**Townships [N(%)]**	**All [N(%)]**
Yes	17(24)	13(24)	25(14)	1(5)	56(17)
No	15(21)	6(11)	60(33)	10(48)	91(28)
Maybe	34(49)	32(59)	39(22)	7(33)	112(35)
No Response	4(6)	3(6)	55(31)	3(14)	65(20)
(Yes + Maybe)	*51(73)*	*45(83)*	*64(36)*	*8(38)*	*248(52)*

Figure 4a: Consideration of Closing Non-Essential Crossings to Improve Safety by Jurisdictions

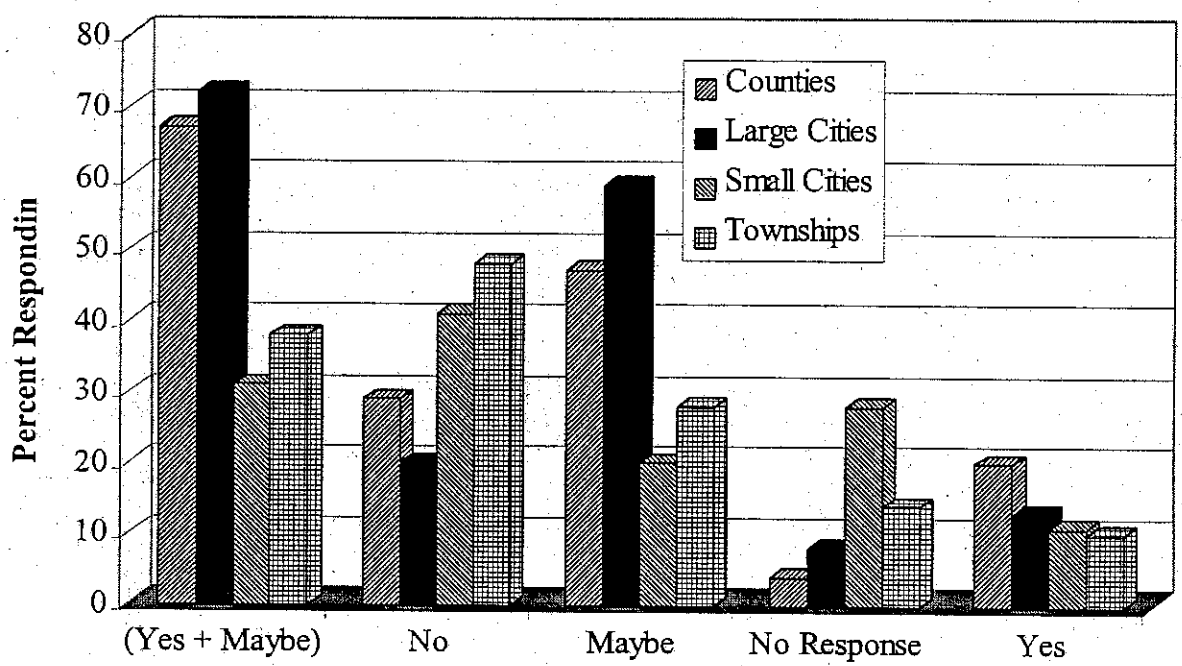


Figure 4b: Consideration of Closing Non-Essential Crossings to Improve Safety (All Jurisdictions)

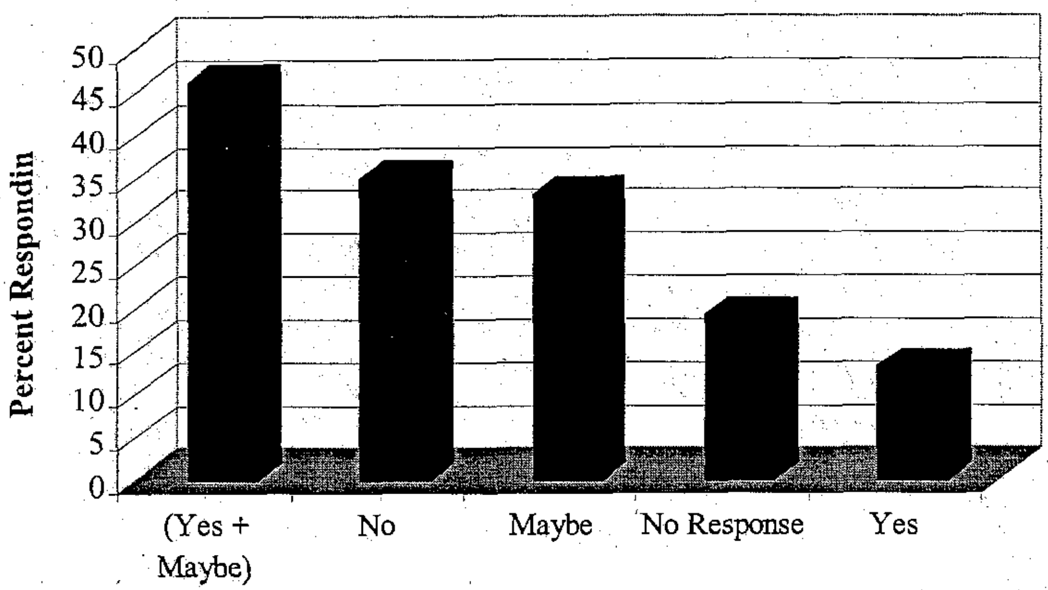


Figure 5a: Consideration of Closing Non-Essential Crossings at no Cost by Jurisdictions

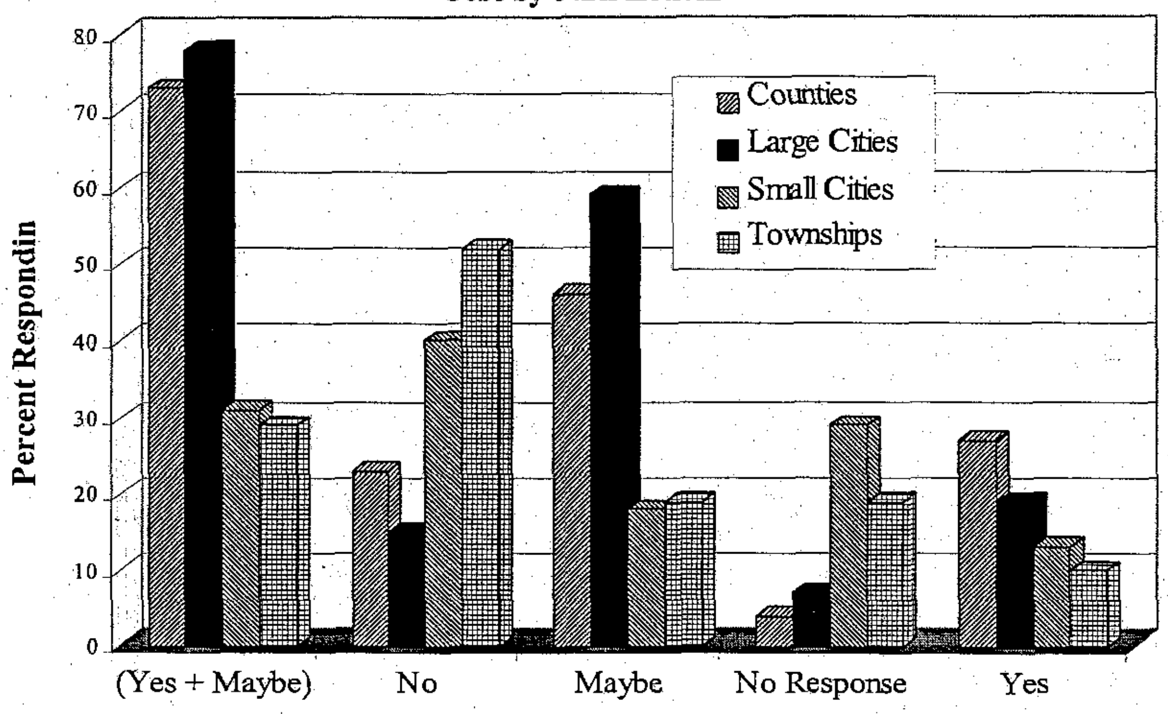


Figure 5b: Consideration of Closing Non-Essential Crossings at no Cost (All Jurisdictions)

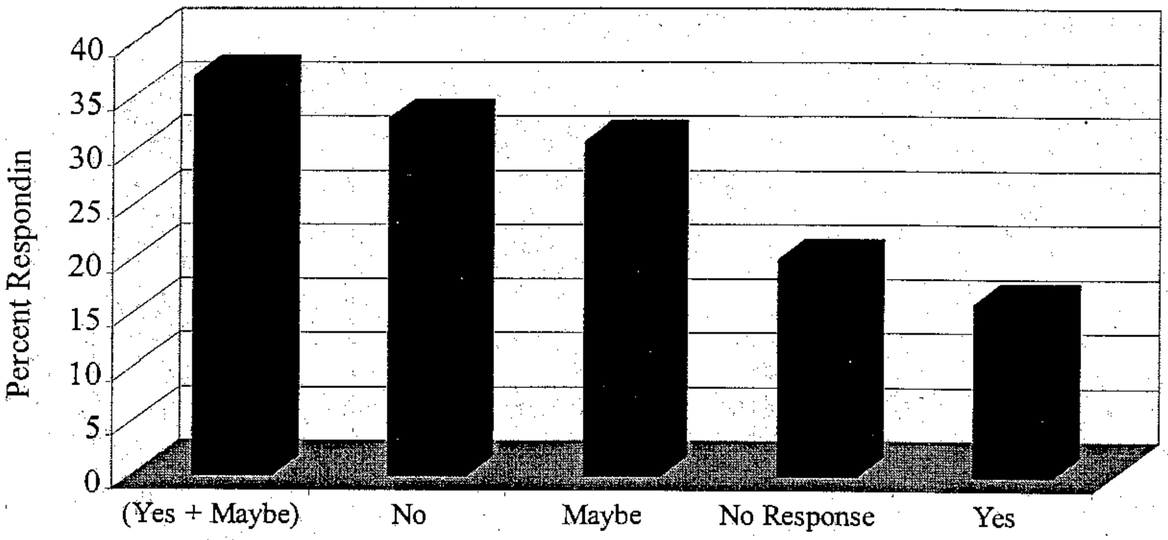


Figure 6a: Consideration of Closing Non-Essential Crossings by Improving Essential Crossings Within Jurisdictions

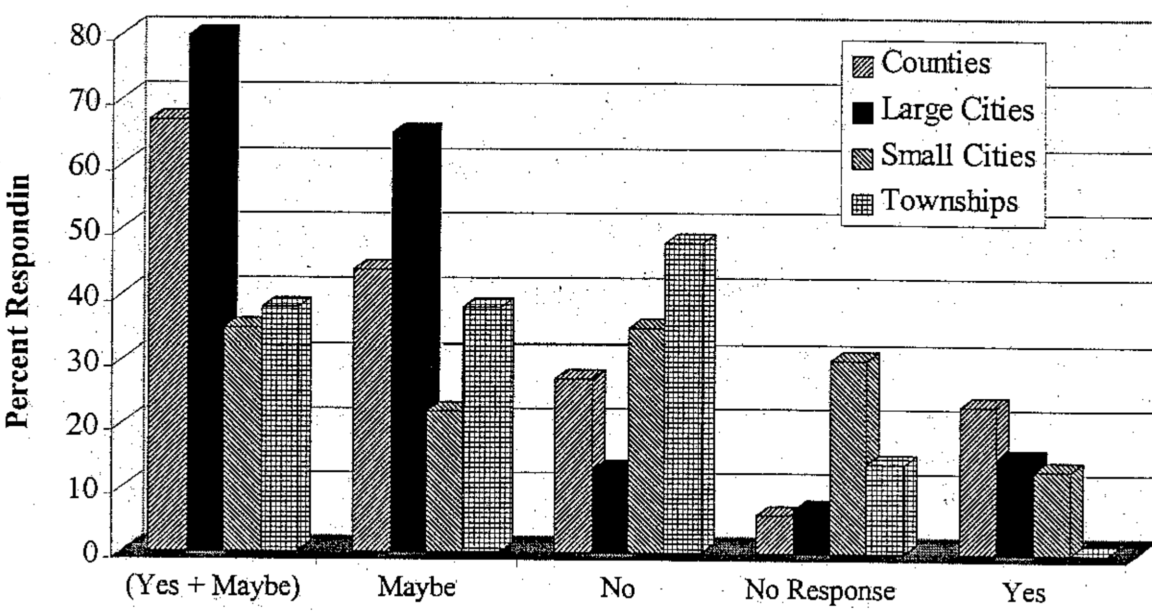


Figure 6b: Consideration of Closing Non-Essential Crossings by Improving Essential Crossings (All Jurisdictions)

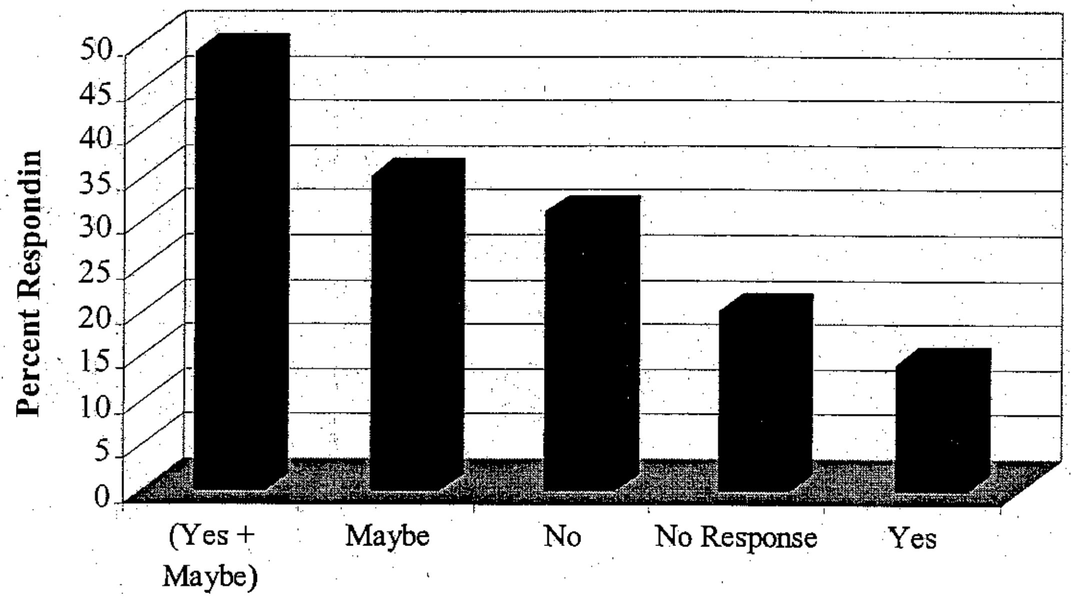


Figure 7a: Consideration of Closing Non-Essential Crossings With Financial Incentives Within Jurisdictions

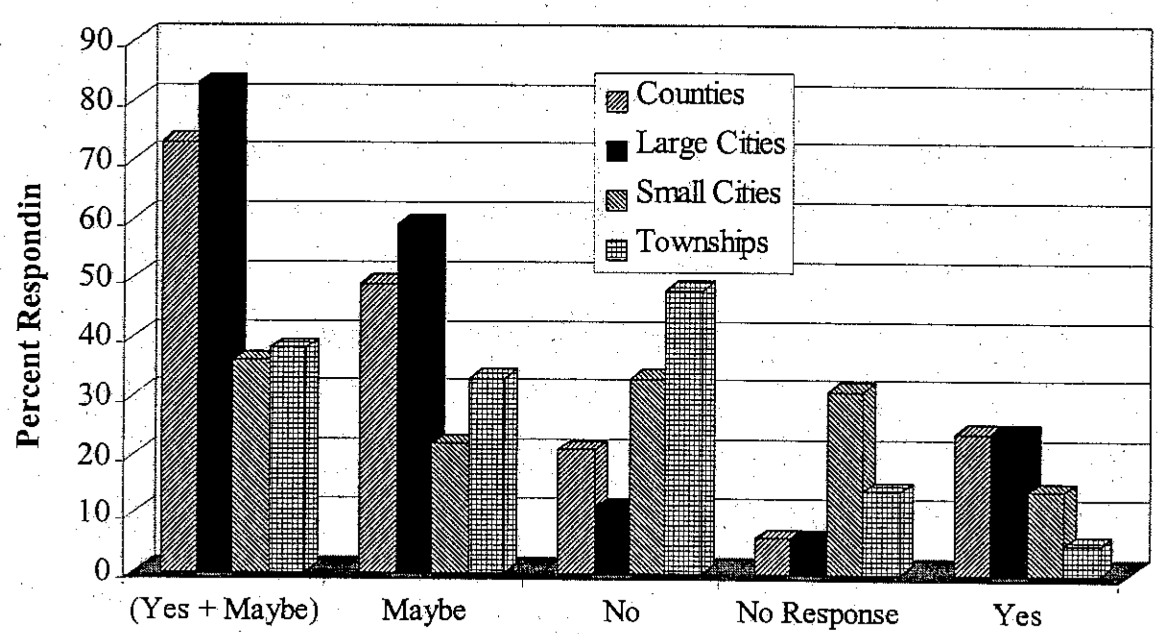
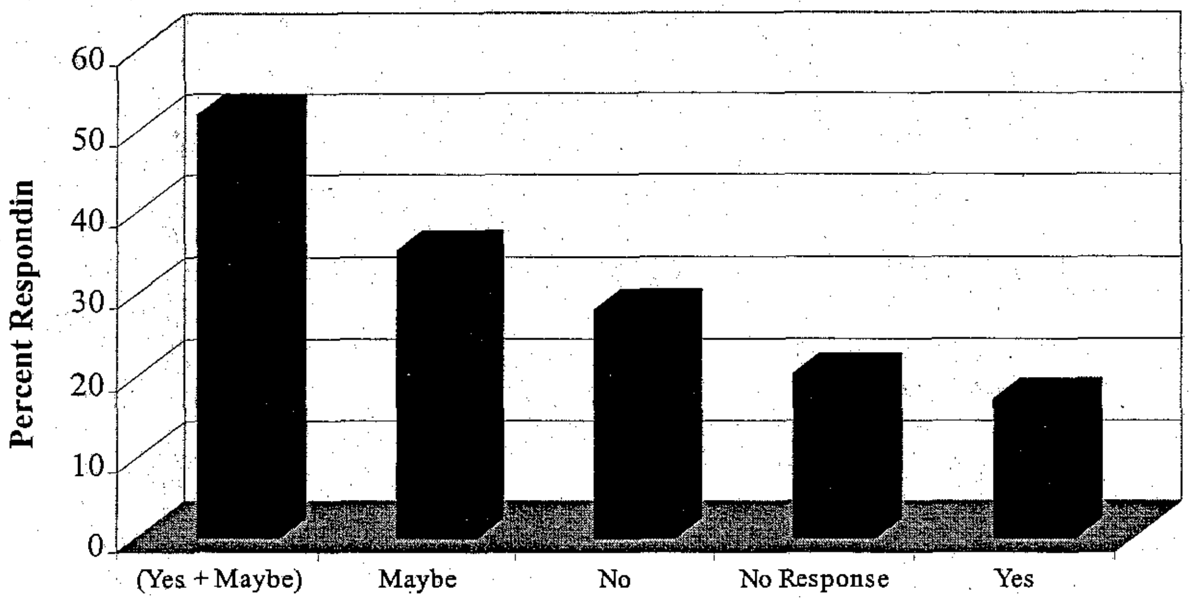


Figure 7b: Distribution of Consideration for Closing Non-Essential Crossings With Financial Incentives (All Jurisdictions)



Willingness to Participate in an Evaluation Study

About half of the respondents were willing to participate in the evaluation study together with the Kansas Department of Transportation. The study would include traffic flows, improved crossing surfaces, safety at essential grade crossings, possible closure of less-needed grade crossings, and financial incentives for closures with no cost to the agency for the study or the improvements. The "maybe" category which could be converted to "Yes" category was 24 percent while those who responded "No" were only 12 percent. Table 9 and figures 8a and 8b show the distribution of responses. Such a willingness rate is considered satisfactory for future success of the consolidation program.

Appendix D contains general comments from respondents for each jurisdiction type.

Table 9: Jurisdictions Willing to Participate In Evaluation of Grade Crossings

Response / Jurisdiction	**Counties [N(%)]**	**Large Cities [N(%)]**	**Small Cities [N(%)]**	**Townships [N(%)]**	**All [N(%)]**
Yes	33(47)	33(61)	81(46)	8(38)	155(48)
No	9(13)	7(13)	20(11)	5(24)	41(13)
Maybe	25(36)	12(22)	36(20)	5(24)	78(24)
No Response	3(4)	2(4)	42(24)	3(14)	50(15)
Yes + Maybe	*58(83)*	*45(83)*	*117(66)*	*13(62)*	*233(72)*

Figure 8a: Distribution of Willingness to Participate in Evaluation Study Within Jurisdictions

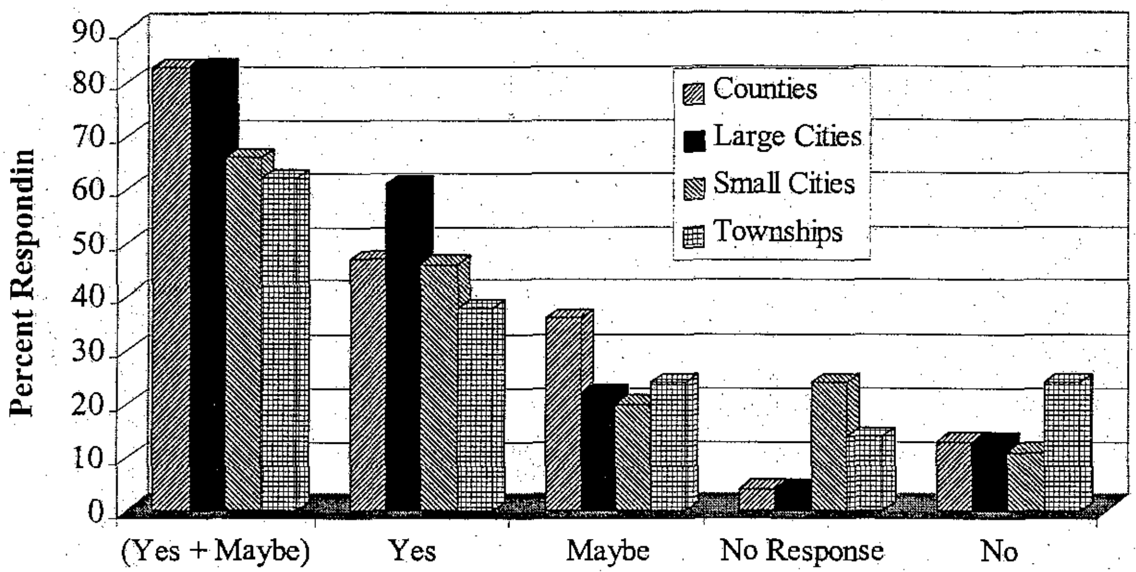
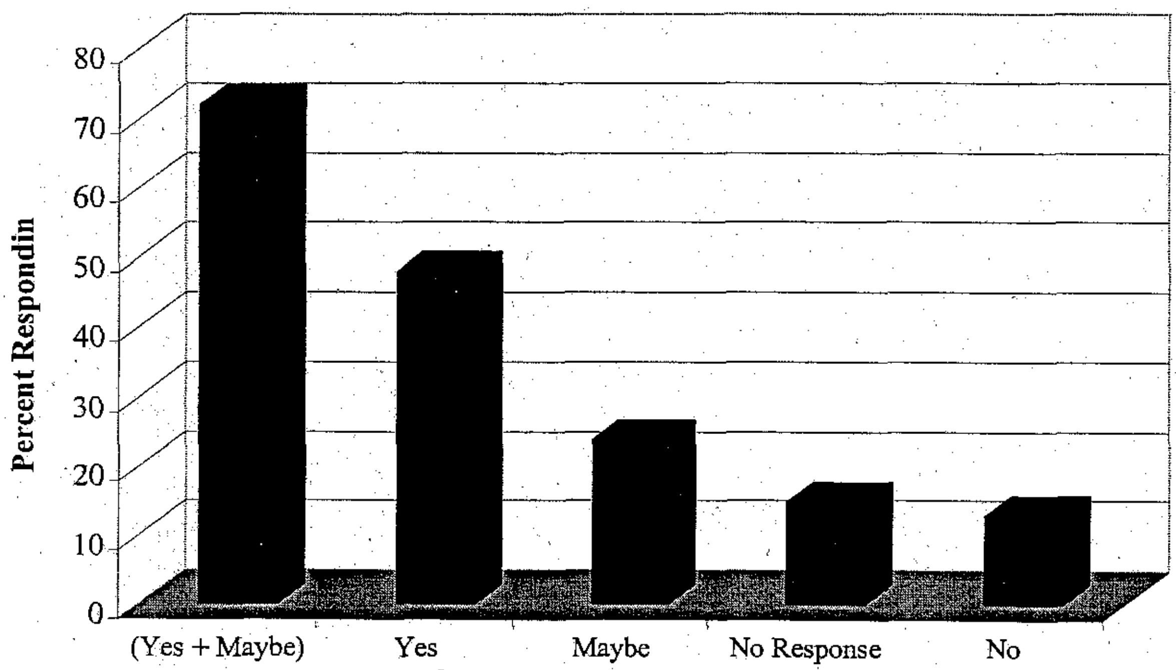


Figure 8b: Distribution of Willingness to Participate in Evaluation Study (All Jurisdictions)



SECTION VI: DEVELOPING DATA ELEMENTS FOR THE KANSAS STUDY

Top Harzadous Individual Grade Crossings

The objective of this phase of the study is to develop data elements that will identify the top hazardous grade crossings (about 5 percent) as candidates for closure using readily available data. The Kansas Highway-Railroad Grade Crossing Inventory" (KDOT Data Base) and the Federal Railroad Administration (FRA) National Data Base were used to meet the objective.

Kansas Inventory. The data elements that can be found in the Kansas Inventory are listed in Appendix E (Data Collection and Users Manual).

SECTION VII: SELECTION OF CROSSING CANDIDATES FOR CLOSURE

Preselection Stage

USDOT recommends a corridor approach when selecting potential grade crossings for closure. To facilitate selecting high-potential corridors, KDOT wanted a model that would select the top individual candidates for closure. The objective of this "preselection" stage was to build a model which would select a list of grade crossings whose closure would clearly enhance safety. i.e., they had characteristics considered "hazardous". The Kansas' grade crossing inventory computer database contains 7,925 crossings. The KDOT project monitor wanted a model that would select about 400 grade crossings, i.e. about 5 percent.

The objective of the model was to select grade crossings that, by nature of their parameters as recorded in the KDOT data base, could be considered good closure candidates. Where several of these grade crossings occur in a corridor, a safety improvement program could be developed in that corridor that would provide net benefits and look reasonable to the public, thus increasing the possibility of acceptance by the local government and the public.

Model building was achieved through the combined efforts of Kansas State University (KSU) personnel and an advisory committee. The advisory committee was made up of staff representing KDOT, Federal Highway Administration (FHWA), Federal Railroad Administration (FRA), several Kansas Counties and Cities, and Union Pacific and Burlington Northern-Santa Fe Railroad companies operating in the state of Kansas. The model was developed by KSU in several stages. Each stage was reviewed by the advisory committee. The model was revised and refined until it was the consensus of the advisory committee that it had selected a list of the top grade crossing closure candidates in Kansas.

Model Building

Phase One. In this initial phase, the eight variables listed in Table 10 were identified and incorporated in the model. Seven of these variables are included in Kansas' grade crossing inventory computer database. The first three variables, i.e., "road type", "average daily traffic (ADT)", and "accessibility" were used as "eliminating" variables. For the road type variable, only rural-local road and urban-local street would be selected by the model. The ADT values were restricted to less than 150 and 750 for rural-local road and urban-local street, respectively. Roads providing the only access to any property would not be included in the selected list of closure candidates. After applying road type, ADT, and accessibility variables to the 7925 crossings in the database, 4101 crossings (52 percent) were retained for possible selection.

Decoding and interpretation of field names and their entries in the computer file was done using the "KDOT Highway-railroad Grade Crossing Inventory Data Collection and User Manual"(KDOT, 1994). In the remaining list all records whose entries in the field of ADT were less than 150 and 750 for rural-local road and urban-local street, respectively, were deleted from the list of closure candidates. Accessibility for the remaining entries was determined by first matching the crossing in the computer file and on a paper map. Matching used "County" and "County crossing number" fields. County or city maps that were supplied by KDOT had crossing numbers written on them corresponding to the location of the crossing. The two nodes (intersections) defining the roadway link over the crossing were identified. The shortest distance traveled between the two nodes (intersections), using roadway links other than that over the crossing, was scaled from the map. The difference between this distance and the length of the roadway link over the crossing was determined. This difference was designated "adverse travel" and was appended as an additional field in the computer file. Where traversing between two nodes was determined to be impossible without the roadway link over the crossing, "no access" was recorded in the data base. Later, all records with "no access" were deleted from the computer file implying that the crossing could not be closed.

Over a period of time, using cutoff values suggested by the advisory committee, a total of 161 different models were formulated by combining different criteria levels that were suggested by the advisory committee for each variable. There were nine single-variable models, 32 two-variable models, 56 three-variable models, 48 four-variable models, and 16 five-variable models. Each of the 161 formulated models was applied separately to the 4101 crossings (those remaining after eliminating variables were applied) to obtain a list of crossings picked by a particular model. The number of crossings picked by different models ranged from "zero" to 1351.

These models were useful for observing the effect that specific variables, and combination of variables had on selecting a subset with certain characteristics. The lists selected by these models were not yielding the desired (by KDOT) subset of a "top 5 percent" of closure candidates.

The approach using cutoff values of the selected variables was abandoned at the suggestion of the advisory committee, and in subsequent models weighted variables were used instead. The first three variables (road type, ADT, accessibility) remained as eliminating variables.

Table 10: Variables Used in Phase One.

Variable Name	Suggested Criteria Level
Road type	Rural-local road and Urban-local street
Average Daily Traffic (ADT)	Rural-local road < 150, urban-local street < 750
Accessibility	With alternative access
Obstruction	All types except vegetation
Crossing angle	$< 30°$ or $< 60°$
Approach horizontal alignment	All curves or sharper than 6° curves
Approach vertical alignment	Grade > 3% or >6%
Rideability	Poor or very poor

Phase Two. Based on phase one which provided an understanding of the effect of various combinations of variables and different cutoff values on the output, KSU and the advisory committee developed a list of weighted variables as discussed below. In this phase, three variables were retained as eliminating variables (road type, ADT, and Accessibility) and the rest in table 10 were replaced or modified and designated as weighting variables. "Rideability" and "approach horizontal alignment" were excluded from the list while "number of trains per day", "train speeds", and "number of tracks" were added to the list. "Obstruction" was replaced by "sight distance". Relative weights were assigned in such a way that a higher weight implied a potentially more "dangerous" condition at the crossing, e.g. a sharp skew vs a 90° crossing angle. The weighting scale was normalized to a percentage-based scale, i.e., 0-100 percent, for better comprehension. A crossing having potentially "worst" conditions for all variables would have a value of 100. Table 11 shows these variables and corresponding weights selected by the consensus of the advisory committee. For each of the 4101 crossings, the model computed the total weight for each crossing which is the sum of the weights of individual variables. 400 Crossings with the highest scores were selected as the initial list of top individual crossing candidates for closure in Kansas. The weights of selected crossings ranged from a high of 86.5 to 59.1.

Table 11: List of Weighting Variables Used in Phase Two and Three.

Variable	Condition	Raw Weight	Normalized weight	
			Phase 1	Phase 2
Crossing Angle	0° - 30°	8	12.5	14.3
	30° - 60°	4	6.25	7.1
	60° - 90°	1	1.56	1.8
Sight Distance*	0% - 25%	16	25	28.5
	25% - 50%	8	12.5	14.3
	50% - 75%	4	6.25	7.1
	75% - 100%	1	1.56	1.8
Approach Grade	Flat	1	1.56	1.8
	0% - 3%	2	3.125	3.6
	4% - 6%	4	6.25	7.1
	> 6%	8	12.5	14.3
Number of Through Trains per Day**	< 1	2	1.56	3.6
	1 - 5	4	3.125	7.1
	5 - 10	8	6.25	14.3
	> 10	16	12.5	28.6
Train Speeds	Fast	16	25	
	Slow	8	12.5	
Number of Tracks	Single	4	6.25	7.1
	> 1	8	12.5	14.3

* The weight varies linearly within groups.

** Initial raw weights is half of that shown

The list could be verified only by subjective judgement. The list was studied by the advisory committee and KDOT personnel. It was the consensus that the list was satisfactory but needed some refinement, because it was not picking up grade crossings in the larger cities that the advisory committee felt should have been on the list.

Phase Three. The cutoff value for the big four cities was adjusted because of the advisory committee's concern that more grade crossings in the large cities should have been selected. It was felt that relaxation of cutoff values for eliminating variables would improve the situation.

During this final phase, essentially the same variables as those in phase two were used, with two major modifications: 1) ADT cutoff value for the four big cities in the state (Kansas City, Wichita, Topeka, and Lawrence) was raised from 750 to 1300; 2) train speed was eliminated from the list of variables.

Train speed was eliminated from the list because the Kansas grade crossing database does not contain actual train speed as a variable. Speed could only be implied by "the number of through (fast) trains" and "number of slow trains" variables. A potential colineariry problem between the number of through trains per day and train speed variables was found to exist. Correlation analysis between variable entries within the database showed a high coefficient of correlation (0.66) between train speed and number of through trains. Therefore, using both variables may introduce bias toward crossings with a high number of through trains.

Table 12 shows the coefficient of correlation on variable values used in phase two. A similar analysis for variable weights also revealed a high correlation coefficient (0.797) between speed and number of tracks. This is shown in table 13.

Table 12: Coefficient of Correlation on Variable Values.

Variable	Sight Distance	Approach Grade	Number of Trains	Train Speed	Number of Tracks	Crossing Angle
Sight Distance	1	-0.158	-0.008	-0.072	-0.178	-0.068
Approach Grade		1	0.211	0.116	-0.050	-0.024
Number of Trains			1	0.660	0.222	-0.028
Train Speed				1	0.300	0.047
Number of Tracks					1	0.132
Crossing Angle						1

Table 13: Coefficient of Correlation on Variable Weights.

Variable	Sight Distance	Approach Grade	Number of Trains	Train Speed	Number of Tracks	Crossing Angle
Sight Distance	1	-0.149	-0.008	0.221	0.169	-0.054
Approach Grade		1	0.182	-0.103	-0.029	0.018
Number of Trains			1	0.053	0.207	-0.030
Train Speed				1	0.797	-0.099
Number of Tracks					1	-0.108
Crossing Angle						1

To equalize the problem of high correlation coefficient between train speed and number of tracks, the weight for the number of through trains was doubled. Rechecking correlation between the remaining variable weights exhibited no serious colinearity problems. Table 14 shows the coefficient of correlation on variable weights used in phase three. The highest coefficient of correlation on variable weights was 0.207. Thus there is no evidence of colinearity between any of the modified variables. A discussion of the final variables is presented in a later section.

Table 14: Coefficient of Correlation on Variable Weights for Modified Variables.

Variable	Sight Distance	Approach Grade	Number of Trains	Number of Tracks	Crossing Angle
Sight Distance	1	0.137	-0.018	0.174	-0.073
Approach Grade		1	0.179	-0.036	0.013
Number of Trains			1	0.207	-0.023
Number of Tracks				1	-0.094
Crossing Angle					1

With the revised model, 423 crossings with the highest scores were selected. The advisory committee noted 19 crossings in the list as either already closed, or in the process of being closed. Also 3 crossings were on railroads that had been abandoned. The 19 crossings were considered to be "evidence" that the list included crossings that obviously had been good candidates. The fact that some abandoned crossings were on the list was due to the computer data base being not as current as prevailing field conditions. This brought the total to 402 crossings.

Variables Used in Phase Three

A discussion of the variables that resulted in the final model follows:

Road Type. This variable had the objective of closing only road links which are functionally used as local roads (rural-local road and urban-local street). These roads are normally characterized by low speed, low surface type, low design standards, and low volume. Closing only this type of road, as opposed to other higher classifications, will minimize the adverse effects of road closure.

Average Daily Traffic Volume. This variable has objectives similar to the road type variable. Only road links with lower traffic volumes would be included in the closure list. The cutoff value for rural-local roads was set at 150 vehicles per day, while those in the four big cities were set at 1300 vehicles per day, and 750 vehicles per day for other cities.

Accessibility. Where the road link over the crossing is the only access to a property, it would be illegal to close that road link because by law it is the right of the property owner to have an access. The purpose of including an accessibility variable was to insure that for any road link proposed for closure, there is an alternate access to the property. This variable was not in the original database. It was obtained manually from county and city maps. The adverse travel ranged from 0 to 19.6 miles (0-31.4 km) and "no access". The average and standard deviation for the adverse travel were 1.67 miles (2.7 Km) and 1.22 miles (2 Km) respectively. Only the "no access" category was used.

Crossing Angle. The ideal horizontal angle between railroad and highway from a traffic engineering point of view is 90°. Crossing angles that deviate significantly from 90° provide a motorist on the highway a more complicated situation in estimating train speed and position and can be critical in motorists' correct decision making at a passive grade crossing. Crossing angles in the KDOT database are coded in 5° increments. Three weighted crossing angle conditions were used in the model: 1) 0°-30°, 2) 30°-60°, and 3) 60°-90°. The weights for each condition were 14.3, 7.1, and 1.8 respectively.

Sight Distance. The importance of adequate sight distance at passive, highway-rail intersections cannot be overemphasized. Sight distance is considered by some highway and traffic engineers as the main factor influencing safety of these highway-railway intersections (Russell, 1997a; Russell et al., 1997b; Russell et al., 1996a; Russell et al., 1996b). Four sight triangles (one in each quadrant of the crossing) were considered. The sight triangle is made up of three distances found in the Kansas data base: 1) distance from the center of the crossing measured along the road approach to an observer standing at point "a" on the highway approach. For a rural road this distance from the center of the crossing to point "a" is fixed at 300 feet, while for streets in municipal or urban areas the distance is fixed at 100 feet. 2) distance measured from the center of the crossing along the railroad to point "b" where the observer's ability to see from point "a" is limited due to obstructions in the quadrants (This distance from the center of the crossing to point "b" is known as "approach clear sight distance"). 3) An oblique line connecting points "a" and "b" that were described above (This oblique line, the road and the railroad track form the boundary of a "sight triangle"). Of the three distances, the first two are enough in defining the sight triangle, and with the distance to the observer fixed, the sight distance at the crossing in the database is defined only by the "approach clear sight distance".

The grade crossing database considers 2000 feet (610 m) as adequate or "ideal" sight distance at the crossing, and is the maximum value in the data base. The model considered "crossing sight distance" as the sum of all four available sight distances from each quadrant as a percentage of 8000 feet (2440 m); i.e., 2000 ft x 4 quadrants would be a situation with completely adequate or "ideal" sight distance in all four quadrants. The categories used in the model were based on the percentage of adequate sight distance; i.e., 100 percent for a crossing where the sum of sight distances in the four quadrants is 8000 feet. Four weighted sight distance conditions were used by the model: 1) 0% - 25%, 2) 25%-50%, 3) 50 - 75%, and 4) 75% - 100%. The weights for these categories were 28.5, 14.3, 7.1, and 1.8 respectively.

Approach Grade. "Hump" crossings, generally considered unsafe, are most likely to be found where there are steep approach grades. Where the grades are different on both approaches, the average of the two values was considered when computing the weight. In the KDOT database, the grade is classified into four groups: 1 for flat, 2 for 0-3%, 3 for 4-6%, and 4 for greater than 6%. The grade presented is the maximum approach grade (over a horizontal distance of not less than 10 feet (3.1 m)) within a distance of 300 feet (91.5 m)of the center of main track. The condition grouping used in the model is the same as the grouping in the data base; i.e., flat, 0% - 3%, 4% - 6%, and >6%. The weights for these conditions were 1.8, 3.6, 7.1, and 14.3 respectively.

Number of Fast (Through) Trains per Day. Similar to ADT variable, the objective was to close crossings with the highest probability of a vehicle-train collision. Other variables being equal, the higher the number of trains per day (higher exposure) the higher the probability of collision. The value in the database represents trains traveling more than 60 mph for rural crossings, and all trains for municipal crossings. Four conditions for this variable were used in the model: 1) less than one train per day, 2) 1 - 5 trains per day, 3) 5 -10 trains per day, and 4) greater than 10 trains per day. The weights for these conditions were 3.6, 7.1, 14.3, and 28.6 respectively.

Number of Tracks. Crossings with multiple tracks are generally considered potentially more dangerous than single tracks. The database separates number of main tracks from other tracks. This variable combines both tracks into a single number. The conditions used in the model were single track, and more than one track with weights of 7.1 and 14.3 respectively.

Corridor Selection Stage

Crossings selected in phase three were plotted manually on county maps to facilitate corridor selection. Allen County is presented in figure 9 as an example. Twelve counties with a high density of selected crossings were chosen to identify corridors. Corridors were formed which were bounded by either city limits' boundaries, or county boundaries were formed. For each corridor the following were determined: County, corridor boundaries, a railroad name, crossings per mile, number of crossings selected in phase three (n), total crossings in the corridor (N), ratio n/N, raw score for each selected crossing, total score, average score, intersecting street for each selected crossing, KDOT and federal crossing numbers. Appendix F shows the final list of corridors.

Diagnostic Team Field Visit

In January of 1997, several members of the project advisory committee accompanied by the County Engineer met in Butler County and spent a day examining several grade crossings in Butler County, Kansas. No closure decisions were made.

One major problem with closures was evident during this visit. As pointed out by the County Engineer, all potential grade crossings were on major farm to market routes with no comparable quality routes available without considerable additional miles of travel for farmers/ranchers to reach town. This situation was clearly unacceptable to the county officials and to the citizens of the county.

Thus, it must be emphasized that having a list of potential candidates, by any formulae or model is not an end in itself. It is a beginning point from which field visits need to be made and follow up negotiations to affect closure promoted where possible.

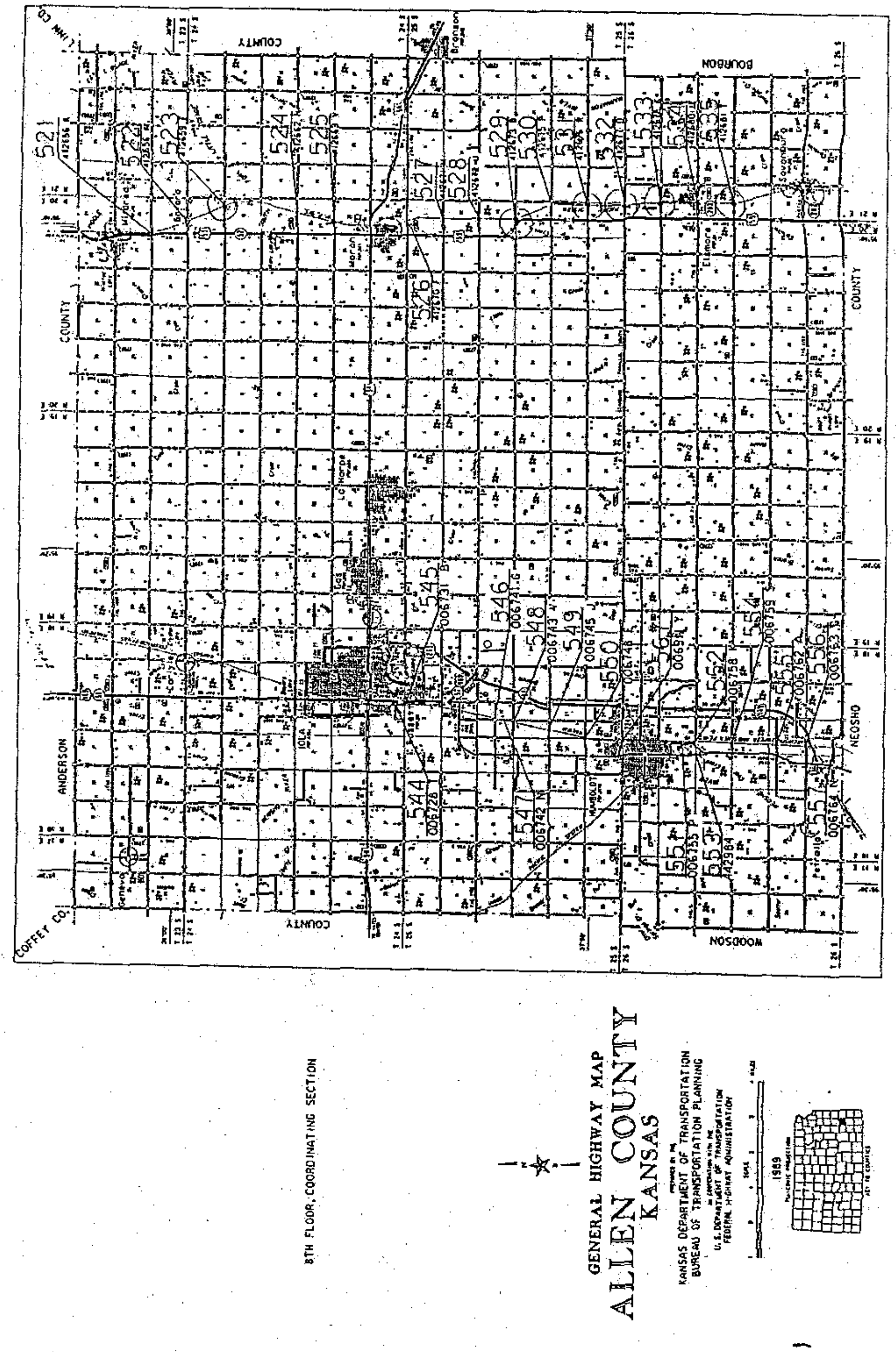


Figure 9: Selected Crossings in Allen County.

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APPENDIX A
MISSOURI STUDY EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

of the

MISSOURI
GRADE CROSSING CLOSURE
STUDY

Originally Prepared by
Richards and Associates
December, 1993

THIS SUMMARY PREPARED BY

MISSOURI
DIVISION OF TRANSPORTATION STAFF

JANUARY, 1994

Study Authority

The Missouri State Legislature recently revised State Statutes to include a study of grade crossing closures. The 1992 Senate Bill Number 765 added Section 389.615 which, among other things, instructed the Division of Transportation (DOT) to "conduct a study to establish priorities for grade crossing closures and a plan for implementing grade crossing closures". According to the legislation the study was to be completed by January 1, 1994.

Study Implementation

In September 1992 the State of Missouri solicited requests for proposals for consultant services for a railroad grade crossing closure study. The Request For Proposals (RFP) specified that "the contractor would conduct research, interviews and analysis in order to establish priority criteria for closing grade crossings and a plan for implementing closures".

Contractor Selected

In April 1993 a contract was awarded to Richards & Associates to conduct the crossing closure study. The contractor, Mr. Hoy Richards, developed procedures to be followed in the implementation of the study. The procedure consisted of twelve steps, which are summarized below:

STEP 1: An Advisory Committee was established to assist the contractor and the DOT staff in the implementation of the study. The purpose of the committee was to:

provide assistance in identifying key personnel to be interviewed during the course of the study;

assist in the design of data recovery forms;

provide liaison between the federal, state and local governmental agencies and railroads operating in Missouri.

In early April the DOT Director appointed a ten member committee. The Advisory Committee included the following organizations and individuals: **Local Governmental Agencies:** Elmer Gillette, Jackson County; Marc Thornsberry, Springfield; Jim Koshmider, Montgomery City; **State Agencies:** Greg Hayes, Missouri Highway and Transportation Department (MHTD); Leroy Meisel, Division of Transportation (DOT); **Federal Agencies:** Don James, Federal Highway Administration; Darrell Tisor Federal Railroad Administration; **Railroad Companies:** Kurt Anderson, Union Pacific; Allen Kuhn, Burlington Northern; **Committee Chairman:** Rick Mooney, Division of Transportation (DOT).

STEP 2: Develop Questionnaire. The Advisory Committee was asked to assist in the development of a questionnaire to be mailed to every municipal and county government in the State of Missouri served by an operating railroad. The questionnaire was to solicit the views of the local jurisdictions regarding highway-rail grade crossing problems; to determine the community's interest in crossing closure projects; to develop a list of factors to be considered in crossing closure; to determine the importance of financial incentives in crossing closure consideration;

maintained by the DOT. The computer based inventory includes all the data elements listed on the U.S. DOT/AAR National Inventory plus data elements supplemented by the DOT. Some of the supplemental data elements are signal control circuitry, sight obstruction and vehicle speed. Secondly, an evaluation would be made of only those crossings that were selected as candidates for closure. This evaluation would follow the "diagnostic team" evaluation approach and would require the collection of field data.

STEP 8: Develop Priority Index. Based upon the results of the review of other state crossing closure programs, review of research reports and papers regarding crossing closures, response to the mail questionnaire, interviews with parties involved in closure projects and input from MHTD and DOT staff it was determined that the prioritization of projects should be based upon the corridor approach rather than on individual crossing evaluations. A corridor is defined as a segment of rail line having two or more at-grade highway-rail intersections. The corridor may include both public and private grade crossings. From the information gathered during the review process, a list of data requirements was prepared by the contractor for presentation to the Advisory Committee. The next step in the development of the crossing closure priority index was the selection of the methodology that was to be used in the calculation of the index. A computer program that assists arriving at decisions that involve the analysis of both hard data and judgement information was utilized.

STEP 9: Develop Crossing Closure Criteria. The Advisory Committee selected the following groups of data elements pertinent to crossing closure: Corridor description; Roadway considerations; Railroad considerations; Safety considerations; and Crossing Use characteristics. These data elements are detailed more thoroughly in Step 3.

STEP 10: Compute a priority index. This step consisted of computing a priority index based upon the software program established. The DOT staff selected samples of crossing closure corridors for this evaluation. Thirty-one test corridors were selected and the data elements computed and arranged in priority order. Verification of the priority ranking was done by utilizing the expertise and experience of the DOT and MHTD personnel and by the contractor making on-site evaluations to observe the crossings.

STEP 11: Benefit/Cost Analysis: The benefit/cost model should measure the benefits of eliminating cost of delays, fatalities, injuries, property damage, energy consumption, signal improvements, signal maintenance, crossing surface maintenance, roadway approach maintenance and environmental damage against the cost of alternate access, increased vehicle operations, additional travel time, potential development of property, reduced business access, improvement of alternative location warning devices, congestion and emergency vehicle access.

The application of benefit/cost analysis will be determined by the physical and operational characteristics of the corridor being evaluated. It may not be necessary to conduct a detailed benefit/cost analysis on every corridor that is a candidate for closure projects.

STEP 12: Funding and Goals. It is recommended that the funding program include financial or in-kind participation on the part of all vested interest parties. The use of Federal funds to improve alternate access and signalization at the alternate

First, a priority listing of crossing closures will be developed. Secondly, the railroad and roadway jurisdiction authority will be notified of the corridors selected. Diagnostic reviews will be scheduled for each selected corridor to obtain data and information not included in the crossing inventory. During the field review representatives of the State, railroad and local governmental jurisdiction will work together to reach a consensus on a preliminary plan and strategy for crossing closure.

Following the diagnostic field review the DOT, cooperating with the railroad and local governmental agency, will prepare documentation for the application for crossing closure. The DOT will file the application for closure. Finally, when the crossing is ordered closed the railroad will be responsible for the removal of the crossing surface material and the restoration of the track roadbed and part of the roadway approach. The local road authority will be responsible for the removal of roadway materials on both roadway approaches to and including the railroad right-of-way line. The roadway authority may also be responsible for the installation and maintenance of roadway barriers on both approaches.

CONCLUSION: The crossing closure plan should stress public safety. Public agencies, in cooperation with the operating railroads, should use all available tools to determine "what is in the interest of public safety". Once this has been determined then the results of their analysis and recommendations should be implemented. The plan provides for the implementation of projects even though there may be individual party objections to crossing closure. It is obvious that an opportunity for public hearing before a judicial representative must be available. However, once the order is issued for the closure it should be the responsibility of the public agencies and the railroad to see that the closure is accomplished in an efficient and effective manner.

A plan that involves all parties to benefit from its implementation should carry with it a financial plan for the involvement of all parties. Although a financial incentive may be necessary for local government participation, it should be offered only after it is determined that there is no other currently available financial ability on the part of the local governmental jurisdiction to participate in the project. Every opportunity must be taken to involve federal funds in this program. Without participation on the part of federal agencies, the projects become localized. If in fact this is a national initiative, then there must be participation on the part of the "national government".

APPENDIX B
EXAMPLE OF DATA WEIGHTING

Attribute and Group Weighting

	Weight	Group Weigh
Group Number 1 - Corridor Considerations		
Total Number of Crossings	0	
Length of Corridor	4	
Average Distance Between Crossings	7	
Average AADT for Corridor	4	
		15
Croup Number 2 - Roadway Considerations		
Number Urban Crossings with less than 750 AADT	6	
Number Rural Crossings with less than 150 AADT	4	
Number of Active Crossings: Constant Warning (1)	0	
Number of Active Crossings: Motion Detector (2)	1	
Number of Active Crossings: DC Circuit (3)	2	
Number of Passive Crossings (4)	3	
Number of Crossings with less than 60 Degrees Angle	3	
Number of Crossings with greater than 0.75 sight Distance Obstruction	6	
		25
Group Number 3 - Railroad Considerations		
Number of Through Trains	8	
Average Train Speed	6	
Number of Passenger Trains	4	
Number of Crossings with a Second Main Track	2	
Number of Crossings with 1 Other Track	2	
Number of Crossings with 2 Other Tracks	3	
		25

Attribute and Group Weighting Continued

	Weight	Group Weight
Group Number 4 - Safety Considerations		
Average Composite Hazard Index	14	
Accidents Past Five Years	12	
Fatalities and Injuries Past Five Years	9	
		35
Group Number 5 - Crossing Use Characteristics*		
Number Crossings With School Bus Use	0	
Number Crossings With Emergency Vehicle Uses	0	
Number of Crossings With Greater Than 15% Truck Use	0	
Number Crossings With Special Vehicle Use	0	
Railroad Operating Requirements	0	
		0
Total Weight		100

* To be evaluated during diagnostic review

APPENDIX C
QUESTIONNAIRE

KANSAS HIGHWAY-RAIL GRADE CROSSING SAFETY STUDY

Name of Respondent: ______________________________

Title: ______________________________

Agency: ______________________________

Agency Jurisdiction (City, County, Township, etc.): ______________________________

Address: ______________________________

Phone: (   ) ____________________

Fax: (   ) ____________________

---

1. Approximately how many railroad grade crossings are there on the roadway system(s) in your jurisdictions? ____________________
2. Do you have concerns regarding the safety at railroad grade crossings on streets and roads in your jurisdictions?

   ____________Yes   __________No
3. If you have concerns, how can they best be described?

   Check all that are applicable

   _______ Need active warning devices

   _______ Train Visibility

   _______ Crossing Surface

   _______ Blockage of the Crossing by Trains

   _______ Signal Malfunction

   _______ Noise from Train Whistles

   _______ Other (Please Specify) ______________________________

CONTINUED ON REVERSE SIDE ☞

4. What factors would your governing body consider in determining if grade crossing is essential?

   Check all that are applicable

   _______ Access to Businesses
   _______ Access to Residential Areas
   _______ Access to New Development
   _______ Emergency Vehicle Blockage
   _______ Affect on Major Traffic Flows
   _______ Traffic Safety
   _______ Public Convenience
   _______ Other (Please Specify) ______________________________

Please list the 3 most important factors (1 = most important)

1. ____
2. ____
3. ____

5. To improve safety at grade crossings, would your governing body consider the closure of non-essential grade crossings?
   ________ Yes   _______ No   _______ Maybe

6. If there was no cost to your agency would your governing body consider the closure of non-essential grade crossings?
   ________ Yes   _______ No   _______ Maybe

7. If safety improvements were to be made at essential crossings under your jurisdiction, would your governing body consider closing less-essential grade crossings?
   ________ Yes   _______ No   _______ Maybe

8. If financial incentives were available to offset the impact of the crossing closure, would your governing body consider the closure of non-essential grade crossings?
   ________ Yes   _______ No   _______ Maybe

9. Would you be willing to participate with the State of Kansas Department of Transportation staff in a grade crossing evaluation study that includes traffic flows, improved crossing surfaces, safety at essential grade crossings, possible closure of less-essential grade crossings, and financial incentives for closures, all with no cost to your agency for the study or the improvements?
   ________ Yes   _______ No   _______ Maybe

APPENDIX D

SURVEY GENERAL COMMENTS

Counties:

#7 Butler County is a County/Township system for road maintenance. All R/R crossings on the county system are on essential major collector routes. I am not aware of any crossings on our road system that could be closed.

#25 See attachment #1

#33 See attachment #2

#292 We have an agreement with KDOT & Santa Fe RR pertaining to crossing closures, gates, and lights.

Large Cities:

#74 FCC and KCC jurisdiction over crossings affects what can be closed. The local government cannot "close" a crossing on its own.

#84 Greens burg closed 2 crossings several years ago and railroad paid matching share for new signals at the remaining 4 crossings.

#90 Most of our railroad crossings are fairly quiet, some of them are rarely used.

#100 There are no non-essential grade crossings in Merriam. All 4 are [on] major arterial streets.

#102 Railroad terminates in Oberlin, so safety at crossings is not a big issue.

Small Cities:

#128 The city of Arlington is satisfied at the present with our crossings. The crossings were just recently repaired.

#132 We only have one crossing on Hwy. South 169 that goes through our city.

#134 Belpre has already been contacted by Santa Fe Railway and Highway Dept. Agreement has already been voted on by council and copy of minutes mailed to both agencies.

#153 Union Pacific does not use this line anymore. Rails have been removed except for the road crossing. It would be helpful if they would remove these rails and ties also.

#155 Crossing just north of city limits is blocked for long periods of time and there is no other way to get into town from northeast of town in county but as you go south viaduct on 160 highway blocks view until you are almost on tracks.

#156 The one crossing is on County road on the south end of our city. The crossing is on our main thoroughfare. The gates are down often for long periods of time. Emergency vehicles cannot get south. Cars go around barricades which is a bad thing. The crossing was just worked on, and it's rougher to go over now than before. The trains speed through here and there have been derailments already.

#158 All our crossings are essential.

#159 We have only one crossing which has lights and gates.

#167 The City of Everest is working with the Union Pacific Railroad and KDOT on a plan of crossing closing in Brown County at this time.

#172 The grade crossing that is my main concern is just outside my jurisdiction on county Rd #439. The safety there concerns me. My only crossing is a little used street to the north used as a private crossing.

#180 The City of Gypsum, Kansas, has checked on our crossings for several years and have had no results. We have an abandoned old mill spur that is a nuisance and needs to be removed. The main street crossing is part of K-4 Highway and is close to being a road hazard.

#186 The city has only one crossing at this time. Some of the questions don't apply to our city. Due to increased population another crossing east of Main St. would be appreciated.

#201 We have only 2 crossings. They are both protected by crossing gates.

#206 The City of Maize feels there should be several things done to our crossings to improve the safety of our streets. They are:

1. flashing lights at crossings
2. streets painted for warning
3. removal of abandoned spurs
4. replace crossing surfaces

#212 KG & E owns the tracks which is seldom used (about once a year).

#219 No trains run through our city so survey does not pertain to us

#229 The city has already closed 2 crossings and the only one left open is the one on the main road which has lights and cross arms.

#232 Our one crossing is an essential crossing.

#243 Both crossings are considered essential.

#246 We have crossing that needs to be lowered and 2 of them some new ties.

#248 Since the closing of the Santa Fe tracks south from Ottawa to Garnett, we have no railroad through the city.

#251 The City of Rose Hill has only 2 grade crossings, and both are essential.

#268 The last railroad to have tracks in Tonganoxie (U.P.) removed its line from here in the mid 1970's.

APPENDIX E
KANSAS INVENTORY DATA ELEMENTS

GENERAL INFORMATION

Railroad Fields That Have State System Counterparts

- County number
- Control section number
- Crossing number
- District number
- Route no. or street name
- National Highway System
- Functional classification
- Average Daily Traffic (ADT)
- Railroad name
- Number of fast (thru) trains
- Number of slow trains
- Number of switch trains
- Sum of all trains (fast, slow & switch)
- Design Hazard Rating
- Section milepost
- Speed limit
- Federal Railroad Serial Number
- Distance into county (for state system crossings)

Railroad Fields That Have Non-State Database Counterparts

- County number
- Railroad crossing number
- City number
- Functional classification
- Average Daily Traffic (ADT)
- Non-state section number
- Non-state switch
- Federal serial number

Railroad Data Fields & Descriptions

- County number (001 thru 105)
- CANSYS control section number
  (001 thru 149 are rural (noncorporate))
  (150 thru 500 are city (corporate))
- Crossing number
  (001 thru 500 are municipal)
  (501 thru 800 are rural)
  (several special cases described in users manual)
- City number
  (when locate within a subsidiary city, names and numbers table given)
- KDOT District No. (1-6)

- Route number or street name (Indicates "T" roads)
- Township (rural crossings)
- Township letter
- Range (rural crossings)
- Section number (left and right) (rural crossings)
- National Highway System
  (0 -- not on national highway system)
  (1 -- national highway system (NHS))
  (2 -- NHS, strahnet connection)
- Functional classification, rural
  (11 -- Interstate)
  (12 -- Other principal arterials)
  (13 -- Minor arterials)
  (21 -- Major collectors)
  (22 -- Minor collectors)
  (31 -- Local roads)
- Functional classification, urban
  (51 -- Interstate)
  (52 -- Freeways and expressways)
  (53 -- Other principal arterials)
  (54 -- Minor arterials)
  (61 -- Collectors)
  (71 -- Local streets)
- Average Daily Traffic (ADT)
  (latest, available data)
- Year of traffic
  (year of latest ADT)
- Direction of inspection
  (direction traveling when approaching crossing)
- Land use
  (1 -- Grassland)
  (2 -- Cultivated upland)
  (3 -- Cultivated bottomland)
  (4 -- Irrigated)
  (5 -- Mineral development)
  (6 -- Central Business District (CBD))
  (7 -- Outlying Business District (OBD))
  (8 -- Residential)
  (9 -- Industrial)
  (10 -- Public Park, etc.)
- Surface type
  (1 -- Bituminous surface treated)
  (2 -- Bituminous mixed surface)

(3 -- Bituminous mixed overlay)
(4 -- Asphaltic concrete)
(5 -- Asphaltic concrete overlay)
(6 -- Portland cement concrete)
(7 -- Brick)
(8 -- Gravel and stone (graded/drained)
(9 -- Earth (graded and drained)
(10 -- Gravel and stone (not graded or drained)
(11 -- Earth (not graded or drained)

- Surface condition
  (1 -- Very good)
  (2 -- Good)
  (3 -- Fair)
  (4 -- Poor)
  (5 -- Very poor)
- Traveled way width of approach
- Right of way width
- Truck turnouts
- Pavement markings
  (1 -- None)
  (2 -- Both)
  (3 -- Approach)
  (4 -- Depart)
- No-passing lines
  (1 -- Yes)
  (2 -- No)
- Approach signs
  (1 -- None)
  (2 -- Plain)
  (3 -- Retroreflectorized)
  (4 -- Subburst)
  (5 -- Prismatic grade)
- Sidewalks @ crossing
  (1 -- None)
  (2 -- One side)
  (3 -- Both sides)
- Highway grade on approach side of crossing
  (1 -- Flat)
  (2 -- 0-3%)
  (3 -- 4-6%)
  (4 -- Greater than 6%)
- Highway alignment on approach side of crossing
  (1 -- Tangent)

(2 -- Moderate curve (less than 6°))
(3 -- Sharp curve (6° and over))

- Highway grade on depart side of crossing
(1 -- Flat)
(2 -- 0-3%)
(3 -- 4-6%)
(4 -- Greater than 6%)
- Highway alignment on depart side of the crossing
(1 -- Tangent)
(2 -- Moderate curve (less than 6°))
(3 -- Sharp curve (greater than 6°))
- Construction material of crossing
(1 -- Untreated wood plank)
(2 -- Treated wood plank)
(3 -- Gravel)
(4 -- Concrete)
(5 -- Asphalt)
(6 -- Cast iron)
(7 -- Rubber)
(8 -- Brick)
(9 -- Earth)
(10 -- Other)
- Condition of crossing material
(1 -- Very good)
(2 -- Good)
(3 -- Fair)
(4 -- Poor)
(5 -- Very poor)
- Rideability
(1 -- Very good)
(2 -- Good)
(3 -- Fair)
(4 -- Poor)
(5 -- Very poor)
- Crossing illuminated
(1 -- None)
(2 -- One side)
(3 -- Both sides)
- Road intersection within 300 feet of crossing
(1 -- None)
(2 -- One side)
(3 -- Both sides)

- Type of crossing protection
  (1 -- Represents crossbucks as the type of crossing protection)
  (2 -- Represents crossbucks (not retroreflectorized) on the approach side)
  (3 -- Represents retroreflectorized crossbucks on the depart side)
- Type of crossing protection
  (1 -- Crossbucks)
  (2 -- Bells)
  (3 -- Wigwag and bells)
  (4 -- Flashing lights or preempted highway traffic signals)
  (5 -- Flashing lights (cantilevered))
  (6 -- Flashing lights and bells)
  (7 -- Flashing lights and bells (cantilevered))
  (8 -- Gates (black & white))
  (9 -- Gates (red & white))
  (10 -- Watchman)
  (11 -- No protection)
  (12 -- Stop signs)
- Retroreflectorized crossbucks
  (1 -- No crossbucks)
  (2 -- Crossbucks (not retroreflectorized))
  (3 -- Crossbucks (retroreflectorized on one side of sign))
  (4 -- Crossbucks (retroreflectorized on both sides of sign))
  (5 -- Prismatic grade)
- Alignment of left railroad approach
  (1 -- Tangent)
  (2 -- Moderate curve)
  (3 -- Sharp)
- Alignment of right railroad approach
  (Code the value that appears on the field sheet. The alignment of the railroad to the right of the crossing (for a distance of about 600 feet) shall be recorded as one of the following.)
  (1 -- Tangent)
  (2 -- Moderate curve)
  (3 -- Sharp)
- Angle of crossing
  (To the nearest 5°)
- Distance to nearest grade separation
  (If within 2500 feet)
- Approach clear sight distance (left)
  (Code, from the field sheet, the clear sight distance looking to the left along the railroad from a position on the centerline of the street approach at a point 100 feet (for municipal crossing) or 300 feet (for rural crossing) from the center of the main track. If the clear view down the tracks is 2000 feet or greater, the view is considered unrestricted and is

reported as '2000'. If the clear view down the tracks is nonexistent (0 feet), the view is reported as '9999'.)

- Approach obstruction to clear view (left)
  (Code, from the field sheet, the correct number to indicate what the obstruction was when looking to the left from a position 100 feet (for municipal crossing) or 300 feet (for rural crossing) from the main track.)
  (1 -- Trees or shrubs)
  (2 -- Other vegetation)
  (3 -- Topography)
  (4 -- Buildings or other man-made objects (belonging to railroad)
  (5 -- Buildings (residential))
  (6 -- Buildings (commercial))
  (7 -- Other man-made obstructions)
  (8 -- Other obstructions)
  (9 -- No obstruction)
  (If the clear view down the tracks is 2000 feet or greater, the view is considered unrestricted and the code used is '9'.)
- Approach position for maximum clear view (left)
  (Code the value marked on the field sheet. When the observer is stationed on the centerline of the approach 100 feet (for municipal crossing) or 300 feet (for rural crossing) from the crossing and his view down the tracks to the left is restricted (less than 2000 feet), he should then proceed toward the crossing until he has an unrestricted view down the tracks. The distance from the observer's position to the crossing should then be noted and coded. In no case should the point of observation be less than 25 feet from the center of the track nearest the observer. If the view is unrestricted (2000 feet) at 100 feet (municipal) or 300 feet (rural) for RR(53), then RR(55) will automatically be 100 feet (municipal) or 300 feet (rural).)
- Approach maximum clear view (left)
  (Code the value shown on the field sheet. When the observer is able to obtain an unrestricted view somewhere between his initial position (100 feet municipal or 300 feet rural from the crossing) and his final position (25 feet from the nearest track), then this field should be coded '2000'. If the observer never obtains an unrestricted view, the clear view at 25 feet shall be coded. If the clear view down the tracks is nonexistent (0 feet), the view is reported as '9999'.)
- Approach clear sight distance (right)
  (Code, from the field sheet, the clear sight distance looking to the right along the railroad from a position on the centerline of the street approach at a point 100 feet (for municipal crossing) or 300 feet (for rural crossing) from the center of the main track. If the clear view down the tracks is 2000 feet or greater, the view is considered unrestricted and is reported as '2000'. If the clear view down the tracks is nonexistent (0 feet), the view is reported as '9999'.)
- Approach obstruction to clear view (right)
  (Code, from the field sheet, the correct number to indicate what the obstruction was when

looking to the right from a position 100 feet (for municipal crossing) or 300 feet (for rural crossing) from the main track.)

(1 -- Trees or shrubs)

(2 -- Other vegetation)

(3 -- Topography)

(4 -- Buildings or other man-made objects (belonging to railroad)

(5 -- Buildings (residential))

(6 -- Buildings (commercial))

(7 -- Other man-made obstructions)

(8 -- Other obstructions)

(9 -- No obstruction)

(If the clear view down the tracks is 2000 feet or greater, the view is considered unrestricted and the code used is '9'.)

- Approach position for maximum clear view (right)

  (Code the value marked on the field sheet. When the observer is stationed on the centerline of the approach 100 feet (for municipal crossing) or 300 feet (for rural crossing) from the crossing and his view down the tracks to the right is restricted (less than 2000 feet), he should then proceed toward the crossing until he has an unrestricted view down the tracks. The distance from the observer's position to the crossing should then be noted and coded. In no case should the point of observation be less than 25 feet from the center of the track nearest the observer. If the view is unrestricted (2000 feet) at 100 feet (municipal) or 300 feet (rural) for RR(53), then RR(55) will automatically be 100 feet (municipal) or 300 feet (rural).)

- Approach maximum clear view (right)

  (Code the value shown on the field sheet. When the observer is able to obtain an unrestricted view somewhere between his initial position (100 feet municipal or 300 feet rural from the crossing) and his final position (25 feet from the nearest track), then this field should be coded '2000'. If the observer never obtains an unrestricted view, the clear view at 25 feet shall be coded. If the clear view down the tracks is nonexistent (0 feet), the view is reported as '9999'.

- Depart clear sight distance (left)

  (Code, from the field sheet, the clear sight distance looking to the left along the railroad from a position on the centerline of the street approach at a point 100 feet (for municipal crossing) or 300 feet (for rural crossing) from the center of the main track. If the clear view down the tracks is 2000 feet or greater, the view is considered unrestricted and is reported as '2000'. If the clear view down the tracks is nonexistent (0 feet), the view is reported as '9999'.)

- Depart obstruction to clear view (left)

  (Code, from the field sheet, the correct number to indicate what the obstruction was when looking to the left from a position 100 feet (for municipal crossing) or 300 feet (for rural crossing) from the main track.

  (1 -- Trees or shrubs)

  (2 -- Other vegetation)

(3 -- Topography
(4 -- Buildings or other man-made objects (belonging to railroad)
(5 -- Buildings (residential))
(6 -- Buildings (commercial))
(7 -- Other man-made obstructions)
(8 -- Other obstructions)
(9 -- No obstruction)
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- Depart maximum clear view (left)
(Code the value shown on the field sheet. When the observer is able to obtain an unrestricted view somewhere between his initial position (100 feet municipal or 300 feet rural from the crossing) and his final position (25 feet from the nearest track), then this field should be coded '2000'. If the observer never obtains an unrestricted view, the clear view at 25 feet shall be coded. If the clear view down the tracks is nonexistent (0 feet), the view is reported as '9999'.
- Depart clear sight distance (right)
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- Depart obstruction to clear view (right)
(Code, from the field sheet, the correct number to indicate what the obstruction was when looking to the right from a position 100 feet (for municipal crossing) or 300 feet (for rural crossing) from the main track.
(1 -- Trees or shrubs)
(2 -- Other vegetation)
(3 -- Topography
(4 -- Buildings or other man-made objects (belonging to railroad)
(5 -- Buildings (residential))
(6 -- Buildings (commercial))

(7 -- Other man-made obstructions)

(8 -- Other obstructions)

(9 -- No obstruction)

(If the clear view down the tracks is 2000 feet or greater, the view is considered unrestricted and the code used is '9'.)

- Depart position for maximum clear view (right)

  (Code the value marked on the field sheet. When the observer is stationed on the centerline of the approach 100 feet (for municipal crossing) or 300 feet (for rural crossing) from the crossing and his view down the tracks to the right is restricted (less than 2000 feet), he should then proceed toward the crossing until he has an unrestricted view down the tracks. The distance from the observer's position to the crossing should then be noted and coded. In no case should the point of observation be less than 25 feet from the center of the track nearest the observer. If the view is unrestricted (2000 feet) at 100 feet (municipal) or 300 feet (rural) for RR(53), then RR(55) will automatically be 100 feet (municipal) or 300 feet (rural).)
- Depart maximum clear view (right)

  (Code the value shown on the field sheet. When the observer is able to obtain an unrestricted view somewhere between his initial position (100 feet municipal or 300 feet rural from the crossing) and his final position (25 feet from the nearest track), then this field should be coded '2000'. If the observer never obtains an unrestricted view, the clear view at 25 feet shall be coded. If the clear view down the tracks is nonexistent (0 feet), the view is reported as '9999'.
- Year of inventory
- Month of inventory
- Day of inventory
- Design status

  (0 -- No design status assigned)

  (1 -- Project assigned)

  (2 -- KCC project)

  (3 -- "G" project)

  (4 -- Project cancelled)

  (5 -- New project assigned after prior project cancelled)

  (6 -- Existing devices considered adequate)

  (7 -- Tentative program)
- Design review year
- Design hazard rating

  (Calculated from a formula developed by the design department. This formula considers the highway traffic, the angle of the crossing, the sight distance in each of the four quadrants, and the number of tracks to obtain this safety rating value.)
- Rank by design hazard rating
- Exposure factor

  (DEXT = (DADT*(DFAST + DSLOW)) + 0.05)
- Non-state control section number

- Index number of rrinvent
- Cansys switch
  (0 -- Not on state highway system)
  (1 -- On state highway system)
- Cansys section milepost
- Speed limit
- Distance into non-state section
- Rank by design hazard rating (state)
- Lens size
  (Valid values are 6, 8 and 12 inch lenses)
- Circuitry
  (1 -- DC circuit)
  (2 -- Style C (AC/DC, etc.)
  (3 -- AFO (Audio Frequency Overlay))
  (4 -- Motion detector (1140B, etc.))
  (5 -- Motion sensor (500, 550, 600, DMD, MAD, etc.))
  (6 -- Phase motion detector (600, DMD, etc.))
  (7 -- Constant warning devices (GCP, HXP, etc.))
- Rank by design hazard rating (non-state)
  (The #1 rank is the highest rating and the most hazardous. This field ranks only non-state highway railroad crossings.)
- Non-state switch
  (This switch is to mark crossings that are in the non-state data base.)
  (0 -- Not in non-state data base)
  (1 -- In the non-state data base)

USDOT/AAR Crossing Inventory

Data that is available in the USDOT/AAR Crossing Inventory (National Inventory) is in two parts, i.e., "inventory information" and "incident information." Significant data elements are:

1. Inventory Information
   - Location and classification
     Crossing number
     Railroad company
     Railroad division/subdivision
     Railroad branch or line name
     State/county
     County map reference number
     Nearest city
     Street or road name
     Highway type and number
     Nearest railroad timetable station
     Railroad milepost
     Crossing type and protection (public)

- Vehicular Information
  Typical number of daily train movements
  Speed of train at crossing
  Type and number of tracks
  Type of warning device(s)
  -- reflectorized crossbuck
  -- nonreflectorized crossbuck
  -- standard highway stop sign(s)
  -- other stop sign(s)
  -- other signs; advance warning
  -- other signs
  Train activated devices/signals
  Constant warning time
  Special non-train activated warning devices
  Commercial power (yes/no)

- Physical Data
  Type of development
  Smallest crossing angle
  Number of highway traffic lanes
  Truck pullout lanes (yes/no)
  Highway paved (yes/no)
  Pavement markings (yes/no)
  Railroad advance warning signs (yes/no)
  Crossing surface type
  Does track run down a street (yes/no)
  Nearby intersection

- Highway Department Information
  Highway system
  Is crossing on state highway system
  Functional classification of road over crossing
  Estimated AADT (ADT)
  Estimated percent trucks

2. Incident data (all reportable accidents)

Information is given on:

- Location
- Incident situation
- Environment
- Train and track
- Crossing warning system

- Motorist action
- Highway vehicle property damage/casualties
  - -- highway vehicle property damage
  - -- total killed
  - -- total injured

This completes the descriptions of readily available data elements that are available for use in screening individual grade crossings and corridors.

APPENDIX F

SELECTED CORRIDORS

TABLE HEADINGS

XING_NO = Crossing Number

STREET NAME = Name of the street/highway intersecting the railroad at the crossing

RAW SCORE = Score of the crossing determined by the selection model

TOTAL SCORE = Sum of scores for all crossings in the corridor selected by the model

AVG SCORE = Average Score per selected crossing in the corridor

OF CANDIDATES, n = Number of crossings in the corridor selected by the model

TOTAL XINGS, N = Number of all grade crossings in the corridor,

RATIO, n/N = Ratio of selected crossings to the total crossings in the corridor,

XINGS PER MILE = Density of grade crossings in the corridor,

RAILROAD NAME = The name of the railroad over the crossing,

CORRIDOR BOUNDARIES = Limits defining the corridor, and

COUNTY NAME = Name of the county in which the corridor is located.

FOOTNOTES

★ = Abandoned, closed or being closed

★★ = Junction (intersection)

✚ = Dual name

CANDIDATES' XING_NO		STREET NAME	SCORE		AVG SCORE	# OF CANDID-ATES, n	TOTAL XINGS, N	RATIO, n/N	XINGS PER MILE	RAILROAD NAME	CORRIDOR BOUNDARIES	COUNTY NAME
KDOT	USDOT		RAW	TOTAL								
567	009612C	T-263	58	538	67.25	8	11	0.73	1.05	BNSF	ROSE HILL - AUGUSTA	BUTLER
561	009621B	T-69	72									
563	009618T	T-412	71									
558	009624W	T-506	68									
559	009623P	T-171	63									
560	009622H	T-308	77									
562	009619A	T-610	59									
566	009613J	T-316	70									
523	670082G	T-518	55	55	55	1	11	0.09	1.13	BNSF	ANDOVER - AUGUSTA	
586	009589K	T-230	77	650	72.22	9	15	0.6	1.82	BNSF	AUGUSTA - EL DORADO	
583	009595N	T-226	75									
582	009596V	T-453	74									
581	009597C	T-226	69									
584	009593A	T-151	65									
585	009592T	T-328	81									
589	009586P	T-247	79									
587	009588D	T-232	62									
588	009587W	T-247	68									
554	439269W	T-160	61	61	61	1	11	0.09	0.64	UP	EL DORADO - GREENWOOD Co.	
605	009538A	T-213	78	256	64	4	11	0.36	0.5	BNSF	EL DORADO - CHASE Co.	
607	009536L	T-309	64									
600	009543W	T-221	61									
602	009541H	T-419	53									
43	439293X	ATCHISON	57	57	57	1	16	0.167	4.27	UP	EL DORADO CITY	

	CANDIDATES' XING_NO		STREET NAME	SCORE		AVG SCORE	# OF CANDID-ATES, n	TOTAL XINGS, N	RATIO, n/N	XINGS PER MILE	RAILROAD NAME	CORRIDOR BOUNDARIES	COUNTY NAME
	KDOT	USDOT		RAW	TOTAL								
	535	006201L	RILEY RD	57	168	56	3	13	0.23	1.24	BNSF	OTTAWA - WELLSVILLE	FRANKLIN
	533	006204G	NEVADA RD	54									
	538	006197Y	TENNESSEE RD	57									
	552	006230W	ARKANSAS RD	77	192	64	3	19	0.158	1.49	BNSF	OTTAWA - OSAGE Co.	
★	544	439581S	INDIANA RD	54									
	559	006220R	INDIANA RD.	61									
★	516	439533C	VIRGINIA RD	60	60	60	1	2	0.5	0.73	UP	RANTOUL -MIAMI Co.	
	521	006583J	WOODSON RD	60	169	56.33	3	9	0.33	1.2	MR	OTTAWA - DOUGLAS Co.	
	522	006585X	MONTANA RD	56									
	523	006588T	STAFORD TER	53									
★	27	439560Y	OAK ST	54	54	54	1	13	0.08	2.8	UP	OTTAWA CITYY	
★	40	439536X	3RD/MAPLE ST ★★	56	56	56	1	5	0.2	1.3	UP	RANTOUL CITTY	
	517	412608V	C-127	76	141	70.5	2	3	0.67	0.67	UP	PARKER - MIAMI Co.	LINN
	519	412614Y	C-7	65									
	522	412620C	C-11	73	378	63	6	11	0.545	0.82	UP	PARKER - ANDERSON Co.	
	527	412630H	C-225	72									
	528	412631P	C-306	65									
	529	412633D	C-29	60									
	532	412636Y	C-202	54									
	525	412626T	C-19	54									
	16	412617U	MAIN ST	71	71	71	1	16	0.06	0.68	UP	PARKER CITY	

CANDIDATES' XING_NO		STREET NAME	SCORE		AVG SCORE	# OF CANDID-ATES, n	TOTAL XINGS, N	RATIO, n/N	XINGS PER MILE	RAILROAD NAME	CORRIDOR BOUNDARIES	COUNTY NAME
KDOT	USDOT		RAW	TOTAL								
550	008714S	C-406	86	474	79	6	10	0.6	1.25	BNSF	EMPORIA - MORRIS Co.	LYON
548	008718U	C-504	85									
552	008712D	C-806	79									
551	008715Y	C-406	78									
546	008720V	C-404	74									
553	008713K	C-806	72									
568	006292U	C-444	79	155	77.5	2	2	1	0.91	BNSF	NEOSHO RAPIDS - OSAGE Co.	
567	006293B	C-451	76									
563	006305T	C-130	59	235	58.75	4	7	0.57	0.88	BNSF	EMPORIA - NEOSHO RAPIDS	
562	006308N	C-228	59									
564	006303E	C-432	59									
561	006310P	C-626	58									
30	006070K	SYLVAN	74	623	69.22	9	11	0.82	1.7	BNSF	EMPORIA CITY	
27	006074M	UNION	73									
29	006071S	COTTONWOOD	73									
26	006075U	MARKET	72									
36	006066V	PEYTON	69									
559	006084T	T-314	68									
37	006312D	CARTER	66									
22	006078P	CONSTITUTION	65									
24	006077H	MERCHANT	63									
14	006295P	MAIN	53	53	53	1	1	1	0.3	BNSF	NEOSHA RAPIDS CITY	
517	813562S	T-137	73	255	63.75	4	11	0.36	0.69	UP	FRANKFORT - MARYSVILLE	MARSHALL
514	813554A	T-134	71									
513	813552L	T 229	57									
509	813541Y	T-224	54									
528	813356E	T-257	67	185	61.67	3	9	0.33	0.77	UP	FRANKFORT - POTTAWATOMIE Co.	
524	813347F	T-351	63									
521	813329H	T-447	55									
505	813790E	T 10	60	240	60	4	8	0.5	0.82	UP	MARYSVILLE - WASHINGTON Co.	
501	813801P	T 2	59									
507	813786P	T 116	66									
504	813793A	T 108	55									

CANDIDATES' XING_NO		STREET NAME	SCORE		AVG SCORE	# OF CANDID-ATES, n	TOTAL XINGS, N	RATIO, n/N	XINGS PER MILE	RAILROAD NAME	CORRIDOR BOUNDARIES	COUNTY NAME
KDOT	USDOT		RAW	TOTAL								
556	010798P	C-222	55	55	55	1	5	0.2	0.91	BNSF	BURDICK - DIAMOND SPRING	MORRIS
541	605176J	C-44	79	140	70	2	2	1	0.42	SSW	DWIGHT - WABAUNSEE Co.	
540	605177R	C-42	61									
526	605209U	C-8	72	260	65	4	5	0.8	1.05	SSW	LATIMER - DICKINSON Co.	
524	605212C	C-4	68									
523	602871W	C-2	63									
525	605210N	C-6	57									
532	605202W	C-18	66	180	60	3	6	0.5	0.92	SSW	LATIMER - WHITE CITY	
533	605201P	C-115	57									
534	605200H	C-113	57									
539	605184B	C-34	54	54	54	1	5	0.2	0.6	SSW	WHITE CITY - DWIGHT	
20	605192T	HARRIS ST	58	58	58	1	5	0.2	0.6	SSW	WHITE CITY	
559	412725R	C-139	55	454	64.75	7	11	0.64	0.86	UP	ERIE - LABETTE Co.	NEOSHO
558	412726X	C-141	55									
560	412724J	C-132	60									
561	412722V	C-237	75									
563	412717Y	C-29	75									
564	412713W	C-225	65									
625	412712P	STEUBAN-7TH ✚	69									
567	412690S	C-105	69	69	69	1	3	0.33	1	UP	STARK - ALLEN Co.	
576	412707T	C-121	63	240	60	4	8	0.5	0.84	UP	ERIE - STARK	
572	412703R	C-317	60									
624	412701C	C-38	59									
570	412697P	C-140	58									
32	412709G	CANVILLE	76	76	76	1	4	0.25	1.63	UP	ERIR CITY	

CANDIDATES' XING_NO		STREET NAME	SCORE		AVG SCORE	# OF CANDID-ATES, n	TOTAL XINGS, N	RATIO, n/N	XINGS PER MILE	RAILROAD NAME	CORRIDOR BOUNDARIES	COUNTY NAME
KDOT	USDOT		RAW	TOTAL								
550	006234Y	T-445	70	70	70	1	5	0.2	0.67	BNSF	MELVERN - QUENEMO	OSAGE
553	006247A	T-634	54	247	61.75	4	5	0.8	1	BNSF	OLIVET - MELVERN	
556	006249N	T-432	68									
558	006252W	T-353	65									
559	006255S	T-426	60									
554	006261V	T-353	60	348	58	6	7	0.86	0.61	BNSF	MELVERN - COFFEY Co.	
555	006262C	T-432	64									
561	006272H	T-422	53									
562	006257F	T-422	58									
563	006273P	T-220	58									
564	006275D	T-418	55									
527	005980D	T-728	53	167	55.67	3	3	1	1	BNSF	CARBONDALE - SHAWNEE Co.	
528	005979J	T-5	55									
529	005977V	T-728	59									
★ 545	439602H	T-642	56	56	56	1	16	0.06	0.91	UP	OSAGE CITY - FRANKLIN Co.	

CANDIDATES' XING_NO		STREET NAME	SCORE		AVG SCORE	# OF CANDID-ATES, n	TOTAL XINGS, N	RATIO, n/N	XINGS PER MILE	RAILROAD NAME	CORRIDOR BOUNDARIES	COUNTY NAME
KDOT	USDOT		RAW	TOTAL								
535	605223P	T-43	60	257	64.25	4	9	0.44	1.24	SSW	LANGDON - ARLINGTON	RENO
536	605221B	T-24	71									
537	605219A	T-22	66									
538	605217L	T-122	60									
524	605237X	T-140	57	177	59	3	9	0.33	1.5	SSW	ARLINGTON - PARTRIDGE	
525	605236R	T-235	60									
529	605232N	T-334	60									
512	605252A	T-154	60	60	60	1	13	0.08	1.58	SSW	PARTRIDGE - HUTCHINSON	
503	602963J	T-503	59	129	64.5	2	7	0.286	1.4	SSW	HUTCHINSON - MCPHERSON Co.	
506	602960N	T-307	70									
543	605412L	T-12	54	107	53.5	2	5	0.4	0.83	SSW	TURON - LANGDON	
544	605410X	T-148	53									
43	008895Y	PERSHING	60	60	60	1	17	0.06	3.9	BNSF	HUTCHINSON	
172	009833E	VANBUREN	62	62	62		5	0.2	2.15	CKRY		
103	605286U	2ND	72	532	66.5	8	9	0.89	2.34	SSW		
87	602415W	MADISON	69									
98	605279J	CHESTNUT	68									
90	605270X	WASHINGTON	68									
99	605280D	CLEVELAND	66									
105	605288H	6TH	66									
175	605282S	REFORMATORY	62									
102	605285M	1ST	61									
189	605243B	MAIN	65	65	65		2	0.5	0.42	SSW	PARTRIDGE	

CANDIDATES' XING_NO		STREET NAME	SCORE		AVG SCORE	# OF CANDID-ATES, n	TOTAL XINGS, N	RATIO, n/N	XINGS PER MILE	RAILROAD NAME	CORRIDOR BOUNDARIES	COUNTY NAME
KDOT	USDOT		RAW	TOTAL								
587	009652A	95TH E	78	378	63	6	11	0.545	1.63	BNSF	MULVANE - BUTLER Co.	
583	009649S	103RD S	72									
586	009651T	111TH S	62									
584	009639L	103RD S	58									
579	009634C	T-270	55									
585	009640F	95THE	53									
590	009396L	T-453	55	180	60	3	8	0.375	0.53	BNSF	DERBY	SEDGWICK
16	009393R	MARKET	64									
17	009392J	CHERRY	61									
203	595030K	19TH / MEAD ✚	57	111	55.5	2	29	0.07	2.187	UP	WICHITA	
218	595050W	BAYLEY MEAD	54									
180	009267W	15TH	58	115	57.5	2	26	0.08	3.56	BNSF		
177	009270E	10TH ST	57									
54	445153J	HANDLEY	54	161	53.67	3	31	0.96	3.123	UP		
55	445151V	OSAGE	54									
74	445102Y	10TH ST	53									
261	670126E	14TH ST	53	53	53	1	19	0.05	3.58	BNSF		
282	009281S	BAYLEY	57	57	57	1	12	0.08	1.8	BNSF		
674	009251A	WEST 61ST	56	NOT SEEN ON THE MAP						BNSF		
★ 123	015167F	SABIN	55							CKRY		
246	670117F	OHIO	54	107	53.57	2	13	0.153	2.183	BNSF		
240	670108G	GREEN	53									

CANDIDATES' XING_NO		STREET NAME	SCORE		AVG SCORE	# OF CANDID-ATES, n	TOTAL XINGS, N	RATIO, n/N	XINGS PER MILE	RAILROAD NAME	CORRIDOR BOUNDARIES	COUNTY NAME
KDOT	USDOT		RAW	TOTAL								
612	009729K	T-54	69	126	63	2	8	0.25	0.77	BNSF	WELLINGTON - BELLI PLAINE	SUMNER
613	009731L	T-152	57									
605	009667P	T-311	55	226	56.5	4	8	0.25	1.6	BNSF	BELLI PLAINE - MULVANE	
602	009661Y	T-307	55									
603	009663M	T-209	54									
606	009668W	T-511	62									
527	014215P	T-302	53	53	53	1	2	0.5	0.91	BNSF	ARIZONA - HARPER Co.	
519	014201G	T-622	53	53	53	1	4	0.25	0.57	BNSF	MAYFIELD - MILAN	
1	014195F	OSBORNE ST	74	74	74	1	1	1	26	BNSF	MAYFIELD CITY	
34	014182E	BLAINE	75	265	66.25	4	4	1	1.06	BNSF	WELLINGTON CITY	
33	014181X	H ST	72									
32	014180R	G ST	62									
29	014176B	JEFFERSON	56									
524	445581F	C-328	60	60	60	1	7	0.142	0.6	UP	ALTOONA - BENEDICT	WILSON
46	445600H	FIFTH	72	396	66	7	8	0.75	1.89	UP	ALTOONA CITY	
49	445596V	NINTH	68									
47	445599R	SEVENTH	67									
50	445597C	TENTH	63									
48	445598J	EIGHTH	63									
52	445594G	FIFTEEN	63									
40	445546S	BUFFALO	53	53	53	1	1	1	0.24	UP	BUFFALO CITTY	