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Final Technical Report

Alternative Solutions to Railroad Impacts on Communities

Minnesota Department
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North Dakota State
Highway Department

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ALTERNATIVE SOLUTIONS TO RAILROAD IMPACTS ON COMMUNITIES

FINAL TECHNICAL REPORT

PREPARED BY

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IN ASSOCIATION WITH

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FOR

MINNESOTA DEPARTMENT OF TRANSPORTATION
NORTH DAKOTA STATE HIGHWAY DEPARTMENT

FEBRUARY 1982

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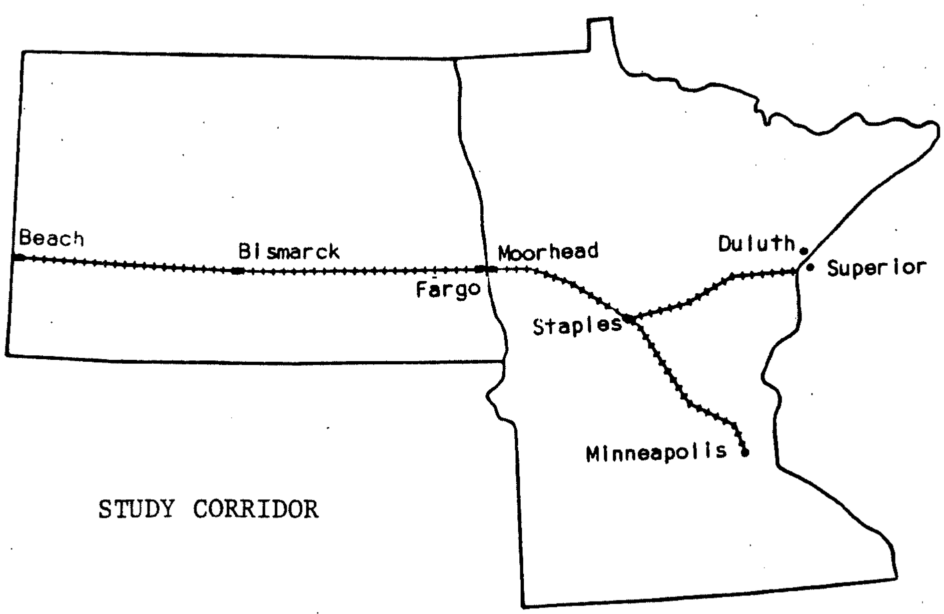
INTRODUCTION

BACKGROUND

This report presents the results of a study known as the Rail Corridor Study. The purpose of the study was to identify community problems arising from conflicts between railroad operations and community activities, and to identify and evaluate possible low-cost solutions to these conflicts. The study was initiated as a result of (1) the formation and activities of the Rail Traffic Task Force, a voluntary group of Minnesota and North Dakota communities organized to identify and resolve railroad/community activity conflicts, and (2) the increasing significance of the coal train impact issue.

The study area is shown in the following exhibit. It is the Burlington Northern, Inc., main line corridor from Beach, North Dakota,



STUDY CORRIDOR

through Fargo North Dakota, and Moorhead, Minnesota, to Staples, Minnesota, and then branching to the vicinities of Minneapolis and Duluth, Minnesota.

In 1976 the Rail Traffic Task Force was formed. Its members recognize that Burlington Northern, Inc., has had a substantial positive effect on the approximately 80 communities located along the corridor, for many years serving as a major employer and providing essential freight transportation links to the rest of the country. The railroad continues to play a vital role in the development and well-being of these communities.

On the other hand, the location of the railroad main line within these communities and local rail service provided to them has created conflicts with community activities. The Task Force has contended that the increase in coal traffic in the corridor has intensified the conflicts. Task Force members, as well as community residents, are concerned that if projected increases in coal traffic occur, the conflicts will become even more serious. The concerns of the Task Force and the actions it has taken to express these concerns are largely responsible for initiating this study.

The efforts of the Task Force and the commitment of the states of Minnesota and North Dakota and the Burlington Northern, Inc., to address community problems attracted the attention of the U.S. Departments of Energy and Transportation. The Departments were attracted by the opportunity to conduct a prototype study of community impacts of railroad operations, particularly unit coal train operations. As coal has come to play a more significant role in meeting the nation's energy requirements, the community impacts of increased unit coal train movements has become an increasing concern of the federal government. Consequently, the U.S. Departments of Energy and Transportation joined the Minnesota Department of Transportation, the North Dakota State Highway Department, Burlington Northern, Inc., and the Rail Traffic Task Force in jointly sponsoring this study. A Study Management Board, on which each of the above study participants was represented, was responsible for policy guidance and approval of study results and products.

STUDY OBJECTIVE AND APPROACH

At the initiation of the study, there were many uncertainties with respect to railroad/community conflicts occurring in the corridor. These uncertainties included:

- The nature of the problems being experienced,
- The location and severity of the problems,
- The factors contributing to the problems,
- The repercussions of the problems on community well-being and on railroad operations, and
- The feasibility and effectiveness of alternative strategies, particularly low-cost strategies, to resolve the problems.

The purpose of this study was to resolve these uncertainties. More specifically, the study objective was to find low-cost solutions to the impacts of railroad/community conflicts occurring along the study corridor.

To accomplish this objective, a three-phase work program was conducted.

Phase I did the following:

- Identified community problems (existing and perceived) resulting from railroad/community conflicts in the corridor,
- Determined in which communities problems occur,
- Determined which communities have the most severe problems, and
- Chose six communities for more in-depth case study.

Phase II did the following:

- Defined and described problems in each case study community,

- Identified alternative low-cost solutions to resolve problems in these communities,
- Evaluated the alternatives and proposed implementation of several as demonstration projects, and
- Identified potential funding sources to implement projects selected for demonstration.

Phase III did the following:

- Implemented the demonstration projects,
- Determined the effectiveness of each project in resolving community problems, and
- Examined the applicability of the projects in other communities.

PRIMARY STUDY CONCLUSIONS

As a result of the Rail Corridor Study, the understanding of rail/community conflicts and of the potential for low-cost actions to reduce these conflicts has been advanced significantly. The basic problems associated with the conflicts have been defined and the factors which contribute to them, including the role of unit coal trains, have been clarified. Analytical methods and procedures have been developed which provide for accurate problem identification and assessment and for alternatives analysis.

Most significantly, the implementation and review of several demonstration projects has shown that low-cost actions can effect significant reductions in rail/community conflicts. Through a variety of actions, general vehicular delay in the case study communities has been reduced by 15 to 30 percent. Because the average duration of delay per vehicle also was reduced, general vehicular delay time was reduced by a larger amount, from 20 percent to 55 percent, depending on the community. Delays to emergency services also have been reduced by at least as much as general vehicular delay. Finally, reductions in crossing accidents ranging from 10 to 75 percent are expected to result from the demonstration projects. These results were achieved at an average project cost of $130,000; half the projects cost under $70,000. The range in cost per community was $115,000 to $640,000, excluding the million-dollar intersection improvement made in one community.

These results can be achieved in other communities as well. It is clear that low-cost actions will not solve all problems in all communities. In some communities, the actions may merely contain problems while more extensive solutions are formulated. In other communities, low-cost actions will be ineffective and can serve no function. The Rail Corridor Study results reveal, however, the exciting potential for low-cost actions to reduce or substantially resolve problems associated with rail/community conflicts.

REPORT ORGANIZATION

This report details the technical approach and the findings which led to the above conclusions. A study summary report and interim reports for Phases I and II also are available on request from the Minnesota Department of Transportation.

The report is divided into two parts. Part A presents the overall results of each study phase. It begins with a description of rail/community conflicts encountered throughout the study corridor. (See Chapter I.) Problems associated with the conflicts and the contributing factors are identified. The findings from the corridor perspective are based on an extensive survey of corridor communities, involving a mail survey of residents, interviews with community and railroad officials, public hearings, and field observations.

Chapter II presents the overall results of the case studies. A set of six community case studies was conducted to develop a better understanding of rail/community conflicts and to identify and test potential low-cost solutions. The communities are representative of corridor communities in general with respect to characteristics, rail/community problems, problem causes, and potentially effective low-cost solutions. The nature, magnitude, and causes of problems experienced in each community are described in Chapter II. This discussion is followed by the definition and evaluation of the demonstration projects implemented in each community to reduce priority problems. The applicability of the demonstration projects in other communities also is presented.

Part B of the report consists of the detailed case studies. One chapter is devoted to each case study community. Community characteristics and problems are detailed. Problem definitions include causes and estimated magnitudes. The demonstration projects are identified. Evaluation of the projects includes observed changes in problem magnitudes attributable to the projects and residents' opinions of the projects effects.

In addition to Parts A and B, the report contains four appendices. The first appendix specifies the methodology used to conduct the case studies. The second appendix identifies the low-cost actions considered for each case study community but not implemented as demonstration projects for a variety of reasons. As such, the material contained in the appendix supplements the understanding of low-cost actions presented in the case studies. Appendix C lists funding sources of low-cost actions. The list was prepared in the spring of 1980 and, consequently, does not reflect the many changes in federal programs which have recently occurred or have been proposed. The last appendix lists actions taken independently by Burlington Northern, Inc., to reduce rail/community conflicts throughout the study corridor. The list provides insight into the applicability of low-cost actions throughout the corridor and reflects the railroad's commitment to resolving these conflicts.

PART A

SUMMARY OF FINDINGS

CHAPTER I

RAIL/COMMUNITY CONFLICTS— THE CORRIDOR PERSPECTIVE

INTRODUCTION

In this chapter, the basic problems resulting from railroad community conflicts experienced throughout the corridor are defined. Variations in problem incidence, severity, and manifestation among communities are explored. The causes of the problems are discussed. Finally, expectations about future problem incidence and severity are presented.

The findings presented in this chapter are based on information on 47 of the 77 corridor communities. The information was obtained from the following sources:

- Review of relevant documents. A review of documents discussing railroad/community conflicts and attendant problems was conducted.

- A mail survey of corridor residents. A survey instrument was developed and mailed to 12,000 randomly selected corridor residents representing 30 corridor communities. The survey asked recipients to identify the problems occurring in their community as a result of railroad/community conflicts. Also, recipients were asked to indicate the severity of each problem. A 25% response rate was obtained.

- Interviews and public meetings with corridor community officials and residents. Regional public meetings were held to provide the opportunity for residents to express their concerns and opinions regarding railroad/community conflicts. About twenty communities were represented at the public meetings. Representatives of each corridor community also were invited to discuss with the consultant the railroad/community conflicts occurring in their community. Over thirty communities elected to be interviewed. They were represented by a variety of people including elected officials, city employees (administrators, planners, police and fire chiefs, emergency service, and public service providers), and interest groups (citizens' advisory committees, Chambers of Commerce).

- Interviews with state and Burlington Northern Railroad officials. To understand the respective state's and the railroad's perceptions of the problems, representatives of the Minnesota Department of Transportation, the North Dakota State Highway Department, and the Railroad were invited to meet with the consultant. Representatives of each Burlington Northern regional and district office associated with the study corridor were interviewed on location.

- Field observations. During the tour of public meetings and interviews, on-site observations were conducted by the consultant to gain a first-hand understanding and appreciation of the problems being experienced.

BASIC PROBLEMS OCCURRING IN THE CORRIDOR

Seven basic types of problems exist or are perceived to exist in corridor communities as a result of rail/community conflicts. These basic problems are:

- Pedestrian safety
- Vehicle safety
- Emergency service delay
- Delays in traveling to and from work and school
- Noise, air pollution, and other environmental disturbances
- Community development problems such as inhibition of economic or residential growth, distribution of economic activity away from preferred locations, and reduced community attractiveness.

Among the seven basic problems, emergency service delays was cited most frequently by corridor residents as a community problem. Almost 60 percent of the respondents to the mail survey stated that emergency service delays are created by railroad community conflicts in their communities.

Delays to emergency services also was cited as the most serious problem resulting from railroad/community conflicts. Recipients of the survey were asked to indicate the degree of severity (not severe, slightly severe, severe, very severe) of each problem in their community. In the opinion of 34 percent of the respondents, emergency vehicle delay is a severe or very severe problem. Response rates for the other problems are reported in Exhibit I-1.

PROBLEM INCIDENCE AMONG COMMUNITIES

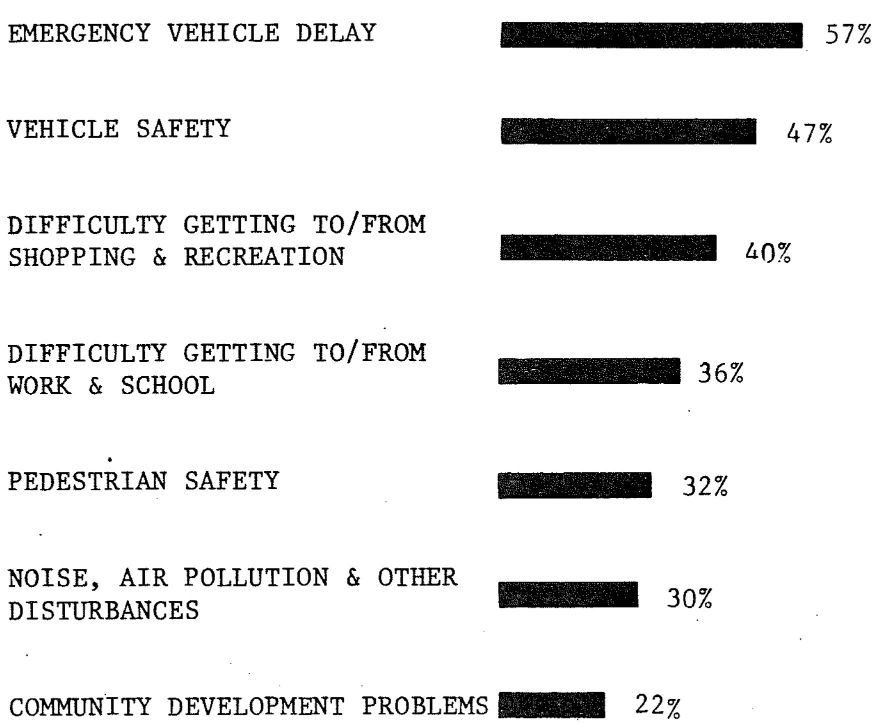
All corridor communities for which information was obtained experience at least one of the seven basic problems identified above. However, the relative extent and severity of each problem varies considerably among communities. What is deemed a serious problem in one community is of no apparent concern in another. This conclusion is revealed by the wide range in responses among communities to mail survey questions (see Exhibit I-2). For example, 74 percent of one community's respondents stated that delays to emergency vehicles is a serious problem in their community. At the other extreme, only 3 percent of another community's respondents indicated that this is a serious problem. Similar ranges are associated with the other problem types.

The survey results also reveal that the communities with the most serious problem (i.e., with the largest percentage of respondents who

EXHIBIT I-1

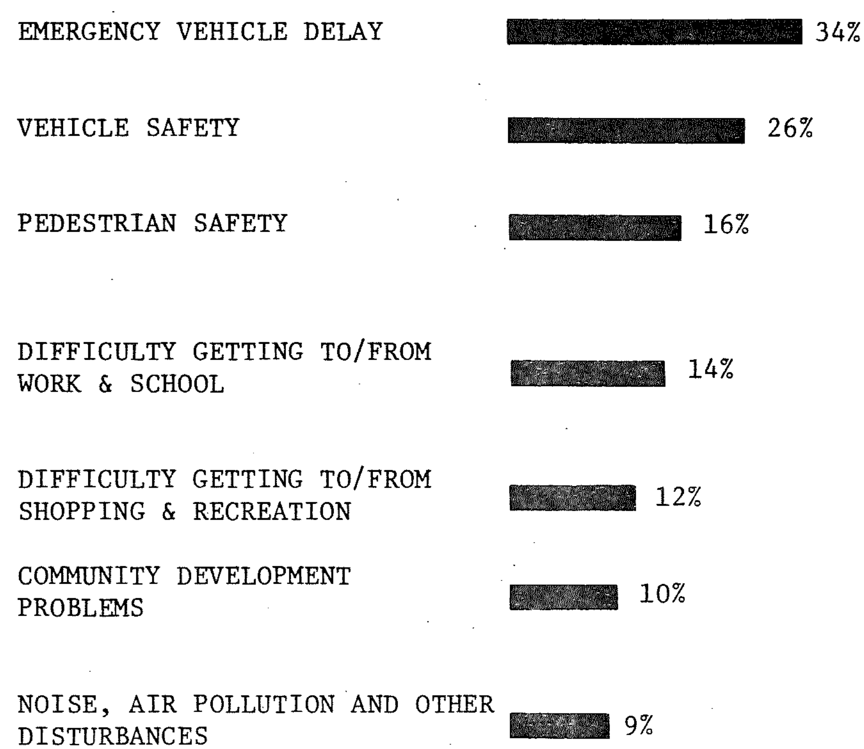
Problems Cited By Corridor Communities

(Percent of Respondents Who Perceive a Problem to Exist)



Problems Cited By Corridor Communities

(Percent of Respondents Who Perceive a Problem to be Severe or Very Severe)



Source: Ernst & Ernst Survey of Study Corridor Residents; December, 1978-February 1979.

EXHIBIT I-2

RELATIVE SEVERITY OF PROBLEMS CITED BY CORRIDOR COMMUNITY

COMMUNITIES	PERCENT OF COMMUNITY RESIDENTS WHO PERCEIVE THE SPECIFIED PROBLEMS AS A SEVERE OR VERY SEVERE PROBLEM IN THEIR COMMUNITY						
	Pedestrian Safety	Vehicle Safety	Environmental Problems	Emergency Vehicle Delay	Delays Traveling To/From Work and School	Delays Traveling To/From Shopping and Recreation	Community Development
MINNESOTA							
Anoka	8	15	3	15	3	0	5
Brainerd	6	26	3	58	12	11	4
Coon Rapids	7	11	11	9	11	11	4
Crowell	3	6	6	3	2	0	8
Detroit Lakes	7	11	4	23	8	3	5
Dilworth	4	11	15	23	20	13	11
Elk River	29	35	13	33	11	13	20
Fridley	11	16	9	8	8	6	8
Hawley	10	5	4	5	5	4	9
Little Falls	11	30	8	74	33	38	21
Moorhead	13	15	7	40	32	11	20
Motley	12	34	9	11	5	5	0
New York Mills	5	18	3	11	2	0	0
Perham	29	66	13	40	21	18	7
Sartell	10	18	14	33	9	8	15
Sauk Rapids	24	41	23	47	23	19	16
Staples	13	12	7	66	19	16	25
St. Cloud	3	16	13	17	13	10	6
Wadena	22	22	7	49	18	9	7
NORTH DAKOTA							
Beach	58	77	15	73	42	38	14
Belfield	18	8	15	9	9	9	5
Bismarck	3	19	7	6	4	1	1
Casselton	32	45	13	52	18	12	9
Dickinson	16	14	13	18	2	12	11
Fargo	25	21	12	18	19	8	8
Jamestown	19	29	13	53	19	14	9
Mandan	11	9	17	6	8	2	17
Sanborn	18	18	0	20	8	10	0
Steele	11	13	8	21	5	5	3
Tapper	16	40	16	12	8	8	4

Source: Ernst & Ernst Survey of Study Corridor Residents, December 1978 - February 1979.

believe a serious problem exists) vary by problem type. Only two of the communities (Beach, North Dakota, and Sauk Rapids, Minnesota) rank among the top ten most severely affected communities in all seven problem areas. Seventy percent of the communities are in the top ten in at least one problem area. The summary of this characteristic of relative problem severity is presented in Exhibit I-3.

EXAMPLES OF COMMUNITY PROBLEMS

It has been shown that the relative incidence and severity of problems differs among corridor communities. There also are differences in the ways problems are manifested in communities. These differences are best understood through examples. The examples presented below are organized by the seven basic problem types previously defined.

- <u>Pedestrian Safety</u>

  In several communities, a large portion of the elderly population resides on the side of the main line opposite to the central business and commercial area. Often these people do not have access to automobiles or by preference travel by foot. As train traffic has increased in the corridor, there has been growing concern for the safety of elderly pedestrians who cross the main line for personal business or social activities. In addition, some communities are concerned that the elderly population is becoming increasingly isolated from the rest of the community due to pedestrian safety fears and delays.

  In one community, a new swimming pool is nearing completion. The pool is located on the south side of the main line adjacent to the community golf course. Because two-thirds of the population resides on the north side of the main line, the community is concerned about the potential safety hazard for children crossing the main line to go swimming.

  A problem occurring with increasing frequency is children crawling underneath standing trains to avoid being late for school or to avoid waiting for th train to move so that they might proceed to their destination.

EXHIBIT I-3

THE FREQUENCY WITH WHICH COMMUNITIES RANK WITHIN THE TOP TEN MOST SEVERELY AFFECTED COMMUNITIES BY PROBLEM TYPE*

NUMBER OF PROBLEM AREAS IN WHICH A COMMUNITY RANKS WITHIN THE TOP TEN	PERCENT OF COMMUNITIES	CUMULATIVE PERCENT OF COMMUNITIES
0	33	33
1	17	50
2	10	60
3	7	67
4	10	77
5	10	87
6	7	94
7	6	100

*Only communities represented in the survey of corridor residents are included in this calculation.

SOURCE: Ernst & Whinney Survey of Study Corridor Residents, December 1978-February 1979.

- Vehicle Safety

  In some communities, local switching operations often activate the gates at a crossing even though the train will not use the crossing. In other communities, the gates are activated by trains standing while the crew takes a break or a crew change occurs. These false warnings at crossings may last up to 20 minutes. Accustomed to this experience, motorists have begun to ignore the warning signals with increasing frequency by weaving their vehicles through the gates. Several fatal accidents have resulted from this practice because the motorist failed to see a train coming from a direction opposite to the switch operation or standing train. In one community, trucks carrying combustible cargo frequently ignore the warning devices. A collision with a train and one of these trucks could produce a major disaster in the community.

  In many communities, the vehicle safety problem results in part from visual obstructions created by sharp curves in the track, and grain elevators, lumber yards, and other rail user facilities located adjacent to the main line crossings.

  Steep approaches to grade crossings have caused accidents in some communities. The steep approach obstructs the motorist's view of trains. Also, to make it up and over the crossings, particularly in icy conditions, drivers will get up speed and are unable to stop if a train is coming.

- Environmental Problems

  Some communities, where residential areas are located near the railroad, are annoyed by train whistles blown late at night.

  As a result of lengthy vehicle delays at railroad crossings on major roadways, some communities report pollution problems. When the delays occur during peak time periods of the day, lengthy queues of idling vehicles are created.

  In one community the natural buffer of trees between a residential development and the main line and railroad yard was removed to provide space for yard expansion required to satisfy growing demand. With the removal of this barrier, the community is no longer shielded from the yard operations. Property values are said to have declined as a result of the visual intrusion.

- Delays to Emergency Vehicles

  For many communities, a central cause of this problem is the existence of only one fire station, or one hospital, or one ambulance service which must serve population on both sides of the main line. When the grade crossings are blocked, a more circuitous route to respond to emergencies is required. In emergency situations, a delay in reaching the emergency location could be critical. For example, a slaughter house, the major employer in one community, burned to the ground because the fire engine was delayed by 20 minutes at a railroad grade crossing.

Other communities' emergency vehicle access problems are complicated by community development patterns and geography. For example, in one community, the residential area is shaped like a triangle with the main line bordering two sides and a river bordering the third side. Emergency services are provided from another part of the community making delays to emergency vehicles a potential problem. Geographic barriers, particularly lakes and rivers, occur frequently in corridor communities and complicate the vehicle delay problem.

The anger caused by delay of emergency vehicles at rail crossings is as much a part of the problem as the actual losses resulting from these delays. Residents related emotional descriptions of the intense anxiety created when a relative accompanies a person in the ambulance and the ambulance is delayed at a crossing on the way to the hospital.

- Delays to Work and School

In one community, children are bused across the main line for a special lunch program. Often they are delayed at crossings going to and from their lunch location. The delays mean a particularly short time for lunch or shortened classroom time.

Many community members express frustration in commuting to work because of blockage by trains. Sometimes they leave with time to spare but are blocked by a train for 20 minutes and reach work late. Other times they leave early and arrive at work extremely early. The unpredictability of delays is as frustrating as the length of delays.

- Delays to Shopping & Recreation

Many of the communities are located near prime recreation areas. The population in these communities often doubles or triples during the summer. When trains block access to the recreation areas, large congestion problems are created which disrupt community activities as well as delay vacationers.

Most corridor communities are too small to support more than one shopping and business area. Further, the shopping and business area has developed along one side of the main line while the residential areas are dispersed on both sides. Often the population split by the main line is in a 35%/65% ratio. Consequently, a significant portion of most communities' residents are subject to delays traveling to/from shopping areas.

- <u>Economic Development</u>

  In several cases the community's growth is constricted by geographical limitations such as rivers and lakes. These communities have developed across the railroad track from the main part of the community where the only available land exists. In other communities existing infrastructure makes development on the "wrong side of the tracks" an economic necessity. These developments further split the communities and increase the incidence of conflicts.

  In some communities development decisions have been made with no regard for the community/railroad conflicts which will be created. An example is a community currently located predominantly on one side of the main line which has planned a major residential development on the other side of the main line.

  In some communities, the closeness of the mainline to the CBD or residential areas has created the fear of derailment as train traffic has increased. While the problem in this case is more one of expectation than a history of accidents, there have been isolated cases where derailments have done substantial damage to adjacent properties.

- Potentially serious delays in responding to medical, fire, and police emergencies.

- Significant and unpredictable delays in travel to/from work, school, business, and social activities.

FACTORS CONTRIBUTING TO COMMUNITY PROBLEMS

The examples cited above reveal that the problems are indeed the result of <u>rail/community conflicts</u>. To clarify this point, Exhibit I-4 lists the factors found to contribute to the incident and severity of the seven basic problem types defined earlier. The factors are grouped to show

EXHIBIT I-4

FACTORS CONTRIBUTING TO COMMUNITY PROBLEMS

Community Transportation System

No grade separated crossings*
At grade crossings close/blocked simultaneously*
Grade separation inadequate
Outdated, inadequate warning devices*
Visual obstruction near rail right-of-way*
Icy roads
Steep approaches to grade crossings
Poorly maintained grade crossings
Volume of vehicle traffic*
State Highways in Communities*
State highway traffic diverted through communities by blocked crossings
Number of crossings and their spacing*
Angle of Roadway approach to crossing
Location of warning signals
Lack of pedestrian crossings*

Community/Railroad Communication

Do not know who to contact concerning problems*
Receive incomplete or inconsistent data
Lack of railroad/emergency vehicle communication*
Railroad not responsive to requests or complaints

Behavior Patterns

Possible misperception of problem severity
Violation of crossing warning signals*
Large volume of pedestrian traffic*

Community Service Patterns, Equipment, and Facilities

One emergency station serving areas on both sides of the main line*
School bus routes require crossing main line*
Transit bus routes require crossing main line*
Location of community recreation facilities vis-a-vis main line*

Community Activities and Development Patterns

Percentage of community split by the main line*
Geographic barriers to development and access*
Significant seasonal variations in population/traffic*
Location of storage tank with combustible chemicals adjacent to main line*
Location of new or planned development*
Location of available land for development
Infrastructure in place
Separation of commercial and business area from residential area by main line*
Separation of residential areas from school, shopping, work and recreation areas by the main line*
Development on soft soil foundation

Railroad Operating Practices

Crew change location*
Local switching operations*
Train speed*
Train length*
Train volume*
Standing trains which block crossings*
Time of day switching operations occur*
Unpredictability of train movements*
Idling trains
Activation of warning signals when unnecessary*

Railroad Facilities

Inadequate spur on siding length*
Mechanical versus automatic switches
Locations of train verifiers
Number of main lines
Location of switching operations*
Not well maintained right-of-way
Location of Yards*
Condition/age of tracks and structures
Track configuration
Location of maintenance facilities
Refueling location

that community characteristics and activity patterns as well as railroad operations and facilities give rise to these problems.

Exhibit I-5 further clarifies the process by which the community problems are created. It presents the dynamic relationship between community activities and railroad operations that create the problems. The exhibit shows how the blocking of grade crossings within communities by railroad operations conflicts with community activities and development, thus creating the seven basic problems previously defined. 1/

An attempt was made to correlate specific community and railroad characteristics with problem incidence and severity to determine whether certain factors are more significant than others in creating problems. A X^2 test was used. The analysis provided no conclusive results. Considerable variation in the combination of factors occurring in the communities made the sample size inadequate to provide statistically significant results. Nonetheless, field observations indicate that certain factors are more significant than others. These factors are identified with asterisks in Exhibit I-4, above.

THE ROLE OF UNIT COAL TRAINS

The role that unit coal trains play in the incidence and severity of community problems is of particular concern in this corridor. A large

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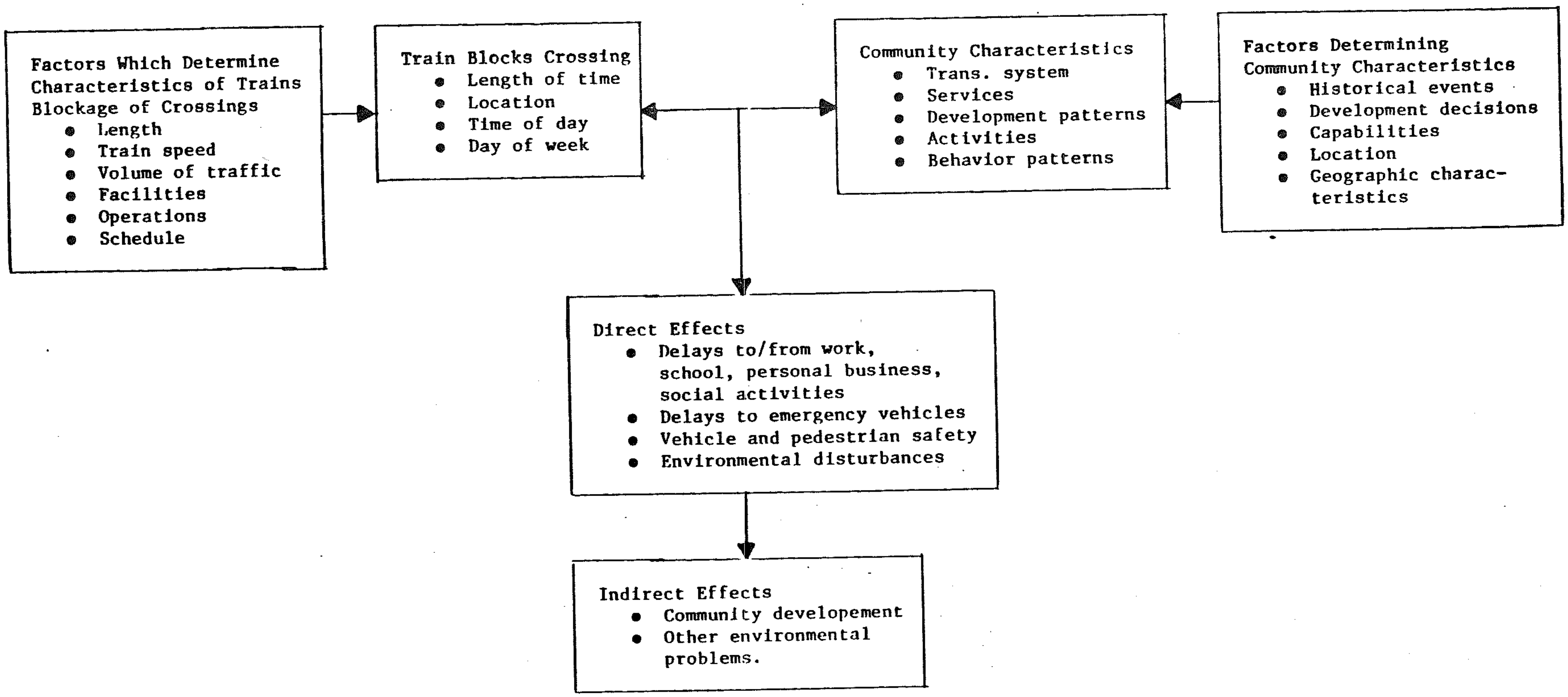
1/ Although some problems reported were not the result of grade crossing blockage (e.g., disturbances to land uses adjacent to the main line), most of the significant problems (i.e., those reported most frequently and those thought to be most serious by community officials and residents) are related to the blocking of grade crossings. Thus, the discussion focuses on these problem types.

EXHIBIT I-5

INTERRELATIONSHIP OF FACTORS CONTRIBUTING TO COMMUNITY PROBLEMS



percentage of the increase in railroad operations in the corridor since 1971 is associated with increases in unit coal trains. Further projections suggest that future train increases will be predominantly unit coal trains. Because of this condition and the perception expressed by many at the outset of the study that unit coal trains are largely responsible for community problems in the corridor, the role of these trains was examined.

Contrary to popular opinion, it was found that unit coal trains are not the sole cause of the community problems. Although unit coal trains may be a significant factor in the development of community programs, they have not created any unique problems, nor are they the sole cause of any of the problems currently existing in the corridor. Rather, it is the cumulative effect of a mix of railroad operations in interaction with community characteristics that creates the problems existing in corridor communities. The relative contribution of unit coal trains to these problems does not differ among communities. The contribution is a function of traffic volume, train operations conducted, the characteristics of rail facilities, and the characteristics of the community. In this particular corridor, the following general observations concerning the relative role of unit coal trains in the development of community problems can be made:

- In most communities, the <u>types</u> of operations conducted by unit coal trains differ only marginally from those conducted by merchandise trains. Consequently, the types of problems to which these trains contribute are the same. This conclusion is substantiated by the fact that the types of problems existing in communities with predominantly coal train traffic differ only marginally from those in communities with predominantly non-coal train traffic. The magnitude of the coal trains' contribution to problems in a given community, however, may differ significantly from merchandise trains for reasons stated below.

- For through train movements under free traffic flow conditions, coal trains will block more crossings simultaneously for a <u>slightly</u> longer period of time than other trains. The difference between the coal and merchandise trains in this regard, however, is small.

- Where both coal trains and merchandise trains conduct yard operations, or other operations requiring deceleration, stopping and acceleration, unit coal trains will block more crossings simultaneously for a slightly longer period of time than the merchandise trains.

- In some communities, merchandise trains conduct set-out and pick-up operations in the yards. In these communities, the merchandise trains may block crossings for a longer period of time than coal trains if the latter do not conduct and are not affected by trains entering and exiting the yards.

- The relative volume of unit coal trains versus other trains varies among communities. West of Casselton, North Dakota, coal trains predominate. East of Casselton, merchandise trains predominate. Thus, unit coal trains are a more significant contributing factor west of Casselton.

- There are definite operating differences between unit coal trains and local freight trains. Thus, the problems that each of these trains create may differ. Alternately, they may contribute to the same problem in a community in different ways.

- Because most of the operating characteristics of unit coal trains and merchandise trains are similar, many, but not all, potential solutions used to address problems created by these trains are similar. Due to the large differences between unit coal trains and local freight trains, potential solutions for problems involving these train types differ more frequently.

PROJECTIONS OF FUTURE COMMUNITY PROBLEMS

Data on the historic trends of problem concurrence and severity in the corridor are unavailable. However, it appears that the extent and magnitude of problems in the corridor will continue to increase. This is indicated by projections of train operations and community development patterns occurring in the corridor. Train projections show modest increases in traffic volume through 1985, one to three trains daily depending on the line segment. All of the increase is expected to be unit coal trains. The projected increases in traffic volume will mean increases in community problems as well.

Also indicating that problems will increase in occurrence and severity is the magnitude and pattern of community development occurring in the corridor. Some corridor communities are experiencing annual average growth rates of 10 percent. Growth translates into increased potential for conflicts between railroad operations and community activities. The development patterns occurring also may worsen existing problems or create new ones. Several corridor communities are experiencing development or have planned development which will further split the community on both sides of the main line. Other communities are locating new schools, recreation facilities, and other public facilities on the side of the main line apart from the primary residential areas of the community. To some extent these development patterns are unavoidable. Choices are limited by available land, geographic features such as lakes and rivers, and past investments in infrastructure. Regardless of the cause, the magnitude and patterns of community growth may increase the occurrence and severity of railroad/ community conflicts and attendent problems.

CHAPTER II

COMMUNITY PROBLEM ASSESSMENTS AND DEMONSTRATION PROJECT RESULTS

INTRODUCTION

In Phases II and III of the study, an in-depth analysis of problems and alternative solutions in the following six case study communities was conducted:

- Beach, North Dakota (population 1,500)
- Casselton, North Dakota (1,800)
- Elk River, Minnesota (7,000)
- Hebron, North Dakota (1,100)
- Moorhead, Minnesota (30,000)
- Sauk Rapids, Minnesota (5,800)

The communities are representative of other corridor communities in terms of characteristics, problems, causes of problems, and potentially effective low-cost solutions.

PROBLEMS CONFRONTING THE COMMUNITIES

The case studies focused on the problems designated as priorities by each community. The problems investigated included emergency vehicle delays; vehicle and pedestrian safety; access problems in traveling to and from work, school, business, and shopping; and community development constraints. Environmental disturbances were not investigated. Although some residents perceived environmental disturbance as a serious problem, most residents considered it a relatively minor one.

Estimates of the magnitudes of priority problems in each community were made (see Exhibit II-1). The estimates, which represent community totals, suggest a wide range of experience. When the estimates are put in per capita terms, however, relative problem magnitudes among communities are less diverse. Also, the rank order of communities by problem magnitude changes when per capita, rather than community-wide, estimates are used, as can be seen in Exhibit II-2. These comparisons show that small communities may have more severe rail/community conflicts than larger communities and illustrate the importance of using per capita as well as absolute estimates when evaluating problem severity in and among communities.

A comparison of railroad operating characteristics among the communities reveals a significant conclusion. Rail/community conflicts are not solely related to the number of train operations conducted in a community. The conflicts derive from the types of railroad operations conducted and from the characteristics of the community as well. For example, while both Elk River and Sauk Rapids experience 25 trains on the average day, the percentage of the day that crossings are blocked on average in Elk River is twice that of Sauk Rapids. The difference is in types of trains, types of operations, and train speeds.

As noted, community characteristics also are an important determinant of the magnitude of rail/community conflicts. Using the Elk River/Sauk Rapids example, in which blocked crossing time in Elk River is twice

ESTIMATES OF CURRENT PROBLEM MAGNITUDES IN CASE STUDY COMMUNITIES 1/

Community	EMERGENCY VEHICLE DELAYS PER YEAR			AUTO/TRAIN ACCIDENTS PER YEAR	ACCESSIBILITY (DELAY PER YEAR AT CROSSINGS			COMMUNITY DEVELOPMENT (DELAY AT CROSSINGS PROVIDING ACCESS TO THE CBD)		
	Ambulance 2/	Fire	Police		Vehicles	Vehicle Hrs.	Person Hrs. 3/	Vehicles	Vehicle Hrs	Person Hrs
Beach, ND	12.5	0.0	--	0.7	84,000	3,700	5,200	NA	NA	NA
Casselton, ND	20.0	0.8	--	0.8	125,000	3,700	5,200	NA	NA	NA
Elk River, MN	18.0	10.0	--	0.3	245,000	9,800	13,700	NA	NA	NA
Hebron, ND	5.3	1.7	--	0.5	44,000	1,900	2,700	NA	NA	NA
Moorhead, MN	91.0	27.0	300.0	2.5	840,000	36,000	50,300	560,000	22,700	32,700 4/
Sauk Rapids, MN	33.0	0.7	--	1.0	284,000	5,700	7,900	NA	NA	NA

1/ Please note that these are estimates of the order of problem magnitude. The estimates appear reasonable but are not statistically verifiable. Also, NA is not applicable; blank spaces mean that a reasonable estimate of problem magnitude could not be developed. No credible estimate of potential pedestrian/train accidents could be developed. Consequently, this problem area is excluded from this exhibit.

2/ It is not possible to estimate with any confidence how many of these delays may be critical to the patient. Previous research suggests that about five percent of the patients confront a life-threatening situation prior to receiving medical attention; about one percent of the patients traveling to the hospital confront a life-threatening situation. However, it is not possible to determine in how many of these cases a delay of the character estimated for these communities will be critical. No critical delays to date have occurred in any of the communities to our knowledge.

3/ Assumes 1.4 persons per vehicle.

4/ Includes delays to transit users.

5/ Residents also are concerned about the safety hazard at the intersection of a local street and a trunk highway created by traffic congestion at the nearby grade crossing during train operations. Average accident experience is 8 per year at this intersection.

6/ Because the equations used to estimate auto/train accidents are based on national data, and due to the difficulties associated with estimating grade crossing accidents, the estimates must be regarded as representing the order of magnitude of what may occur in the communities. They should not be regarded as accurate predictions of what will inevitably occur.

EXHIBIT II-2

PER CAPITA MAGNITUDE OF SELECTED CASE STUDY COMMUNITY PROBLEMS

	PER CAPITA PROBLEM MAGNITUDE 1/ (Number Per Average Year)		
Community	Ambulance Delays	Vehicles Delayed	Auto/Train Accidents
Beach, ND	.0083	56	.0005
Casselton ND	.0111	69	.0004
Elk River, MN	.0026	35	.0001
Hebron, ND	.0048	40	.0004
Moorhead, MN	.0030	28	.0001
Sauk Rapids, MN	.0056	48	.0002

1/ Community populations are:

Beach	1,400
Casselton	1,800
Elk River	7,000
Hebron	1,100
Moorhead	30,000
Sauk Rapids	5,800

that of Sauk Rapids, it would seem that problem magnitudes would be larger in Elk River. This is not the case, however, because Sauk Rapids' development patterns cause community activities to conflict more frequently with train operations than those in Elk River (see Exhibits II-I and II-2).

These comparisons verify the Phase I conclusion that community problems experienced along the corridor result from the interaction of railroad operations and community characteristics; they are not caused solely by railroad activities. The comparisons also reveal that simple indices of rail operations (such as train volumes) and community characteristics (such as population or daily traffic volumes) may distort an accurate assessment of absolute and relative problem magnitude among communities.

The case study analyses indicate that coal trains indeed contribute to the magnitude of problems experienced. More specifically, the railroad's contribution to delayrelated problems attributable to coal trains in each case study community is approximately as follows:

Beach, North Dakota--75%
Casselton, North Dakota--25%
Elk River, Minnesota--12%
Hebron, North Dakota--60%
Moorhead, Minnesota--25%
Sauk Rapids, Minnesota--12%

As discussed earlier, the differences among communities are functions of the number and type of coal train operations relative to other train operations.

The number of coal trains operating in the corridor will continue to increase. This will contribute, along with further growth in corridor communities, to a worsening of rail/community conflicts. But a dramatic worsening of the conflicts will not occur in the near term, as some have predicted. Current projections indicate that there may be no increase by 1985 over 1980 levels in unit coal trains through Beach and Hebron, largely due to the rerouting of some trains on other BN main lines. The other case study communities may experience an increase of one to three unit coal trains per day by 1985. There also may be some additional mixed freight trains on the main line east of Casselton. Based on these projections and projections of community growth, Casselton and communities east would experience an increase in delay-related problems of 5 to 20 percent by 1985, if no mitigating actions were taken.

DEMONSTRATION PROJECTS—DEFINITION AND EVALUATION

The identification of potential demonstration projects began in Phase I with the development of a list of actions thought to be low in cost and capable of mitigating rail/community conflicts. During the Phase II case studies, this list was expanded and the alternatives were analyzed for their worth as demonstration projects. Exhibit II-3 lists the actions investigated and the problems each was designed to address. In the last column of the exhibit are designated the actions selected for implementation as demonstration projects. The following pages contain a brief description of each demonstration project, the communities in which it was implemented, its effectiveness in reducing rail/community conflicts, and its implementation cost.

Emergency Service/Railroad Communication System. Establishment of an emergency communication system is being tested in Casselton, Elk

EXHIBIT II-3

ACTIONS INVESTIGATED AS POTENTIAL LOW-COST SOLUTIONS TO THE PRIORITY PROBLEMS IN THE SIX CASE STUDY COMMUNITIES

ACTION	PROBLEMS THE ACTIONS ARE DESIGNED TO ADDRESS IN THE CASE STUDY COMMUNITIES						SELECTED FOR DEMON-STRATION
	EV	CD	AWS	ABS	VS	PS	
RAILROAD OPERATING CHANGES							
Ensure standing trains do not unnecessarily activate the gates and flashers by stopping the trains short of the activation circuit, thereby eliminating unnecessary delays at crossings.		X	X	X	X		
Increase maximum allowable train speed through communities to reduce the amount of time crossings are blocked and vehicles delayed.	X	X	X	X			X
Ensure that trains using sidings stop well clear of the crossings to avoid unnecessary crossing blockage and to avoid creating a visual obstruction of other approaching trains on parallel tracks.	X		X	X	X		
Schedule local switching operations to off-peak hours to reduce the number of motorists who will experience crossing delays.		X	X	X			
Allow delayed vehicles to clear the crossing periodically while switching operations are being conducted.			X	X			
Break trains that must straddle crossings for several minutes to avoid excessive vehicle delays.	X		X	X			
Redistribute trains from one mainline to another; the mainlines are parallel but separated by a few hundred feet; the mainline to which trains would be distributed affects fewer people than the other.		X	X	X			
Relocate crew change points outside of or farther from the community to reduce the crossing delays associated with stopping the train.	X	X	X	X			
Reroute trains around communities using existing tracks.	X	X	X	X			
Relocate the train verifier farther from the community to eliminate slow train speeds in the community as the by-check operation is conducted.	X	X	X	X			
RAILROAD FACILITY CHANGES							
Install grade crossing predictors to activate the gates at crossings in order to reduce early signal activation, thus reduce delays and hazards at crossings.	X	X	X	X	X	X	X
Extend crossing gate arms to prevent motorists from crossing the mainline when the gates are down.					X		
Install automatic gates at crossings in place of less effective grade crossing protection devices.					X		X
Alter rail sidings to eliminate blockage of crossings while trains use the sidings and to permit faster train speeds through the community while entering/exiting sidings.	X		X	X	X		X
Construct fencing along rail right-of-way to inhibit pedestrians from crossing at unprotected locations.						X	
Straighten track alignment to permit faster train speed through the community.	X	X	X	X			
Improve maintenance of the grade crossing surface.					X		
COMMUNITY FACILITY CHANGES							
Implement street and highway improvements designed to reduce delays at crossings and nearby intersections congested by vehicles delayed at crossings.			X	X	X		X
Remove visual obstructions along the rail right-of-way near crossings.					X		
Close selected hazardous highway/rail grade crossings.					X		X
Construct new crossings at both ends of the community as alternative routes for emergency vehicles only.	X						
Construct a grade-separated pedestrian crossing.						X	

EXHIBIT II-3 (Continued)

ACTIONS INVESTIGATED AS POTENTIAL LOW-COST SOLUTIONS TO THE PRIORITY PROBLEMS IN THE SIX CASE STUDY COMMUNITIES

ACTION	PROBLEMS THE ACTIONS ARE DESIGNED TO ADDRESS IN THE CASE STUDY COMMUNITIES						SELECTED FOR DEMON-STRATION
	EV	CD	AWS	ABS	VS	PS	
COMMUNITY SERVICE CHANGES							
More strictly enforce laws against crossing the tracks, violating activated warning signals.					X		
Upgrade ambulance service from a basic life support to an advanced life support system; this increases the ability to stabilize patients at the emergency scene and thus reduces the probability that a delay in traveling to the hospital will be critical.	X						
Equip fire service volunteers with personal equipment to conduct emergency operations prior to engine company arrival, thus reducing the adverse effects of crossing delay to the engine company.	X						
Establish emergency services on both sides of the mainline.	X						
Provide ambulance and fire service vehicles on both sides of the mainline.	X						
Relocate the emergency stations to the side of the mainline on which the majority of emergency calls occur, thus minimizing potential delays.	X						
Reroute school buses to avoid more hazardous crossings.					X		
Use alternative routes to respond to emergencies when first choice crossings are blocked by slow-moving or standing trains.	X						
Establish a volunteer rescue squad to complement the existing ambulance service and to provide emergency medical service stations on both sides of the mainline.	X						X
Establish a volunteer ambulance service to complement the existing private service and to provide emergency medical service stations on both sides of the mainline.	X						
Redesign transit bus routes to minimize times the mainline must be crossed.		X	X				
PUBLIC EDUCATION							
Institute pedestrian safety patrols for the safety of children crossing the mainlines on their way.						X	X
Conduct a marketing campaign to overcome people's perceptions of significant access problems to business centers.		X					
Conduct a pedestrian safety education program in the schools.						X	X
COMMUNICATIONS							
Establish an emergency service/railroad communication system to provide the capability to alter train operations and avoid blocking designated crossings in emergency situations.	X						X
Improve general community/railroad communications.	X	X	X	X	X	X	X
COMMUNITY DEVELOPMENT							
Direct new development in a way that will minimize future rail/community conflicts.	X	X	X	X	X	X	

KEY:

EV = Emergency Vehicle Delay
VS = Vehicular Safety
PS = Pedestrian Safety
AWS = Access to Work/School
ABS = Access to Personal Business/Social Activities
CD = Community Development
EN = Environment

River, Moorhead, and Sauk Rapids. The purpose of the system is to circumvent or to minimize emergency service delays at crossings. The system functions as follows:

> A private telephone line, dedicated to communicating the need to cross the main line to respond to a medical, fire, or police emergency, has been installed in the local railroad agent's (or the train dispatcher's) office. Only the designated local emergency service provider(s) know(s) the private telephone number. The emergency service provider uses the phone to inform the agent of emergency calls that require crossing the main line. The agent is called <u>only</u> in situations in which a delay in response may adversely affect emergency outcome. Having been notified of an emergency, the agent determines the necessity and feasibility of changing train operations in or near the community to avoid blocking the predesignated emergency crossing. According to preestablished guidelines, the agent instructs train crews, via the established radio communication system, to change train operations accordingly (e.g., slow down, speed up, or stop). Both the agent and the emergency service provider record the communication and its outcome.

The cost to establish and maintain the communication systems is small. Phone installation cost is about $90 and the monthly service charge is about $20. These costs are being paid by Burlington Northern. In the one case in which the phone is located in the train dispatcher's office rather than the local agent's office, a long-distance charge is incurred by the emergency service provider for each call.

The emergency communication systems were established only within the last month or two. This is not a sufficient period of time for evaluating the systems. While the phones have been used several times, no alteration of train operations has been necessary to date. Prior to implementation of the projects, it was estimated that up to 100 percent of the potential emergency service delays at crossings could be eliminated by the communication system. The projects will continue to be monitored to determine actual effectiveness.

Rescue Squad. Establishment of a rescue squad was recommended for Sauk Rapids to reduce delays at crossings in responding to medical emergencies. The project was not implemented because funding (up to $25,000 for a vehicle and $2,000 for annual operating costs) was not obtained. In Moorhead, however, a rescue squad was established within the fire department as a component of the emergency service system in 1976. Moorhead's system provides insight into how a rescue squad can circumvent delays at rail/highway crossings.

A rescue squad consists of people trained in basic emergency medical techniques and provided with medical supplies and equipment. The rescue squad provides a first-response capability only. It is not licensed to transport patients. The squad can treat the patient at the emergency scene until the ambulance service arrives. Thus, by locating the squad on the side of the main line opposite the ambulance service, emergency service can be promptly provided even if the ambulance service is delayed at a crossing.

The rescue squad has definite economic advantages over establishing duplicate ambulance services. The cost is considerably less. An investment of $70,000 may be required to establish a second ambulance service, but a rescue squad will cost $10,000 to $25,000, depending on the equipment purchased. Annual operating costs for the proposed Sauk Rapids volunteer squad would have cost from $1,000 to $3,000. Sixty to one hundred hours of training are required for personnel.

In Moorhead, the principal medical emergency service is provided by a private ambulance service. Through radio communication between the dispatcher and the ambulance driver, delays at rail/highway crossings are reported. In the case of a delay of significance to patient outcome, the dispatcher radios the police department or the rescue squad for assistance. In addition to receiving calls for assistance from the ambulance service, the rescue squad is dispatched to all life-threatening medical emergencies reported through the City's 911 emergency telephone system. Both the police and the rescue squad members are trained in emergency medical treatment; the rescue squad vehicle is equipped with life-support equipment. Thus, the rescue squad or the police can provide first-response aid to victims until the ambulance service arrives. Since its inception, the rescue squad has responded to 125 medical emergencies annually or about nine percent of all medical emergencies that occur each year. During this period, no crossing delays have occurred which have adversely affected victims.

Intersection Improvements. In Sauk Rapids, improvements to a major intersection adjacent to the main line crossing were made to improve traffic flow. While not low-cost compared to other demonstration projects (the improvements cost $1 million), intersection improvements are much less expensive than grade separations or rail relocations. This project enabled the effect of the improvements on traffic delays associated with railroad operations to be assessed. Modifying an intersection in Elk River was recommended as a demonstration project, but has not yet been implemented. Because more extensive changes to the Elk River intersection may be implemented in the next few years, Mn/DOT decided to postpone possible implementation of the demonstration project.

In Sauk Rapids, major improvements to the primary intersection in the city were completed in 1981. The improvements included widening approaches in all directions, changing traffic channelization, and introducing a new traffic signalization system. The BN main line is located about 100 feet west of the intersection. A comparison of traffic flows through the intersection before and after the improvements indicates delays associated with railroad operations have been reduced. Vehicles delayed by trains were observed to clear the intersection after a train has passed in almost half the amount of time as before (48 seconds versus 81 seconds on average). Also, normal traffic flow subsequent to a train's departure was restored more quickly. Overall, the improvements have resulted in an 8 to 10 percent reduction in the number of vehicles delayed, a 15 to 30 percent reduction in average delay per vehicle, and a 20 to 35 percent reduction in total vehicle delay time in the 15-minute period subsequent to train departure. The total reduction in vehicle delay time is 9.3 vehicle hours (about 13 person hours) daily.

In Elk River, delays at the intersection are caused when motorists wanting to cross the adjacent main line are blocked from doing so by rail operations. Because of inadequate road capacity for vehicles wishing to turn at the intersection, the vehicles waiting to cross the main line congest the intersection, causing delays to through traffic which would bypass the blocked crossing if road capacity were sufficient. The congestion filters into the adjacent central business district and disrupts business activity. The traffic movements resulting from congestion (frequent stops and starts, use of the wrong lanes to bypass waiting vehicles) increases the accident potential of the intersection. Another problem at this intersection is the lack of adequate traffic signal coordination, which sometimes results in trapping motorists between the crossing gates when a train is approaching.

The recommended improvements would have increased intersection capacity within the existing right-of-way. The recommendations included (1) removal of on-street parking to allow turning lanes to be established, (2) redesign of an off-street parking lot, and (3) installation of a new system to improve the flow of traffic through the intersection and to resolve the "trapped motorists" problem. These improvements were estimated to cost about $25,000 and were expected to reduce vehicle delay at the intersection by 15 to 40 percent. Safety conditions also were expected to improve.

Rail Siding Changes. In Beach, siding modifications, which will include installation of power switches at each end of the siding, will be made within the next two years. Already implemented is an operating policy to generally reduce the use of the siding in Beach. This policy has been made possible by the lengthening of sidings east and west of Beach to accommodate longer trains. The siding changes will reduce vehicle delay at crossings in Beach in several ways. Restricting use of the siding to one train will mean that trains need not block the crossings while occupying the siding. (Currently, when two trains are in the siding, one often must block the crossings because of limited siding capacity.) Installation of a power switch will eliminate the need for the train to be stopped in the town while a crewman throws the lead switch, permitting the train to enter or exit the siding. Remote control provided by power switches will allow trains to maintain speeds up to 25 mph when entering and exiting the siding. Restricting siding use to one train also will allow more siding distance for accelerating and decelerating the train, again resulting in increased train speeds through the town. The expected overall reduction in general traffic and emergency service delays at crossings in Beach is 25 percent. A five percent reduction in delay has been accomplished to date.

Similar results are expected to occur in Hebron. It was recommended that the siding in Hebron be lengthened to permit trains to stop farther from the crossings and provide more distance for acceleration and deceleration. Installation of power switches under Burlington Northern's proposed centralized traffic control program also will permit faster train speeds entering and exiting the siding through town. These changes have been postponed by Burlington Northern pending traffic increases. Siding alterations in Hebron will cost $360,000; those in and near Beach will exceed $600,000 when completed. Given that the siding changes are a component of the Burlington Northern's capital improvement program to increase main line capacity and to increase operating efficiency, these projects reveal how a capital improvement program which is sensitive to rail/community conflicts can accomplish community as well as railroad objectives.

Safety Education. A safety education program was conducted in Casselton schools in response to the concern for the safety of children who cross the main line while walking to and from school and to and from the recently completed public swimming pool. The program, conducted by the police chief, was undertaken to increase the precautions taken by children when crossing the main line. The program has not been effective in the opinion of local officials, primarily because of its limited scope and follow-up. A second safety project, construction of a fence along the railroad right-of-way in Hebron to discourage pedestrians, mainly children, from crossing the main line at locations other than signalized crossings, was not implemented. Further study revealed that available locations for the fence substantially compromised its effectiveness as a safety measure.

Grade Crossing Predictors. Installation of grade crossing predictors (GCPs) is an action that was implemented in all six case study communities. At crossings where current protection is provided by flashing lights or crossbucks, automatic gates were installed along with the GCPs.

GCPs reduce rail/community conflicts through the elimination of early signal activation. Previously, grade crossing warning signals in the communities were activated by circuits located a set distance from each crossing. When the train entered the section of track containing the circuit, the crossing warning signals were activated. The distance of the circuit from the crossing was determined by the maximum allowable train speed through the crossing. Most states require that crossing signals be activated at least 20 seconds prior to the time the fastest train would arrive at the crossing. This means that trains moving slower than the maximum allowable speed will activate signals often considerably in excess of 20 seconds before train arrival. For example, a train moving at 5 mph may activate the signals 6 minutes or more before it enters the crossing. Also, trains that enter the track circuit and then stop activate the signals until they start again and move through the crossing. The activation of signals a considerable time before train arrival at the crossing is referred to as "early signal activation."

Early signal activation contributes to rail/community conflicts in three ways. First, it increases the amount of time crossings are closed to vehicular traffic. In some communities, a significant portion of the blocked crossing time (up to 40 percent) is the result of early signal activation. Second, early signal activation has resulted in frequent violation of warning signals by motorists and has thus reduced the credibility of warning signals, and hence, their effectiveness. Finally, early signal activation is aggravating to community residents and heightens rail/community conflicts in general.

GCPs eliminate early signal activation by determining the speed of the approaching train and activating the signals at a set time interval prior to train arrival at the crossing (usually 25 to 35 seconds). In this way, vehicle delay and safety problems associated with early signal activation are reduced.

A comparison of crossing delays in the case study communities before and after installation of the GCPs reveals that the expected improvement, a reduction of 10 to 25 percent, depending on the community, has occurred. According to the observations, the GCPs have resulted in a 5 to 30 percent reduction in the probability of delay. The duration of delay also has been reduced, resulting in an overall reduction in vehicle hours of delay ranging from 10 to 45 percent. Delay to emergency services has been similarly reduced.

The variation in results among the communities is a function of the amount of early signal activation experienced before the GCPs were installed. In communities experiencing slow-moving trains, delayed trains, and/or significant local switching operations, early signal activation is a large component of blocked crossing time. In these communities, GCPs can effect a large reduction in delay occurrence and duration. In communities experiencing more through train movements at relatively faster speeds, GCPs have a less substantial effect on delay.

To establish the effectiveness of GCPs in reducing rail/highway crossing accidents requires several years of accident statistics. The reason is that crossing accidents occur infrequently in a given community; thus, a sample size large enough to establish statistically verifiable results requires several years to obtain. Since the GCPs were installed in the case study communities only within the last year, an adequate accident history is not yet available.

Another way to measure the effectiveness of GCPs in reducing crossing hazards is the number of traffic violations involving motorists' crossing the main line against the warning signals. This is a reasonable indicator of safety improvement because the major safety reason for installing GCPs is to reduce this motorist behavior. Observations of motorist behavior in the case study communities reveal that the number of times motorists cross against warning devices has declined significantly since the GCPs were installed. In Moorhead, the percentage of violations observed declined by 50 to 90 percent at the crossings with GCPs. For crossings at which GCPs were not installed, the number of violations actually increased by 20 percent. In the other case study communities, although crossing violations were reported as a frequent occurrence, none were recorded during the Phase III observation period. These observations suggest that the expected improvement in crossing safety (i.e., a 40 percent reduction in accidents) may indeed result from installation of GCPs.

Similarly, determination of safety improvements resulting from installation of automatic gates requires a longer observation period than has elapsed to date. However, the effectiveness of automatic gates is well-established from previous research. The research indicates that gates are generally 45 percent more effective than flashing lights and 90 percent more effective than crossbucks as a warning device. This order of magnitude reduction in crossing accidents can be expected over time in the case study communities in which automatic gates were installed.

The costs of installing GCPs ranged from $45,000 to $75,000 per crossing. Installation of GCPs with automatic gates cost from $65,000 to $100,000 per crossing. GCPs also cost about $300 more per year to maintain than distance-activating circuits; automatic gates may cost about $500 per year more to maintain than lesser devices. Offsetting the costs is the reduction in safety hazards, which reduces the railroad's liability and associated costs.

Increasing Train Speeds. In Moorhead, two actions were implemented to increase train speeds through the City in an effort to reduce access delays to the central business district (CBD). The actions include (1) installation of a power switch to replace the manual switch at the lead to the Burlington Northern's Dilworth yard just east of Moorhead and (2) changing signal circuitry on the main line to permit an increase in the maximum allowable train speed from 25 to 35 mph. The actions were implemented only on the southern line of the two parallel main lines bordering the CBD and separating it from the residential community. The southern line experiences 80 percent of the rail operations and separates 75 percent of the population from the CBD. (A more even distribution of trains between the main lines was investigated but found to be expensive and ineffective in reducing CBD access problems.)

It is apparent that an increase in maximum allowable train speed will decrease the amount of time crossings are blocked. (Therefore, the amount of vehicle delay will decrease.) The power switch also permits faster train speeds through Moorhead and thus contributes to a reduction in crossing delays. This is accomplished by eliminating the stop/start movements required to operate the existing manual switch and enter the yard. That is, entrance to Dilworth yard used by eastbound, nonlocal trains was controlled by a manually operated switch. The manual switch required a train to stop, a crewman to throw the switch manually, and the train to proceed through the switch and to stop again while the crewman returned the switch to its original position and rejoined the train. The power switch provides for remote control of the switch and permits maintenance of 25 mph while entering the yard.

As a result of these actions, the average train speed on the southern main line in Moorhead is now 29 mph, versus 20 mph before the changes. The increased train speed, in turn, has resulted in a 45 percent reduction in vehicles delayed at crossings on the line. Because the actions were not implemented on the northern main line, which also bounds the CBD, overall CBD accessibility has improved by a smaller amount, 27 percent. Emergency services also will benefit from the increased train speeds. It is estimated that about 25 percent fewer ambulance, fire, and police service delays will be experienced because train speeds were increased. The capital cost of implementing the actions was about $60,000.

The railroad will experience a net annual operating savings of $90,000 as a result of the increased train speed.

Community/Railroad Communications. In all communities, an effort was made throughout the study to improve general community/railroad communications. Discussions with communities while carrying out Phases I and II of the study revealed that there have been misunderstandings, misperceptions, inaccurate data and assumptions, and frustration with communication breakdowns between communities and the railroad. The repercussions of the communication problem were apparent, for example, when some community officials questioned the motivation behind actions taken by the railroad to reduce rail/community conflicts. The resulting confusion heightened community animosity toward the railroad and worsened perceptions of the rail/community conflicts. Similarly, the absence of clear communication channels has led communities either (1) to report problems to the wrong railroad official, resulting in no railroad response to the community complaint or (2) to fail to report problems at all. The resulting frustrations needlessly fuel the rail/community conflicts.

Using the Rail Corridor Study as a vehicle, the communities and the railroad have established clearer channels of communication and more frequent interaction. The opinion of most community and railroad officials is that the effort has been successful and worthwhile. Both sides are more aware of each other's problems and constraints and are acting more cooperatively to resolve problems. The railroad in particular has actively pursued resolution of rail/community conflicts in the case study communities and in numerous other corridor communities through the introduction of capital improvements, the changing of operating practices, and the provision of project funding. Railroad officials report that increased involvement in rail/community conflict resolution provides professional as well as personal rewards.

The one demonstration project that was not well-received by community residents is the closing of a crossing in Casselton. The crossing is closed to vehicular traffic, but is being maintained as a pedestrian crossing. It is part of the effort to reduce crossing accidents. Automatic gates and GCPs were installed at the other three crossings in the community. It is the policy of the State of North Dakota, when deciding crossing improvements, to consider the possibility of closing one or more crossings in a community while upgrading others. The policy is predicated in part on a community-wide approach to improving crossing safety (to funnel traffic to crossings with the most effective warning devices) and in part on economics (the allocation of limited resources among crossings and communities in the State). For these reasons, and based on the finding that the closing would have a marginal effect on traffic patterns and travel times, a decision was made to close the crossing.

Residents of Casselton are appealing the decision. The residents contend that the closing has reduced accessibility within the community to both pedestrians and motorists, has increased crossing hazards, and has had an adverse environmental effect on the community. This has been true because of an unexpected effect of the demonstration projects, for which remedial actions have been taken. Trains delayed in Casselton tended to stop across or near the closed crossing (they previously stopped outside of Casselton). This created a visual obstruction to trains using the second main line track. Also children were observed to crawl between train cars when this occurred. The tendency of delayed trains to stop near the crossing increased the perceived noise levels in the town as well. Whereas trains previously started to accelerate outside of town, they were accelerating within town causing increased noise levels. In addition, train speeds through town were lower as a result of this practice and caused longer blocked crossing time. Burlington Northern has taken steps to ensure that trains will resume the practice of stopping outside of Casselton when delayed, which should resolve the residents' concerns. The residents opposed the crossing closing for other reasons. There is less direct access between some parts of the community—one must now travel two additional blocks for some trips, incurring less than one minute additional travel time; traffic has increased at the crossings that were not closed--650 cars daily; and, there are no warning signals at the portion of the crossing maintained for pedestrians, mostly children and elderly persons. In time, these concerns may be alleviated by the rail/community conflict improvements resulting from the demonstration projects.

CASE STUDY COMMUNITY RESULTS

A summary of the extent to which the demonstration projects have reduced problems in each case study community is presented in Exhibit II-4. Exhibit II-5 shows the contribution of each demonstration project to community problem reduction. The results reveal considerable variation among communities in the extent to which rail/community conflicts have been reduced. There also is considerable variation in the effectiveness of individual demonstration projects among communities. These variations are a function of (1) community characteristics--service characteristics and

EXHIBIT II-4

REDUCTIONS IN RAIL/COMMUNITY CONFLICTS ACTIVATED BY THE DEMONSTRATION PROJECTS

Community	Vehicular Delay # Delayed	Vehicular Delay Delay Time	Emergency Service Delays	Expected Crossing Accidents
Beach, ND	-15%	-30%	-15%	-75%**
Casselton, ND	-15%	-30%	-70%**	-70%**
Elk River, MN	-25%	-55%	-50%**	-35%**
Hebron, ND	-25%	-45%	-25%	-70%**
Moorhead, MN	-30%	-50%	-100%** (medical emergencies)	-35%**
Sauk Rapids, MN	-15%	-35%	-100%** (medical emergencies)	-10%**

* Estimated annual change in problem magnitude resulting from the demonstration projects.

** Further observations are required to verify these estimates.

EXHIBIT II-5

REDUCTIONS IN RAIL/COMMUNITY CONFLICTS BY COMMUNITY AND BY DEMONSTRATION PROJECT

Community	Actions Taken	Emergency Service Delays	Vehicular Delays # Delayed	Vehicular Delays Delay time	Crossing Accidents
Beach, ND	GCPs and gates were installed at the crossings	-10%	-10%	-20%	-75%*
	Sidings outside of the community were lengthened in order to reduce the number of trains using the Beach siding	-5%	-5%	-10%	N/A
Casselton, ND	Automatic gates were installed at the 3rd and 6th Avenue crossings. The 8th Avenue crossing was closed to vehicular traffic but maintained as a pedestrian crossing. GCPs were installed at all crossings.	-15%	-15%	-30%	-70%*
	An emergency service/railroad communication system was established.	-65%	N/A	N/A	N/A
	A safety education program was conducted in the schools.	N/A	N/A	N/A	No effect
Elk River, MN	GCPs were installed at all crossings. The crossings already had automatic gates.	-25%	-25%	-55%	-35%*
	An emergency service/railroad communication system was established.	-30%; Not fully tested*	N/A	N/A	N/A
Hebron, ND	GCPs and automatic gates were installed at all community crossings.	-25%	-25%	-45%	-70%*

EXHIBIT II-5 (Continued)

Community	Actions Taken	Emergency Service Delays	Vehicular Delays # Delayed	Vehicular Delays Delay time	Crossing Accidents
Moorhead, MN	A power switch was installed in place of the manual switch at the Dilworth Yard lead.	-5%	-5%	-10%	N/A
	The allowable train speed was increased from 25 mph to 35 mph.	-20%	-20%	-30%	0%*
	GCPs were installed at all crossings on the southern main line.	-5%	-5%	-10%	-35%*
	An emergency service/railroad communication system was established.	Not fully tested	N/A	N/A	N/A
	A rescue squad was previously established.	-100% (medical emerg.)	N/A	N/A	N/A
Sauk Rapids, MN	Improvements were made to the TH15/ Benton Drive intersection.	-8%	-8%	-25%	N/A
	GCPs were installed at the 1st Avenue South Crossing.	-7%	-7%	-10%	-10%*
	An emergency service/railroad communication system was established.	-100% (medical emergencies)* not fully tested	N/A	N/A	N/A

Estimated annual change in problem magnitude resulting from the demonstration projects. Estimates with an asterisk require further observation to verify. "N/A" indicates that the project was not applicable to the problem.

development and activity patterns, and (2) railroad characteristics--operations and facilities. Together, these characteristics determine whether implementation of a given low-cost action is feasible and the extent to which the action can reduce rail/community conflicts.

The emergency communication system, established in four of the communities, provides an example. To determine the feasibility and effectiveness of the communication system, a simulation model was developed. The model determines if sufficient time is available to alter train operations, before the emergency service provider must cross the main line, in order to avoid emergency service delay. The critical variables in the model are train characteristics (size, speed, and location) and emergency service characteristics (location of the vehicle and the staff, response time). Using the model, it was determined that in some communities (Beach and Hebron) the amount of time from the receipt of an emergency call to the crossing of the main line was not sufficient to alter train operations. An attempt to alter train operations could lengthen rather than reduce delay time. In other communities (Casselton and Elk River), train operations could not be altered in time to circumvent delays to volunteers as they travel to the station, but they could be altered to avoid delays from the station to the emergency site and then to the hospital. In these cases, only a portion of the delays could be circumvented. Finally, in one case (Sauk Rapids), response time is such that all emergency service delays can be circumvented.

GCPs were installed at crossings in each case study community. The reduction in vehicles delayed at crossings which is attributable to the GCPs ranges from 5 to 30 percent. This range is directly related to the magnitude of early signal activation experienced in each community before the GCPs were installed. As discussed earlier, GCPs reduce crossing delays by eliminating early signal activation. Consequently, the effectiveness of the GCPs is limited by the magnitude of early signal activation.

Early signal activation is a function of train speeds and the location of the circuit which activates the crossing signals. In a community in which train speeds do not vary significantly, the circuit can be located such that the signals are activated in a relatively short time, on average, prior to a train's arrival at the crossing. This is the case, for example, in Moorhead where the average signal time prior to train arrival was 1 1/4 minutes. In such cases, the contribution of early signal activation to blocked crossing time is small and there is little opportunity for GCPs to reduce blocked crossing time. In Moorhead, early signal activation accounted for only 5 percent of the blocked crossing time (after train speeds were increased). Consequently, the installation of GCPs in Moorhead resulted in reducing vehicle delays at crossings by only 5 percent. In contrast, early signal activation in Elk River accounted for almost 30 percent of the blocked crossing time. This was due to a wide range in train speeds through the City. Through trains operated at speeds up to 45 mph through Elk River, some local trains conducted lengthy, slow-moving operations. Consequently, the installation of GCPs in Elk River effected a considerable reduction in blocked crossing time (30 percent) and hence, in crossing delays.

Similar differences in community and railroad characteristics among the case study communities dictated different approaches to reducing rail/community conflicts, which resulted in different degrees of problem reductions. In Beach, Casselton, and Hebron, automatic gates, as well as GCPs, were installed, resulting in larger reductions in expected crossing accidents than in communities in which only GCPs were installed. In the latter communities, the crossings were equipped with gates prior to the study, leaving less opportunity to reduce accident potential.

Only in Moorhead was there an opportunity to significantly increase the speed of through trains. Speeds were increased from 20 to 29 mph, on average, resulting in a 20 percent reduction in blocked crossing time and vehicle delay. In the other communities, through train speeds already were as high as permitted by safety standards, or the communities were reluctant to allow increases in train speeds. (The communities' primary concern with respect to increasing train speeds is crossing safety. Research indicates, however, that crossing hazard is not statistically correlated with train speed.) Moorhead also had the opportunity to install a power switch in place of a manual switch at the lead to the Dilworth yard, because a centralized train control system (CTC) is in place. The switch contributed to increased train speeds through the City, and thus to reduced crossing delays. Power switches at the sidings in Beach and Hebron also have been proposed but cannot be installed until CTC is extended to these locations. Installations of the power switches and other siding changes in Beach and Hebron may result in a 25 percent decrease in crossing delays.

The changes presented above represent observed and projected reductions in problem magnitude. Another concern in evaluating the demonstration projects is the change in community residents' perceptions of problem magnitudes that has occurred since the projects were implemented.

This was determined by comparing community residents' responses to a mail survey conducted at the outset of the study and again at study completion. Recipients of the survey were asked their opinion with respect to the severity of problems associated with rail/community conflicts.

There are limitations to comparing the before and after opinions of those who responded to the survey. One limiting factor is that railroad operations experienced during the time each survey was administered may have differed. This could not be determined without a lengthy period of railroad operations observation, which was beyond the study resources. Also, one demonstration project, establishment of emergency communication systems in four communities, was not implemented until after the survey was administered. Consequently, the residents' opinions with respect to emergency service delays do not reflect the substantial reduction in delays expected to result from the communication systems. Despite these limitations, a comparison of the survey results is instructive.

Responses to the survey by community are presented in Exhibit II-6. The priority problems in each community (the problems the demonstration projects were designed to mitigate) are enclosed in boxes. Statistically significant changes in opinions are identified with asterisks; other entries are interpreted as no change in residents' perceptions of problem magnitude.

Comparison of respondents' opinions before and after the demonstration projects were implemented indicates that residents perceive improvement in 60 percent of the priority problems addressed. From 37 to 67 percent fewer respondents perceive these problems to be serious since the projects were implemented. If the emergency service delay problem is

EXHIBIT II-6

RESIDENTS' OPINIONS OF PROBLEM SEVERITY--
PHASE I AND PHASE II SURVEY RESULTS

Percentage of Respondents Who Perceive the Problem To Be Serious

	VS	PS	EVD	AWS	ASR	EN	CD
Beach							
Before	77%	58%	73%	42%	38%	15%	14%
After	35*	19*	62*	21*	18*	19	8
Casselton							
Before	45	32	52	18	12	13	9
After	25*	34	66*	22	16	38*	17*
Elk River							
Before	35	29	33	11	13	13	20
After	22*	13*	38	16	8	13	20
Hebron	Not surveyed						
Moorhead							
Before	15	13	40	22	11	19	20
After	12	6	45	17	13	5*	8*
Sauk Rapids							
Before	41	24	47	23	19	23	16
After	23*	11*	35*	14	7*	16	16

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1. Legend
   VS = vehicle safety
   PS = pedestrian safety
   EVD = emergency service delay
   AWS = access to work and school
   ASR = access to shopping and recreation
   EN = environmental disturbance
   CD = community development

2. An asterisk indicates that the change is statistically significant at the 90 percent confidence level.

3. Boxed items indicate the priority problems designated by each community, which also are the problems the demonstration projects were designed to mitigate.

eliminated from the comparison (for those communities in which the effects of the emergency communication system have not yet been realized) the percentage of priority problems improved is 80 percent.

While significant improvements in most priority problems have occurred, non-priority problems have been reduced or have not been changed since the last survey was taken, according to the respondents. The exception is in Casselton. Residents of Casselton perceive a worsening of rail/community conflicts for the reasons previously explained.

Three additional observations can be made concerning changes in perceived problem magnitude. One observation is that respondents from communities in which demonstration projects were highly visible (i.e., Beach and Sauk Rapids) perceive more significant changes than respondents from other communities. In Elk River and Moorhead, less than 30 percent of the respondents were aware of the actions taken to reduce problem magnitudes, according to survey responses. In Beach and Sauk Rapids, an average of 70 percent of the respondents were aware of the actions taken. This result suggests that an effort to educate the public of actions taken could change residents' perceptions of problem magnitudes.

Another observation is that statistically significant changes in perceived problem magnitude tend to correspond directly to the percentage of respondents who perceived the problems to be serious in the original survey. This result is due in part to the nature of the test of statistical significance. A larger change in opinion is required for a finding to be statistically significant when the percentage of respondents who perceive a problem to be serious is small. Also to be kept in mind is that the problems with which there was less concern (i.e., those which fewer respondents identified as serious) were not the target of the demonstration projects. Less change in these cases would be expected.

A third observation is that in some communities, some segments of the population benefited more than others from the demonstration projects. These significant sub-community improvements are not apparent in a community-wide survey. An example occurs in Elk River. Whereas the general public perceives no change in accessibility to work and school, school officials reported the elimination of lengthy school bus delays which used to occur regularly. Similarly, in Moorhead, the demonstration projects were implemented on only one of the main lines. This may explain why survey respondents perceive a significant reduction in the community development problem (i.e., accessibility to the business district) but not in general accessibility throughout the community.

Overall, the evaluation reveals that the demonstration projects have resulted in priority problem reductions which are measurable from observation and which in the majority of cases are perceived by community residents as significant changes.

APPLICABILITY OF DEMONSTRATION PROJECTS TO OTHER COMMUNITIES

The experience of the case study communities is instructive to others. Certain preconditions, defined in terms of community and railroad characteristics, must exist for specific low-cost actions to be feasible. Community and railroad characteristics also will determine the extent to which a given low-cost action will reduce rail/community conflicts. These conditions are summarized in Exhibit II-7. The information presented in the exhibit can be used to determine opportunities to reduce conflicts in other corridor communities.

EXHIBIT II-7

APPLICABILITY OF DEMONSTRATION PROJECTS TO OTHER CORRIDOR COMMUNITIES

Demonstration Project	Preconditions For Feasibility	Potential Results
Grade Crossing Predictors	Significant amount of early signal activation, e.g., in excess of one minute per train.	Is strictly a function of the amount of early signal activation. Most effective in situations with a mix of slow and fast train speeds, with significant local switching, and/or with frequent train delays.
	Frequent motorist violation of warning signals at crossings.	Reduction of 40 percent or more in violations and hence in accident exposure.
Automatic Gates	Lesser current crossing warning devices, e.g., flashing lights or crossbucks.	Reduction in expected accidents ranging from 45 percent (replacing flashing lights) to 90 percent (replacing crossbucks).
Power Switch	Centralized train control system.	Is a function of the number of trains using the switch and the amount of time crossings are blocked when the switch is used. Is particularly effective when the switch is located within the community. Blocked crossing time may be reduced by 6 minutes or more per mile-long train.
Emergency Communication System	Sufficient lead time (i.e, time from receipt of emergency call to time that rail line is crossed) to alter train operations. Train speeds less than about 40 mph. For speeds in excess of 40 mph, the potential crossing delay is small.	In situations in which the lead time is 3 minutes or longer, all potential delays may be circumvented. If lead time is less than 3 minutes, the communication system may be useful only to reduce particularly lengthy delays, e.g., when a switching operation is being conducted or a train is stopped in or near the crossing.
Increase Train Speeds	Current train speeds held below safe operating speed.	Applies only to through trains and is a function of the current average speed and the increased speed. E.g., a change from 20 mph to 30 mph would reduce delay per train by about 33 percent; a change from 30 mph to 40 mph would reduce delay per train by 25 percent.
Siding Changes	An existing siding in or near the community.	Is a function of the type and frequency of siding use.
Rescue Squad	Sufficient number of volunteers or sufficient budget to hire a paid staff.	Is a function of the number of potential emergency service crossing delays annually and the probable duration of delay. Many rural communities served by distant ambulance services establish rescue squads regardless of crossing delay problems.
Intersection Improvements	A major intersection adjacent to a main line crossing.	Is a function of the spill-over effect of crossing delays on traffic flow through the intersection and the frequency of occurrence.

It is important to understand that the information presented in Exhibit II-7 is restricted to the low-cost actions specified. If the preconditions listed do not prevail in a community, it is possible that these specific low-cost actions may be unfeasible or ineffective in that community. However, it would be an inappropriate conclusion that nothing could be done to reduce rail/community conflicts in the community. Other low-cost actions are available, such as those listed in Exhibit II-3 earlier in this report.

CONCLUSIONS

The Rail Corridor Study has made several significant advances in the understanding of rail/community conflicts and of the potential for low-cost actions to reduce these conflicts. The basic problems associated with the conflicts have been defined and the factors which contribute to them, including the role of unit coal trains, have been clarified. Analytical methods and procedures have been developed which provide for accurate problem identification and assessment and for alternatives analysis.

Most significantly, the implementation and review of several demonstration projects has shown that low-cost actions can effect significant reductions in rail/community conflicts. Through a variety of actions, vehicular delay in the case study communities has been reduced by 15 to 30 percent. Because the average duration of delay per vehicle also was reduced, vehicular delay time was reduced by a larger amount, from 20 percent to 55 percent, depending on the community. Delays to emergency services also have been reduced by at least as much as was vehicular delay. Further reductions (up to 100 percent in one case) are expected to result from the emergency communication systems. More experience with the systems is required before a definitive conclusion concerning their effectiveness can be made. Finally, reductions in crossing accidents ranging from 10 to 75 percent are expected to result from the demonstration projects. Importantly, community residents perceive these problem reductions to be significant improvements in most cases. These impressive reductions in rail/community conflicts were achieved at an average project cost of $130,000; half of the projects cost under $70,000. The range in cost per community was $115,000 to $640,000, excluding the million-dollar intersection improvement made in Sauk Rapids.

The results achieved in the case study communities can be achieved in other communities as well, through the application of similar or new low-cost actions. Low-cost actions will not solve all problems in all communities. In some communities, the actions may render problems more manageable while more costly solutions are formulated. In other communities, low-cost actions will be ineffective and can serve no function. The demonstration projects reveal, however, the exciting potential for low-cost actions to reduce or substantially resolve problems associated with rail/community conflicts.

PART B

CASE STUDIES

PART B: CASE STUDIES

INTRODUCTION

This part of the technical report presents the case studies conducted during Phases II and III of the Rail Corridor Study. The purpose of the case studies was to develop a better understanding of rail/community conflicts, including their causes and magnitudes, and to demonstrate low-cost ways to resolve the conflicts. Six communities were selected for this purpose. The communities, and their respective populations, are as follows:

Beach, ND	(1,500)
Casselton, ND	(1,800)
Elk River, MN	(7,000)
Hebron, ND	(1,100)
Moorhead, MN	(30,000)
Sauk Rapids, MN	(5,800)

These communities were selected because they are representative of other corridor communities in terms of characteristics, rail/community conflicts and their causes, and potential low-cost ways to reduce the conflicts.

The case studies involved an in-depth assessment of problems associated with rail/community conflicts and the implementation and evaluation of low-cost problem solutions. Methods were developed and applied to measure problem magnitudes in each community (see Appendix A). The methods also were used to conduct an assessment of the potential effectiveness of low-cost solution alternatives.

Selection of demonstration projects proceeded in five steps. First, a list of alternative actions thought to be low in cost and capable of mitigating rail/community conflicts was developed. Second, the alternatives were screened; those determined to be unfeasible, ineffective, or of no demonstration value were eliminated. Third, the remaining alternatives were compared in terms of potential problem-solving effectiveness, implementation cost, institutional considerations, and effects on other problems and community or railroad conditions. Fourth, the results of the analyses were presented to the case study communities to determine which were acceptable or unacceptable for implementation and to determine the priority ranking for the acceptable actions. Finally, the Management Board selected the actions warranted for implementation as demonstration projects based on the information generated in the previous steps. The demonstration project selection process is further detailed in Appendix B.

The demonstration projects were funded and implemented by the railroad, the respective state transportation agencies, and local governments, depending on the project. Public funding was obtained from existing state programs and from local government general revenues. The railroad funded all rail facility and operation projects and also participated in grade crossing improvement costs.

The demonstration projects were evaluated by comparing before and after measurements of problem magnitudes. The methodology (see Appendix A) involved field observations and interviews with railroad and community officials and community residents.

The case studies which follow focus on a definition of the problems experienced in each community, including estimated problem magnitudes. Subsequently, the demonstration projects implemented in each community are defined and evaluated in terms of the extent to which actual problem reductions were achieved.

* * *

Two demonstration projects implemented in most of the communities: (1) grade crossing predictors and (2) emergency communication systems. To avoid redundancy in the case study write-ups, these projects are defined below.

Grade Crossing Predictors. Installation of grade crossing predictors (GCPs) is an action that was implemented in all six case study communities. At crossings where current protection is provided by flashing lights or crossbucks, automatic gates were installed along with the GCPs.

GCPs reduce rail/community conflicts through the elimination of early signal activation. Previously, grade crossing warning signals in the communities were activated by circuits located a set distance from each crossing. When the train entered the section of track containing the circuit, the crossing warning signals were activated. The distance of the circuit from the crossing was determined by the maximum allowable train speed through the crossing. Most states require that crossing signals be activated at least 20 seconds prior to the time the fastest train would arrive at the crossing. This means that trains moving slower than the maximum allowable speed will activiate signals often considerably in excess of 20 seconds before train arrival. For example, a train moving at 5 mph may activate the signals 6 minutes or more before it enters the crossing. Also, trains that enter the track circuit and then stop activate the signals until they start again and move through the crossing. The activation of signals a considerable time before train arrival at the crossing is referred to as "early signal activation."

Early signal activation contributes to rail/community conflicts in three ways. First, it increases the amount of time crossings are closed to vehicular traffic. In some communities, a significant portion of the blocked crossing time (up to 40 percent) is the result of early signal activation. Second, early signal activation has resulted in frequent violation of warning signals by motorists and has thus reduced the credibility of warning signals, and hence, their effectiveness. Finally, early signal activation is aggravating to community residents and heightens rail/community conflicts in general.

GCPs eliminate early signal activation by determining the speed of the approaching train and activating the signals at a set time interval prior to train arrival at the crossing (usually 25 to 35 seconds). In this way, vehicle delay and safety problems associated with early signal activation are reduced.

Emergency Service/Railroad Communication System. Establishment of an emergency communication system is being tested in Casselton, Elk River, Moorhead, and Sauk Rapids. The purpose of the system is to circumvent or to minimize emergency service delays at crossings. The system functions as follows:

A private telephone line, dedicated to communicating the need to cross the main line to respond to a medical, fire, or police emergency, has been installed in the local railroad agent's (or the train dispatcher's) office. Only the designated local emergency service provider(s) know(s) the private telephone number. The emergency service provider uses the phone to inform the agent of emergency calls that require crossing the main line. The agent is called <u>only</u> in situations in which a delay in response may adversely affect emergency outcome. Having been notified of an emergency, the agent determines the necessity and feasibility of changing train operations in or near the community to avoid blocking the predesignated emergency crossing. According to preestablished guidelines, the agent instructs train crews, via the established radio communication system, to change train operations accordingly (e.g., slow down, speed up, or stop). Both the agent and the emergency service provider record the communication and its outcome.

The cost to establish and maintain the communication systems is small. Phone installation cost is about \$90 and the monthly service charge is about \$20.

CHAPTER III

CASE STUDY: MOORHEAD, MINNESOTA

COMMUNITY CHARACTERISTICS

Moorhead is a community of 30,000 people located on the Minnesota's North Dakota border. It is separated from North Dakota by the Red River (see Exhibit III-1). The City of Fargo (population 60,000) is located across the river from Moorhead. A double track main line of the Burlington Northern bisects Moorhead. The tracks are about 600 feet apart in the western end of the city and cross each other near the eastern end. About 75 percent of the city population resides south of the main line with the remaining 25 percent located on the north side. About one and one-half miles east of Moorhead, in Dilworth, is a Burlington Northern rail yard.

The central business district (CBD) of Moorhead is located along Center Avenue, between the two main line tracks. City Hall also is located in the CBD. The CBD extends from 4th Street to 10th Street. Competing commercial areas are principally shopping centers in outlying areas of both Moorhead and Fargo and the Fargo CBD. Other than in the CBD, employment centers are located throughout Moorhead. The principal industrial area is in the southeast section of the City between I-94 and the two rail lines which continue south of Moorhead.

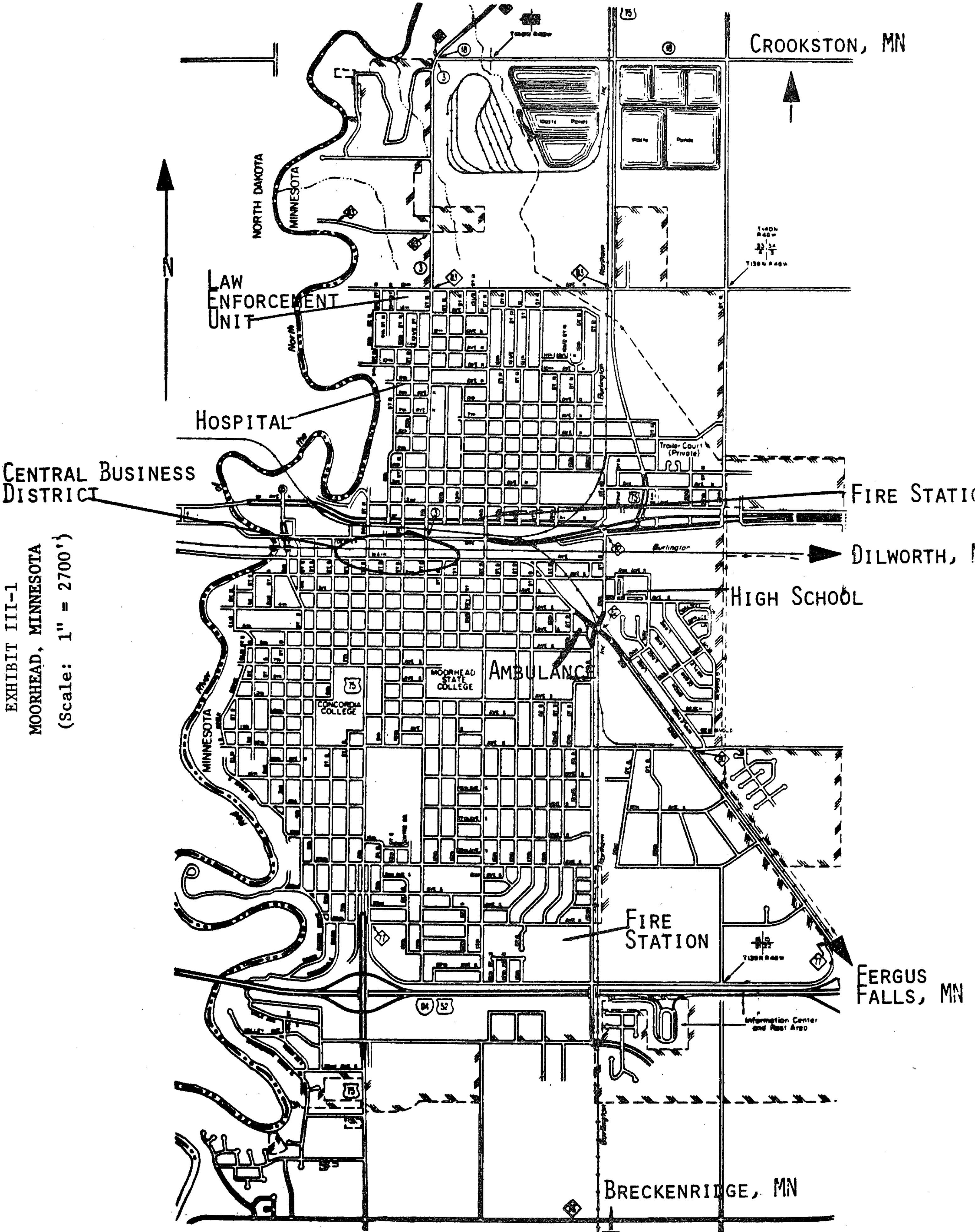


EXHIBIT III-1
MOORHEAD, MINNESOTA
(Scale: 1" = 2700')

Major community facilities include two fire stations, one located on each side of the main line. The ambulance service is located south of the main line at 20th Street South and 5th Avenue South. It is privately owned and operated with the central station located in Fargo. Several hospitals exist throughout the Fargo/Moorhead area. The law enforcement center is on the north side of the city on 13th Avenue between 9th and 10th Streets. Schools are located throughout Moorhead with the high school complex located near 21st Street just south of the main line. Moorhead has two colleges, Moorhead State and Concordia; both are centrally located south of the main line.

As noted, residential areas exist on both sides of the main line. The estimated growth rate for Moorhead is 1.2 percent per year. Residential development is occurring such that the current population split by the main line will prevail in the foreseeable future.

The street system in Moorhead is in a grid pattern. There are five crossings on the northern main line track. There are nine crossings on the southern main line track. All crossings are at grade, with two exceptions. There is a grade separation on 1st Avenue North at the eastern end of the city. A second underpass is located on 3rd Street. However, this underpass is not built to normal state highway standards (it is narrow and often allows only one lane of traffic to move at a time); the underpass is closed by flooding during different parts of the year. The annual average daily traffic figures for the crossings and the type of protection at each crossing prior to the demonstration projects are presented in Exhibit III-2.

EXHIBIT III-2

CROSSINGS IN MOORHEAD, MN

Crossing	AADT	Crossing Protection
Old NP Line:		
4th Street	2054	Gates
5th Street	4700	Gates
6th Street	3350	Gates
8th Street	14350	Gates
10th Street	2150	Semaphores
11th Street	9130	Gates
14th Street	5470	Gates
21st Street	8730	Gates
Old GN Line:		
8th Street	8380	Semaphores
10th Street	1180	Gates
11th Street	8530	Gates
14th Street	5470	Gates

Source: Metropolitan Auto-Rail Study, Fargo-Moorhead Metropolitan Council of Governments, December, 1975, p. R-20.

RAILROAD OPERATIONS

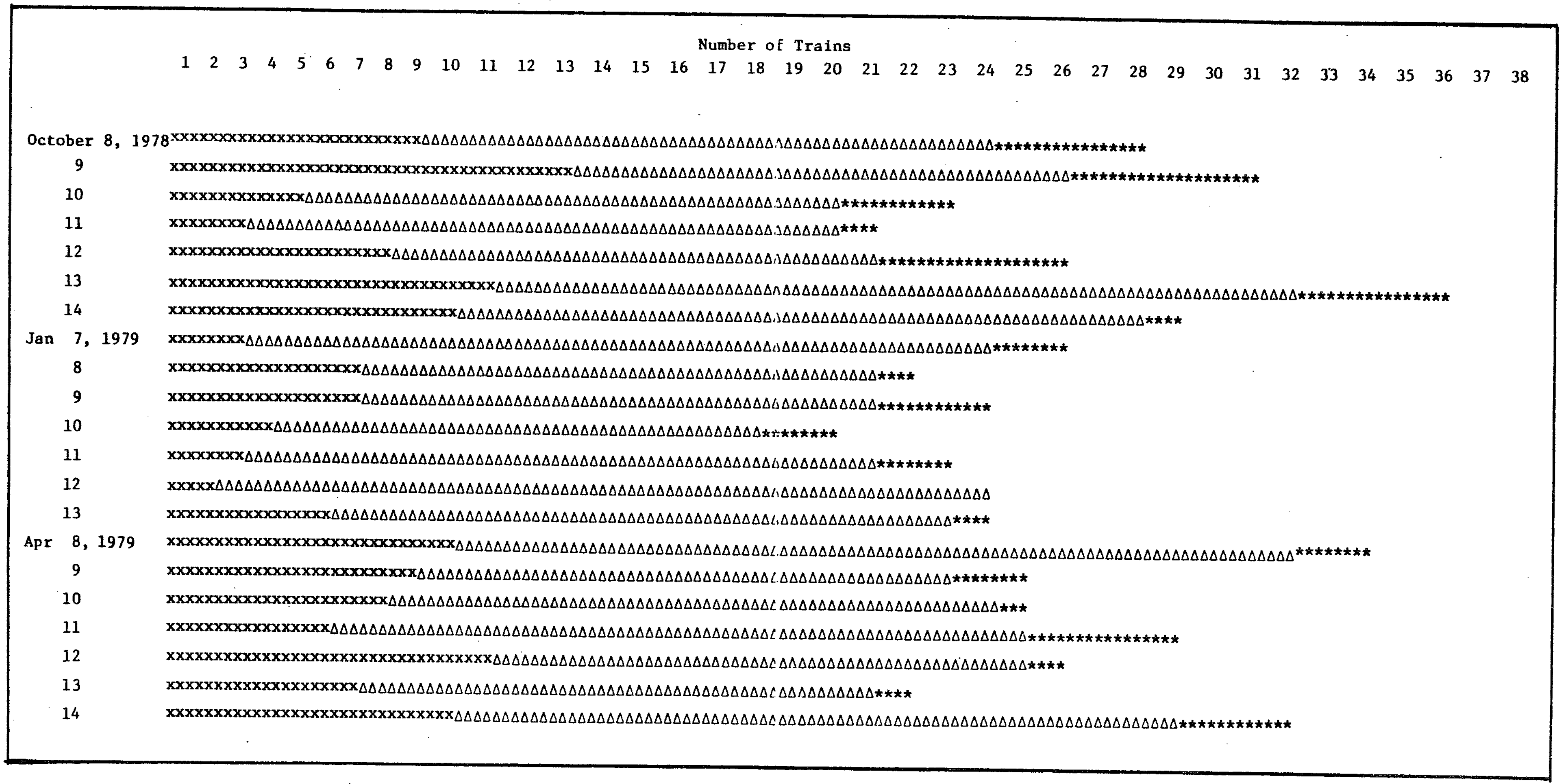
An average of 29 trains pass through Moorhead each day. Of these, 8 are unit coal trains, 17 are mixed freight trains, and 4 are local trains. In addition, several trains conduct local switching operations each day. On any given day, the number of trains passing through Moorhead varies considerably (see Exhibit III-3). There also is no consistent pattern of train distribution by day of the week or hour of the day. During most hours of the day, fewer than two trains pass through Moorhead. It was observed that over time trains are distributed evenly between daytime and nighttime.

As noted above, two parallel main line tracks are located in Moorhead. The northern track is called the old GN line, having been a part of the Great Northern Railroad prior to the merger with the Northern Pacific Railroad and the formation of the Burlington Northern, Inc. The southern track is called the old NP line. The lines cross at Moorhead junction, located a few hundred feet east of the 21st Street crossing. The old GN line continues south from the junction to Breckenridge. The old NP line continues due east. The lines were connected after the merger to permit interchange of traffic.

The average distribution of rail traffic between the two lines is about 70 percent on the old NP line and 30 percent on the old GN line. This means that on the average day about 21 trains operate on the old NP line and 8 trains operate on the old GN line. On average, 26 trains cross 21st Street and continue east on the old NP line. A daily average of three trains proceed south on the old GN line. During a week-long observation

EXHIBIT III-3

NUMBER OF TRAIN ARRIVALS PER DAY IN MOORHEAD, MN. DURING A THREE WEEK OBSERVATION PERIOD*



Train Type

xxxxx Coal

ΔΔΔΔΔ Mixed Freight

***** Local

* Information is for Moorhead Junction, located just east of 21st Street.

Data Source: Burlington Northern train sheets for October 8-14, 1978, January 9-13, 1979, and April 8-14, 1979.

period, a daily average of 14 local switching movements were recorded. Most of these (eight) occurred on the old GN lines; the remainder were observed on the old NP line.

AMOUNT OF TIME CROSSINGS ARE BLOCKED BY TRAINS

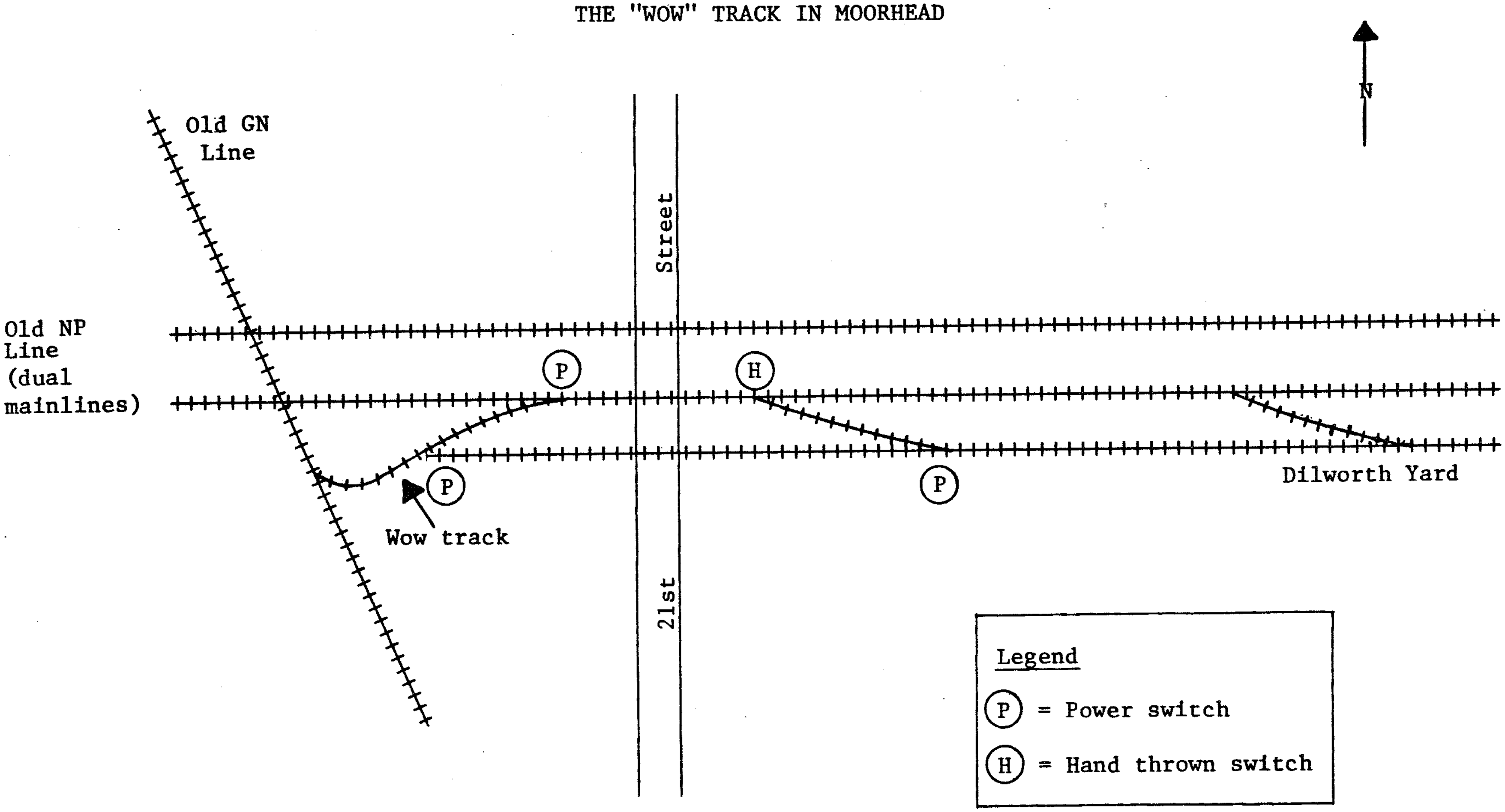
The amount of time crossings are blocked by trains is a function of the types of train operations conducted as well as the number of train operations. Train operations can be defined in terms of train speeds and train delays. Both of these basic parameters are influenced by railroad facilities and railroad operating policies.

Prior to implementing the demonstration projects, the maximum allowable train speed in Moorhead was set at 25 mph. The limit was established by BN operating instructions in effect at the time. Also influencing train speeds were crossover movements made by trains between the old NP and old GN lines at Moorhead junction. These movements were conducted on the "WOW" track, the configuration of which is presented in Exhibit III-4. The geometrics of this track restricted train speeds to a maximum of 10 mph in conducting crossover movements. On average, a crossover was made by one and one-half long (non-local) trains per day.

Train operations involving the Dilworth yard also affected movements in Moorhead. The lead to Dilworth yard used by eastbound, non-local trains, located just east of the 21st Street crossing in Moorhead, was controlled by a manually operated switch. The train deceleration/acceleration associated with this operation slowed train speeds through Moorhead. Train operations conducted in Dilworth also affected train operations in Moorhead to the extent that train congestion occurred. Trains were sometimes required to stop in Moorhead when a

EXHIBIT III-4

THE "WOW" TRACK IN MOORHEAD



preceding train was conducting an operation in Dilworth. Usually the waiting trains lined up outside of Moorhead. However, on occasion, the trains stopped in Moorhead blocking several crossings simultaneously for the duration of the wait.

(One other train operation that contributed substantially to the blockage of crossings in Moorhead was eliminated prior to this study.) At West Fargo, a new connection between the former Northern Pacific line and the Great Northern line, called the West Fargo connection, was completed at a cost in excess of $3.5 million. This allowed coal trains going to Cohasset to bypass Moorhead entirely and eliminated a low speed, double movement for each train in Moorhead.)

The overall effect of the railroad facility and operating conditions was an average train speed through Moorhead ranging from one mph to 25 mph and averaging 14 mph to 20 mph, depending on location. An average of two trains per day stopped in Moorhead as a result of various operating requirements. These characteristics, as well as other operating characteristics in Moorhead, are summarized in Exhibit III-5.

Based on the train operating characteristics described above and on field observations of rail operations, an estimate of the amount of time crossings were blocked in Moorhead was made. The estimate was divided into three parts:

- The time trains occupy the crossings
- The time gates and/or flashing light signals are activated prior to and after through train occupation
- The time gates and/or flashing lights are activated when no team is occupying or proceeding to the crossing.

EXHIBIT III-5

TRAIN OPERATIONS IN MOORHEAD, MN.[1/]

(Before Demonstration Projects)

Line	Train Type	# Trains		Ave. # Cars	Speed (mph)		# of Trains Stopped[2/]
		Ave.	Range		Ave.	Range	
Old NP	Coal	6		104	20	11-25	
	Mixed Freight	13	N/A	82	20	1-25	N/A
	Local	2		12	24	1-25	
	Total	21		84	20	1-25	
Old GN	Coal	2		104	12	1-25	
	Mixed Freight	4	N/A	82	15	1-25	N/A
	Local	2		12	16	1-25	
	Total	8		84	14	1-25	
21st Street	Coal	7	2-12	104	22	6-25	1/2
	Mixed Freight	17	13-22	82	17	6-25	1
	Local	2	0- 5	12	18	1-25	1/2
	Total	26	23-36	84	18	1-25	2

1/ Derivation of the data is described in Appendix A.

2/ Trains stop at Moorhead Junction for various reasons: train meets, wait for orders, inspection and tests, line up, set outs and pick-ups.

Separate estimates were made for crossings on the old GN line, the old NP, and the 21st Street crossing. The estimates are presented in Exhibit III-6.

The exhibit shows that on the average day crossings in Moorhead were blocked from 3.4 percent of the day to 7.5 percent of the day, depending on location. This amount of blocked crossing time varied from these averages on a day-to-day basis. For example, based on the variation in number of trains per day, the percentage of the day that the 21st Street crossing was blocked ranged from 6 percent to 11 percent. Blocked time for the other crossings probably varied within a similar range.

The amount of time crossings were blocked per occurrence was estimated to range from less than one minute, in the case of a short local train operating at reasonable speed, to over sixteen minutes. The distribution of blocked crossing time per occurrence on the average day is presented in Exhibit III-7. The exhibit reveals that two-thirds or more of the trains blocked the crossings for five minutes or less. The average per train was about 4 minutes and the longest time recorded for a blocked crossing occurrence during a week of field observations was 21 minutes.

PROBLEMS

Results of the mail survey of Moorhead residents conducted in Phase I revealed that (1) delays to emergency vehicles, (2) delays in traveling to and from work and school, and (3) community development problems were the rail/community conflicts of most concern in Moorhead (see Exhibit III-8). Persons representing Moorhead in the study verified these results and decided that the case study should focus on their resolution.

EXHIBIT III-6

AMOUNT OF TIME (in minutes) CROSSINGS ARE BLOCKED IN MOORHEAD, MN., ON THE AVERAGE DAY 1/ 2/

Line	Train Type	Amount of Time Crossings are Blocked by (minutes)				% of Day Crossings Are Blocked (from Column 7)
		Train Occupancy	Gates/Flashers Activated by a Moving Train	Gates/Flashers Activated - No Train Present or Stopped Trains	Total	
Old NP	Coal	4	17	-	21	1.4
	Mixed Freight	42	9	-	51	3.5
	Local	3	3	-	6	0.4
	Total	49	29	6	84	5.8
Old GN	Coal	10	1	-	11	0.8
	Mixed Freight	13	3	-	16	1.1
	Local	5	5	3	13	0.9
	Total	28	9	11	48	3.4
21st St.	Coal	23	6	-	29	2.0
	Mixed Freight	53	14	-	67	4.6
	Local	5	7	-	12	0.9
	Total	81	27	-	108	7.5

1/ Derivation of data is described in Chapter II. Data represent averages for all crossings.

2/ Totals may exceed numbers by train type in cases where attribution by train type is uncertain.

EXHIBIT III-7

DISTRIBUTION OF TIME CROSSINGS ARE BLOCKED BY A SINGLE TRAIN BY TRAIN TYPE, MOORHEAD, MN[1/]
(Percentage of All Trains)

Line	Time Crossings Are Blocked (Minutes)	Coal	Mixed Freight	Local	Total
Old NP	1.0- 1.9	--	12.0	85.0	27.5
	2.0- 2.9	31.8	38.0	6.0	28.8
	3.0- 3.9	41.0	26.0	3.0	24.3
	4.0- 4.9	18.2	8.0	--	8.6
	5.0- 5.9	--	10.0	--	5.0
	6.0- 6.9	4.5	2.0	--	2.1
	7.0- 7.9	--	--	3.0	0.8
	8.0- 8.9	--	--	--	--
	9.0- 9.9	4.5	--	--	1.1
	10.0-10.9	--	--	--	--
	11.0-11.9	--	--	--	--
	12.0-12.9	--	--	--	--
	13.0-13.9	--	2.0	--	1.0
	14.0-14.9	--	--	--	--
	15.0-15.9	--	--	--	--
	16.0-and over	--	--	3.0	0.8
	Total	100.0	100.0	100.0	100.0
Old GN	1.0- 1.9	--	11.9	75.0	14.6
	2.0- 2.9	12.5	23.8	4.2	19.2
	3.0- 3.9	12.5	16.6	4.2	14.7
	4.0- 4.9	25.0	26.2	4.2	18.3
	5.0- 5.9	--	4.8	4.2	3.4
	6.0- 6.9	25.0	9.5	4.2	13.8
	7.0- 7.9	--	2.4	4.2	1.9
	8.0- 8.9	25.0	2.4	--	9.0
	9.0- 9.9	--	2.4	--	1.5
	10.0-10.9	--	--	--	--
	11.0-11.9	--	--	--	--
	12.0-12.9	--	--	--	--
	13.0-13.9	--	--	--	--
	14.0-14.9	--	--	--	--
	15.0-15.9	--	--	--	--
	16.0-and over	12.5	--	--	3.6
	Total	100.0	100.0	100.0	100.0
21st Street Line	1.0- 1.9	--	4.9	90.0	10.4
	2.0- 2.9	22.7	34.5	6.0	29.0
	3.0- 3.9	45.6	31.1	3.0	32.9
	4.0- 4.9	13.6	14.8	--	13.3
	5.0- 5.9	--	4.9	1.0	3.3
	6.0- 6.9	13.6	--	--	3.7
	7.0- 7.9	--	--	--	--
	8.0- 8.9	--	3.3	--	2.1
	9.0- 9.9	4.5	3.3	--	3.3
	10.0-10.9	--	--	--	--
	11.0-11.9	--	1.6	--	1.0
	12.0-12.9	--	1.6	--	1.0
	13.0-13.9	--	--	--	--
	14.0-14.9	--	--	--	--
	15.0-15.9	--	--	--	--
	16.0-and over	--	--	--	--
	Total	100.0	100.0	100.0	100.0

1/ Derivation of the data is described in Chapter II. The data represent averages for all crossings.

EXHIBIT III-8

RESPONSE OF MOORHEAD RESIDENTS TO
THE PHASE I MAIL SURVEY

Problem	Percentage of Residents Who Perceive the Problem to be Serious
Emergency Vehicle Delay	40
Access to Work/School	32
Community Development	20
Vehicular Safety	15
Pedestrian Safety	13
Access to Shopping/Recreation	11
Environmental	7

Following is a description of the nature and magnitude of each of these priority problems.

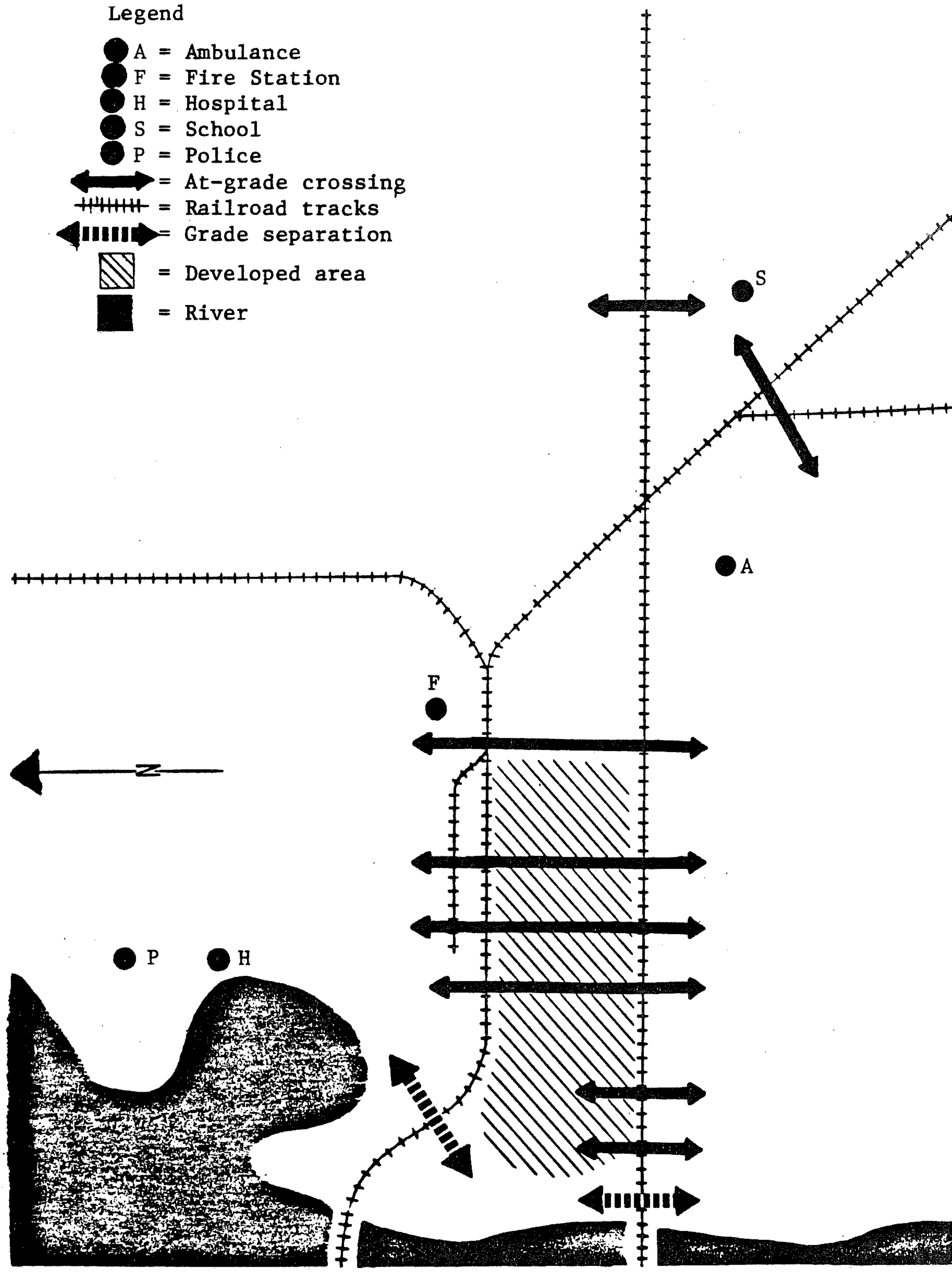
Community Development Problems. The primary community development problem in Moorhead involved the central business district (CBD). As shown in Exhibit III-9, the CBD is bordered on three sides by main line tracks and on the fourth side by the Red River. All crossings providing access to the CBD are at-grade with the exception of one. However, the grade-separated crossing at Third Avenue does not provide good access to the CBD—it requires a circuitous route, it is narrow and often allows only one lane of traffic, and it is closed by flooding during parts of the year. The CBD is the site of a large urban renewal project, a $30 million investment designed to revitalize the area's business activity. It was initiated at a time when city officials perceived train operations to be on the decline. However, train operations increased and are expected to continue to increase. The additional traffic increased the frequency with which delays in gaining access to the CBD were experienced.

City officials and residents believed that the increased rail operations contributed to a less-than-successful renewal project. They contended that rail operations isolated the CBD from the community. Business activity was relocating from the CBD to outlying shopping centers in part because people want to avoid the frequent delays experienced at grade crossings which provide the only access to the CBD. New commercial and office development was locating away from the CBD for similar reasons.

It is difficult to verify these contentions and even more difficult to establish the extent to which blocked crossings inhibit business activity in the CBD. Retail trade data show that whereas Moorhead was

EXHIBIT III-9

PHYSICAL CHARACTERISTICS OF MOORHEAD THAT CONTRIBUTE TO RAIL/COMMUNITY CONFLICTS



was growing more quickly than its counterpart (Fargo) between 1967 and 1972, it grew significantly slower than Fargo between 1972 and 1977 when rail operations were increasing. The respective growth rates in retail sales were 43 percent (Moorhead) and 34 percent (Fargo) from 1967 to 1972. The rates were 55 percent versus 120 percent from 1972 to 1977. While the number of retail establishments grew in Fargo between 1972 and 1977 by 15 percent, Moorhead experienced a 12 percent decline. 1/ Fargo has several grade-separated crossings that provide access to its CBD, suggesting that the accessibility problems experienced in traveling to the Moorhead CBD contribute to the relatively poorer performance in retail trade. But, the growth dynamics are considerably more complex than this suggests. Relatively better tax structures, the attractiveness of the new West Acres shopping center, and other variables have influenced the distribution of business activity between the two cities. Nonetheless, it is apparent that the delays experienced at crossings providing access to the Moorhead CBD detracted from its appeal as a place to locate or to do business.

During Phase II, it was estimated that the crossings providing access to the CBD were blocked 5.8 percent of the average day on the old NP line and 3.4 percent of the day on the old GN line. The distribution of delay time by line also was significant. The old NP, on which 70 percent of the train operations in Moorhead occurred, separated 75 percent of the population from the CBD. The GN line separates only 25 percent of the

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1/ U.S. Bureau of Census, Census of Retail Trade, for 1967, 1972, and 1977, U.S. Government Printing Office, Washington, D.C. The retail sales data represent city-wide experience. CBD-specific data are not available for Moorhead prior to 1972.

population. Thus, the line with the heavier traffic also separated a larger proportion of the population from the CBD.

The degree to which access to the CBD was reduced by train operations was revealed by the amount of vehicle delay occurring at CBD crossings. On an annual basis, it was estimated that 560,000 vehicles were delayed at these crossings. The average delay per vehicle was two and one-half minutes, meaning that almost 23,000 vehicle hours of delay were experienced at these crossings annually.

The bus system in Moorhead also is an important transportation link between the community and the CBD. It, too, is affected by railroad operations. The bus system is oriented to the CBD. Loop routes all converge on Center Avenue. It was estimated during Phase II that in six percent of the crossings made by the buses, a delay was experienced. Significantly, in two percent of the crossings, the delay was five minutes or longer. This length of delay disrupted the coordination of routes to the extent that cancellation of one loop trip (meaning delays of over 30 minutes to patrons) was necessary to retain the tightly coordinated schedule.

The reduced CBD accessibility indicated by these statistics of vehicle delay probably understates the negative effects of the train operations. As noted above, the amount of blocked crossing time and, consequently, delay that occurred on a day-to-day basis varied from the average statistics. This variation affected peoples' perception of accessibility to the CBD and the way they had to respond to the potential of being delayed at crossings. Perceptions often are based on the worst case situation. Thus, the variation in blocked crossing time may have created the impression that CBD access was worse than it actually was. Perhaps more important was that people who had to adhere to a schedule must plan trips to the CBD with the expectation of encountering a worse-than-average delay at grade crossings. Consequently, train operations altered schedules and cost time to Moorhead residents even when crossing delays were not actually experienced. In this way, delay in traveling to the CBD was worse than the average day statistics suggest.

Emergency Vehicle Delays

Delays at grade crossings are experienced by all the emergency service providers in Moorhead--the fire department, police, and ambulance service. The situation is created by the necessity to cross the main line to respond to emergencies because resources are inadequate to provide duplicate emergency services on both sides of the main line. Exhibit III-9 above shows the location of the various emergency service providers in Moorhead.

The ambulance service, a private establishment, is located south of the old NP line. Several hospitals are located in Moorhead and Fargo; the principal hospital in Moorhead is located on the north side of the city near the river. In this situation, two types of crossing delays may be experienced: (1) traveling from the ambulance station to an emergency on the north or east side of the City, and (2) traveling to the hospital from an emergency on the south or east side of the City. Historical data show that approximately three crossings per day are made in providing emergency medical service. Prior to the demonstration projects, it was estimated that in eight percent of these crossings a delay was experienced. This meant that about 90 ambulance delays at crossings occurred annually. The average duration of delay was estimated to be two and one-half minutes; delays varied from a few seconds to over 15 minutes.

As with emergency medical delays estimated for the other case study communities, it is not possible to determine the consequences of experiencing 90 delays per year. The consequences will be determined by the specific situations in which the delays occur. The ambulance service stated, however, that no grade crossing delay experienced in responding to medical emergencies has been critical or detrimental to the patients in the past 16 years.

As with emergency medical services, the fire service is often required to cross the main line to respond to emergency calls. There are two fire stations in Moorhead, one located on each side of the City. Originally, the fire department had one station, located between the main line tracks, in the CBD. In 1974, the City relocated this station to the current north side location. A second station was established on the south side in part to minimize crossing delays. Despite the location of fire services on both sides of the City, crossing the main line is frequently required to provide adequate response to emergencies, particularly emergencies located south of the main line where the predominant residential, commercial, and industrial areas are located. Of course, emergencies within the CBD require crossing the main line regardless of which engine company responds.

Data provided by the Moorhead Fire Department reveal that an annual average of 320 crossings of the main line are required to respond to fire calls; this was over 60 percent of all calls received. It was estimated that over eight percent of the crossings made in responding to fire emergencies experienced a delay at a grade crossing. This meant that about 27 delays per year were experienced. The average expected delay time was estimated to be two and one-half minutes with a range of several seconds to over 15 minutes. While a delay definitely compromises the quality of fire service provided, the consequences of delay, again, cannot be specified.

The police service is stationed in the law enforcement center located in the northwest section of the City. Patrols are dispersed throughout the City in part to minimize the necessity of crossing the main line in response to an emergency call. However, the number of patrol units available to the Police Department is too few to eliminate crossing the main line in emergencies. During a three-week (Phase II) observation period, 17 cases of delay to patrol units responding to calls were recorded. The average delay experienced was 3 1/2 minutes with a range of 1/2 to 10 1/2 minutes. This translated into almost 300 delays on a annual basis. There were apparently no serious repercussions associated with the recorded delays.

Access to Work/School

Delays in traveling to and from work and school was the third priority problem specified for Moorhead. The mail survey of Moorhead residents, conducted in Phase I, indicated that a substantial percentage of the population (70 percent) must cross railroad tracks on their way to and from work. A smaller percentage (30 percent) indicated that they or their children must cross railroad tracks in traveling to and from school.

It was estimated in Phase II that from 5 percent to 10 percent of the work/school trips that require crossing the main line were delayed at crossings, on the average day. The expected delay was two and one-half to five minutes per occurrence depending on travel route. The estimated delay ranged up to 20 minutes.

Another way to establish the magnitude of delay traveling to work and school is to estimate the number of vehicles delayed at Moorhead crossings. 1/ It was estimated that 2,300 cars were delayed at main line crossings in Moorhead each day. With an average delay of just over two and one-half minutes, 96 vehicle hours of delay, or 135 person hours of delay (assuming 1.4 participants per vehicle), occurred each average day. This translates into annual figures of:

- 840,000 vehicles delayed,
- 36,000 vehicle hours of delay, and
- 50,000 person hours of delay. 2/

DEMONSTRATION PROJECTS

In an effort to reduce the priority problems experienced in Moorhead, the following demonstration projects were implemented.

- A power switch was installed in place of an manual switch at the Dilworth yard lead.
- Grade crossing predictors were installed at all crossings on the Old NP Line.
- The allowable train speed was increased from 25 to 35 mph on the Old NP Line.

1/ This figure includes delays to persons traveling for purposes other than related to work or school and consequently will overstate delays specifically related to work and school travel. On the other hand, average delay statistics, as noted on p. VIII-20, understate the time cost incurred by residents as a result of rail/community conficts.

2/ These estimates are exclusive of school bus and transit delays.

- An emergency service/railroad communication system was established.

In addition, a rescue squad, previously implemented by the city, was evaluated in terms of the reduction in rail/community conflicts achieved.

Significant reductions in the magnitudes of Moorhead's priority problems were achieved with implementation of the demonstration projects. Delays at crossings providing access to the CBD and at other crossings were reduced by 30 percent; vehicle delay time at crossings was reduced by 50 percent. Accidents at grade crossings are expected to be reduced by 35 percent. Finally, medical emergency service delays could be eliminated entirely. These results were achieved for a total cost of $540,000. Railroad operating cost savings ($90,000 annually) will result from the projects as well. Following is a discussion of each demonstration project.

Installation of the power switch ($59,000; funded by Burlington Northern, Inc.) accounted for 17 percent of the crossing delay reductions. This was achieved because the power switch replaced a manual switch at the lead to the Dilworth Yard. The manual switch required a train to stop, a crewman to throw the switch by hand, the train to proceed through the switch and stop again while the crewman returned the switch to its original position and then rejoined the train. The train deceleration/acceleration associated with this operation slowed train speeds through Moorhead. When the average unit coal train or mixed freight train (6,000 feet and 4,900 feet, respectively) stopped for the switch to be thrown, crossings from 10th Street through 21st Street were blocked. An average of two trains use the lead daily.

The power switch provides for remote control of the switch, which eliminates the need to stop and enables trains to maintain a 25 mph speed into the yard. This change resulted in a reduction of 7 to 10 minutes each (average) day in blocked crossing time.

The installation of grade crossing predictors (GCPs) at all Old NP Line crossings also accounted for 17 percent of the reduction in crossing delays. An expected 35 percent reduction in crossing accidents also is attributable to the grade crossing predictors.

As noted earlier, grade crossing predictors reduce crossing delays and crossing hazard by eliminating early signal activation. Along the Old NP line, the average gate activation time prior to train arrival was 75 seconds. With the predictors, the average time now is 30 seconds. Thus, a reduction in blocked crossing time of 20 minutes daily for each crossing was achieved with the predictors. The absence of early signal activation appears to have had a positive influence on motorists' behavior, as well. The observed frequency of motorists driving around the gates as a train approached declined by 50 to 90 percent at crossings where predictors were installed. On the Old GN line, where predictors were not installed, the frequency actually increased by 20 percent. These observations support the expectation that grade crossing predictors will reduce crossing accidents. The predictors cost $460,000 to install (about $60,000 for each crossing). The cost was shared by the state (95%), the railroad (2 1/2%), and local government (2 1/2%).

The third and most effective demonstration project involved increasing allowable train speed on the Old NP line from 25 mph to 35 mph. This project accounted for almost two-thirds of the crossing delay reductions achieved in Moorhead. To increase allowable speeds required some signal modifications (accomplished with installation of the grade crossing predictors) 1/ and a change in BN operating instructions for Moorhead.

Prior to implementing this demonstration project, speeds on the Old NP line were limited to 25 mph. Actual train speeds averaged 20 mph. Train speeds now average 29 mph, resulting in a 45 percent reduction in blocked crossing time on the Old NP line. Because the speed was not changed on the Old GN line, which also bounds the CBD, overall CBD accessibility has improved by a smaller amount, 27 percent. Emergency services also will benefit from the increased train speeds. It is estimated that about 25 percent fewer ambulance, fire, and police service delays will be experienced because train speeds were increased. Increasing speeds required little cost beyond that to install the grade crossing predictors. Furthermore, the railroad will experience a net annual operating savings of $90,000 as a result of the increased train speed.

The last project evaluated in Moorhead is the rescue squad. A rescue squad was established within the Moorhead fire department as a component of the emergency service system in 1976. A rescue squad consists of people trained in basic emergency medical techniques and provided with medical supplies and equipment. The rescue squad provides a first-response capability only. It is not licensed to transport patients. The squad can treat the patient at the emergency scene until the ambulance service

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1/ While signal systems may require modification in order to safely increase train speeds, installation of grade crossing predictors is not a prerequisite to increased speeds.

arrives. Thus, by locating the squad on the side of the main line opposite the ambulance service, emergency service can be promptly provided even if the ambulance service is delayed at a crossing.

In Moorhead, the principal medical emergency service is provided by a private ambulance service. Through radio communication between the dispatcher and the ambulance driver, delays at rail/highway crossings are reported. In the case of a delay of significance to patient outcome, the dispatcher radios the police department or the rescue squad for assistance. In addition to receiving calls for assistance from the ambulance service, the rescue squad is dispatched to all life-threatening medical emergencies reported through the City's 911 emergency telephone system. Both the police and the rescue squad members are trained in emergency medical treatment; the rescue squad vehicle is equipped with life-support equipment. Thus, the rescue squad or the police can provide first-response aid to victims until the ambulance service arrives. Since its inception, the rescue squad has responded to 125 medical emergencies annually or about nine percent of all medical emergencies that occur each year. During this period, no crossing delays have occurred which have adversely affected victims.

The Moorhead rescue squad costs $20,000 to initiate (vehicle and equipment costs) and $25,000 annually to operate. In other places, less sophisticated vehicles and volunteer personnel are used to reduce rescue squad costs to an initial investment of $10,000 and an annual cost of $1,000 to $3,000.

A summary of the demonstration project results in Moorhead is presented in Exhibit III-10.

EXHIBIT III-10

PRIORITY PROBLEM REDUCTIONS IN MOORHEAD
ATTRIBUTABLE TO DEMONSTRATION PROJECTS 1/

Actions Taken	Emergency Service Delays	Vehicular Delays # Delayed	Vehicular Delays Delay time	Crossing Accidents	Cost Capital	Cost Annual O&M 2/
A power switch was installed in place of the manual switch at the Dilworth Yard lead.	-5%	-5%	-10%	N/A	$ 59,000	--
The allowable train speed was increased from 25 mph to 35 mph.	-20%	-20%	-30%	0%*	--	($90,000) 3/
GCPs were installed at all crossings on the southern main line.	-5%	-5%	-10%	-35%*	$460,000	$2,500
An emergency service/railroad communication system was established.	Not fully tested	N/A	N/A	N/A	$90	$240
A rescue squad was previously established.	-100%	N/A	N/A	N/A	$20,000	$25,000
Combined Projects	-100%	-35%	-50%	-35%	$539,090	($62,260)

1/ Further observations are required to verify estimates identified with an asterisk.

2/ Incremental cost.

3/ Signal modifications capital costs are accounted for under grade crossing predictors. The railroad may experience a $90,000 annual savings.

CHAPTER IV

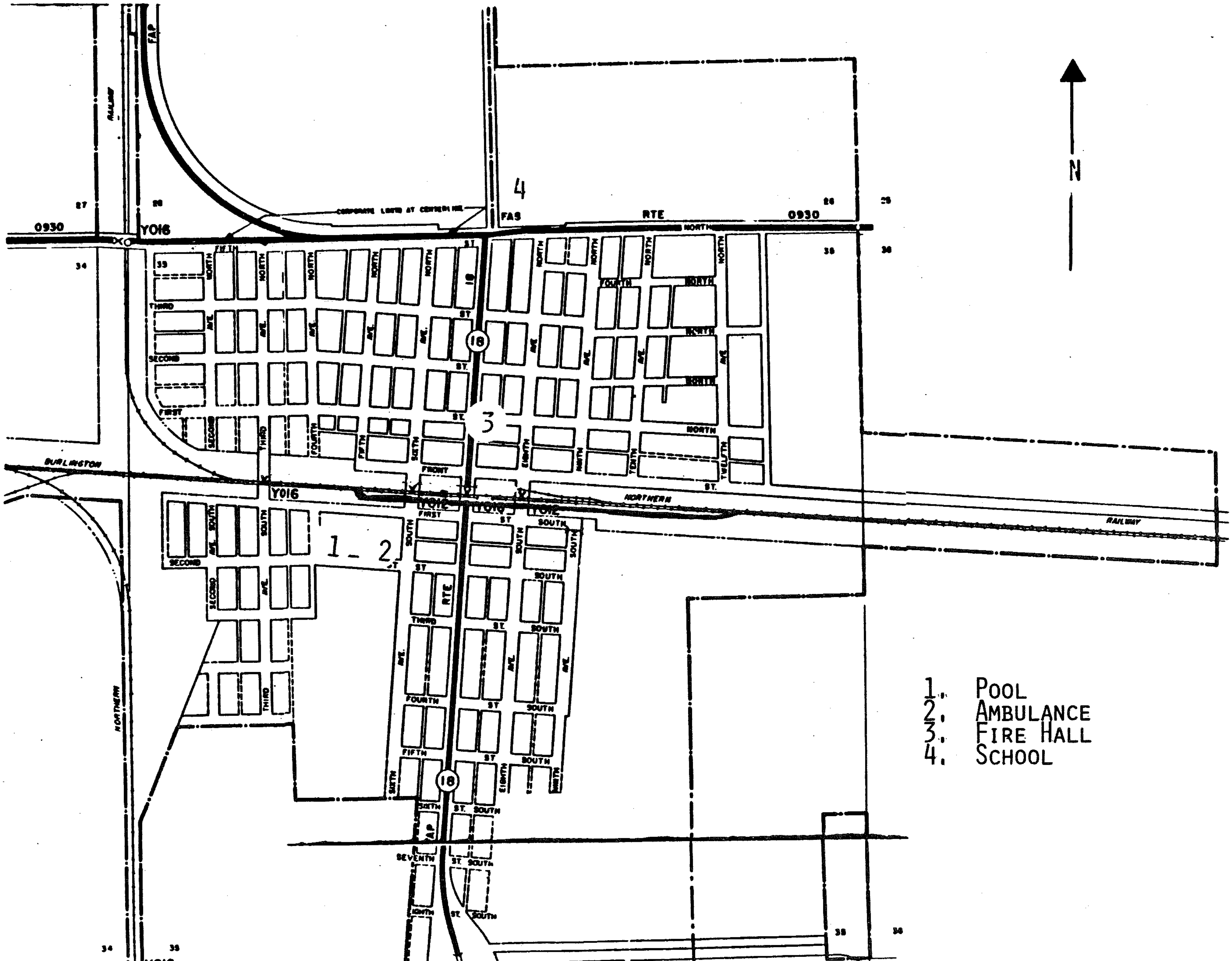
CASE STUDY: CASSELTON, NORTH DAKOTA

COMMUNITY CHARACTERISTICS

Casselton is a community of 1,800 people located 20 miles west of the North Dakota/Minnesota border. The community is bisected by a double track main line of the Burlington Northern, Inc. Two-thirds of the population currently resides on the north side and one-third resides on the south side of the main line.

The commercial area of Casselton is situated on Front Street, which runs adjacent and parallel to the main lines. (See the map presented as Exhibit IV-1.) Also located north of the main line are the schools, the fire and police stations, and city hall. The ambulance vehicles and one fire truck are kept on the south side of the main line. The emergency services serve a geographic area extending about 15 miles south and west of the town. The schools serve a similar geographic area. Most of the industry at which Casselton residents are employed is located south of the main line. Some residents also commute to work in Fargo and Moorhead via I-94. A swimming pool was recently constructed south of the main line; tennis courts are planned for construction adjacent to the swimming pool. A second recreation area with tennis courts is located in the northwest corner of the community.

EXHIBIT IV-1
CASSELTON, N.D,
(Scale: 1" = 900')



The residential area, as noted, is located on both sides of the main line. The estimated growth rate in Casselton is two percent per year. Residential development is occurring on both sides of the main line in a ratio that will essentially maintain the two-thirds/one-third population split. Residential development occurring on the south side tends to be oriented more to elderly and lower-income households.

The street system in Casselton is in a grid pattern. There are four at-grade crossings (the Eighth Avenue crossing was closed as part of the demonstration projects). Two of these are within 700 feet of each other; a third and the least-traveled crossing is separated from the others by 1000 feet. The fourth crossing is in the northwest corner of Casselton. The major north/south crossing is State Highway 18; it has an annual average daily traffic (AADT) of about 3,850 vehicles. AADTs of the other crossings are presented in Exhibit IV-2. The exhibit also presents the type of protection device at each crossing before the demonstration projects.

Running parallel to and about three-fourths mile north of the main lines is Cass County Highway 10. It provides access to the Fargo/Moorhead area via connections with County Highway 11, east of Casselton, or I-94. I-94 is about two miles south of Casselton and can be reached via Highway 18.

RAILROAD OPERATIONS

Thirty-four trains pass through Casselton on the average day. Of these, nine are unit coal trains, eighteen are mixed freight trains, and four are local trains. On any given day, the number of trains passing

EXHIBIT IV-2

CROSSINGS IN CASSELTON, ND

CROSSING	AADT (1979)[1/]	CROSSING PROTECTION
Eighth Avenue	650	Flashing lights
Langer Avenue (State Highway 18)	3,850	Automatic gates and flashing lights
Sixth Avenue	825	Flashing lights
Third Avenue	100	Crossbucks and stop signs
Fifth Street North	725	Crossbucks

1/ AADT (annual average daily traffic) estimates were provided by the North Dakota State Highway Department.

through Casselton varies considerably. The variation is presented in Exhibit IV-3. No consistent pattern of distribution by time of day or day of the week was observed.

Operations conducted by these trains include through movements, switching operations, and stopovers. The stopovers average seven per day (two unit coal trains, four mixed freight trains, and one local train); stopovers average 38 minutes and are required to conduct crew breaks, obtain train orders, conduct train inspections and air tests, and provide for train meets. Summary characteristics of the trains that operate within and through Casselton are presented in Exhibits IV-4.

AMOUNT OF TIME CROSSINGS ARE BLOCKED

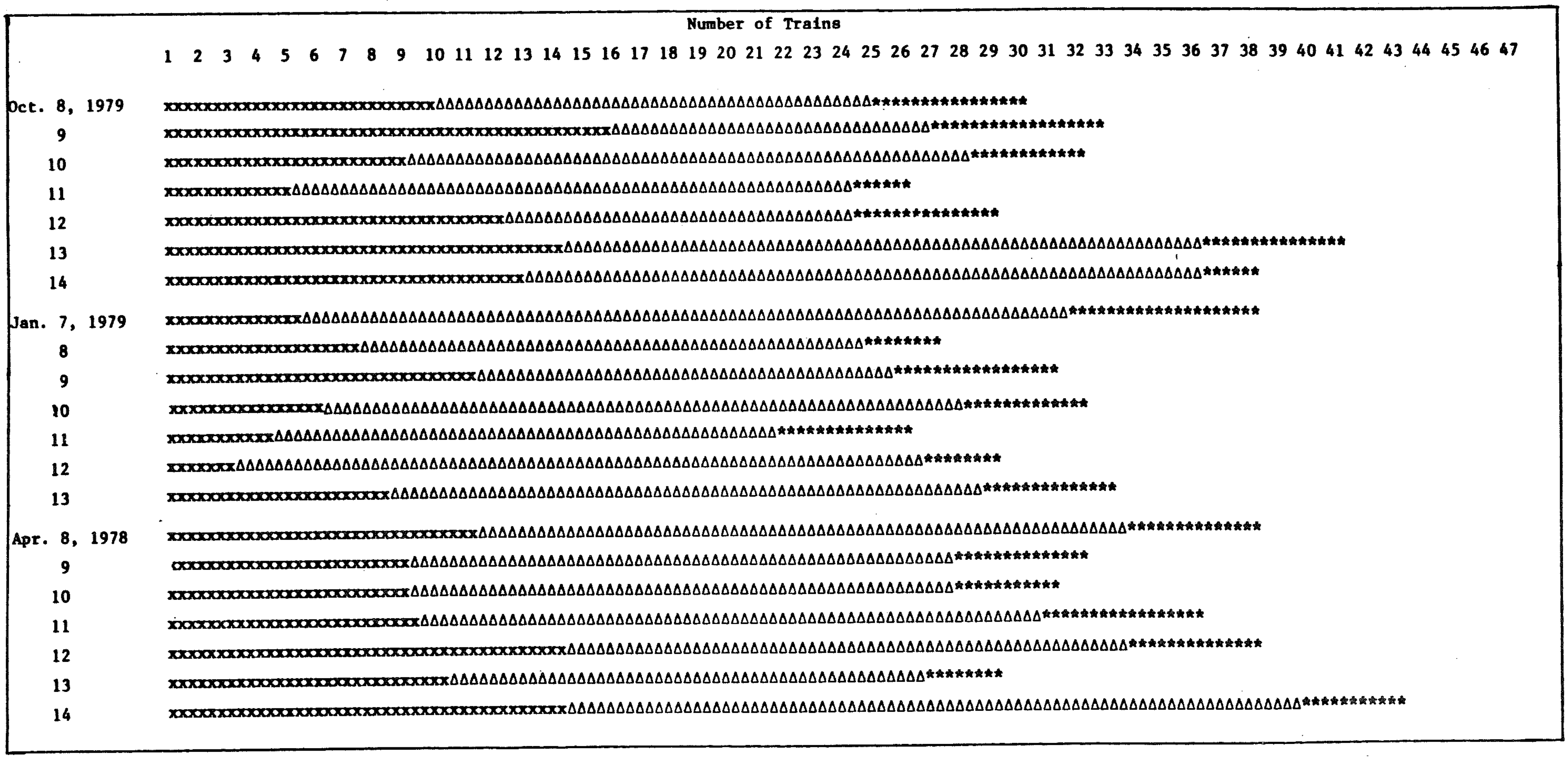
The amount of time crossings are blocked by railroad operations in Casselton was estimated for the average day and was divided into three parts:

- The time trains occupied crossings
- The time gates and/or flashers were activated prior to and after through train occupation
- The time gates and/or flashers were activated by trains stopped in Casselton but not occupying crossings.

The estimates of each of these three components and total blocked crossing time are presented in Exhibit IV-5. The exhibit shows that prior to the demonstration projects the crossings in Casselton were blocked for as much as 29 percent of the average day. This maximum amount of time includes time when gates and/or flashers were activated by trains stopped elsewhere than in the crossings. While this was cited as a frequent occurrence by

EXHIBIT IV-3

NUMBER OF TRAIN ARRIVALS PER DAY IN CASSELTON, ND,
DURING A THREE-WEEK OBSERVATION PERIOD



<u>Train Type</u>

xxxxxx **Coal**

ΔΔΔΔΔΔ **Mixed Freight**

****** **Local**

EXHIBIT IV-4

TRAIN OPERATIONS IN CASSELTON, NORTH DAKOTA 1/

TRAIN TYPE	# TRAINS		AVE. NO. CARS	SPEED (MPH)		NO. OF TRAINS STOPPED 2/
	AVE.	RANGE		AVE.	RANGE	
COAL	9	2-16	104	28	15-45	2
MIXED FRT.	18	11-26	82	24	5-45	4
LOCAL	4	0-5	12	5	1-10	1
TOTAL	31	25-42	84	24	1-45	7

1/ Derivation of the data is described in Chapter II.

2/ Trains stop in Casselton for a variety of reasons including: to conduct train meets, to obtain orders, to have a crew break, to conduct inspections, to conduct pick-up and set-out operations.

EXHIBIT IV-5

AMOUNT OF TIME (in Minutes) CROSSINGS WERE BLOCKED IN CASSELTON, NORTH DAKOTA ON THE AVERAGE DAY 1/

(Before Demonstration Projects)

	Amount of Time (Minutes) Crossings Were Blocked					
Train Type	Train Occupancy	Gate/Flashers Activated by a Moving Train	Gate/Flashers Activated by Stopped Trains	Total	Total Columns 2&3	% of Day Crossings Are Blocked (from Column 5)
Coal	22	12	76	110	34	2.4%
Mixed Frt.	47	32	152	231	79	5.5%
Local	6	22	38	66	28	1.9%
Total 2/	75	66	266	407	156	10.4%

1/ Derivation of data is explained in Appendix A. The data represent averages for all crossings.

2/ Totals may exceed the sum of the blocked time by train type due to crossings closed (i.e., signals activated) in the absence of a passing train.

Casselton officials, it did not occur 100 per cent of the time. 1/ Also, when it did occur, motorists proceeded through the crossings after recognizing that no train was approaching. Without the inclusion of this time that signals were activated, crossings in Casselton were blocked by through trains for 2.5 hours on the average day or 10.6 percent of the 24-hour period. The amount of time crossings were blocked by a single train ranged from 2.0 to 16.6 minutes. About 60 percent of the rail operations blocked crossings for 2.0 to 3.9 minutes.

PROBLEMS

Results of the Phase I mail survey of Casselton residents revealed that delays to emergency vehicles, vehicular safety, and pedestrian safety were the problems of most concern to Casselton residents. (Survey results are presented in Exhibit IV-6.) Persons representing Casselton in the study verified these results and decided that the case study should focus on their resolution. Following is a description of the nature and magnitude of each priority problem.

Emergency Vehicle Delays

Casselton is centrally located in Cass County. Partly as a result of this status, Casselton provides fire and ambulance service to an

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1/ The BN has put a sign prior to the bonded rail that directs trains that stop to do so before reaching the sign. Casselton officials have noted that this has significantly reduced the number of times gate/flashers are activated by stopped trains; but, it has not eliminated the problem. Since the installation of the sign in September, about two instances per week of false signal activation have been observed by community officials.

EXHIBIT IV-6

RESPONSE TO CASSELTON RESIDENTS TO
THE PHASE I MAIL SURVEY

Problem	Percentage of Residents Who Perceive The Problem to be Serious
Emergency Vehicle Delay	52
Vehicular Safety	45
Pedestrian Safety	32
Access to Work/School	18
Environmental	13
Access to Shopping/Recreation	12
Community Development	9

area extending about 15 miles south and west of the town. The hospital to which medical emergencies are taken is located in Fargo, some 20 miles east of Casselton. The fire and ambulance services are provided by volunteers who reside in and around Casselton. There are thirty fire service volunteers and twenty-six ambulance service volunteers.

Ambulance Service. The three volunteers who are on call at any given time are informed of the emergency and its location by a one-way beeper-radio which they carry with them. The Cass County sheriff's office receives the emergency calls and alerts the volunteers. When the volunteers receive the call, they go to the temporary ambulance garage, located two blocks south of the main line. Two vehicles are kept in the garage; one is a back-up vehicle. They then proceed to the emergency location. After on-site medical attention is administered, the patient is transported to the hospital in Fargo via State Highway 18 and I-94.

Responding to emergency calls with this system can require up to three crossings of the main line in one emergency situation: (1) the volunteers cross in traveling to the garage, (2) a crossing is made to reach the emergency location, and (3) a crossing is made to transport the patient to the hospital. An annual average of 120 calls are made by the Casselton ambulance service. Based on the distribution of volunteers' residences and work places and the distribution of the service population on both sides of the main line, it is estimated that 235 crossings are made in responding to medical emergencies annually. Prior to the demonstration projects, it was estimated that 22 delays were experienced annually given the number of crossings and the railroad operating characteristics described above. Ten of these delays were to volunteers as they traveled to the ambulance station. Delays traveling to the emergency location and from there to the hospital were estimated at six each per year. The average delay was estimated to be 1.8 minutes; and ranged from a few seconds to over 10 minutes.

The potential consequences of experiencing 22 delays per year are not clear. They depend on the specific emergency situations and the difference that a delay will make in effectively responding to these situations. Given statistics on medical emergencies, in perhaps 5 percent of the Casselton cases, or in one of the 22 delays projected annually, the delay would involve life-threatened patients. It is not possible, however, to estimate in how many of these cases a delay would be critical. (For further discussion of this issue, see Appendix A, "The Consequences of Delay".)

Fire Services. The fire service provided by Casselton has available three trucks (two tankers and one utility truck). The vehicles are kept at two stations, one on each side of the main line. A hotel operator in Casselton receives the emergency calls. The volunteers are alerted by the sounding of the siren at the firehouse; each volunteer has a one-way communication phone with which they are informed of the fire's location. Volunteers residing or working near the firehouse go to the firehouse and drive the engines to the fire. Others proceed directly to the fire.

As with ambulance calls, the fire service is often required to cross the main lines in responding to an emergency. Some volunteers may have to cross to arrive at the firehouse; some of the engines may have to be driven across the main lines to reach the emergency location.

Approximately 50 fire calls are made annually. The stationing of fire vehicles on both sides of the main line means that some response can be made without delay. However, in about one-third of the fire calls the main lines must be crossed to provide a full response to fires. Given the nature of the response system and the railroad operations occurring in Casselton, it was estimated that less than one of these crossings was delayed annually before the demonstration projects were implemented. As with medical emergencies, the consequences of a delay are uncertain.

Vehicular Safety

Increases in the number of trains operating through Casselton led to a concern for motorist safety at grade crossings. The concern was heightened by the location of a grain elevator at the Eighth Avenue crossing, which reduces the ability to see approaching trains. Increased use of the Third Avenue crossing, which had only a stop sign and crossbucks for protection, also was of concern. The primary basis of the vehicular safety concern, however, stemmed from motorist response to early signal activation--activation of crossing signals (1) when a train stopped away from the crossing, and (2) when a train approached the crossing slowly such that considerable time elapsed before the train arrived at the crossing.

Early signal activation decreased the credibility and respect for the crossing signals. The signals were no longer considered to indicate that a train would occupy the crossing momentarily and consequently that the motorist should not proceed through the crossing. Rather, the signals were perceived only to warn the motorist that a train might arrive at the crossing within several seconds or several minutes. This led motorists to frequently cross against the signals or to detour to the less well-protected Third Avenue crossing. At Langer Avenue, motorists drove around the gates; at Eighth and Sixth Avenues, they crossed against the flashing signals. Thus, the signals were rendered less effective than they would otherwise have been. It was estimated that the hazard at a crossing with gates and flashers may be increased by 40 percent or more as a result of early signal activation. There have been two train/vehicle accidents in Casselton in the past five years, one at the Third Avenue crossing and one at the Fifth Street North crossing. (The latter is not a main line crossing.)

Pedestrian Safety

As with vehicular safety, this concern emerged along with the increase in rail operations in Casselton. With the commercial, business, and government area located on the north side of the main lines and elderly and lower-income households located predominantly on the south side, pedestrians frequently cross the tracks for personal business, shopping, and social purposes. The concern for pedestrian safety also was focused on hazards to children crossing the tracks to go to the new swimming pool. The pool is located one block south of the tracks and west of Sixth Avenue South. The main line separates the pool from about 70 per cent of the children by residential location. On an average day in the summer, it is estimated that 240 children cross the main line going to and from the pool. It is further estimated that .09 of these children will arrive at a crossing as a train is arriving. This does not mean that an accident will result in these cases. Since the pool opened in the summer of 1979, no accidents have occurred.

DEMONSTRATION PROJECTS

Many actions were analyzed as possible ways to reduce the priority problems experienced in Casselton (see Appendix B). From the alternatives, the following demonstration projects were selected and implemented:

1. Crossing improvements--Automatic gates and grade crossing predictors were installed at the Third Avenue and Sixth Avenue crossings. Grade crossing predictors also were installed at the Langor Avenue crossing, which already was equipped with automatic gates. The Eighth Avenue crossing was closed to vehicular traffic, but maintained as a pedestrian crossing.

2. Emergency communication system--A communication system linking the fire service and the local railroad agent was established. The system has been expanded to include the ambulance service.

Implementation of these actions has resulted in reducing crossing delays to 15 percent and expected crossing accidents by 70 percent. Emergency service delays may be reduced by 70 percent as well. The contribution of each demonstration project to these problem reductions is presented in Exhibit IV-7. Project costs are also presented.

Despite the measurable improvement achieved in Casselton, community officials and residents are displeased with the closing of the Eighth Avenue crossing. As noted above, the crossing was closed to vehicular traffic, but is being maintained as a pedestrian crossing. The closing is part of the effort to reduce crossing accidents. Automatic gates and GCPs were installed at the other three crossings in the community.

It is the policy of the State of North Dakota, when deciding crossing improvements, to consider the possibility of closing one or more crossings in a community while upgrading others. The policy is predicated

EXHIBIT IV-7

REDUCTIONS IN RAIL/COMMUNITY CONFLICTS IN CASSELTON ATTRIBUTABLE TO DEMONSTRATION PROJECTS

Actions Taken	Emergency Service Delays	Vehicular Delays		Crossing Accidents	Cost	
		# Delayed	Delay time		Capital	Annual O&M
Automatic gates were installed at the 3rd and 6th Avenue crossings. The 8th Avenue crossing was closed to vehicular traffic but maintained as a pedestrian crossing. GCPs were installed at all crossings.	-15%	-15%	-30%	-70%*	$236,595	$1,000
An emergency service/railroad communication system was established.	-65%*	N/A	N/A	N/A	$100	$240
A safety education program was conducted in the schools.	N/A	N/A	N/A	No effect	--	--
Combined Projects	-70%*	-15%	-30%	-70%*	$236,695	$124

* Further observations are required to verify estimates.

in part on a community-wide aproach to improving crossing safety (to funnel traffic to crossings with the most effective warning devices) and in part on economics (the allocation of limited resources among crossings and communities in the State). For these reasons, and based on the finding that the closing would have a marginal effect on traffic patterns and travel times, a decision was made to close the crossing.

Residents of Casselton are appealing the decision. The residents contend that the closing has reduced accessibility within the community to both pedestrians and motorists, has increased crossing hazards, and has had an adverse environmental effect on the community. This has been true because of an unexpected effect of the demonstration projects, for which remedial actions have been taken. Trains delayed in Casselton tended to stop across or near the closed crossing (they previously stopped outside of Casselton). This created a visual obstruction making it difficult to see trains using the second main line track. Also children were observed to crawl between train cars when this occurred. The tendency of delayed trains to stop near the crossing increased the perceived noise levels in the town as well. Whereas trains previously started to accelerate outside of town, they were accelerating within town causing increased noise levels. In addition, train speeds through town were lower as a result of this practice and caused longer blocked crossing time. Burlington Northern has taken steps to ensure that trains will resume the practice of stopping outside of Casselton when delayed, which should resolve the residents' concerns. Other reasons the residents opposed the crossing closing are the following: There is less direct access between some parts of the community--one must now travel two additional blocks for some trips, incurring less than one minute additional travel time; traffic has increased at the crossings that were not closed-650 cars daily; and there are no warning signals at the portion of the crossing maintained for pedestrians, mostly children and elderly persons.

The closing of the Eighth Avenue crossing was a component of a trade-off which many communities may confront. For the inconveniences of one less crossing, actions were taken to reduce the overall rail/community conflict experienced in the community. It is the consultant's opinion that the residents' concerns with the closing of the crossing will dissipate as the community-wide benefits of the demonstration projects are realized.

CHAPTER V

CASE STUDY: SAUK RAPIDS, MINNESOTA

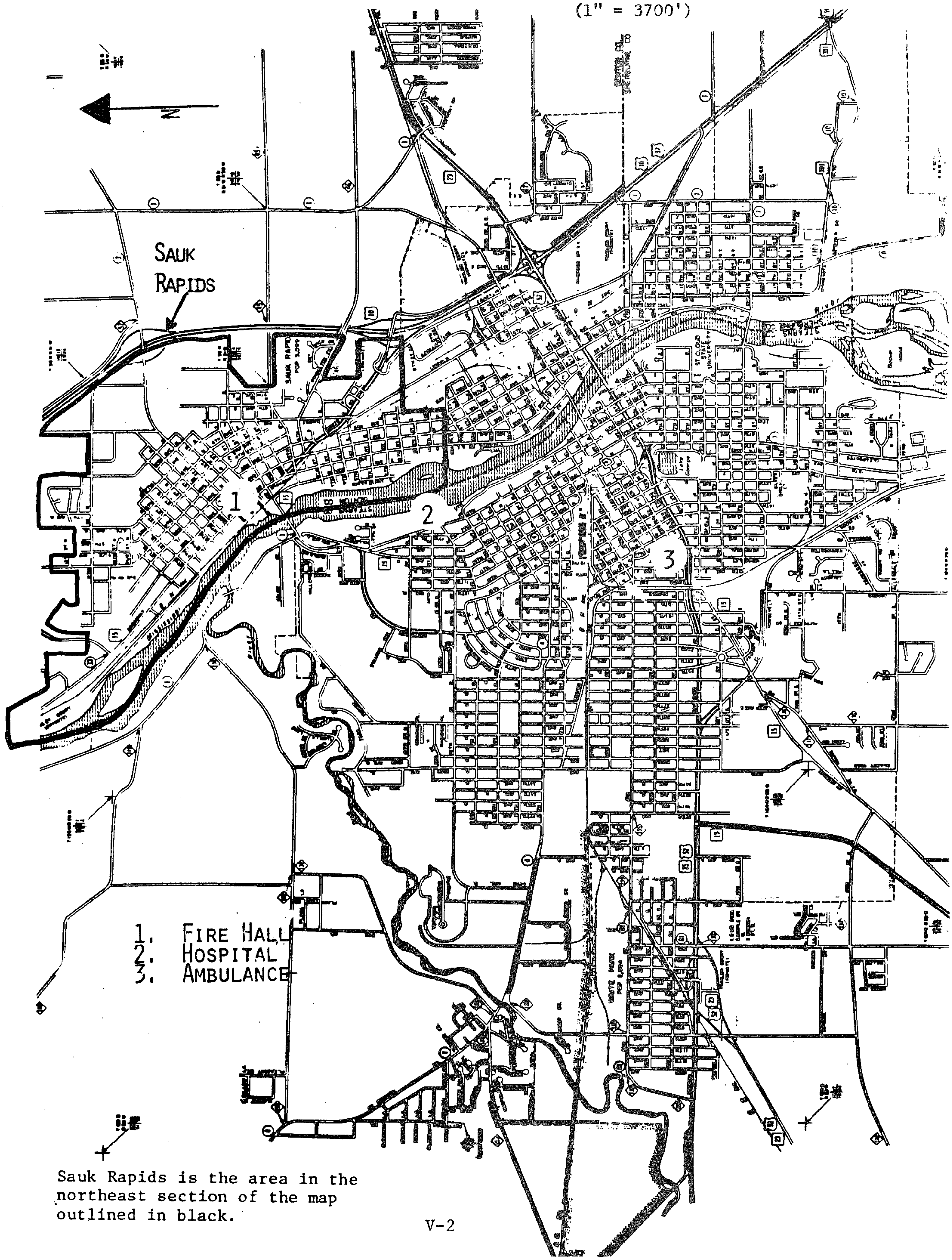
COMMUNITY CHARACTERISTICS

Sauk Rapids, Minnesota, is a community of 5,800 people. It is located on the Mississippi River about 70 miles northwest of the Twin Cities. The city is part of the St. Cloud metropolitan area; the City of St. Cloud, population 42,000, is located across the river from Sauk Rapids. (See Exhibit V-1, a map in which Sauk Rapids is the outlined area in the northeast section, and Exhibit V-2, an inset to Exhibit V-1 depicting Sauk Rapids.)

Like the other case study communities, Sauk Rapids is split by a Burlington Northern, Inc. (BN) main line. The line runs roughly parallel to the river. About 75 percent of the population resides north of the main line; the remainder of the population is located south of the main line--between the main line and the river. Sauk Rapids is expected to increase in population by 12 percent by 1985. Development trends are such that the future distribution of population on both sides of the main line will not differ significantly from the current split.

The central business district in Sauk Rapids is located principally along Benton Drive, north of TH-15 and the BN main line. An industrial park also is in the northeast section of the city adjacent to State

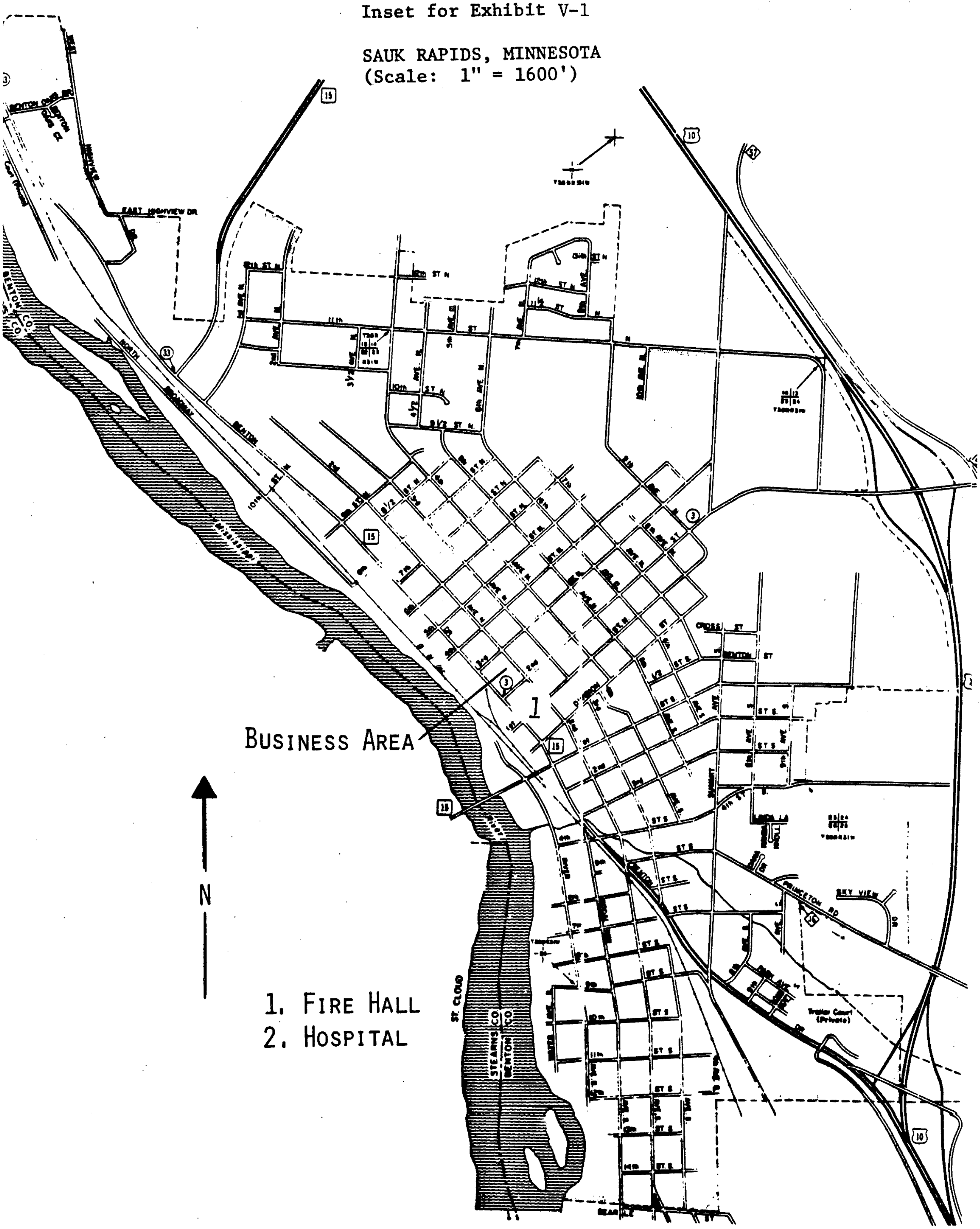
EXHIBIT V-1 Sauk Rapids/St. Cloud, MN
(1" = 3700')



Sauk Rapids is the area in the northeast section of the map outlined in black.

EXHIBIT V-2
Inset for Exhibit V-1

SAUK RAPIDS, MINNESOTA
(Scale: 1" = 1600')



Highway 10 between 2nd and 11th Streets. However, many Sauk Rapids residents shop and most are employed in St. Cloud.

Medical emergency service is provided by a private company located in St. Cloud where the area hospital also is located. Fire service in Sauk Rapids is provided by a volunteer force stationed in the northeast part of the city.

The streets in Sauk Rapids are basically in a grid pattern. The principal streets in the city are Benton Drive and 1st Street (TH-15). 2nd Avenue also is a principal north/south street. State Highway 10 bypasses the city on its eastern boundary.

There are seven main line crossings in Sauk Rapids. All are at grade. Exhibit V-3 lists the crossings of concern in this study and the annual average daily traffic estimates and type of crossing protection equipment of each.

RAILROAD OPERATIONS

Twenty-five trains pass through Sauk Rapids on the average day. Of these, 3 are unit coal trains, 20 are mixed freight trains, and 2 are local trains. There are no passenger trains currently operating through Sauk Rapids. In addition to the through trains, an average of one train per day conducts local switching operations in Sauk Rapids. Less than one train per day is required to stop in Sauk Rapids for other reasons than the conduct of local switching operations.

On any given day, the number of through trains will vary, sometimes substantially, from the average. The range in number of trains per

EXHIBIT V-3

CROSSINGS IN SAUK RAPIDS, MN

Street1/	AADT2/	Protection
1st Street South	11,000	Automatic gates and flashing lights
2nd Avenue South	2,640	Flashing lights
South Broadway	250	Flashing lights
9th Street South	150	Crossbucks

1/ The focus of Sauk Rapids' concern is on the three crossings designated above. Other crossings in Sauk Rapids are located at 8th Street North, 10th Street North, and Benton Oaks Drive.

2/ Figures provided by MnDOT represent 1977 and 1978 data.

day recorded during three different weeks in 1978 and 1979 ranged from 13 to 36. The variation in number of trains per day is presented in Exhibit V-4. The trains are quite evenly distributed among the days of the week. It also was observed that train arrivals are evenly distributed throughout the day. About 50 percent of the trains arrive between 6 a.m. and 6 p.m. over time. The fairly even distribution of train arrivals throughout the day also is apparent from the observation that in only 30 percent of the hours of the average day does more than one train pass through Sauk Rapids. Three or more trains arrive in the City during the same hour less than two percent of the time.

The result of these operating characteristics is that the average speed of trains in Sauk Rapids is the highest of that in all the case study communities. It is 38 mph and ranges from 5 mph to 60 mph depending on type of train. A summary of train operating characteristics is presented in Exhibit V-5.

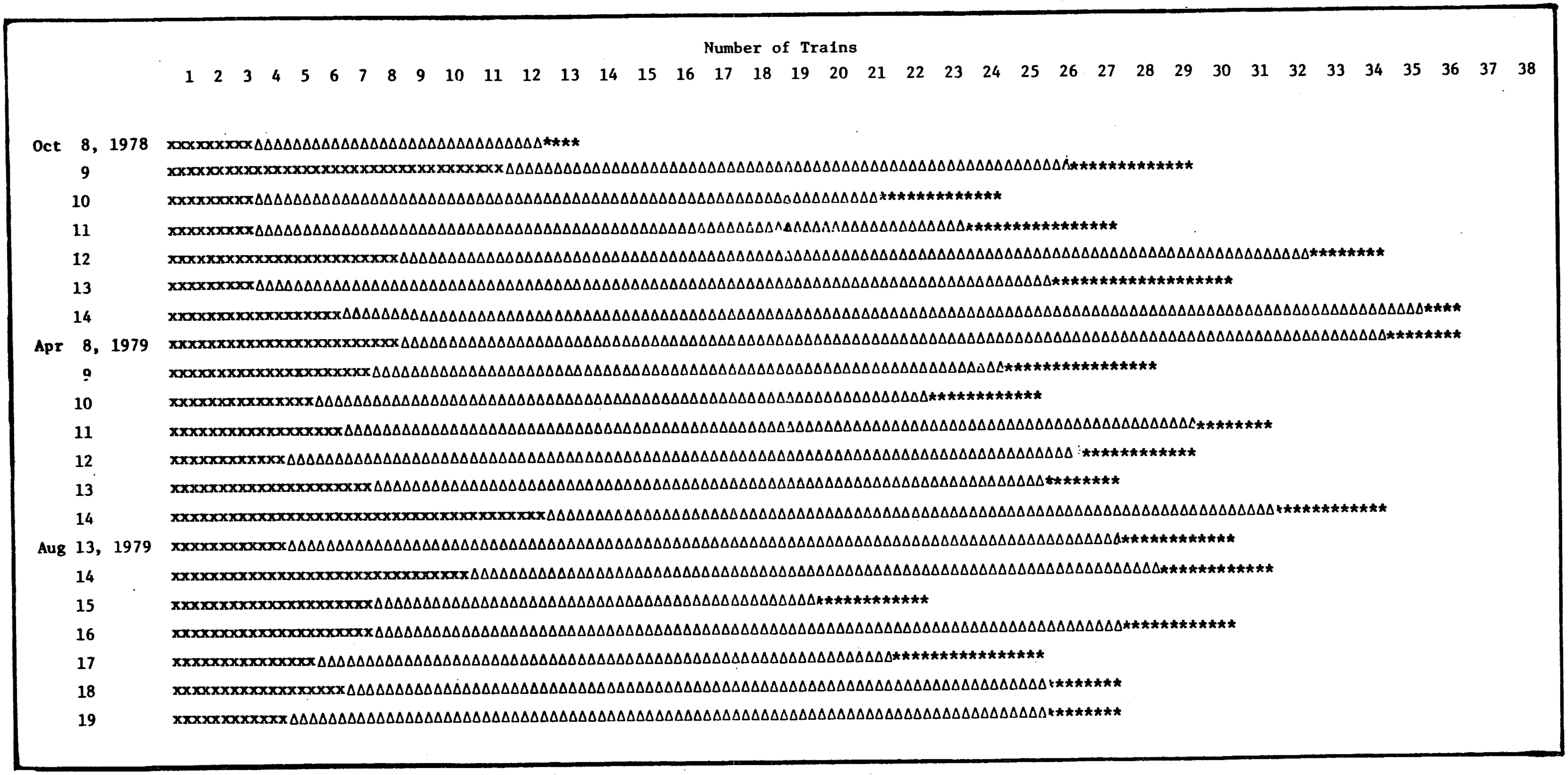
AMOUNT OF TIME CROSSINGS ARE BLOCKED

Prior to the demonstration projects, it was estimated that the average daily amount of time crossings are blocked by train operations in Sauk Rapids was 63 minutes, or 4.4 percent of the 24-hour period. (See Exhibit V-6.) The two minutes per day that crossing warning signals were activated with no train present or approaching was caused by switching operations in St. Cloud just south of Sauk Rapids.

On a day-to-day basis the percentage of blocked crossing time varied from the average shown in the exhibit. The percentage varied as a function of the number and length of trains and train speeds. Based only

EXHIBIT V-4

NUMBER OF TRAIN ARRIVALS PER DAY IN SAUK RAPIDS, MN. DURING A THREE-WEEK OBSERVATION PERIOD



Train Type

xxxxx Coal

ΔΔΔΔΔ Mixed Freight

***** Local

Source: Burlington Northern train sheets.

EXHIBIT V-5

TRAIN OPERATIONS IN SAUK RAPIDS, MN.[1]

Train Type	# Trains		Ave. # Cars	Speed (mph)		# of Trains Stopped[2]
	Average	Range		Average	Range	
Coal	3	1-12	106	42	10-50	
Mixed Frt.	20	12-29	83	38	9-60	
Local	2	1-4	11	21	5-43	
Total	25	13-36	83	38	5-60	

1/ Derivation of the data is described in Chapter II.

2/ Total number of trains stopped in Sauk Rapids during the three-week period was three, too few to be included in the average day profile.

EXHIBIT V-6

AMOUNT OF TIME (IN MINUTES) CROSSINGS ARE BLOCKED IN SAUK RAPIDS, MN ON THE AVERAGE DAY 1/

Train Type	AMOUNT OF TIME (Minutes) CROSSINGS ARE BLOCKED					% of Day Crossings Are Blocked (from Column 5)
	Train Occupancy	Gates/Flashers Activated by a Moving Train	Gates/Flashers Activated with No Train	Total	Total Columns 1&2	
Coal	7	2	-	9	9	0.6
Mixed Freight	32	15	-	47	47	3.3
Local	5	2	-	7	7	0.5
Total	44	19 2/	2	65	63	4.4

1/ Derivation of data is described in Chapter II. The data represent averages for all crossings.

2/ Excludes occasions when gates are activated in excess of 60 seconds prior to train arrival. This occurs with most frequency at 2nd Avenue South and South Broadway. It is estimated to average 4.4 times per day; total amount of time is 27 minutes.

on the variation in number of trains operating in Sauk Rapids, the percentage of time that crossings in the city were blocked ranged from 2 percent to over 6 percent daily.

The amount of time that the crossings were blocked by a single train ranged from less than one minute to eight minutes. The average or expected amount of blocked crossing time per train is 2 1/2 minutes.

PROBLEMS

Results of the mail survey of Sauk Rapids' residents revealed that emergency vehicle delays and vehicle safety were the problems resulting from rail/community conflicts that most concerned residents (see Exhibit V-7). Persons officially representing the city in the study confirmed these results and decided that the case study should focus on the resolution of those two problems. Following is a description of the nature and magnitude of these priority problems in Sauk Rapids, prior to implementation of the demonstration projects. A discussion of general traffic delay also is provided.

Emergency Vehicle Delays

Both the fire service and the ambulance service must cross the main line to respond to emergency calls. This situation creates the potential for experiencing emergency service delays.

The fire service in Sauk Rapids is provided by an all-volunteer squad. The fire equipment is kept at the fire hall located in the northeast part of town, on Benton Drive between 1st and 2nd Streets North. The fire department's service area extends 10 miles to both the north and south of and three miles to the east of the city. When a fire call is

EXHIBIT V-7

RESPONSE OF SAUK RAPIDS RESIDENTS
TO THE PHASE I MAIL SURVEY

Problem	Percent of Residents Who Perceive the Problem to be Serious
Emergency Vehicle Delay	47
Vehicle Safety	41
Pedestrian Safety	24
Access to Work/School	23
Environmental Problems	23
Access to Shopping/ Recreation	19
Community Development Problems	16

received, the volunteers are notified by the sounding of the fire hall siren. Most of the volunteers are located on the same side of the main line as the fire hall, so that no crossing is required to reach the station. At the station, engine companies are formed from the assembled volunteers and they then proceed to the fire. There is one part of the service area that the fire equipment must cross the main line to reach. It is the residential area located between the main line and the river in the southern part of the city. This area contains about 25 percent of the city's population. An average of 17 fire calls per year are made to this area. With a probability of being delayed at a main line crossing of .044, it was estimated that the fire service experienced less than one delay per year in responding to fire calls to this area.

The ambulance service was subject to a substantially greater number of delays. Emergency medical service is provided by a private company located in St. Cloud on St. Germaine Street at 17th Avenue. In responding to emergency calls in Sauk Rapids northeast of the main line and to the area east and north of Sauk Rapids, the TH-15 crossing is used. In responding to the area south of the main line, Division Street to 2nd Avenue is the preferred route. This latter route does not require crossing the main line. Essentially, 100 percent of all medical emergency patients are taken to the hospital. The hospital is located in St. Cloud on 16th Avenue near 12th Street.

It is estimated that the main line at TH-15 must be crossed 800 times annually to provide emergency medical service to Sauk Rapids and beyond. It was further estimated, prior to the demonstration projects, that in 35 of these trips a delay at the crossing was experienced. The delays were split about evenly between those experienced traveling to the emergency site and those experienced traveling to the hospital. The length of delays probably averaged about 2 1/2 minutes, but would range up to 10 minutes. 1/

Vehicle Safety

There were two types of vehicle safety problems in Sauk Rapids. One concerned the safety of private vehicles, and the other concerned the safety of school buses. The safety problems were associated with the southern crossings which were protected only with flashing lights. The problem is compounded by the fact that the tracks are curved near these crossings, limiting visibility of approaching trains. Another factor was the early activation of warning signals at all crossings in the city. Early signal activation is defined as the activation of warning signals a considerable length of time prior to train arrival at the crossing. The circuits that activate the warning signals were located about 2,750 feet from the crossing. This distance was determined by the maximum allowable train speed in Sauk Rapids; it ensured that trains moving at the maximum speed activated the warning signals 25 to 30 seconds prior to train arrival. However, a train moving at 5 mph activated the signals for more than 6 minutes before it entered the crossing; a train speed of 15 mph resulted in signals being activated 2 minutes before the train entered the crossing. In Sauk Rapids, 10 percent of the trains traveled at 15 mph or less.

1/ These are estimates, because records of actual delay were not maintained by the service.

Activation of signals when no train approached the crossings resulted from three situations. First, trains stopped in Sauk Rapids for various reasons (e.g., to conduct train meets or equipment inspection) activated the signals, sometimes for the duration of the stop. This occurred about once every two days in Sauk Rapids. A second, more frequent cause of early signal activation was the conduct of switching operations in St. Cloud, just south of Sauk Rapids. The location of the warning signal circuits often caused the signals to activate in Sauk Rapids when the switching operations were occurring in St. Cloud. This type of early signal activation occurred once per average day in Sauk Rapids. Finally, the signals were activated by local switching operations conducted within Sauk Rapids but not within the crossings. This occurred one time per day as well.

The effect of early signal activation was that motorists, frustrated by the "unnecessary" delay, crossed the main line against the signals, thereby risking a serious accident. The track curvature at some of the crossings and the angular street approach to the crossings hindered visibility of approaching trains and increased the risks associated with crossing against the signals.

Estimates of safety hazard at the crossings in Sauk Rapids indicate that early signal activation increased the potential for crossing accidents by over 60 percent. This meant, according to the estimates, that one crossing accident would occur in Sauk Rapids every year rather than once every year and a half. The concern of city officials for grade crossing safety was heightened by the exposure of school buses to accidents at the crossings. Over 80 main line crossings a day are made by school buses.

Vehicle Delay

As noted earlier, most Sauk Rapids residents are employed in St. Cloud. Many do their shopping and personal business in St. Cloud. To make these trips, in many cases, the main line must be crossed, principally at TH-15. According to the results of the Phase I rail survey, 80 percent to 90 percent of Sauk Rapids' residents must cross railroad tracks in traveling to and from work and shopping. As a result of this situation, Sauk Rapids decided to implement improvements to the TH-15/Benton Drive intersection in order to reduce delays at the TH-15 crossing.

Estimation of vehicle delay in Sauk Rapids showed before the improvements that about 700 vehicles daily were delayed at main line crossings. This translated into 284,000 delayed vehicles annually. With an average delay per vehicle of 1.2 minutes, 5,700 hours of vehicle delay and 8,900 hours of person delay were experienced annually at the crossings. Eighty-six percent of the delay occurred at the TH-15 crossing.

DEMONSTRATION PROJECTS

After considering a variety of low-cost remedial actions (see Appendix B), the following actions were selected by the city council and the Management Board for implementation in Sauk Rapids:

1. Establishment of a rescue squad
2. Establishment of an emergency service/railroad communication system
3. Installation of gates and grade crossing predictors at the 2nd Avenue South, South Broadway, and Ninth Street South crossings. Installation of grade crossing predictors at the TH-15/Benton Drive crossing.

In addition, the effects on crossing delays of the TH-15/Benton Drive intersection improvements, implemented independently of this study, were assessed. While not low-cost compared to other demonstration projects (the improvements cost $1 million), intersections are less expensive than construction of grade-separated crossings or rail relocations. Assessing the effects of this project enabled determination of its relative cost-effectiveness as a way to mitigate rail/community conflicts.

Of the approved demonstration projects only two have been implemented, the emergency communication system and the intersection improvements. (The intersection improvements included installation of grade crossing predictors at the TH-15/Benton Drive crossing.) The rescue squad was not established because funding ($10,000 to $25,000) could not be obtained. Also, the emergency communication system may negate the usefulness of a rescue squad. 1/

Crossing improvements at the 2nd Avenue South, South Broadway, and Ninth Street South crossings have been postponed pending construction of other improvements to those streets. The crossing improvements will cost about $270,000 and could reduce crossing accidents in Sauk Rapids by over 50 percent. Grade crossing delays would be reduced by less than 5 percent.

1/ A rescue squad consists of people trained in basic emergency medical techniques and provided with medical supplies and equipment. The rescue squad provides a first-response capability only. It is not licensed to transport patients. The squad can treat the patient at the emergency scene until the ambulance service arrives. Thus, by locating the squad on the side of the main line opposite the ambulance service, emergency service can be promptly provided even if the ambulance service is delayed at a crossing.

As noted above, the TH-15/Benton Drive intersection improvements were assessed with respect to crossing delays. The improvements were completed in 1981 and included widening approaches in all directions, changing traffic channelization, and introducing a new traffic signalization system. The BN main line is located about 100 feet west of the intersection. A comparison of traffic flows through the intersection before and after the improvements indicates delays associated with railroad operations have been reduced. Vehicles delayed by trains were observed to clear the intersection after a train has passed in almost half the amount of time as before (48 seconds versus 81 seconds on average). Also, normal traffic flow subsequent to a train's departure was restored more quickly. Overall, the improvements have resulted in an 8 to 10 percent reduction in the number of vehicles delayed, a 15 to 30 percent reduction in average delay per vehicle, and a 20 to 35 percent reduction in total vehicle delay time in the 15-minute period subsequent to train departure. The total reduction in vehicle time is 9.3 vehicle hours (about 13 person hours) daily.

As part of the intersection improvements, grade crossing predictors were installed at the crossing adjacent to the intersection. By eliminating early signal activation, the predictors have reduced vehicular delays by about 7 percent and potential crossing accidents by 10 percent. The predictors cost around $60,000 to install.

An emergency service/railroad communication system was established in Sauk Rapids in December. The system provides the ambulance service with a direct telephone line to the local train agent who is stationed in St. Cloud. This system has the potential to eliminate all ambulance service delays at crossings. The potential success is a function of the five-minute lead time (the time from receipt of an emergency call until the ambulance arrives at the crossing), which should be sufficient to circumvent delays by altering train operations. The communication system cost $90 to install and $20 to maintain. The railroad is funding the system.

Exhibit V-8 presents a summary of the demonstration project results.

EXHIBIT V-8

REDUCTIONS IN RAIL/COMMUNITY CONFLICTS IN SAUK RAPIDS
ATTRIBUTABLE TO DEMONSTRATION PROJECTS

Actions Taken	Emergency Service Delays	Vehicular Delays		Crossing Accidents	Cost	
		# Delayed	Delay time		Capital	Annual O&M
Improvements were made to TH15/ Benton Drive intersection.	-8%	-8%	-25%	N/A	$940,000	--
GCPs were installed at the 1st Avenue South Crossing.	-7%	-7%	-10%	-10% 2/	$60,000	$300
An emergency service/railroad communication system was established.	-100% 1/ 2/	N/A	N/A	N/A	$90	$240
Combined Projects	-15%	-15%	-35%	-10%	$1,000,090	$540

1/ Applies only to medical emergencies.

2/ Further observations are required to verify these estimates.

CHAPTER VI

CASE STUDY: ELK RIVER, MINNESOTA

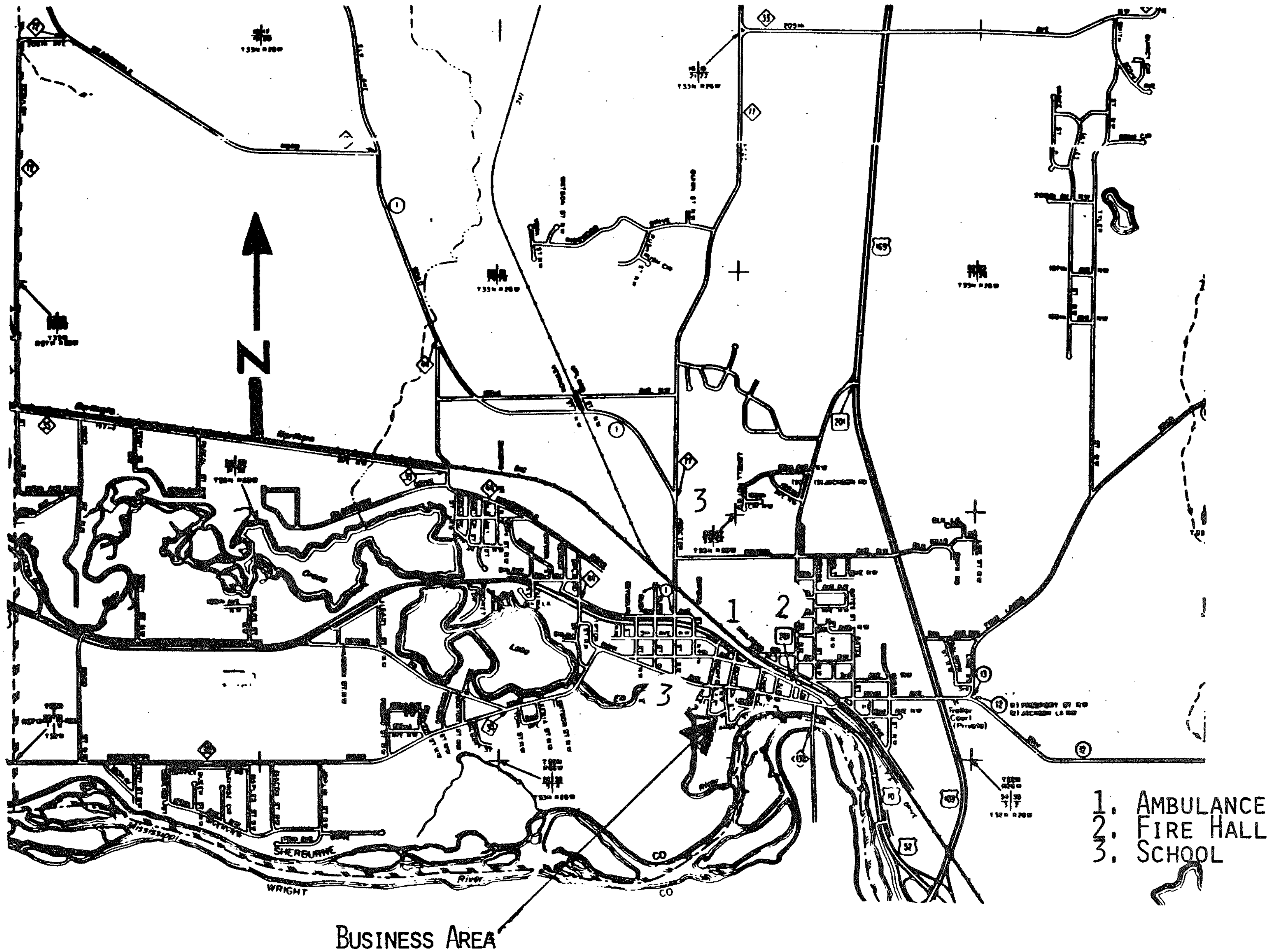
BACKGROUND

Elk River, Minnesota, a community of 7,000 people, is located on the Mississippi River about 30 miles northwest of Minneapolis/St. Paul. The community is split by a double track main line of Burlington Northern, Inc. (BN) (see Exhibit VI-1.) The main line runs in an east/west direction through the city, parallel to the river. Ninety percent of the city's land area is north of the main line. However, the CBD is situated south of the main line and 70 percent of the population resides there. This population includes residential areas outside of the corporate units, south of the river; while this is not within the city boundaries, it is included in the city's community services area.

The city streets are laid out in an irregular pattern, conforming to the contours of the Mississippi River, the Elk River, and the series of lakes located within the city. The street system includes TH-10, a major arterial which runs in an east/west direction through the city, roughly parallel to the main line. TH-169, a dual-lane highway, is on the eastern side of the city. The only grade separation in the city is located on TH-169 and is a three-to five-minute drive from the CBD. The principal

EXHIBIT VI-1

MAP OF ELK RIVER, MN
(Scale: 1" = 3200')



main line crossings in Elk River are at Proctor and Jackson Streets and Main Avenue. All of these crossings are equipped with automatic gates. The annual average daily traffic on the crossings are 520 (Proctor Street), 4,740 (Jackson Street), and 3,780 (Main Avenue). AADT on TH-10 where it crosses Jackson Street is about 13,000 vehicles. 1/

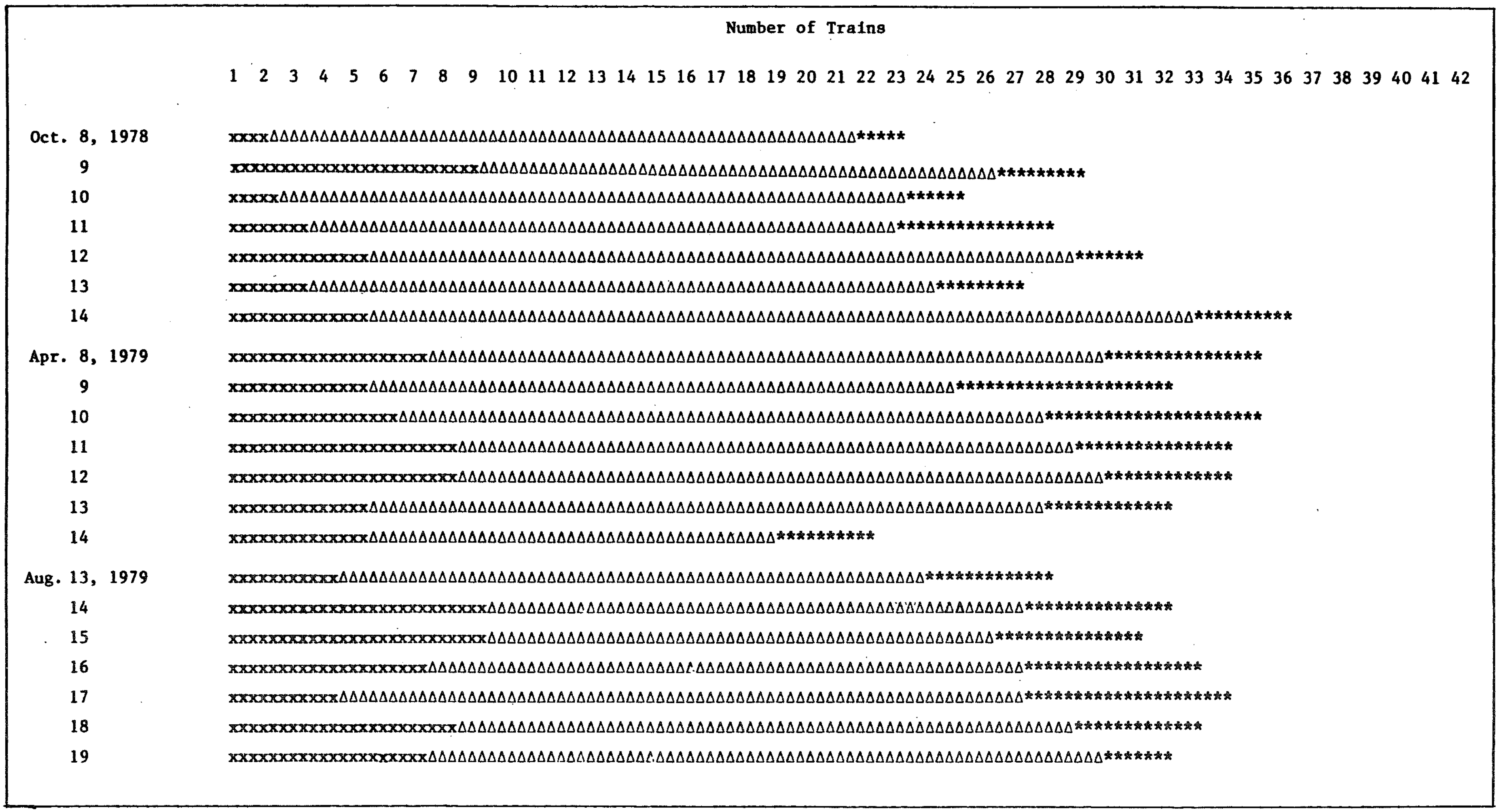
As noted above, the central business district (CBD) is situated south of the main line. More specifically, it is located in the area bounded by TH-10, the Mississippi and Elk Rivers, and Norfolk Street. The location of the CBD is creating difficulties in business development. The community is growing at a rate of about three percent annually. Most development is occurring north of the main line, where the bulk of developable land is located. But development of the business area is constrained by the scarcity of land within the existing CBD and the restrictions that the main line, TH-10, and adjacent residential areas place on the availability of land for business district expansion.

Most employment within the city is located within the CBD or in an area north of the main line. Many Elk River residents commute to Minneapolis/St. Paul to work. Most community facilities and services also are located north of the main line. The fire department and ambulance service are located on Jackson Street. The hospital used by Elk River residents is in Anoka, 10 miles southeast of the city.

1/ Traffic figures were provided by the Minnesota Department of Transportation.

EXHIBIT VI-2

NUMBER OF TRAIN ARRIVALS PER DAY IN ELK RIVER, MN, DURING A THREE WEEK OBSERVATION PERIOD



<u>Train Type</u>

xxxxx Coal

ΔΔΔΔΔ Mixed Freight

***** Local

RAILROAD OPERATIONS

Twenty-five trains pass through Elk River on the average day. Of these, 3 are unit coal trains, 18 are mixed freight trains, and 4 are local trains. On any given day, the number of trains passing through the city varies considerably. The variation, presented in Exhibit VI-2, shows that a range of 23 to 36 trains may pass through the city in a twenty-four hour period. The trains are quite evenly distributed among the days of the week and the hours of the average day, as well. It was found that over time train arrivals in Elk River are evenly distributed between daytime and nighttime. Within these periods no apparent peaking occurs; during most times of the day, no more than two trains per hour pass through the city.

Train operations conducted in Elk River consist primarily of through train movements. Some local switching operations are conducted in the city and an average of 2 trains per day stop in the city for various reasons (e.g., to obtain orders, to conduct pick-up and set-out operations, and to conduct inspections and equipment testing). Average train speed in Elk River is 22 mph. These and other train operating characteristics are summarized in Exhibit VI-3.

AMOUNT OF TIME THE CROSSINGS ARE BLOCKED

Prior to implementing the demonstration projects, the amount of time crossings are blocked by railroad operations in Elk River was estimated for the average day. The estimate was divided into three parts:

- The time trains occupied crossings
- The time gates and/or flashing lights were activated prior to and after through train occupation, and
- The time gates and/or flashers were activated by trains stopped in Elk River but not occupying crossings.

EXHIBIT VI-3

TRAIN OPERATIONS IN ELK RIVER, MN 1/

Train Type	# Trains		Ave. # Cars	Speed (Mph)		# of Trains Stopped 2/
	Ave.	Range		Ave.	Range	
Coal	3	2- 9	106	28	17-37	0
Mixed Freight	18	14-28	83	25	6-42	1
Local	4	1- 7	11	6	3-14	1
Total	25	23-36	83	22	1-45	2

1/ Derivation of the data is described in Chapter II.

2/ Trains stop in Elk River for a variety of reasons, including: (a) to obtain orders, (b) to conduct inspections and equipment tests, and (c) to conduct pick-up and set-out operations.

The estimates of each of these three components and total blocked crossing time are presented in Exhibit VI-4. The exhibit shows that the crossings in Elk River were blocked for over eight percent of the average day. On a day-to-day basis, the variation in number of train operations resulted in a percentage of blocked crossing time varied from slightly under 7 percent to over 12 percent.

Exhibit VI-4 also shows that the automatic gates at the crossings in Elk River were observed to be activated by stopped trains for a significant amount of time (over 50 minutes) per day. This is the amount of time that trains were stopped in Elk River for the various activities noted above. However, this component of blocked crossing time was not included in the blocked crossing calculation because its actual frequency of occurrence was uncertain, but known to be small. Inclusion of this time in the calculation therefore would have overestimated the average day's blocked crossing time.

The amount of time the crossings were blocked by a single train ranges from 2 to 13 minutes, according to field observation. The average or expected amount of blocked crossing time was almost five minutes.

PROBLEMS

Results of the Phase I mail survey revealed that vehicle safety, emergency vehicle delays, and pedestrian safety were the problems resulting from rail/community conflicts of most concern to the Elk River residents (see Exhibit VI-5). Persons representing Elk River confirmed this information but decided that the case study should focus on the resolution of the vehicle safety and emergency vehicle delay problems only. They also

EXHIBIT VI-4

AMOUNT OF TIME (IN MINUTES) CROSSINGS WERE BLOCKED IN
ELK RIVER, MN, ON THE AVERAGE DAY
(Before Demonstration Projects)

Train Type	Amount of Time (minutes) Crossings are Blocked					% of Day Crossings Are Blocked (from Column 5)
	Train Occupancy	Gates/Flashers Activated by a Moving Train	Gates/Flashers Activated by Stopped Trains	Total	Total Columns 1&2	
Coal	9	7	0	16	16	1.1%
Mixed Freight	34	28	13	75	62	4.3%
Local	7	36	40	83	43	3.0%
Total	50	71	53	174	121	8.4%

1/ Derivation of data is described in Chapter II. The data represent the averages for all crossings.

EXHIBIT VI-5

RESPONSE OF ELK RIVER RESIDENTS TO
THE PHASE I MAIL SURVEY

PROBLEM	PERCENTAGE OF RESIDENTS WHO PERCEIVE THE PROBLEM TO BE SERIOUS
Vehicle Safety	35
Emergency Vehicle Delay	33
Pedestrian Safety	29
Community Development Problems	20
Access to Shopping/Recreation	13
Environmental Problems	13
Access to Work/School	11

requested that attention be given to vehicle delays experienced at the Jackson Street/TH-10 intersection since they affect the development of the central business area as well as general accessibility in the city. Following is a description of the nature and magnitude of each of these priority problems.

Vehicle Safety

The residents' concern for vehicle safety had two components: (1) safety at crossings for both general vehicle traffic and for school buses and (2) safety at the intersection of TH-10 and Jackson Street as it is affected by vehicles blocked at the Jackson Street rail crossing.

Despite the fact that the crossings in Elk River were equipped with automatic gates, the safety hazards at the crossings were of concern. One reason for this concern was the frequent occurrence of "early signal activation." That is, with some frequency the gates at the crossings were activated by stopped trains, trains conducting switching operations but not entering the crossing, or slowly approaching trains. In these cases, the gates were down when no train was approaching the crossing or when a train would not enter the crossing for some time. In cases where the train was stopped or was conducting switching operations, the gates were activated for the duration of the train operation. Gates activated and blocking the crossing for 20 to 30 minutes prior to train arrival had been observed in these situations. In the case of a slowly moving train, the gates were activated for up to several minutes before the train arrived at the crossing. This is because the circuits that activated the gates were located a distance from the crossings that ensured the gates were activated about 30 seconds before the fastest-moving train entered the crossing. In Elk River, the circuits were set for trains traveling at 79 mph, i.e., AMTRAK passenger trains. This meant that the circuit was located about 3,500 feet from the crossing. With this spacing, a train traveling at 15 mph activated the gates for 2 1/2 minutes before it arrived at the crossing; a train traveling at 5 mph activated the gates for 8 minutes. It was estimated that 25 percent of all trains travel at 15 mph or less in Elk River.

The effect of early signal activation was that motorists, frustrated by "unnecessary" delay at the crossings, weaved between the gates rather than wait for the train to arrive. The situation was made more hazardous by the track curvature at the crossings, which restrict motorists' ability to see oncoming trains. While no accidents had occurred in the past 2 1/2 years at crossings in Elk River, city officials believed that continuation of this situation would inevitably result in serious mishaps. Estimates of accident potential at the crossings suggested that early signal activation increased safety hazards at the crossing by 40 percent. This meant, according to the estimates, that a crossing accident would occur once every three years rather than once every five years in Elk River. 1/

The second safety problem concerning Elk River residents was the safety hazard at the TH-10/Jackson Street intersection. A schematic of the intersection is presented in Exhibit VI-6. The problem involved impedance

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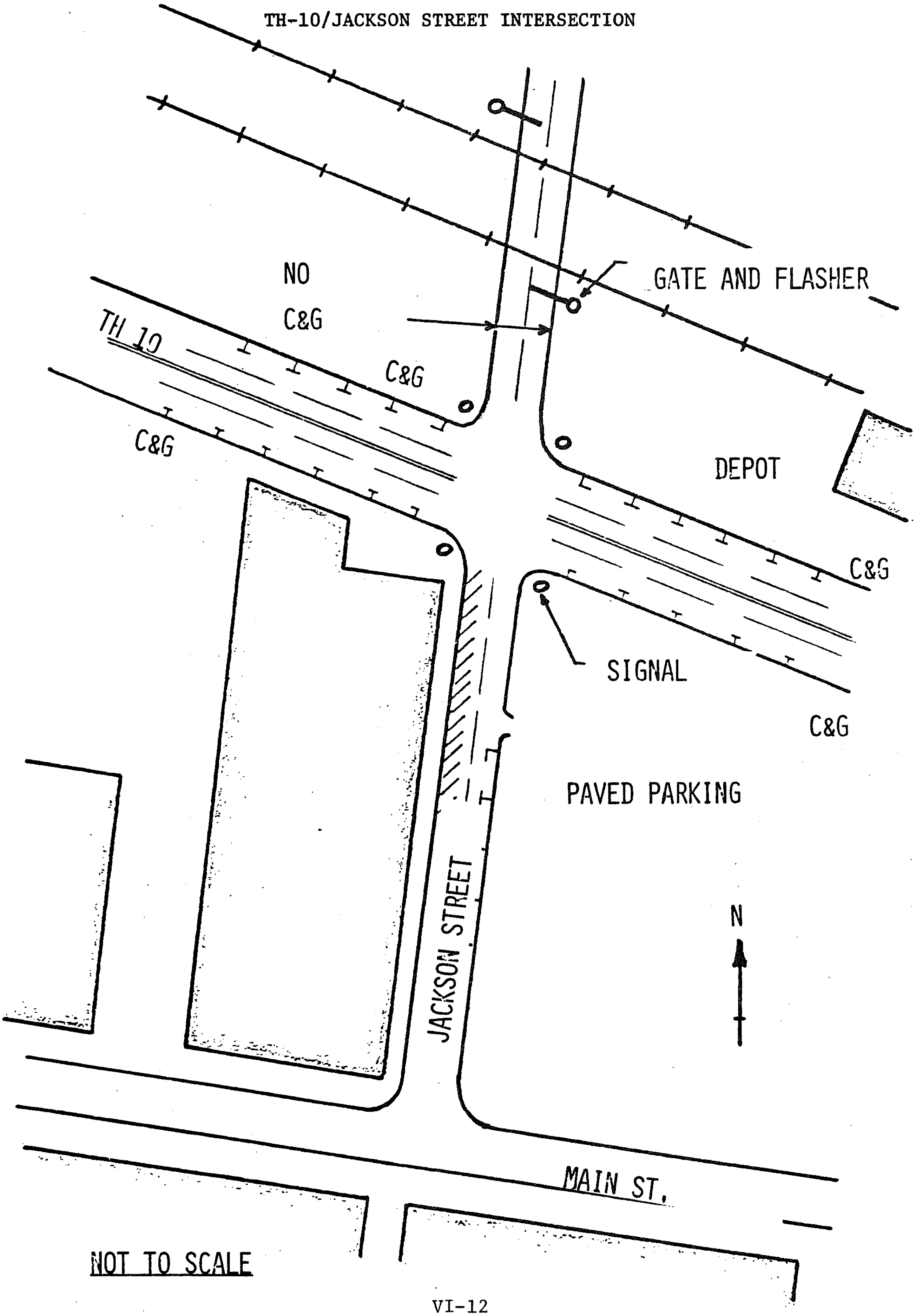
1/These estimates are calculated using formulas derived from national accident experience at rail/highway grade crossings. They should be considered illustrative of crossing hazard; they do not represent accident prediction. (See Chapter 2.)

EXHIBIT VI-6

TH-10/JACKSON STREET INTERSECTION



of traffic flow as a result of the congestion created in the intersection when the Jackson Street rail crossing was blocked. There was room for only one stopped car on Jackson Street between TH-10 and the main line north of it. Similarly, there was little or no capacity on TH-10 for vehicles waiting to turn onto Jackson Street and cross the main line and no place for vehicles traveling south to north on Jackson Street to wait while the crossing is blocked. Consequently, when the Jackson Street crossing was blocked by train operations, vehicles waiting to cross the main line congested the intersection. Traffic backed up on TH-10 in both directions and on Jackson Street and Main Avenue in the central business district. As through traffic attempted to proceed through the intersection, around the waiting vehicles, the potential for accidents was increased. Police records show that an average of eight accidents occurred at this intersection annually. The records, however, did not indicate whether these accidents occurred during a situation as just described.

A final element in crossing safety at Jackson Street was the poor coordination between the automatic gates at the crossing and the traffic signals at the intersections on either side of the crossing. The result was that vehicles were observed to become trapped within the crossing when the gates were activated by an approaching train. The trapped motorists' ability to "scatter" out of the path of the train, sometimes breaking gate arms, has prevented any accidents from occurring so far, but the potential for serious accidents to occur in these circumstances remained.

Because of the hazard associated with the Jackson Street/ TH-10 intersection, school buses, which make over 120 main line crossings each day, were routed away from the Jackson Street crossing. The use of other crossings, however, was considered the lesser of evils since the other crossings had disadvantages as well. At Main Avenue, the approach to the crossing is sufficiently steep to cause traction problems in icy conditions. Once a bus gained sufficient momentum to make it over the crossing, it was difficult to stop for a train. There have been incidents where school buses have hit gates or have been hit by gates at this crossing. Proctor was considered a safer crossing. However, conflict with switching operations was more frequent at Proctor than at the other crossings, making delay at this crossing a more frequent and lengthier occurrence.

Emergency Vehicle Delays

Elk River provides fire and emergency medical service to residential areas beyond the corporate limits as well as within the city. The frequent necessity to cross the main line in responding to emergencies creates the potential for experiencing delays in providing service.

The fire department in Elk River is located a few blocks north of the main line. It is an all-volunteer force. When an emergency occurs, the volunteers are notified by the sounding of a fire siren. They go to the fire house, man the equipment, and proceed to the fire as soon as a sufficient number of volunteers are prepared. Three engines are dispatched to respond to each call. The engines disperse in different directions if the primary crossing to fires located south of the main line (Jackson Street) is blocked.

With this system, two types of delay may be experienced: (1) volunteers may be delayed while traveling to the fire station; (2) the engine companies may be delayed in traveling from the fire station to the fire location.

In recent years, the fire department responded to 90 fire calls annually. In all cases, volunteers were required to cross the main line to reach the station. In two-thirds of the cases, the fire was located south of the main line and thus required the main line to be crossed. Based on these characteristics and the characteristics of train operations in Elk River, it was estimated that 10 delays per year were experienced in responding to fire calls. 1/ Six of these delays were experienced by volunteers traveling to the fire station and thus inhibited an immediate, full response to the call. The remaining four delays were experienced by the engine companies as they traveled to the fire and meant a delay in any response to the call. The expected (average) delay in each situation was estimated to be 2 1/2 minutes; delays ranged from a few seconds to 13 minutes or more.

The ambulance service is in essentially the same situation as the fire service. The ambulance service is staffed by an all-volunteer force. The ambulance is kept in the fire station. Thus, like the fire service, delays to volunteers traveling to the fire station after being notified of a medical emergency and delays in traveling from the fire station to the emergency location may be experienced. Because the main line does not have to be crossed in traveling from the emergency location to the hospital in Anoka (the TH-169 grade separation can be used) delays for this part of the emergency response are not experienced.

1/ Fire service and ambulance delays described are estimated based on probability calculations. Records of actual delays were unavailable.

The ambulance service averages 180 medical emergency calls per year. It was estimated that in 10 percent of these calls a delay was experienced at a rail crossing. Of the 18 expected delays per year, 10 were experienced as the ambulance was being driven to the medical emergency site; the other 8 were delays to volunteers as they traveled to the fire station. As with fire service delays, the estimated length of delay was 2 1/2 minutes, but any given delay ranged from a few seconds to over 13 minutes.

The potential consequences of ambulance delays at crossings are not clear. They will depend on the specific emergency situations and the difference that a delay will make in effectively responding to these situations. Given general statistics on medical emergencies, in perhaps five percent of the cases, or in one of the eighteen delays projected annually, the delay will involve life-threatened patients. It is not possible, however, to estimate in how many of these cases a delay will affect patient outcome. The consequences of fire service delays similarly cannot be estimated with any confidence. (For further discussion of this issue, see Appendix A, "The Consequences of Delay".)

<u>Vehicle Delay</u>

As noted above, community officials representing Elk River in the study considered vehicle delays at crossings to be a problem deserving concern and resolution. While vehicle delay at all three crossings in the city was of concern, there was particular interest in reducing delays at the Jackson Street crossing and the adjacent Jackson Street/TH-10 intersection. Congestion at this intersection when the crossing was blocked caused delay not only to through traffic on TH-10, but also to motorists conducting business, traveling to and from work, or shopping in the central business district (CBD). When the Jackson Street crossing was blocked, traffic was often backed up into the CBD on Jackson Street and Main Avenue.

It was estimated that on the average day, 670 vehicles were delayed at blocked crossings in Elk River. The average delay per vehicle was estimated to be 2 1/2 minutes. This daily delay translates into the following delay estimates on an annual basis:

- 245,000 vehicles
- 9,800 vehicle-hours
- 13,700 person-hours

The Jackson Street crossing accounted for about two-thirds of the vehicle delay experienced in Elk River. However, the delay figures presented above include only delay to motorists waiting to cross the main line. At the Jackson Street crossing, the delayed vehicles also congested the Jackson Street/TH-10 intersection, causing delay to other motorists. It was estimated that this situation resulted in additional delay per year of 60,000 vehicles, 1,200 vehicle hours, and 1,700 person hours. The effect that this delay had on business activity in the CBD is unknown. It was apparent, however, that it did disrupt activity in this area to some extent.

DEMONSTRATION PROJECTS

The City Council, and subsequently the Management Board, approved three actions for implementation as demonstration projects in Elk River. The actions were (1) Jackson Street/TH-10 intersection improvements, (2) a fire service/railroad emergency communication system, and (3) grade crossing predictors for installation at all three crossings. The latter two projects were implemented. The intersection improvements have been postponed. Because more extensive changes to the intersection may be implemented within the next few years, Mn/DOT decided to postpone possible implementation of the project. The recommended improvements would have increased intersection capacity within the existing right-of-way by (1) removal or on-street parking to allow turning lanes to be established, (2) redesign of an off-street parking lot, and (3) installation of a new system to improve the flow of traffic through the intersection and to resolve the "trapped motorists" problem (see Exhibit VI-7 for details). These improvements were estimated to cost about $25,000 and were expected to reduce vehicle delay at the intersection by 15 to 40 percent. Safety conditions also were expected to improve.

The two projects that were implemented have resulted in significant reductions in vehicular delays and are expected to reduce emergency service delays and grade crossing accidents. Vehicular delays have been reduced by 25 percent, which is attributable to installation of the grade crossing predictors. Vehicular delay time was reduced by 55 percent. The grade crossing predictors also may result in a 35 percent decline in crossing accidents. Observations conducted after the predictors were installed indicate that motorists no longer risk drive around the gates; this change was observed by the police chief as well. The actual effectiveness of the predictors with respect to safety will take several years to establish.

EXHIBIT VI-7

RECOMMENDED CHANGES TO THE JACKSON STREET/TH 10
INTERSECTION IN ELK RIVER, MINNESOTA

Remove parking on south side of Trunk Highway 10 to the west of Jackson between Jackson and the block to the west for approximately 700 ft.

Provide left-turn storage on Trunk Highway 10 for eastbound Trunk Highway 10 turning north on Jackson.

Provide left-turn storage lane on northbound Jackson south of Trunk Highway 10 for left-turning motorists desiring to travel on westbound Trunk Highway 10.

Remove first two angle parking spaces along southbound Jackson to south of Trunk Highway 10. Removal of two spaces is necessary to prevent parkers from backing into TH 10 stream.

Remove parking spaces on east side of Jackson adjacent to parking lot south of Trunk Highway 10. This will be reserved for through and right-turn vehicles only. This will be required to prevent unsafe swerving movements for northbound motorists.

Remove parking on the south side of Trunk Highway 19 to the east of Jackson for about 430 ft. This will be used to provide through movement for vehicles on Trunk Highway 10.

Remove parking on north side of Trunk Highway 10 to the east of Jackson. These spaces are south of the B-N depot.

Provide left-turn storage lane on Trunk Highway 10 for westbound motorists desiring to turn left onto southbound Jackson.

Remove parking on the north side of Trunk Highway 10 to the west of Jackson.

The installation of grade crossing predictors also has benefited the school bus operation. As noted earlier, the buses are driven over the Proctor Street crossing for safety reasons, but experienced significant delays (of 20 to 30 minutes) due to early signal activation. Records kept by school system officials reveal that no significant delays have been eliminated.

The grade crossing predictors benefit emergency services as well. By reducing blocked crossing time attributable to early signal activation, fewer emergency service delays will be experienced. In addition, an emergency service/railroad communication system was established in December. While there has been insufficient experience with the system, it is expected to reduce emergency service delays to 30 percent. The combination of the grade crossing predictors and the communication system could reduce emergency service delays by 50 percent.

The cost to implement the demonstration projects was $114,670; the communication system cost $90 to install and will cost $20 monthly plus long-distance service charges to operate. The grade crossing predictors cost $114,580 to install. The railroad paid for the communication system. The state funded 95 percent of the grade crossing predictors installation cost (federal funds accounted for 95 percent of this total). The railroad and local governments funded the remaining 5 percent.

A summary of the demonstration project results is presented in Exhibit VI-8.

EXHIBIT VI-8

REDUCTIONS IN ELK RIVER RAIL/COMMUNITY CONFLICTS ATTRIBUTABLE TO DEMONSTRATION PROJECTS

Actions Taken	Emergency Service Delays	Vehicular Delays		Crossing Accidents	Cost	
		# Delayed	Delay time		Capital	Annual O&M
GCPs were installed at all crossings.	-25%	-25%	-55%	-35%*	$114,580	$1,000
An emergency service/railroad communication system was established.	-30%*	N/A	N/A	N/A	$90	$240
Combined Projects	-50%*	-25%	-55%	-35%	$114,670	$1,240

* Requires further observation to verify estimated effects.

CHAPTER VII

CASE STUDY: BEACH, NORTH DAKOTA

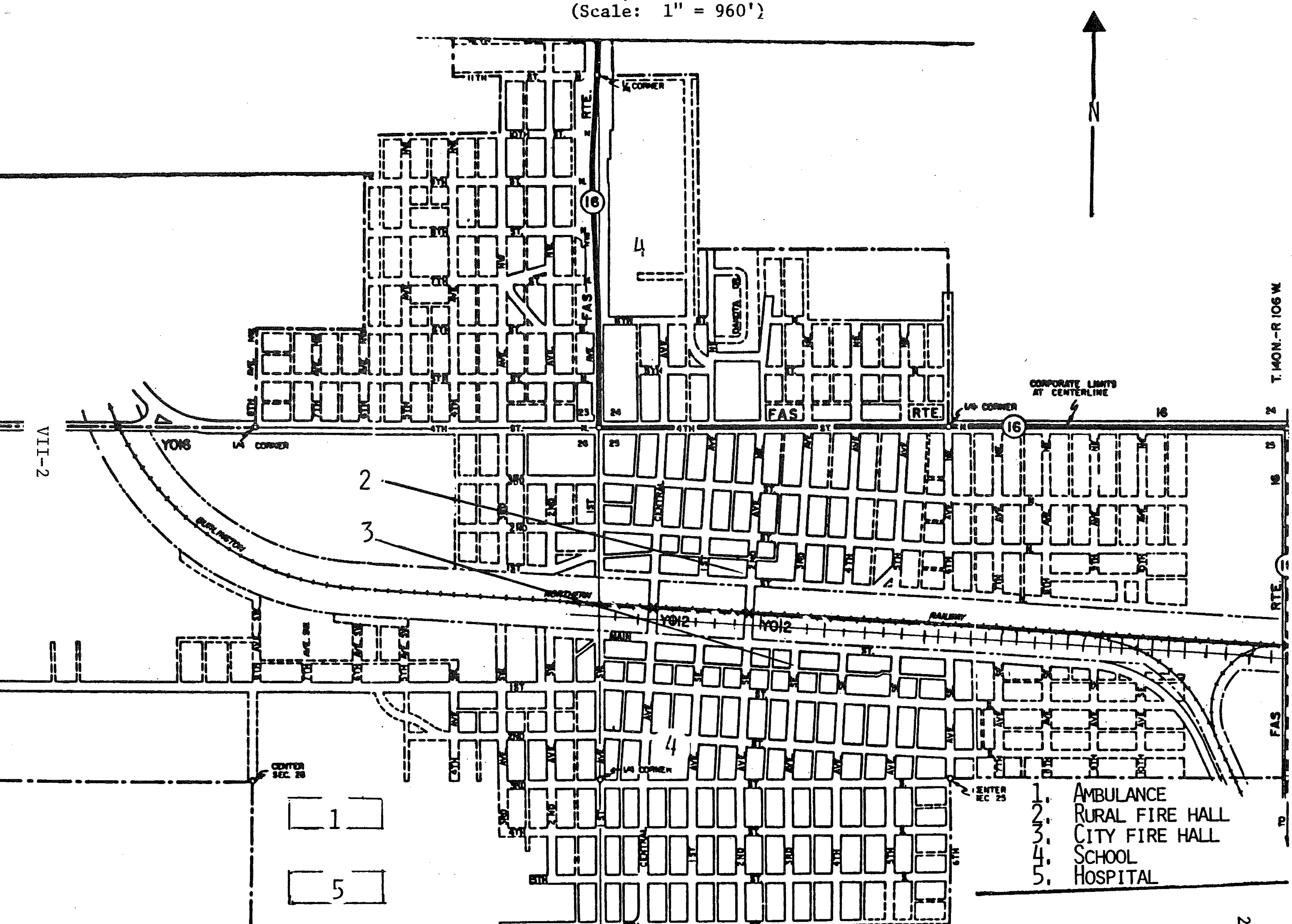
COMMUNITY CHARACTERISTICS

Beach is situated on the western end of North Dakota, near the Montana state line. Its population numbers approximately 1,500 and is growing because of the energy industry boom in the area. Slightly more than half (55 percent) of the community residents live north of the Burlington Northern main line. (See Exhibit VII-1.) The central business district is located along Central Avenue, the main arterial in Beach, perpendicular to the rail line and to the south of it. Access to I-94, approximately 1 mile north of Beach, is made via State Highway 16, which skirts the community on the north and east.

Many of the existing community services are located south of the main line, including the hospital, situated in the southwest corner of Beach at 5th Street and 2nd Avenue SW; one of the city fire trucks, located in a new fire station on Main Street; the elementary school, between Central, 1st Avenue, 2nd, and 3rd Street; and the County Office Building on 1st Avenue SE between 1st and 2nd Streets. (Beach is the County Seat for Golden Valley County.) North of the main line are located the high school and the Fire Barn for the city and rural fire trucks.

EXHIBIT VII-1

BEACH, NORTH DAKOTA
(Scale: 1" = 960')



As in most North Dakota communities, the streets in Beach are in a gridiron pattern. There are two railroad crossings at Central and 2nd Avenues. Central Avenue is the more travelled street, with average daily traffic of 4,900; 2nd Avenue handles approximately 1,200 cars each day. There are two additional crossings outside the community along the westerly extension of 4th Street N and State Highway 16, to the east of Beach. Neither one of these two crossings is used for travel within town. The rail-related problems in Beach stem from two primary factors: (1) the existence of a siding used for train meets that parallels the main line through the length of the city and (2) the fact that there are only two crossings linking one side of Beach to the other.

RAILROAD OPERATIONS

On the average day, there are 15 trains operating in or through Beach. Twelve of these are unit coal trains, and three are mixed freight trains. There are no longer any passenger trains operating through Beach. Train traffic has decreased by approximately 20 percent since the study was begun two years ago. In 1979, an average of 19 trains per day passed through Beach; thirteen were coal trains, five were mixed freight trains.

Three types of train movements occur in Beach: (1) through movements, (2) switching movements associated with local service, and (3) movements into and out of the siding by unit coal and mixed freight trains primarily for the purposes of conducting train meets. The siding in Beach, shown in Exhibit VII-1 above, begins some 250 feet west of Central Avenue and runs easterly for more than two miles. The siding is on the south side of the main line.

Train arrivals vary somewhat throughout the week (see Exhibit VII-2). Arrivals by time of day are fairly uniform. On average, approximately 70 percent of the trains arrive during the daytime hours of 5:30 a.m. to 8:30 p.m. One train usually arrives during the afternoon peak period (for street and highway travel) of 4 to 6 p.m. and one train arrives between the hours of 6 p.m. to 8 a.m. The maximum train speed through Beach is 50 mph. However, most trains were observed to pass through at between 25 and 40 mph. Summary statistics for train movements are shown in Exhibit VII-3.

PROBLEMS

The residents of Beach were surveyed for their opinions concerning rail/community conflicts in early 1979. Based on the survey results and interviews with city representatives, four major problem areas were designated as priority problems in Beach to be addressed in the study. These areas are, in order of priority:

- Vehicle Safety
- Emergency Service Delay
- Pedestrian Safety
- General Vehicular Delay

It is noteworthy that the existing and potential problems in Beach are less a function of the number of trains operating in Beach than the type of operations that are conducted. If the trains travel through without stopping, delay problems are relatively small, given the train volume. If, on the other hand, train crews stop trains just short of

EXHIBIT VII-2

NUMBER OF TRAIN ARRIVALS PER DAY IN BEACH, N.D., DURING FOUR WEEKS IN 1978-79

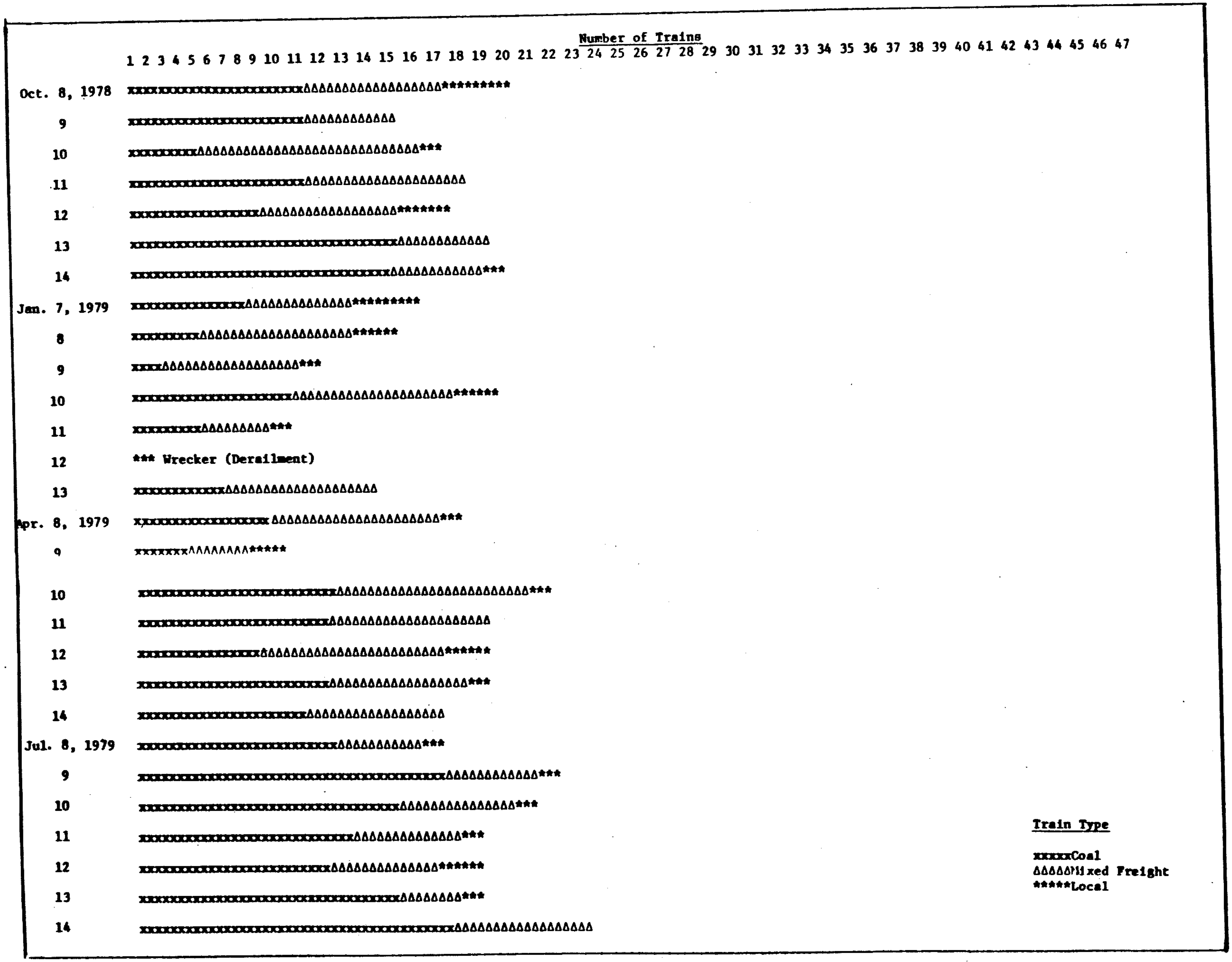


EXHIBIT VII-3

TRAIN OPERATIONS IN BEACH, NORTH DAKOTA
ON THE AVERAGE DAY

(Before Demonstration Projects)

Train Type	# Trains Ave.	# Trains Range	Average # Cows	Speed (MPA) Ave.	Speed (MPA) Range	# Trains Stopped
Coal	12	9-15	104	--	--	3
Mixed Freight	3	1-4	80	--	--	1
Local	< 1	0-1	10	--	--	1
Total	15	12-19	90	27	25-40	5

crossings and create visual obstructions or block the crossings completely, or if the crews do not allow motorists to clear the intersection before they return to the main line after the train meet is completed, problems of significant magnitude result.

The next sections describe the characteristics of the priority problems.

Vehicle Safety

The vehicle safety issue in Beach was the function of several factors: (1) crossing protection characteristics; (2) number and types of train operations; (3) obstructed views for both southbound and northbound motorists; and (4) motorists behavior.

Prior to the demonstration projects, the protection signals at both of the main crossings in Beach were flashing lights. Since the flashing lights were activated by trains at a fixed distance from the crossings, a slow-moving train could set off the warning several minutes before the train arrived at the crossing. Further, when there were trains parked on the main line or the siding midway between the two crossings, the signals were activated for as long as the train stood there. Experience with these situations led motorists to consider the lights as a warning, rather than as a prohibition to cross. This impression led motorists to cross the line despite the warning lights and thus increased the likelihood of auto/train accidents.

Obstructed views for motorists compounded the crossing safety problem. When trains on the siding stopped just short of Central Avenue so that the crossing was opened but the crossing signals activated, the parked train obstructed motorists' view of the main line. Therefore, motorists risking to cross against the signal in the absence of a moving train were not able to see whether a train was approaching on the main line. This further heightened the possibility of crossing accidents. Adding to crossing hazard at Central Avenue was the storage of lumber by a local firm adjacent to the tracks near the crossing. This prevents southbound motorists crossing against the signal from seeing eastbound trains until the automobile is very close to the tracks.

The other concerns over safety related to the existence of crossbuck protection at the westerly extension of 4th Street N. The approach geometrics are poor, creating a hazardous crossing, especially during winter months when whiteouts occur. This was the cause of a fatal auto-train collision which occurred in January 1978.

Emergency Vehicle Delay

Fire protection service is provided from two locations: (1) the city/rural fire barn immediately to the north of the main line and (2) the City Hall location south of the main line. Two rural trucks and the city pumper were garaged north of the tracks and one city truck was on the south side. There are 35 volunteers for both systems and all persons are on-call at all times. Notification of a fire emergency is made with the siren at the fire station.

The rural fire area covers six and one-half townships around Beach. Rural fire units also respond to city calls. City fire trucks can respond only to nearby rural calls. The city pumper, however, stays within the city limits at all times.

Crossing delays were a concern when rural fire calls came from south of Beach, since all rural vehicles are garaged to the north of the tracks, or when the pumper was needed south of the line. In these cases, there was the potential for fire trucks to be delayed at main line crossings. The city and rural fire services respond to about 12 fire calls annually. There were no recorded instances in which fire trucks were delayed at the crossings.

Ambulance service is provided from the hospital, located in the southwest corner of the community. The service is operated by 20 to 25 volunteers, located throughout Beach. A minimum of two persons are on call at any one time. The ambulance serves Beach and all of Golden Valley County. Emergency calls are made to the hospital; volunteers then are notified by the hospital dispatcher through the scanners which they carry on their persons. Only once during 1977-1978 was the crew delayed at a crossing. However, the opportunity for delay at crossings is possible whenever calls are made from north of the main line.

Pedestrian Safety

The problem of pedestrian safety in Beach arises because of the existence of high-speed trains, an open right-of-way where one can walk across the tracks at any point between 2nd and Central Avenues, and a substantial number of senior citizens and school children who cross the main line as pedestrians on a daily basis (approximately 450 crossings per day, combined). The pedestrian safety problem is not supported by a history of accidents. No pedestrian accidents have been recorded, revealing the preventive orientation of the community in this problem area.

General Vehicular Delay

There are two major facets to this problem: the location of the siding and the way in which the siding is used. Because the siding through Beach is 11,000 feet long, it is just long enough to hold two long trains (unit coal trains average 5900 feet and mixed freight trains 4900 feet.) In 1979, neither of the nearest passing sidings to the east or west of Beach were long enough to accommodate a coal train. As a result, the siding at Beach was frequently used (by 4 trains per day, on average) and at times was occupied by two trains simultaneously. However, when two long trains occupy the siding, or when a single west-bound train pulls up to the end of the siding, west of Central Avenue, to allow room for a second west-bound train on the siding, both crossings are blocked. Data from BN conductor delay reports for 4 representative weeks in 1978-1979 show that the average time in the siding per train was 70 minutes. Therefore, any time that the western end of the siding was used, and the train was not broken at a crossing, movement between the two parts of Beach was halted for an extended period of time.

DEMONSTRATION PROJECTS

In the second phase of the study, a list of low-cost actions that would address one or more of the identified problems was developed. Each action was evaluated for feasibility, for conformity with the community's priorities, and for its generalizability as a demonstration project. (Details of this procedure are presented in Appendix B.) From this evaluation, the following projects were selected for implementation.

(1) Relocate the siding (relocate the lead to the east of 2nd Avenue) and rearrange trackage to provide for this change,

(2) Install power switches at both ends of the siding as part of the BN's program to install centralized train control on the main line, and

(3) Install gates and grade crossing predictors at the 2nd Avenue and Central Avenue crossings.

As of December 1981, the demonstration projects in Beach had not all been implemented. Because of the downturn in the economy, the Burlington Northern deferred part of its capital program, including two projects intended for Beach--installation of the power switches on the siding, and relocation of the siding to outside of Beach. However, other actions were taken by the BN which reduced the use of the siding in Beach from its 1979 level, and thus provided much of the intended effect of the siding relocation. That is, the passing tracks east and west of Beach, at Sentinel Butte and Yates, respectively, were lengthened to accommodate coal trains. As a result, the use of the siding in Beach was decreased from 4 to 2 1/2 trains daily.

The grade crossing predictors and automatic gates were installed at the two crossings in Beach, and also at the Highway 16 crossing east of Beach, in early 1981. In late 1981, the signals were observed to be working as expected, with a quite uniform warning time regardless of train speed. A summary of each project's status and actual cost is in Exhibit VII-4.

In evaluating the extent to which the demonstration projects were effective in reducing the rail/community problems in Beach, comparison was

EXHIBIT VII-4

STATUS OF DEMONSTRATION
PROJECTS IN BEACH

December 1981

Action	Status	Cost
Relocate Siding Out of Beach	Deferred	N/A
Install Gates & Grade Crossing Predictors	Installed; accepted by NDSHD October 1981	$ 24,614
Install Power Switches	Deferred indefinitely	N/A
Lengthen sidings east and west of Beach	Completed	$500,000

made between what the size of the problems would be today without versus with the project. Overall, the projects have reduced rail/community problems relative to what they would have been without the projects. The effect of the crossing protection improvements and siding changes together has been to make general vehicle delay 15 percent lower than it would be without the project, and to decrease the probability of emergency vehicle delay by 15 percent. The crossing protection improvements reduce the estimate of crossing accidents by over 77 percent relative to what it would be without the project - from one every 18 months to one every 6 1/4 years. A summary of the evaluation findings is in Exhibit VII-5.

The reduction in estimated crossing accidents was brought about only by the crossing protection improvements. However, both the protection improvements and the siding changes influenced the estimated reductions in vehicle delays. A further analysis of the two indicates that, given the characteristics of through train movement and number of trains using the siding in Beach, 70 percent of the estimated reduction in delays is accounted for by the installation of the grade crossing predictors, and 30 percent by the decrease in the percentage of through trains that are scheduled onto the passing track at Beach.

EXHIBIT VII-5

BEACH-PROJECT SUMMARY

(effect of all projects)

	Without 1/	With 2/	Percent Change
Probability of delay	5.4%	4.6%	-15
Estimated ambulance delays/yr.	12.5	10.7	-14
Estimated fire delays/yr. 3/	0	0	0
Estimated auto/train accidents/yr.	.67	.2	-77
Yearly vehicles delayed	120,400	102,590	-15
Yearly vehicle hours of delay	5,260	3,815	-28
Yearly person hours of delay	7,360	5,340	-28

1/ Based on 11.7 through trains, 3.3 trains (22% of non-local trains) on siding, 0 local trains, 4900 ADHT Central Ave., 1210 ADHT 2nd Ave., flashing lights crossing protection.

2/ Based on 12.4 through trains, 2.4 trains (16% of non-local trains) on siding, 0 local trains, 4900 ADHT Central Ave., 1210 ADHT 2nd Ave., automatic lights and grade crossing predictors crossing protection.

3/ Beach now has fire equipment on both sides of the tracks.

CHAPTER VIII

CASE STUDY: HEBRON, NORTH DAKOTA

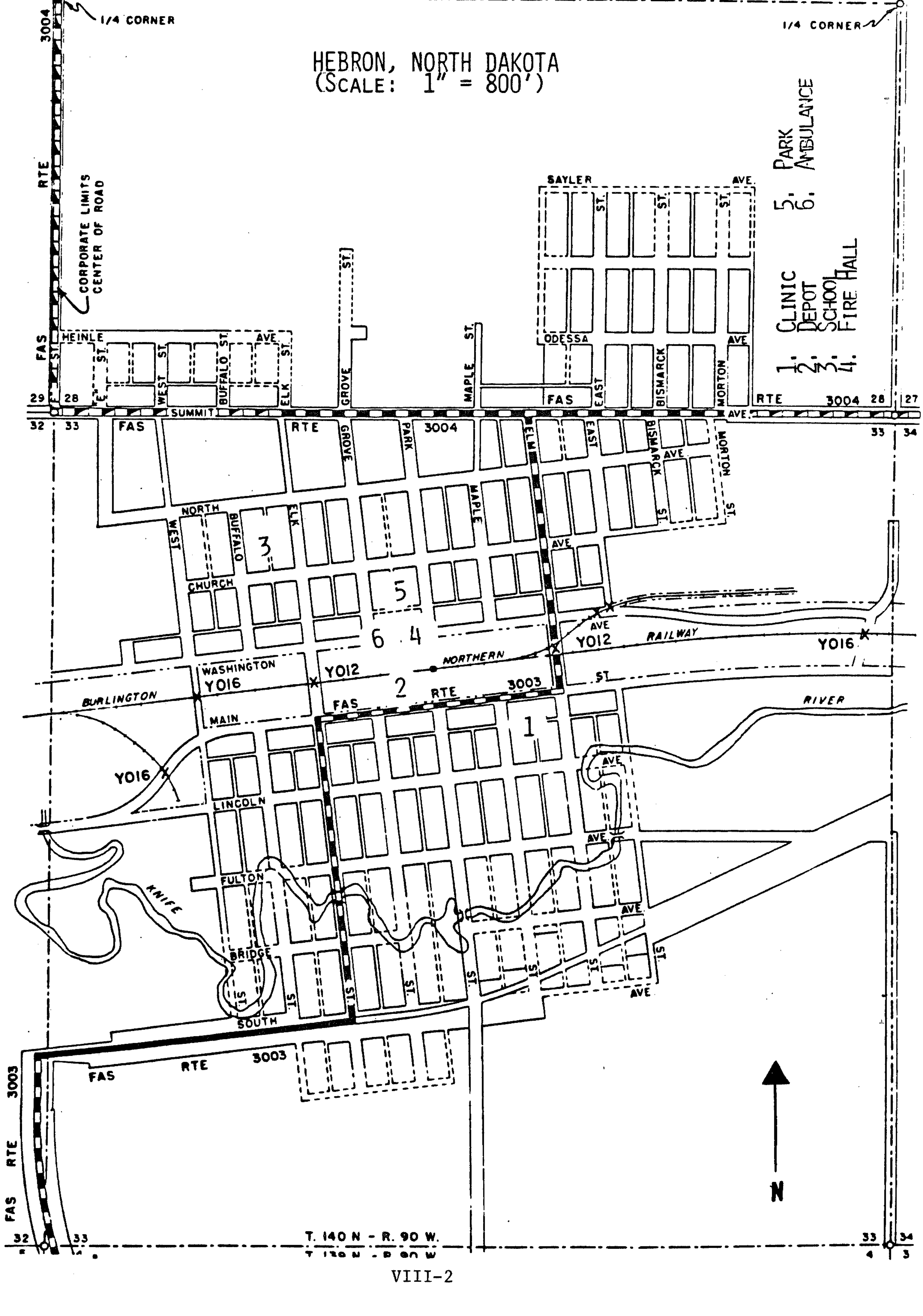
COMMUNITY CHARACTERISTICS

Located some 40 miles east of Dickinson and 60 miles west of Bismarck, Hebron is a community of approximately 1,100 persons in western Morton County. The Burlington Northern main line bisects the community almost evenly, with half the population residing north of the main line and the other half residing south of the main line. (See Exhibit VIII-1.) Access to I-94 is gained by two interchanges some two miles south of town.

Most of the commercial activity in Hebron is located south of the main line along Main Street (FAS Route 3003), where one finds grain elevators, implement dealers, cafes, a grocery store, and the town's only medical clinic. North of the main line are located the fire barn (where the city offices are situated) on the northwest corner of Park and Washington Avenues; the school, located between Church and North, Buffalo and Elk Streets; and the city park, to the north of the Fire Barn. Hebron is approximately one-half mile wide from east to west and three-quarters of a mile wide from north to south.

The street system is a gridiron pattern. There are three grade crossings in the community, at West Street (315 AADT), Elk Street (1650

EXHIBIT VIII-1



VIII-2

AADT), and Elm Street (1775 AADT). Prior to the demonstration projects, all streets were currently protected by flashing lights.

The major community services are provided by the combination of fire, police, and ambulance service from the fire barn on the north side and emergency medical treatment from the clinic on the south side. Should major medical treatment be required, patients are transferred to the hospital at Richardton, some 12 miles to the west.

Largely due to the high percentage of senior citizens in the community (nearly 30 percent) and to the lack of expanding industrial activity in the area, Hebron's population is quite stable and is not expected to grow during the next decade. Owing to the large number of senior citizens and to school children on the south side who walk to the north side school, there is substantial pedestrian traffic across the main line, mostly at the train depot.

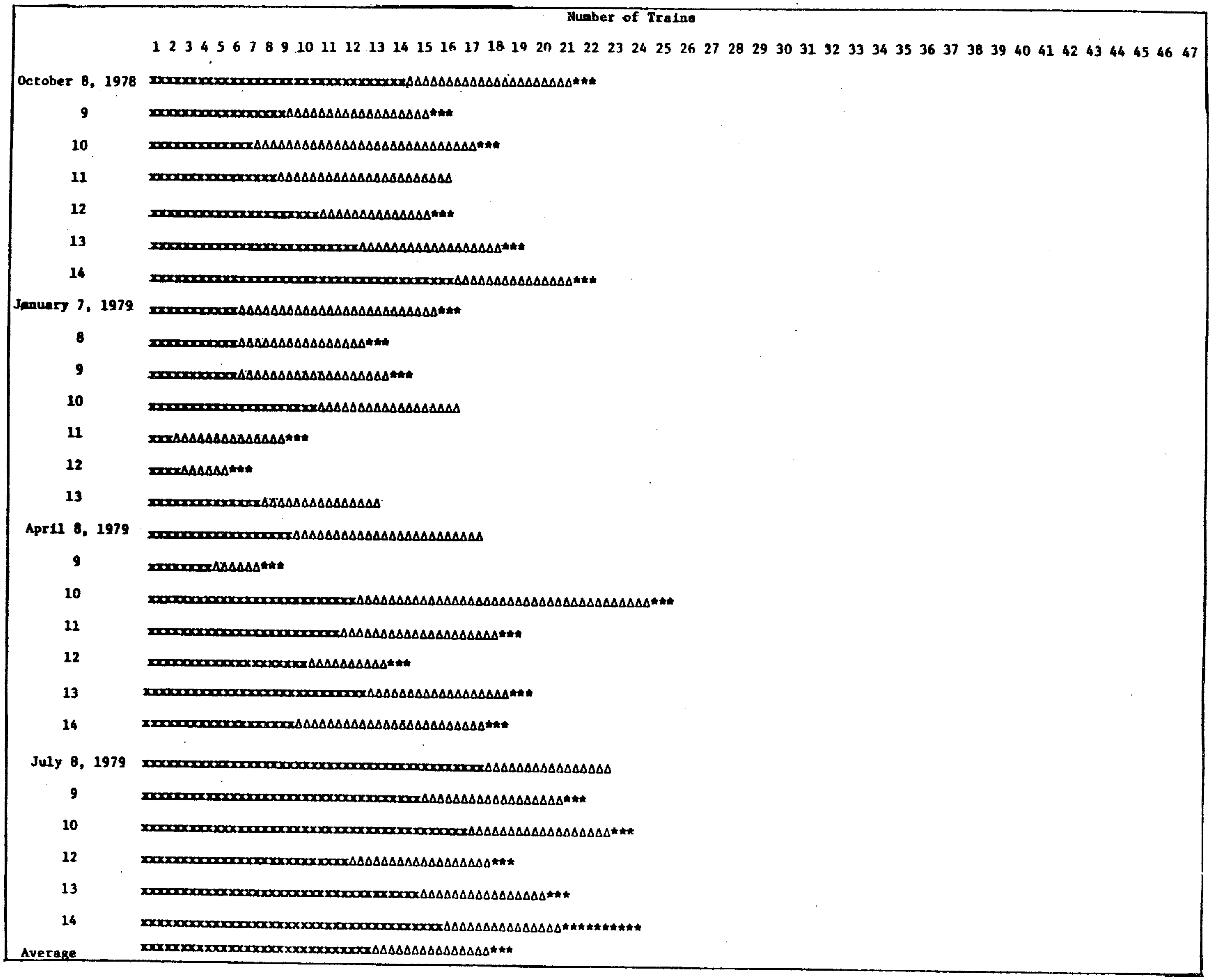
RAILROAD OPERATIONS

Sixteen trains operate through Hebron on the average day. Twelve of these are unit coal trains, three are mixed freight, and one is a local train. (Train traffic has decreased by about 16 percent since the study was begun two years ago. At that time, there was an average of 19 trains a day operating through Hebron. As can be seen from Exhibit VIII-2, there is considerable variation in train movements from one season to the next and from one day to the next. Generally speaking, the summer months show a larger number of daily train movements than in January.

There are three types of train movements in Hebron: (1) through movements, (2) switching movements associated with the local train, and (3)

EXHIBIT VIII-2

NUMBER OF TRAIN ARRIVALS PER DAY IN HEBRON, ND, DURING FOUR WEEKS IN 1978-1979[1/]



Train Type

xxxxxxxx Coal

ΔΔΔΔΔΔΔΔ Mixed Freight

Source: Burlington Northern Train Sheets movements in and out of the siding by unit coal and mixed freight trains for the purposes of conducting train meets. There is, on the average, one train per day which uses the siding for the purpose of meeting incoming trains. The average time per train in the siding is less than 30 minutes. The local train is in town for an average of 30 minutes. Train arrivals are uniformly distributed throughout all hours of the day. Approximately 60 percent of the daily trains arrive during the daytime hours of 5:30 a.m. to 8:30 p.m. Summary statistics for train operations are shown in Exhibit VIII-3.

PROBLEMS

Unlike the other case study communities, Hebron was not formally surveyed during Phase I of this study. This was not by design; the corridor communities that were surveyed were selected at random from stratified groups. However, a site visit and interviews with approximately 24 community leaders and representatives were performed on January 25, 1979. At that time, several problems were identified by community leaders as deserving attention. These problems, in order of priority, are:

- Pedestrian Safety
- Vehicle Safety
- Emergency Vehicle Delay
- General Vehicular Delay.

The next sections describe the characteristics of each of these problems.

Pedestrian Safety

There are many senior citizens in Hebron (approximately 310). Nearly 30 percent of them live north of the main line and walk regularly

EXHIBIT VIII-3

TRAIN OPERATIONS IN HEBRON, NORTH DAKOTA
ON THE AVERAGE DAY

(Before Demonstration Projects)

Train Type	# Trains Ave.	# Trains Range	Speed (MPH) Ave.	Speed (MPH) Range	# Trains Stopped
Coal	12	10-17	--	--	1
Mixed Freight	3	1-4	--	--	0
Local	1	0-2	--	--	1
Total	16	13-21	35	6-44	2

to destinations south of the main line. It is estimated that approximately 240 of the total 440 daily pedestrian trips across the main line are made by senior citizens. In addition, nearly 100 children who walk to school live to the south of the main line, which means that approximately 200 school trips are made by children walking across the main line every day. The school provides a hot lunch program and discourages children from walking home for lunch.

Pedestrians follow the route past the depot for many of their crossings. On the northbound trip, this crossing can be especially hazardous because the depot creates a visual obstruction for persons who would look to the left (westbound). Furthermore, the main line crosses the path only a few feet north of the depot and unsuspecting or careless pedestrians may be caught unaware of the approaching danger. Pedestrian safety also is affected by the fact that the sidewalks at Elm and Elk Streets, and at the depot, are in disrepair and, during the winter, are nearly impassable. The winter causes extra hardships for seniors, due to the existence of slippery walkways. In spite of these hazards, pedestrian accidents (let alone fatalities) are rare in Hebron. The only recorded pedestrian accident within the past 5 years was a fatality, occurring at night during the fall of 1979, between the depot and Elk Street.

<u>Vehicle Safety</u>

Vehicle safety concerns in Hebron at the start of the study were a function of the type of crossing protection, roadway approach geometrics, and train speeds. The two main crossings in Hebron were protected by flashing lights. The signals were activated by circuits located at a predetermined distance from the crossings. This signal system resulted in significantly longer signal activation times for slow trains (over six minutes for a train moving at five mph) than the 25 seconds allowed for the fastest train. Because of the frequent occurrence of long delays between signal activation and train passage, many motorists formed a habit of disregarding the signals. The procedure for many motorists was to approach the tracks with caution if the signals are activated, to decide if there was time to clear the crossing before the train arrived, and to take action. As a result, the effectiveness of the crossing protection on vehicle safety was much reduced. The hazard of ignoring unreliable signals was exacerbated by visual obstructions. Buildings on the south side of the tracks created visual obstructions for northbound motorists at the Elk Street crossing, and a further obstruction was created when there were train cars standing on the industrial siding adjacent to the crossing.

The Elk Street crossing also was made hazardous by poor vertical alignment. Since the rail line was been constructed several feet above the street level, the approach to the crossing on both sides had an approximately five percent positive grade. Winter made this approach slick when snow-covered. The concern for the safety of crossing motorists was heightened by the fact that school buses also use this crossing.

The West Street crossing also had two problems which contributed to hazardous crossings. First was the existence of crossbuck control. In 1978, a decision was made to close the East Street crossing in Hebron in exchange for an improvement in protection devices at West Street. As a result, flashing lights were installed and automatic gates were planned, before the initiation of this study. The second problem associated with the West Street crossing was that it crossed the siding as well as the main line. The siding was used by trains in such a fashion that eastbound coal trains blocked the crossing, or were stopped so near the crossing that northbound motorists could not see the tracks to the west and thus had difficulty crossing safely. The only recorded vehicle fatality which resulted from an auto/train collision occurred here in 1974.

Emergency Vehicle Delay

Fire protection and ambulance service are provided from the fire barn located north of the main line. There are five fire trucks garaged at this location, three of them city trucks (including a pumper) and two rural trucks. Fire protection is provided by 35 volunteers, all of whom are on call at all times. The siren atop the fire barn is activated by the hotel manager who receives emergency calls. Volunteers are then expected to arrive at the fire hall within 60 seconds of the sounding of the siren to begin preparation for departure. City fire trucks are responsible for all calls within the city limits and assist in rural calls within one mile of the city limits (with the exception of the pumper which remains in the city at all times). Rural fire calls are made within a distance of 20 miles north or south and 10 miles to east and west of Hebron. Annually the city and rural fire services make about 15 fire calls. The calls are distributed evenly between the north and south sides of the main line. About two delays annually were estimated to occur, lasting an average of approximately 2 1/2 minutes.

For ambulance service, there are 31 volunteers, any three of whom are on call at all times. Emergency calls are received by the hotel manager who then alerts the volunteers. The response time from receipt of an emergency call until the ambulance is dispatched is approximately five minutes. According to the chief of the ambulance service, 11 of the 31 volunteers are trained Emergency Medical Technicians (EMT) who administer care at the emergency site and then transfer the patient to the clinic, located just off Main Street to the south side of the main line. (Should further treatment be required, the patient is taken to the hospital at Richardton, some 12 miles to the west.) This means the ambulance must always cross the main line, either on the first leg (to the patient) or on the second leg (to the clinic). Also, volunteers may have to cross the main line in traveling to the fire barn before proceeding to the emergency. The ambulance service makes about some 56 calls annually. Slightly over half of the calls are from south of the main line. It was estimated that five ambulance calls each year were delayed at a crossing with an annual average delay of 2 1/2 minutes.

General Vehicular Delay

Underlying many of the problems experienced in Hebron is the blocking of autos and school buses by trains at crossings. From information obtained in 1979, on the average day, 120 vehicles were delayed at crossings. Each vehicle blocked at the crossings waited an average of 2.4 minutes. The actual delay time ranged from a few seconds to nearly 15 minutes.

Analysis of the data shows that the number of trains alone does not explain the extent of the vehicular delays. Through trains occupy crossings for short periods of time (e.g., 1 minute 45 seconds for a 106-car unit coal train traveling at 45 mph). This means that 30 through trains per day traveling at this speed would block crossings in Hebron for approximately 3.6 percent of an average day, roughly the same level of blockage which existed in Hebron in 1979 with an average of only 19 trains per day. The blockage which arose occurred primarily, therefore, from three factors:

(1) Through trains traveling slower than 45 mph,

(2) Trains entering and leaving the siding, and

(3) The presence of the local train.

DEMONSTRATION PROJECTS

In the second phase of the study, a list of low-cost actions that would address one or more of the identified problems was developed. Each action was evaluated for feasibility, for conformity with the community's priorities, and for its value as a demonstration project. (Details of this procedure are in Appendix B.) From this evaluation, the following projects were selected for implementation:

- Extend the siding 1800 feet to the west and install power switches at both ends of the siding (the power switches will be installed as part of the BN's program of introducing centralized train control on the main line),
- Install gates and grade crossing predictors at all three crossings, and
- Install fencing on the north side of the main line between Elk and Elm Streets in conjunction with establishing a school safety patrol at crossing locations.

As of December 1981, only the installation of gates and grade crossing predictors has been accomplished. Further evaluation of available siting for fencing led to a determination that the fencing would have limited effectiveness and it was eliminated as a demonstration project.

The Burlington Northern deferred the siding extension and power switch installation in its effort to limit its 1981 capital program.

The automatic gates and grade crossing predictors were installed in early 1981 at a cost of about $222,000. Observations in November 1981 found the signals to be working as expected, yielding a uniform warning time of 25-35 seconds regardless of train speed. A summary of each project's status and actual cost is in Exhibit VIII-4.

In evaluating the extent to which the signal demonstration project accomplished in Hebron--installation of gates and grade crossing predictors--was effective in reducing rail/community problems, a comparison was made between the problem magnitudes that would occur with and without the project. This comparison revealed that the project reduced general vehicle delay by 27 percent relative to what it would have been had the project not been implemented. The probability of emergency vehicle delays also was reduced by 27 percent, and the estimate of train-auto accidents decreased by 70 percent. A summary of the evaluation findings is found in Exhibit VIII-5. Actions unrelated to the project also have contributed to reducing the magnitude of rail/community problems in Hebron. The 16 percent reduction in train volume which has occurred since 1979 has reduced Hebron's exposure to rail operations equal approximately to the percentage decline in trains.

EXHIBIT VIII-4

STATUS OF DEMONSTRATION PROJECTS IN HEBRON

December 1981

Action	Status	Cost
Lengthen the siding and install power switches	Deferred	--
Install gates and grade crossing predictors	Installed: accepted by the NDSHD February 1981	$222,242
Install fencing on the right-of-way	Eliminated as a demonstration project	--

EXHIBIT VIII-5

SUMMARY OF DEMONSTRATION PROJECT
EFFECTS, HEBRON

	Without	With	Percent Change
Probability of delay	6.0%	4.4%	-25%
Estimated ambulance delays/yr.	5.3	3.9	-25%
Estimated fire delays/yr.	1.7	1.3	-25%
Estimated auto/train accidents/yr.	.46	.14	-70%
Yearly vehicles delayed	50,700	37,230	-25%
Yearly vehicle hours of delay	2,200	1,173	-45%
Yearly person hours of delay	3,079	1,643	-45%

1/ Based on 11.7 through trains, 3.3 trains (22% of non-local trains) on siding, 0 local train, 4900 ADHT Central Ave., 1210 ADHT 2nd Ave., flashing lights crossing protection.

2/ Based on 12.4 through trains, 2.4 trains (16% of non-local trains) on siding, 0 local train, 4900 ADHT Central Ave., 1210 ADHT 2nd Ave., automatic lights and grade crossing predictors crossing protection.

3/ Beach now has fire equipment on both sides of the tracks.

APPENDICES

APPENDIX A

METHODS DEVELOPED TO ESTIMATE PROBLEM MAGNITUDES AND TO EVALUATE EFFECTIVENESS OF ALTERNATIVE LOW-COST ACTIONS

INTRODUCTION

Basic to an understanding of the case study results is knowledge of the data and methods used to conduct the case studies. In particular, a knowledge of the data used to develop a profile of railroad operations and the methods used to estimate the magnitude of problems created by rail/community conflicts is necessary. This information is presented in this chapter. The chapter is divided into five parts, as follows:

- Development of railroad operations profiles
- Calculation of potential emergency vehicle delays at crossings
- Calculation of potential vehicle delay at crossings, and
- Calculation of vehicle accidents at crossings.

DEVELOPMENT OF RAILROAD OPERATIONS PROFILES

For each case study community, a data base was developed consisting of information on community development and activity patterns, community services and facilities, and railroad operations and facilities. The community information is presented in the case study write-up on each community (see Chapters IV-IX). The information presented in the write-ups was obtained through field observations, interviews with community officials, and data maintained by either the local or state government. The information is straightforward; its derivation needs no further clarification than is presented in the case studies. The same is true for information on railroad facilities; the information was provided by the Burlington Northern, Inc. (BN).

The development of the railroad operations profile for each community, on the other hand, warrants explanation. The profile consists of a set of characteristics describing the basic rail operations experienced in the community. These characteristics are identified in Exhibit A-1. As can be seen, two types of information are contained in the profile: daily averages and ranges. The exhibit also identifies the primary source of data for each characteristic.

Three basic data sources were used to develop the profiles: train sheets and conductor delay reports maintained by the BN and field observations in each of the communities. The BN maintains a daily record (train sheet) of all through train operations at various locations along the corridor. For every train that passes the specific locations, a variety of information is recorded, including the train identification number, train length in number of cars (loaded and empty), train weight, and the time of day the train arrived and left the location.

The conductor delay reports supplement the train sheets with information on specific operations conducted by trains. A delay report is maintained by each train conductor for each run. In the report are recorded train operations, other than through movements, that were conducted. Operations include, for example, train meets, crew breaks,

EXHIBIT A-1

RAILROAD OPERATIONS PROFILE DATA

Characteristic	Data Source
Number of trains/day - range - average	BN train sheets
Train speed - range - average	Field observations
Train length - range - average	BN train sheets
Train arrival by hour of day	BN train sheets
Train operations	BN train sheets, conductor delay reports and field observations
Amount of time crossings are blocked - signal activation time, average and range - train occupation time, average and range	Calculated based on above data

waits for orders, air tests, set-out/pick-up operations, and inspections. The time of the operation also is recorded.

To develop the operations profile in each community, three weeks of train sheet and conductor delay report data were obtained for a representative period of time. The operation profile was defined in two dimensions. For manageability and comprehension, a typical day of railroad operations was estimated based on the sample average for each characteristic. To capture the variation in rail operations that occur day-to-day, the range of observations for each characteristic was recorded.

To complete the profile, field observations of rail operations in each community were made. The information presented in Exhibit A-2 was recorded for all train operations conducted in each case study community. From these observations two additional rail operating characteristics were calculated. First, the distribution of train speed by train type was estimated by dividing observed train length by the observed time during which the train occupied the crossing. Lengths of fifty-four feet per freight car and fifty-three feet per coal car were used to calculate train length from observed train length in number of cars. Second, a frequency distribution for the amount of time crossings were blocked during the observation period by train type, was calculated. The block time was divided into three components: (1) signal time prior to train arrival at the crossing, (2) train time in the crossing, and (3) signal time after the train leaves the crossing.

EXHIBIT A-2

Community ____________
Crossing ____________
Observer ____________
Date ____________

RAILROAD OPERATIONS RECORDING FORM

Time	Train Type C=Coal F=Freight	Train Direction (E = east) (W = west)	Train Length (# cars)	Length of Time Crossing Is Closed (Minutes)				Train Operation S = Stopped X = Switching T = Through	Number of Vehicles Delayed	Number of Vehicles That Crossed Against Signals
				Signals Start	Train Arrives	Train Leaves	Signal Stops			
				0:00						
				0:00						
				0:00						
				0:00						
				0:00						
				0:00						
				0:00						

Using the train sheet, delay report, and observation data, the final, and most important, characteristic of rail operations, the amount of time crossings are blocked on average, was estimated. The calculation was performed as follows:

$$\Sigma_t \; (T \, S_t + T_t \, S_t' + T_t \, O_t)$$

where:

T = average number of trains per day

S = the distribution of signal time prior to train arrival at the crossing

S' = the distribution of signal time after the train leaves the crossing

O = the distribution of time trains occupy the crossing

t = train type (unit coal train, mixed freight train, local and switching trains).

In addition to estimating current (1979) rail operating characteristics in each community, future (1985) characteristics were projected. To estimate future characteristics, the average number of trains per day was projected by train type. For unit coal trains, the projections were based on data provided by the BN and other studies. 1/ For

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1/ Projections on which the increase in unit coal trains estimates were based include, in addition to Burlington Northern data, the following: National Transportation Policy Study Commission, National Energy Transportation Study, and coal production projections presented in the following studies: Analysis of the 1985 Western Coal Transportation Requirements - Preliminary Paper (Oct. 1978), North Dakota State University; Western Coal Development Monitoring System - WCDMS (April 1979), Office of Coal Supply Development, DOE; Energy Information Administration Forecast (1979), Energy Information mixed freight and local trains, the BN projections for the 1979-1983 period were extrapolated to 1985.

To translate train projections into operating characteristics, it was assumed that the estimated current average value of each characteristic by train type prevails through 1985. For example, the additional amount of time crossings in a community may be blocked by coal trains in 1985 was estimated by multiplying the number of additional coal trains projected in 1985 by the average amount of time a coal train blocks crossings in the community in 1979. This approach may underestimate blocked time because it does not account for the increase in train conflicts, and therefore delays, that may occur with increased train volume. However, the relatively small increase in number of trains expected to occur in the case study communities between now and 1985 indicates that the amount of underestimation is likely to be small.

Projections were made only to 1985 because these projections are based largely on existing contracts for the purchase of coal and therefore are quite accurate. Beyond 1985, there are uncertainties

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Administration (EIA), DOE; National Transportation Policies Through the Year 2000 (June 1979), National Transportation Policy Study Commission; Rail Transportation Requirements for Coal Movement in 1985 (1978), Input-Output Computer Services, Inc; Coal Transportation Capability of the Existing Rail and Barge Network, 1985 and Beyond (September 1976), Manalytics, Inc.; An unpublished study done by Rocky Mountain Industries, a Union Pacific subsidiary, in 1979; and also an unfinished national energy transportation study - work is being done by USDOT, USDOE, CACI, Inc., TERA, and several other consultants.

associated with coal projections. Using 1985 projections may introduce a conservative bias into estimates of future rail/community conflict magnitudes, since by 1990 and beyond, further increases in western coal production will occur.

Exhibit A-3 presents a summary of current (1980) railroad operating characteristics estimated for each case study community.

CALCULATION OF EMERGENCY SERVICE DELAYS AT CROSSINGS

Estimating Current Delays

Delays in the provision of emergency services (fire, medical, police) were cited in all six case study communities as a priority problem. Indeed, residents throughout the study corridor identified emergency service delays to be the most serious community problem resulting from rail operations. 1/ Two separate issues were evaluated: the potential number of service delays that may be experienced per time period and the possible consequences of such delays.

An estimate of the potential number of emergency service delays is simply the product of the number of times, on average, that the main line must be crossed to respond to emergencies during a period of time and the probability that the crossing will be blocked during that period. To estimate the possible consequences of a delay to emergency service providers is a much more complex problem. This section describes how the relevant estimates were made in conducting the case studies.

Typically in the study corridor communities there is one emergency medical, fire, and police service that serves areas on both sides

1/ Ernst & Whinney, Alternative Solutions to Railroad Impacts on Communities--Phase I Report: Problem Definition, Minnesota Department of Transportation, St. Paul, Minnesota, October 1979, p. 11.

EXHIBIT A-3

RAILROAD OPERATIONS IN THE CASE STUDY COMMUNITIES

(Pre-Demonstration Projects)

Case Study	Trains Per Day 1/ Average	Trains Per Day 1/ Range	Ave. Length (cars)	Speed (mph) Average	Speed (mph) Range	Operations 2/	% of Day Crossings Are Blocked 3/
Beach, ND							
Coal	12	0-17	104				4.1
Mixed Freight	3	0-11	80	N/A	N/A		0.9
Local	1	0-3	10				0.4
Total	16	1-23	90	27	13-45	T,S,M.CB,O	5.4
Casselton, ND							
Coal	9	2-16	104	28	15-45		2.3
Mixed Freight	18	11-26	82	24	5-45		5.4
Local	4	0-5	12	5	1-10		1.9
Total	31	25-42	84	24	1-45	S,M,O,I,CB,T,A	10.4
Elk River, MN							
Coal	3	2-9	106	27	17-37		1.0
Mixed Freight	18	14-28	83	25	6-42		4.3
Local	4	1-7	11	6	3-14		3.0
Total	25	23-36	83	22	3-42	T,S,I,O,A	8.4
Hebron, ND							
Coal	12	1-18	104				3.9
Mixed Freight	3	3-12	80	N/A	N/A		1.3
Local	1	0-3	10				0.8
Total	16	6-25	89	35	6-44	T,S,M,CB,O	6.0
Sauk Rapids, MN							
Coal	3	1-12	106	40	10-45		0.5
Mixed Freight	20	12-29	83	38	9-50		3.3
Local	2	0-4	11	21	5-40		0.2
Total	25	13-45	83	38	5-50	T,M,I	4.1
Moorhead, MN (NP line)							
Coal	6		104	20	11-25		1.4
Mixed Freight	13		82	20	1-25		3.5
Local	2		12	24	1-25		0.4
Total	21		84	22	1-25	S,T	5.8
(GN line)							
Coal	2		104	11	1-25		0.8
Mixed Freight	4		82	15	1-25		1.1
Local	2		12	16	1-25		1.0
Total	8		84	14	1-25	S,T	3.4
(21st Street)							
Coal	7	2-12	104	21	6-25		2.0
Mixed Freight	17	13-22	82	17	6-25		4.6
Local	2	0-5	12	18	1-25		0.9
Total	26	23-36	84	18	1-25	S,M,O,I,T,A	7.5

1/ Represents the numbr of trains operating in the community per day, not the number of operations conducted by trains per day. Thus, a train that enters and exits a crossing more than once per day is counted only once. The estimate of blocked crossing time, however, accounts for multiple operations by a single train.

2/ Operations conducted include switching (S), train meets (M), receipt of orders (O), inspection (I), crew breaks (CB), testing (A), through movements (T).

3/ Totals may exceed the sum of blocked time by train type due to crossings closed (i.e., signals activated) in the absence of a passing train.

of the main line. There is consequently the possibility that a response to an emergency will be delayed to the extent that the route to the emergency is blocked by railroad operations. In medical emergencies, a delay could occur in traveling from the emergency station to the scene or in traveling from the scene to the hospital. Because many corridor communities have volunteer emergency services, there also is the possibility that volunteers will be delayed at crossings on their way to the station.

Most data required to estimate emergency vehicle delays are available from communities. The case study communities provided the number of fire and medical emergencies to which they responded in the past year. The communities also provided an estimate of the geographic distribution of emergencies. Typically, the distribution is similar to the division of service area population by the main line. By knowing the route taken to the hospital, the percentage of medical emergencies in which the main line had to be crossed to travel to the hospital was determined.

The communities were unable to provide data on the number of emergencies in which volunteers had to cross the main line to arrive at the fire hall or ambulance station before traveling to the emergency scene. This statistic was estimated using probabilities based on the location of the volunteers relative to main line and the station.

The above information was used to estimate the number of times per time period (a year was used in this study) the main line must be crossed in responding to emergencies. The second statistic required to calculate the potential number of emergency services delays is the probability that a delay will be experienced in crossing the main line. Since it was observed in case study communities that train arrivals are evenly distributed throughout the typical day, the probability of delay equals the percentage of time, during the typical day, crossings are blocked. This probability is the estimate of blocked crossing time from the railroad operations profile divided by 24.

With the above information, estimation of the potential number of emergency service delays is straightforward. It is the number of expected emergency vehicle crossings per time period times the probability of delay.

To illustrate the calculation of potential ambulance delays at a crossing, one of the case study communities, Casselton, is used. In Casselton, the ambulance station is located on the south side of the main line. The ambulance service is staffed by 26 volunteers; 9 of the volunteers live or work on the south side of the main line, the other 17 are located on the north side of the main line. The service area population is equally divided by the main line. The hospital is located in Fargo, twenty miles east of Casselton. To travel to the hospital, I-94, located about 3 miles south of Casselton, is used. Crossing the main line is required to reach I-94, if an emergency is located north of the main line. About 120 medical emergency calls are made per year. Crossings in Casselton are blocked by train operations 10.4 percent of the average day. Since volunteers located on the north of the main line must cross it to arrive at the station, the probability that at least one volunteer must cross the main line in an emergency is 0.968. 1/ With this data base, an estimate of medical emergency delays per year was made as shown in Exhibit A-4.

It was found in comparing observed and estimated emergency delays at crossings that estimates based on the described procedure are reasonably accurate. Exhibit A-5 presents data on observed and estimated emergency service delays for the case study communities for which data are available. The comparison reveals no significant difference between the measures.

Estimating Effects of Remedial Action

The method used to estimate emergency delays also is used to estimate the changes in number of delays that occurred or are expected to occur with the implementation of various remedial actions. For example, relocation of the Casselton ambulance station to the north side of the main line would change the probability that a volunteer(s) must cross the main line to arrive at the station from .968 to .738; the probability that the

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1/ The probability of .968 that at least one volunteer must cross the main line in traveling to the ambulance garage was determined as follows:

Volunteer Location: South	North		Probability of This Team Composition
3	0	$_3C_0$	= (1) (9/26) (8/25) (7/24) = .032
2	1	$_3C_1$	= (3) (9/26) (8/25) (17/24) = .235
1	2	$_3C_2$	= (3) (9/26) (17/25) (16/24) = .471
0	3	$_3C_3$	= (1) (17/26) (16/25) (15/24) = .262
			1.000

where $_xC_y$ equals the combination of x volunteers from the north side taken y at a time.

The probability is $_3C_1 + {_3C_2} + {_3C_3}$

or .235 + .471 + .262 = .968

EXHIBIT A-4

ESTIMATED MEDICAL EMERGENCY DELAYS AT CROSSINGS PER YEAR IN CASSELTON, NORTH DAKOTA

1. Volunteers may be delayed at crossings on their way to the ambulance station 12 times per year on average. This estimate was derived as follows:

   - Probability that a volunteer must cross the main line = .968
   - Probability of being delayed = .104
   - Number of medical emergencies per year = 120

   Then,

   (.968) X (.104) X (120) = 12.08

2. The ambulance may be delayed at a crossing while traveling to the emergency scene six times per year on average. This estimate was derived as follows:

   - Probability that the main line must be crossed = .5
   - Probability of being delayed at the crossing = .104
   - Number of emergency calls per year = 120

   Then,

   (.5) X (.104) X (120) = 6.24

3. The ambulance may be blocked at a crossing while traveling to the hospital six times per year on average. This estimate was derived as follows:

   - Probability that main line must be crossed = .5
   - Probability of being delayed at a crossing = .104
   - Number of medical emergencies per year = 120

   Then,

   (.5) X (.104) X (120) = 6.24

4. Thus, there may occur on average, 22 delays at crossings per year in responding to medical emergencies in and around Casselton.

EXHIBIT A-5

COMPARISON OF OBSERVED AND ESTIMATED
EMERGENCY VEHICLE DELAYS AT CROSSINGS
IN CASE STUDY COMMUNITIES

Fire Emergencies	
Observed	Estimated
0.0	.5
0.0	.7
1.0	.2
35.0	27.0

Medical Emergencies	
Observed	Estimated
.5	.8
1.0	2.0
24.0	22.0
85.0	91.0
56.0	33.0

main line must be crossed in traveling to the emergency or the hospital would not change. The overall result would be a reduction of 3 delays per year on average, or a 15 percent reduction from the estimated current number.

Similarly, it is possible to estimate the effects on emergency service delays of actions that decrease the amount of time trains block crossings. In Casselton, increasing the maximum allowable train speed, currently set at 40 mph by city ordinance, to 60 mph would decrease the blocked crossing time by about 30 minutes per average day. This would reduce the probability of experiencing a delay at crossings to .084 and would result in a 20 percent reduction in emergency service delays.

Estimating Future Delays

Estimates of future emergency service delays also can be made. This is done by projecting the number of emergency calls (a function of population change), the location of the calls (a function of the future service area population distribution on either side of the main line), and the amount of time crossings will be blocked on the average day (a function of the future number and types of train operations as explained in the previous section). To illustrate, the calculation for Casselton in 1985 is as follows:

1. Number of medical emergency calls = 135, i.e., the current number times 1.126, since 1985 population will be 112.6% of the current population.

2. Population distribution is not expected to change. Thus, the location of medical emergencies will remain evenly divided on both sides of the main line.

3. The probability of delay at a crossing = .111, i.e., the current amount of blocked crossing time plus the amount of time resulting from the addition of three unit coal trains

per day by 1985 divided by 24 hours. 1/

Using this information and the calculation procedure described above results in an estimated 29 emergency service delays on average per year by 1985. This would be an increase of about 30 percent over the estimate for 1979.

The Consequences of Delay

A final concern with emergency service delays is the consequences of such delays. For fire and police emergencies, one can state possible consequences (e.g., additional property loss because the fire was not contained earlier; inability to apprehend a criminal). To put probabilities on these potential outcomes, however, is not possible.

The situation is similar with medical emergencies, except that it is known that the number of cases in which a delay would be critical for the patient or would otherwise have a detrimental effect on the patient's medical outcome is small. It appears that 5 to 10 percent of medical emergencies are life-threatening situations prior to the provision of emergency medical treatment at the scene. Once treatment is administered, this percentage drops considerably; one to two percent of all medical emergencies remain life-threatening after receiving on-the-scene treatment and until emergency room treatment is begun. (The statistics for any specific area may vary considerably from these numbers. For example, in St. Paul, Minnesota, the proportion of medical emergencies that are

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1/ Review of existing electric utility contracts to purchase coal made subsequent to the preparation of this section suggests that this projection of additional coal trains may be high.

life-threatening prior to on-site treatment is estimated at 25 percent.) 1/

These statistics, then, represent the proportion of patients for whom survival is sensitive to treatment delay. This does not mean, however, that a delay in treating these patients will be detrimental to them. For example, one study has found that a lower-bound estimate of the proportion of patients for whom prompt emergency room treatment is critical is 0.11 of one per cent of all emergency department patients. 2/ "Prompt" in this calculation is defined as receiving on-site treatment within 15 minutes and emergency room treatment within 70 minutes of an onset of symptoms or occurrence of injury. The estimate also assumes that the patient would become critical within 30 minutes of onset of symptoms or occurrence of injury if treatment were not administered.

This calculation reveals the complexity of estimating the emergency service delay consequences. The consequences depend on the patient's condition as well as the amount of elapsed time prior to treatment. Further, the patient's location relative to the emergency medical service location is important. In the above example, a 5-minute delay at a crossing would not affect patient outcome if the patient is located less than 10 minutes from the ambulance station. On the other hand, if the patient were located almost 15 minutes from the station, a delay of only one minute would

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1/ The information on which these statistics were based was obtained from the following sources: The American Ambulance Association; the National Association of Emergency Medical Technicians; the Public Health Services Administration, National Services Research Center; St. Paul Department of Fire and Safety Services; North Dakota State Health Department; Robert B. Andrews, Graduate School of Management, University of California at Los Angeles.

2/ Robert B. Andrews, Ph.D., "Treatment and Outcomes for Critical Patients, Preliminary Results," Emergency Medical Services, November/December 1978, p. 98.

be critical. As a result of this complexity, the consequences of emergency medical service delays were not estimated. It can be concluded, however, that delays at crossings that will be critical or detrimental to patient outcome will be few in number. Nonetheless, the potential for a critical delay is real.

CALCULATION OF POTENTIAL ACCIDENTS AT CROSSINGS

A priority problem cited by five of the six case study communities is vehicle safety at crossings. Pedestrian safety also was cited by several of the case study communities. Corridor-wide, vehicle and pedestrian safety were ranked second and fifth in seriousness among eight problems identified by the residents surveyed in Phase I. No method was found to estimate pedestrian accidents in the communities. This section focuses on estimating vehicle accidents at crossings.

A variety of methods exist for estimating vehicle hazard at rail grade crossings. 1/ The one selected for use in this study is the result of research conducted by the U.S. Department of Transportation's Transportation Systems Center (TSC). 2/

The TSC method was used to establish an estimate of expected accidents per year. In appropriate cases, these estimates were adjusted to

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1/ Federal Highway Administration, Railroad Highway Grade Crossing Handbook, U.S. Department of Transportation, Washington, D.C., August, 1978.

2/ The TSC method is one of the few available that estimates expected accidents during a period of time rather than a relative hazard index. The equations were developed through statistical (step-wise regression) analysis of national accident data for 1975. A report that documents the equations is currently in draft form and is being reviewed by FHWA before publication.

reflect conditions at specific crossings. In particular, the estimates were increased for crossings at which "early signal activation" frequently occurs. The adjustments made are explained below. Because the TSC equations are based on national data, and due to the difficulty associated with estimating grade crossing accidents in general, the estimates of expected accidents for the case study communities must be regarded as representing only the order of magnitude of what may occur. They should not be regarded as accurate predictions of what will inevitably occur.

Three separate equations for estimating expected accidents were developed by TSC. A separate equation was developed for each of three classes of crossing protection: passive protection (no gates or lights of any kind), flashing lights protection (lights, signals, or bells but not gates), and automatic gates protection (with or without flashing lights). The equations are presented in Exhibit A-6, along with the definitions of the variables. The values associated with the variables are specified in the tables that follow the exhibit.

To illustrate the use of the equation, consider the example of crossings in Sauk Rapids, Minnesota, a case study community. Information on the crossings selected for analysis required by the equations is as follows:

Crossing	Protection	T	AADT	DT	MT	P	FL	L
1	Gates	25	11,750	13	2	5,800	minor arterial	2
2	Lights	25	2,650	13	2	5,800	minor arterial	2
3	Lights	25	250	13	2	5,800	local	2
4	Passive	25	150	13	2	5,800	local	2

EXHIBIT A-6

EQUATIONS USED TO ESTIMATE ACCIDENTS PER YEAR AT RAIL-HIGHWAY GRADE CROSSINGS

EQUATIONS

- For passive protection

  EA = HI*DT*MT*HP*P*FC

- For flashing lights protection

  EA = HI*DT*MT*L*P*FC

- For automatic gates protection

  EA = HI*MT*L

VARIABLES

DT = number of day through trains on average

EA = estimated number of accidents per year

FC = highway functional classification

HI = basic hazard index, a function of trains per day and annual average daily traffic

HP = highway pavement

L = number of highway lanes

MT = number of main tracks

P = population of the community in which the crossing is located

With this information and the data presented in Exhibits A-7 through A-9, the calculations estimating expected accidents per year for each crossing are as follows:

- Crossing #1, EA = (.043)(2.15)(1.46) = .135
- Crossing #2, EA = (.14)(1.34)(1.73)(1.07)(1.04)(0.75) = .271
- Crossing #3, EA = (.04)(1.34)(1.73)(1.07)(1.04)(0.65) = .067
- Crossing #4, EA = (.15)(1.60)(2.01)(1.43)(1.10)(0.21) = .159

An adjustment was made to these base estimates due to the frequent occurrence of early signal activation. Grade crossing warning signals in Sauk Rapids, and most other communities, are activated by circuits located set distances from the crossings. As the train enters the section of track containing the circuit, the crossing warning signals are activated. The distance of the circuit from the crossing is determined by the maximum allowable train speed through the crossing. That is, the Interstate Commerce Commission requires that crossing signals be activated at least 25 seconds prior to the time the fastest train would arrive at the crossing. This means that trains moving slower than the maximum allowable speed will activate signals in excess of 25 to 30 seconds before train arrival. For example, trains moving at five mph activate the signals in excess of six minutes before it enters the crossing. Also, trains that enter the track circuit and then stop activate the signals until they start again and move through the crossing. The activation of signals a considerable time before train arrival at the crossing is referred to as "early signal activation." At crossings where early signal activation is a frequent occurrence, the warning signals lose credibility and therefore effectiveness. Motorists no longer consider the signals an indication that train arrival is imminent.

EXHIBIT A-7

VALUES FOR VARIABLES USED IN THE PASSIVE PROTECTION FORMULA

HI =

TOTAL TRAINS PER DAY	ANNUAL AVERAGE DAILY HIGHWAY TRAFFIC												
	1-100	101-300	301-500	501-700	701-900	901-1500	1501-3000	3001-5000	5001-7000	7001-9000	9001-15000	15001-30000	>30000
<1	.02	.02	.03	.03	.03	.04	.04	.06	.06	.07	.08	.10	.14
1	.02	.03	.04	.05	.05	.06	.08	.10	.11	.12	.14	.17	.23
2	.02	.04	.06	.07	.07	.08	.10	.13	.15	.16	.18	.21	.27
3	.03	.05	.07	.08	.09	.10	.12	.15	.17	.19	.21	.24	.30
4	.03	.06	.08	.09	.10	.12	.14	.17	.20	.21	.24	.27	.32
5	.03	.07	.09	.10	.11	.13	.16	.19	.21	.23	.25	.28	.33
6	.04	.08	.10	.11	.12	.14	.17	.20	.23	.24	.27	.29	.33
7	.04	.08	.11	.12	.13	.15	.18	.22	.24	.26	.28	.30	.34
8	.04	.09	.11	.13	.14	.16	.19	.23	.25	.27	.29	.31	.34
9	.04	.09	.12	.14	.15	.17	.20	.24	.26	.27	.30	.32	.34
10	.05	.10	.12	.14	.16	.18	.21	.24	.27	.29	.30	.32	.34
11-20	.06	.12	.15	.17	.18	.20	.24	.27	.30	.31	.32	.34	.33
21-40	.07	.15	.19	.21	.22	.25	.28	.31	.33	.33	.34	.34	.31
41-60	.08	.17	.21	.23	.25	.27	.30	.33	.34	.34	.34	.33	.28
61-80	.09	.19	.23	.25	.27	.29	.31	.33	.34	.34	.34	.33	.27
81-100	.10	.20	.24	.26	.27	.29	.32	.34	.34	.34	.34	.32	.26
>100	.10	.20	.24	.26	.28	.30	.32	.34	.34	.34	.33	.32	.25

DT =														
	1.00	1.12	1.20	1.26	1.31	1.35	1.39	1.42	1.45	1.48	1.50	1.60	1.74	1.83	1.94
where no. of day through trains is	0	1	2	3	4	5	6	7	8	9	10	11-20	21-30	31-40	>40

FC =						
	0.77	0.59	0.45	0.35	0.27	0.21
where the class is*	Interstate	Expressway	Principle Arterial	Minor Arterial	Collector	Local

MT =						
	1.00	1.42	2.01	2.86	4.05	5.75
where no. of main tracks is	0	1	2	3	4	5

HP =		
	1.43	1.00
where highway is	paved	not paved

P =					
	1.00	1.10	1.20	1.31	1.44
where population is*	<5,000	5-10,000	10-25,000	25-50,000	>50,000

* Obtained from code for the functional classification of the highway. FC is determined by the units digit of the code. P is determined by the tens digit.

Source: Worksheet provided by the Office of Research, Federal Highway Administration.

EXHIBIT A-8

VALUES FOR VARIABLES USED IN THE FLASHING LIGHTS PROTECTION FORMULA

	1-100	101-300	301-500	501-700	701-900	901-1300	1301-1700	1701-2100	2101-2500	2501-3000	3001-4000	4001-5000	5001-6000	6001-7000	7001-8000	8001-9000	9001-10000
<1	.00	.01	.01	.01	.01	.02	.02	.02	.02	.02	.03	.03	.03	.04	.04	.04	.05
1	.01	.01	.02	.02	.02	.02	.03	.03	.03	.04	.04	.05	.05	.06	.06	.07	.07
2	.01	.02	.02	.02	.03	.03	.03	.04	.04	.05	.05	.06	.07	.07	.08	.09	.09
3	.01	.02	.02	.03	.03	.04	.04	.05	.05	.06	.06	.07	.08	.09	.10	.10	.11
4	.01	.02	.03	.03	.03	.04	.05	.05	.06	.06	.07	.08	.09	.10	.11	.12	.12
5	.01	.02	.03	.03	.04	.04	.05	.06	.06	.07	.08	.09	.10	.11	.12	.13	.14
6	.01	.02	.03	.04	.04	.05	.06	.06	.07	.08	.09	.10	.11	.12	.13	.14	.15
7	.01	.03	.04	.04	.04	.05	.06	.07	.07	.08	.09	.10	.12	.13	.14	.15	.16
8	.01	.03	.04	.04	.05	.06	.06	.07	.08	.09	.10	.11	.12	.14	.15	.16	.17
9	.01	.03	.04	.04	.05	.06	.07	.08	.08	.09	.10	.12	.13	.14	.16	.17	.18
10	.01	.03	.04	.05	.05	.06	.07	.08	.09	.10	.11	.12	.14	.15	.16	.18	.19
11-15	.02	.03	.04	.05	.06	.07	.08	.09	.10	.11	.12	.14	.16	.17	.18	.20	.21
16-20	.02	.04	.05	.06	.07	.08	.09	.10	.11	.13	.14	.16	.18	.20	.21	.23	.25
21-25	.03	.04	.06	.06	.07	.09	.10	.11	.13	.14	.16	.18	.20	.22	.24	.26	.27
26-30	.03	.05	.06	.07	.08	.10	.11	.12	.13	.15	.17	.19	.22	.24	.26	.28	.30
31-40	.03	.05	.07	.08	.09	.11	.12	.14	.15	.17	.19	.22	.24	.27	.29	.31	.33
41-60	.04	.06	.08	.09	.11	.12	.14	.16	.17	.19	.21	.25	.28	.30	.33	.35	.38
61-80	.04	.07	.09	.11	.12	.14	.16	.18	.20	.22	.24	.28	.31	.34	.37	.40	.43
81-100	.05	.08	.10	.12	.13	.15	.17	.19	.21	.24	.27	.31	.34	.37	.41	.44	.47
>100	.05	.08	.10	.12	.14	.16	.18	.20	.22	.25	.28	.32	.35	.39	.42	.46	.49

	10001-12000	12001-14000	14001-16000	16001-18000	18001-20000	20001-24000	24001-28000	28001-32000	32001-40000	40001-50000	>50000
<1	.05	.06	.06	.07	.07	.08	.09	.10	.11	.13	.18
1	.08	.09	.10	.10	.11	.12	.14	.15	.17	.20	.29
2	.10	.11	.12	.13	.14	.16	.17	.19	.22	.25	.37
3	.12	.13	.15	.16	.17	.19	.21	.23	.26	.30	.43
4	.14	.15	.16	.18	.19	.21	.24	.26	.29	.34	.49
5	.15	.17	.18	.20	.21	.23	.26	.29	.32	.38	.55
6	.16	.18	.20	.21	.23	.25	.28	.31	.35	.41	.59
7	.18	.19	.21	.23	.25	.27	.30	.33	.38	.44	.64
8	.19	.20	.23	.25	.26	.29	.32	.36	.40	.47	.68
9	.20	.21	.24	.26	.28	.31	.34	.38	.43	.50	.72
10	.21	.23	.25	.27	.29	.32	.36	.39	.45	.52	.75
11-15	.23	.27	.28	.31	.33	.36	.40	.44	.50	.58	.85
16-20	.27	.30	.33	.35	.38	.42	.47	.51	.58	.68	.98
21-25	.30	.33	.36	.39	.42	.47	.52	.57	.65	.76	1.09
26-30	.33	.36	.40	.43	.46	.51	.57	.62	.70	.82	1.19
31-40	.36	.40	.44	.48	.51	.56	.63	.69	.78	.91	1.32
41-60	.41	.46	.50	.54	.58	.64	.71	.79	.89	1.04	1.50
61-80	.47	.52	.57	.61.	.66	.73	.81	.89	1.01	1.18	1.70
81-100	.51	.57	.62	.67	.72	.79	.89	.98	1.10	1.29	1.80
>100	.53	.59	.64	.70	.75	.82	.92	1.01	1.15	1.34	1.90

DT =	1.00	1.08	1.12	1.16	1.18	1.21	1.23	1.24	1.26	1.27	1.29	1.34	1.41	1.46	1.51
where no. of day through trains is	0	1	2	3	4	5	6	7	8	9	10	11-20	21-30	31-40	>40

MT =	1.00	1.32	1.73	2.28	3.00	3.95	5.20
where no. of main tracks is	0	1	2	3	4	5	>5

L =	1.04	1.07	1.11	1.16	1.20	1.24	1.29	1.34	1.38
where lane is	1	2	3	4	5	6	7	8	>8

P =	1.00	1.04	1.08	1.12	1.16
where population is*	>5	5-10	10-25	25-50	>50

FC =	0.93	0.87	0.80	0.75	0.70	0.65
where the class is*	Interstate	Express	Principal Arterial	Minor Arterial	Collector	Local

* Obtained from code for the functional classification of the highway. FC is determined by the units digit of the code. P is determined by the tens digit.

EXHIBIT A-9
VALUES FOR VARIABLES USED IN THE AUTOMATIC GATES PROTECTION FORMULA

	ANNUAL AVERAGE DAILY HIGHWAY TRAFFIC														
	1-100	101-300	301-500	501-700	701-900	901-1500	1501-3000	3001-5000	5001-7000	7001-9000	9001-13000	13001-20000	20001-30000	30001-50000	>50000
HI = TOTAL TRAINS/DAY <1	.008	.008	.008	.008	.008	.008	.008	.008	.008	.008	.008	.008	.008	.008	.008
1	.009	.010	.010	.010	.010	.010	.011	.011	.011	.011	.011	.012	.012	.012	.012
2	.010	.011	.011	.012	.012	.012	.013	.013	.013	.014	.014	.014	.015	.015	.016
3	.010	.012	.013	.013	.013	.014	.014	.015	.015	.016	.016	.017	.017	.018	.019
4	.010	.013	.013	.014	.014	.015	.015	.016	.017	.017	.018	.019	.019	.020	.021
5	.011	.013	.014	.015	.015	.016	.017	.018	.018	.019	.019	.020	.021	.022	.023
6	.011	.014	.015	.016	.016	.017	.018	.019	.020	.020	.021	.022	.023	.024	.025
7	.011	.014	.016	.016	.017	.018	.019	.020	.021	.022	.022	.023	.025	.026	.027
8	.011	.015	.016	.017	.018	.018	.020	.021	.022	.023	.023	.024	.026	.028	.020
9	.011	.015	.017	.018	.018	.019	.021	.022	.023	.024	.025	.026	.028	.029	.030
10	.011	.016	.017	.018	.019	.020	.021	.023	.024	.025	.026	.027	.029	.031	.033
11-20	.012	.018	.019	.021	.021	.023	.025	.027	.029	.030	.031	.033	.035	.038	.040
21-40	.015	.021	.024	.026	.027	.029	.032	.036	.040	.041	.043	.046	.050	.055	.060
41-60	.016	.024	.028	.030	.032	.035	.040	.045	.050	.052	.055	.059	.066	.072	.080
61-80	.016	.027	.031	.034	.036	.040	.045	.052	.059	.061	.065	.071	.078	.087	.100
81-100	.016	.028	.034	.037	.040	.043	.050	.058	.066	.068	.073	.081	.089	.100	.110
>100	.017	.029	.035	.038	.041	.045	.052	.061	.069	.072	.077	.085	.093	.106	.120
L =	1.21	1.46	1.76	2.12	2.56	3.08	3.72	4.49	5.42						
where no. of highway lanes is	1	2	3	4	5	6	7	8	>8						
MT =	1.00	1.47	2.15	3.15	4.62	6.78	9.95								
where no. of main tracks is	0	1	2	3	4	5	>5								

Rather, the signals indicate only that a train may arrive within the next several minutes, if at all. Consequently, with increasing frequency, motorists pause when the signals are activated and then proceed through the crossing rather than stop and wait for the train to pass.

Adjustments to the base estimates of expected accidents are made to reflect the loss in protection effectiveness resulting from early signal activation. The degree of reduced signal effectiveness resulting from early signal activation has not been documented and consequently is not incorporated explicitly into existing equations used to estimate crossing accidents. However, indicators of the relative effectiveness of various crossing protection devices can be used to estimate the possible range of reduced effectiveness that could result. These indicators are presented in Exhibit A-10. In the case study analyses, it was assumed that the effectiveness of automatic gates is reduced towards that provided by flashing lights. The indicators reveal that this assumption means the effectiveness of automatic gates may be reduced by as much as 82 percent. It was decided, however, that early signal activation does not completely eliminate the effectiveness of the crossing protection. Therefore, one-half of the 82 percent reduction in effectiveness was used to estimate the effects of early signal activation for automatic gate protection. For crossings with flashing lights, effectiveness was assumed to be reduced by 95 percent, assuming the lights tend towards the effectiveness of stop signs at crossings as a result of early signal activation.

Applying these judgments to the estimated base accident rates in Sauk Rapids provides the following results:

- Crossing #1, EA = 1.4 X .135 = .189
- Crossing #2, EA = 1.95 X .271 = .528

EXHIBIT A-10

THE RELATIVE HAZARD RELATIONSHIPS FOR TRAFFIC CONTROL DEVICES AT RAILROAD GRADE CROSSINGS

Type of Device	Relative Hazard
Crossbucks	1.00
Stop Signs	0.58
Wigwags	0.34
Flashing Lights	0.20
Automatic Gates	0.11

Source: Factors Influencing Safety at Highway-Rail Grade Crossings, National Cooperative Highway Research Program, Report 50, National Academy of Sciences, Washington, D.C., 1958.

- Crossing #3, EA = 1.95 X .067 = .131
- Crossing #4, no change, EA = .159

Overall, then, the estimated accident rate per year for the selected crossings in Sauk Rapids is 1.007.

The purpose of using the above calculation procedure is to establish the magnitude of current and future safety hazards at crossings, and to estimate the safety effects of implementing various remedial actions. The estimated accident rates generated by the above equations were found to be reasonable for these purposes. They compare favorably with observed rates for the case study communities (see Exhibit A-11). Information required to estimate future accident rates (i.e., daily traffic, daily trains) is readily available. Finally, the equations are sensitive to a variety of changes that may result from the implementation of remedial actions (e.g., upgrading crossing protection, eliminating early signal activation, changing train schedules or routes), and therefore can be expected to provide reasonable estimates under differing situations. 1/

CALCULATION OF VEHICLE DELAYS AT CROSSINGS

Four of the case study communities specified vehicle delays at rail/highway crossings as a priority problem. More specifically, the

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1/ To estimate the effects of upgrading crossing protection, relative hazard indices as well as the equations presented above were used. That is, the safety improvement resulting from installing gates in place of flashing lights at a crossing was estimated by applying the percentage improvement in relative crossing protection effectiveness to the estimated accident rate. From Exhibit II-11, the ratio is .09/.20, i.e., a 45 percent reduction in the expected accident rate. It was found that the potential improvement using this approach differed marginally from that generated by the TSC formulas.

EXHIBIT A-11

COMPARISON OF OBSERVED AND ESTIMATED VEHICLE ACCIDENT RATES AT CROSSINGS IN THE CASE STUDY COMMUNITIES

Accident Rate Per Year	
Observed*	Estimated
0.5	0.3
0.2	0.8
0.0	0.3
0.2	0.4
2.6	2.5
1.3	1.0

* Source: Minnesota Department of Transportation, North Dakota State Highway Department, community police officials. Rates include accidents that occurred only at the crossings designated for study.

communities cited difficulties in traveling to work and school and in traveling to business and social activities as problems resulting from rail operations. Corridor-wide, these accessibility problems ranked third and fourth among the seven problems identified by residents surveyed.

When problems of accessibility grow beyond the inconvenience level, they create significant community development problems. Concerns over the isolation of sections of communities which are separated from the principal business, industry, and social centers by the main line were expressed by some community officials. Deterioration of such isolated residential sections (i.e., the development of a "south side of the tracks") is a possibility foreseen by some community officials. Another possibility is the deterioration of a business area to which access is restricted by train operations. In one case study community, Moorhead, Minnesota, the latter type of community development problem has been identified as a priority concern.

Since it is virtually impossible to directly establish the extent to which rail/community conflicts create community development problems, indirect estimation measures must be developed. In this study, accessibility problems (i.e., vehicle delay) for the areas of concern are used to judge the magnitude of community development problems as well as to establish the problem-solving effectiveness of alternative remedial actions. The estimates of vehicle delay are derived from two sources: (1) vehicle delays observed in the communities, and (2) the amount of time during which crossings are blocked by railroad operations on the typical day.

For each of the communities, observations of railroad operations and vehicle delays associated with those operations were recorded for selected crossings. The information recorded included the amount of time the crossings were blocked by railroad operations and the number of vehicles that were delayed. In larger communities in which congestion created by vehicles delayed at crossings may contribute significantly to vehicle delay time, the amount of time delayed vehicles needed to clear the crossing after train departure was recorded. In Moorhead, for example, the congestion aspect of crossing delays added about 30 percent to total vehicle delay at crossings. From these data, rates of vehicle delay (the number of vehicles delayed per minute of blocked crossing time) were calculated. Separate rates for daytime and nighttime were calculated to take into account the fact that over 70 percent of average daily traffic occurs in daytime hours. 1/

From the railroad operations profile, the amount of time on the average day that crossings are blocked was calculated. As with the vehicle delay rates, separate calculations of blocked crossing time were made for daytime and nighttime.

The multiplication of the respective delay rates by the estimates of blocked crossing time provided an estimate of the number of vehicles delayed on an average day in each community. The vehicle delay estimate was allocated among the crossings according to annual average daily traffic distributions.

Data for crossings on the old NP line in Moorhead, Minnesota, illustrate this calculation procedure. During the observation period,

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1/ Factors Influencing Safety at Highway-Rail Grade Crossings, National Cooperative Highway Research Program Report 50, National Research Council, National Academy of Sciences, Washington, D.C., 1968, p. 59.

6,945 vehicles were observed to be delayed at crossings during the seven-day period. Closed crossing time equaled 352 minutes. The observed rate of vehicle delay, then, was 19.7 vehicles per minute of blocked crossing time. This rate represents the time of day between 5:30 a.m. and 8:30 p.m., the period of the day the observations were made. The rate for the remainder of the day was calculated based on the distribution of traffic by time of day. Typically, 86 percent of daily traffic occurs between 5:30 a.m. and 8:30 p.m. Thus, the rate of vehicle delay for the period 8:30 p.m. to 5:30 a.m. equals (14/86) (19.7), or 3.2 vehicles per minute of blocked crossing time.

The amount of time the crossings on the old NP line are closed by railroad operations is calculated to be 84 minutes on the average day. About 55 minutes of this time occurs between 5:30 a.m. and 8:30 p.m. Thus, the estimate of vehicles delayed per day at crossings on the old NP line in Moorhead equals:

(19.7) (55) + (3.2) (29) = 1180 vehicles per day

After estimating the number of vehicles delayed per typical day, the amount of vehicle delay time was calculated. For this calculation, it was assumed that vehicles arrive at the crossings at a uniform rate and therefore that their delay time per vehicle would be, on average, one-half of the time that the crossing is blocked. For the old NP line in Moorhead, the average delay per vehicle was estimated to be 1.9 minutes. However, it also was found that vehicle congestion caused by blocked crossings added thirty percent to the vehicle delay time during the daytime hours. Thus, the calculation of vehicle minutes of delay per day on the old NP line in Moorhead is:

1,085 vehicles delayed between 5:30 a.m. and 8:30 p.m.
times 2.5 minutes of delay per delayed vehicle
plus

95 vehicles delayed between 8:30 p.m. and 5:30 a.m.
times 1.9 minutes of delay per delayed vehicle
equals

3,000 minutes of vehicle delay per day.

As with the other methods used to estimate problem magnitude, the method used to estimate vehicle delay satisfies the purposes of this study. It establishes a reasonable estimate of the accessibility problems created by railroad operations and can be used to estimate future problems. (Estimates of future problem magnitude are made by increasing the vehicle delay rates by the estimated growth in AADT or population and by increasing the blocked crossing time according to projected train operations.) The technique also can be used to estimate changes in accessibility that result from implementation of remedial actions. In Moorhead, for example, several actions were implemented to reduce the amount of time crossings are blocked (e.g., by increasing allowable train speeds). The reduction in blocked crossing time that resulted from these actions was input into the vehicle delay estimating technique to determine the effect on accessibility. Similarly, the effects of actions resulting in increased street capacity and therefore less congestion at crossings or resulting in rerouting of traffic around crossing-related congestion can be estimated using the method described.

APPENDIX B

SUMMARY OF LOW-COST ACTIONS ALTERNATIVES ANALYSIS

In this appendix is presented the alternatives analysis that was performed for each case study community. The analysis culminated in the selection of low-cost actions for demonstration in each community.

The analysis proceeded in five steps. During Phases I and II of the study, a list of actions thought to be low in cost and to be capable of mitigating rail/community conflicts was developed. The actions identified (see Exhibit B-1) included changes in rail facilities and operations, changes in community services and facilities, establishment of railroad/community communication systems, public education programs, and redirection of community development patterns. The alternatives were then analyzed for their worth as demonstration projects. First, the alternatives were screened; those determined to be unfeasible, ineffective, or of no demonstration value were eliminated. Second, the remaining alternatives were compared in terms of potential problem-solving effectiveness, implementation cost, institutional considerations, and effects on other problems and community or railroad conditions. Third, the results of the analyses were presented to the case study communities to determine which were acceptable or unacceptable for implementation and to determine the priority ranking for the acceptable actions. Finally, the Management Board selected the actions warranted for implementaton as demonstration projects based on the information generated in the previous three steps.

The actions selected for demonstration are presented in Exhibit B-2. Exhibit B-3 presents the actions not recommended for demonstration and the reasons for their elimination. It should be noted that some actions presented in Exhibit B-3 may be effective in mitigating rail/community conflicts in other communities. They simply did not satisfy the criteria established for demonstration projects in this study.

EXHIBIT B-1

ACTIONS CONSIDERED FOR RESOLVING PRIORITY PROBLEMS IN THE CASE STUDY COMMUNITIES

	Beach	Casselton	Elk River	Hebron	Moorhead	Sauk Rapids
Make siding changes 1/	X			X		
Install power switches at ends of siding/yard entry 2/	X		X	X	X	
Break trains that must stand at crossings & post flagmen 3/	X		X		X	X
Institute school safety program	X	X		X		
Establish school safety patrol at the crossings	X	X		X		
Install fencing along right-of-way 4/	X			X		
Provide transit service 5/	X			X		
Construct grade-separated pedestrian crossing	X	X		X	X	
Establish emergency service/BN communication 6/	X	X	X	X	X	X
Establish alternative route for emergency vehicles 7/	X	X	X			X
Redirect community development patterns to minimize future rail/community conflicts	X	X				X
Install gates and/or grade crossing predictors 8/	X	X	X	X	X	X
Stop trains far enough from the crossings to avoid activating signals		X		X	X	
Reroute school buses/transit vehicles			X	X	X	

	Beach	Casselton	Elk River	Hebron	Moorhead	Sauk Rapids
Establish duplicate emergency services on both sides of the main line		X	X	X		
Restrict local switching operation to off-peak traffic hours			X		X	
Increase allowable train speed through the community		X			X	
Upgrade ambulance service from a basic life support to an advanced life support system 9/		X			X	X
Establish a volunteer rescue squad 10/			X		X	X
Improve general community/BN communications		X	X		X	X
Extend gate arms on existing gates to prevent motorists from crossing when the gates are down		X	X			
More strictly enforce laws against crossing the tracks against the signals		X	X			X
Close one or more crossings 11/		X				X
Construct facilities/disperse emergency vehicles to both sides of the track		X	X			
Allow crossing to clear before switching train returns to the crossing			X			X
Equip fire service volunteers with personal equipment to conduct emergency fire operation prior to engine arrival 12/		X				X
Consolidate trains on one of the two main lines that runs through the community 13/					X	
Conduct a campaign to overcome perception of significant CBD access problems 14/					X	

EXHIBIT B-1 (Continued)

	Beach	Casselton	Elk River	Hebron	Moorhead	Sauk Rapids
Reroute trains on a different line around the community 15/					X	
Locate crew changes farther outside of the community 16					X	
Change location of train verifier 17/					X	
Maintain grade crossing surface	X					
Remove visual obstructions in the railroad right-of-way near crossings	X					
Relocate school lunch program to avoid students having to cross the tracks	X					
Extend existing siding to serve additional rail users			X			
Straighten track alignment to permit faster train speed			X			
Establish a volunteer ambulance service						X
Establish an ambulance service sub-station operated by the existing, privately owned service						X
Designate existing underpass for emergency vehicle use only					X	
Improve highway intersection near rail crossing 18/			X			

EXHIBIT B-1

NOTES

1/ In Beach, the siding would be relocated out of the town, and other sidings east and west of town would be lengthened. In Hebron the end of the siding furthest from the community would be lengthened. Both changes would reduce the incidence of trains stopping on the siding so as to block crossings in the community.

2/ Installation of power switches in place of manual switches will permit trains to maintain a 25 mph speed while entering/exiting the siding. Manual switches require trains to stop while a crewman hand throws the switch permitting trains to change tracks. The increased train speeds reduce blocked crossing time, thereby reducing emergency vehicle and general traffic delays.

3/ In cases where trains must straddle the crossings, breaking the trains to keep one of the crossings open will minimize crossing delays. Posting flagmen will allow motorists to cross safely the main line between the broken train.

4/ Fencing would channel pedestrians to protected grade crossings; it would restrict crossings at intermediate, unprotected locations along the main line.

5/ Public transit would be provided to elderly and children to reduce the number of pedestrian crossings made, as well as provide convenient service to those who are transportation disadvantaged.

6/ The communication system would operate as follows:

- The local railroad agent would be equipped with a pagcom, compatible to that issued to volunteers. When informed of an emergency, he would determine the necessity and feasibility of changing train operations to avoid blocking the designated emergency vehicle crossing as the vehicle travels to the emergency site. He would instruct train crews to change operations (e.g., slow down or stop) via the established radio communication system.

- The local agent also would be equipped with a radio with which to communicate with ambulance personnel. The ambulance personnel would estimate the time it will take to arrive at the crossing on the trip from the emergency site to the hospital. They would radio this information to the local agent. The agent would ensure that the crossing is not blocked during this time. The ambulance personnel would notify the agent as soon as they have passed the crossing so that he could instruct train crews to proceed with normal train operations.

7/ In Beach, the proposed route is west of the central business district, but is the only crossing not crossed by the siding. Casselton's proposal consists of constructing new crossings at both ends of town, for emergency vehicles only. In Elk River and Sauk Rapids, the proposed routes, although circuitous, would avoid having to cross the main line.

8/ Gates are proven to be superior to other devices as a crossing protection device. A grade crossing predictor is a device used to activate the gates or flashing lights at crossings. The device determines the speed of the train and activates the crossing signals twenty-five seconds prior to train arrival at the crossing. This will eliminate two problems: (1) standing trains will no longer activate crossing signals, and 30 signals will not be activated for several minutes prior to the arrival at the crossing of a slow-moving train. This action will reduce vehicle delays by reducing the time between signal activation and train arrival at the crossing, and will reduce the safety hazard at crossings due to unreliable signal information.

9/ An advanced life support system provides additional capability to stabilize the patient at the emergency site. It thus reduces the number of life-threatening trips from the emergency site to the hospital and the probability that a delay at a grade crossing will be critical. (This capability is provided by an additional life-support equipment maintained in the ambulance, personnel trained to use the equipment, and a receiving station at the hospital.)

10/ A rescue squad would consist of volunteers provided with requisite equipment and medical supplies to enable them to provide a first-response capability. Personal vehicles or a rescue squad vehicle, kept at the on-call volunteer's location, could be used. The rescue squad would respond to calls only on the side for the main line where the ambulance is not garaged. The squad would not be licensed to transport patients; the squad would work in conjunction with the existing ambulance service and would defer to the ambulance service personnel when they arrived at the emergency site. This service does not require state licensing nor is it subject to other regulations imposed on volunteer ambulance services. Rescue squads have been successfully established in Minnesota's communities.

11/ Closing a crossing decreases vehicle exposure to trains by directing traffic to fewer and safer crossings. It also decreases crossing maintenance costs and will offset increased costs associated with upgrading protection at other crossings in the community.

12/ Fire fighters would be provided with equipment such as asbestos vests, oxygen masks and tanks, and extraction apparatus that would enable them to conduct life-saving operations prior to engine arrival.

13/ Currently, the average distribution of coal and mixed freight trains traveling through Moorhead is 80% on the old Northern Pacific (NP) line and 20% on the old Great Northern (GN) line. A redistribution of trains to the GN line might reduce delays in traveling to and from the central business district (CBI). This might result because the NP line separates a greater percentage of the population from the CBD (i.e., 70%) than does the GN line (i.e., 30%). In investigating this action, two alternatives were considered (a) a 50%/50% distribution and (b) a 20%/80% NP/GN distribution of coal and mixed freight trains.

14/ The objective of the campaign would be to convince travelers in Moorhead that the potential crossing delays in traveling to the CBD are not as serious as they may perceive.

15/ Use of an alternative route to the Twin Cities from west of Fargo/Moorhead by trains originating or destined to the Twin Cities or beyond would permit circumvention of Moorhead.

16/ Conducting crew changes farther east of Moorhead than currently is done would allow trains to begin deceleration at a point farther east and thus may allow maintenance of higher speeds through Moorhead.

17/ A verifier conducts a checking of trains as they pass by his location. The trains are required to slow down to about five mph to allow this to be done. This is currently done near 23rd Street in Fargo. This action would relocate checking outside of Fargo so that by the time the train reached Fargo and Moorhead, normal train speeds would be resumed and crossings blocked for a shorter period of time.

18/ These improvements are designed to reduce vehicle delay at the intersection. Also by reducing congestion, they are meant to resolve the accident hazard at this intersection when a train is present in the crossing.

EXHIBIT B-2

ACTIONS SELECTED FOR DEMONSTRATION
BY COMMUNITY

Action	Beach	Casselton	Elk River	Hebron	Moorhead	Sauk Rapids
Emergency service/RR communication system		X	X		X	X
Rescue squad					X	X
Intersection improvements			X			X
Power switches	X			X	X	
Grade crossing predictors	X	X	X	X	X	X
Automatic gates	X	X	X	X	X	X
Crossing closing		X				
Faster train speeds					X	
Rail siding modifications	X			X		
Safety program in schools		X				
Improve community/RR communications	X	X	X	X	X	X

EXHIBIT B-3

ACTIONS ELIMINATED AS POTENTIAL SOLUTIONS TO RAIL-RELATED PROBLEMS*

Action	Reason(s) for Elimination
Ensure standing trains do not activate the gates and flashers by having the trains stop short of the activation circuit.	This action has already been implemented by the railroad through instructions to train crews and the posting of signs at the bonded rail.
Extend the gate arms at crossings to prevent motorists from crossing when the gates are down.	This action would aggravate problems created by early signal activation since it would preclude motorists from crossing the main lines in these situations. It could increase the vehicle safety problem by diverting traffic to less-protected crossings. It also creates the possibility of motorists being "trapped" within the crossing by the gate arms.
More strictly enforce laws against crossing the tracks against the signals.	This action is deemed unacceptable until the early signal activation problem is resolved. It is believed that it would aggravate the rail/community conflict more than it would reduce the vehicle safety problem.
Equip fire service volunteers with personal equipment to conduct emergency operations prior to engine arrival.	Instances in which its equipment would be used are too few for this action to have any effect on the emergency service delay problem.
Establish duplicate emergency services on both sides of the main line.	While potentially quite effective, there are not enough volunteers to operate duplicate services. The substantial cost of duplicating services excludes this action from the low-cost category.
Upgrade the ambulance service from a basic life support to an advanced life support system.	The training required to establish the advanced life support system (500 to 800 hours instruction and clinic experience) is prohibitive given a volunteer system. Maintenance of proficiency also may be difficult given the relatively few times per year such a system may be utilized.
Disperse emergency vehicles on both sides of the mainline.	For the emergency service, this is equivalent to duplicating services on both sides of the mainline. It could be very effective but is not feasible due to lack of a sufficient number of additional volunteers.
Establish a direct emergency service/railroad communication system for the volunteer fire service.	Lead time (i.e., time from receipt of emergency call until fire engine arrives at crossing) is inadequate for the requisite train crew response to be decided, communicated, and implemented. Lead time averages 3 minutes; a 5-minute minimum may be required.
Construct a grade-separated pedestrian crossing.	This action would not be cost-effective.

* This exhibit is a composite of all actions eliminated. However, the same action may have been eliminated in some c the case study communities, but may have been implemented in others.

Action	Reason(s) for Elimination
Institute pedestrian safety patrols for the safety of children crossing the main lines to go to the swimming pool in Casselton.	While potentially a very effective action, it is unlike that volunteers could be found to be safety patrolers (six persons per day on five-hour shifts during the swimming months would be required). To pay persons to safety patrolers renders this an unfeasible action due limited city funds (cost may be $8,000 per summer).
Construct a new pedestrian walkway at Tenth Avenue in Casselton.	May reduce potential accidents (tripping over the rail), but is unique to Casselton and consequently is not a goo demonstration project candidate.
Redirect/control development patterns.	While this action could make a significant contribution to the reduction of emergency vehicle delays in the lon run, in the short-run (i.e, less than 10-15 years) its effect would be negligible. There are two reasons for this result: (1) development patterns are restricted t currently available land and infrastructure; (2) even with total control over the location of new development, the current community split would not change significantly for several years.
Reroute school buses/transit vehicles.	Alternative routing is not acceptable: (1) travel time would increase considerably, (2) the necessity of crossing two lanes of high-speed traffic with no signals makes this route potentially more hazardous than using the grade crossings for school buses in Elk River and (3 in Moorhead, re-routing still would not eliminate conflicts.
Schedule local switching operations for off-peak hours.	Rescheduling will have a negligible effect on the amount of vehicle delay experienced due to the distribution of highway average daily traffic by hour of day.
Establish an alternative emergency vehicle route.	Additional travel time incurred in using the route would exceed the expected (average) delay to emergency vehicles. Consequenty, use of the alternaitve would result in longer delays in more cases than using existin routes.
Extend the end of the midtown siding to serve the lumber yard in Elk River.	Service to the yard is too infrequent for this action to have a significant effect on vehicle delay. Its implementation cost does not appear warranted.
Straighten track alignment to permit faster train speed in Elk River.	The railroad has recently completed track improvements that permit train speeds consistent with the railroad's policies on train speed limits. Track alignment straightening would accomplish little, if any, ability t further increase operating speeds.
Reroute trains around the community (use the Wilmar route).	This action is unacceptable to the railroad due to the substantial costs and logistics problems associated with using the Wilmar alternative.

Action	Reason(s) for Elimination
Relocate crew changes farther east of Moorhead.	This would not result in the desired train speed increase in Moorhead because the current crew change location (on the main line in Dilworth) does not require train speed deceleration until the train passes 21st Street.
Change location of train verifier.	This action would influence only one percent of all rail operations occuring in the Fargo/Moorhead area. Because current verification occurs in Fargo, even with this action, train speeds in Moorhead are unlikely to be affected.
Construct grade-separated pedestrian crossings linking parking lots and CBD in Moorhead.	This action would not be adequate to overcome the delay problem. The walking distance from the parking lot to the CBD may be more of a deterrent to shop or locate business in the CBD than are delays at crossings.
Conduct a campaign to overcome perception of significant CBD access problems in Moorhead.	Calling further attention to the situation may make the perception of potential delay worse than it already is. More importantly, the accomplishments of a marketing program may be negated as soon as those convinced that access to the CBD may not be poor experience a significant grade crossing delay.
Designate the Third Street underpass for emergency vehicle use only in Moorhead.	The additional travel time required to use this route (3-4 minutes) exceeds the expected delay when a train is encountered (2 minutes). In less than 1% of the cases it would be quicker to take the Third Street route. An additional disbenefit of this action is the elimination of the only north/south route not requiring crossing the main lines to general traffic.
Establish an ambulance service sub-station in Sauk Rapids operated by the existing, privately owned service.	The ambulance service provider stated that establishment of a sub-station is not economically feasible; he does not appear interested in operating a subsidized operation.
Break standing trains that are blocking crossings.	The railroad should ensure that trains always are uncoupled to clear a crossing if the amount of time the crossing is blocked will be minimized in so doing. Also, a standing train should not occupy the designated emergency vehicle crossing. However, there are too few recorded experiences of standing trains occupying crossings for this action to effect a significant reduction in any problem.
Maintain crossing surface.	This should be done on a regular basis by the railroad.
Remove visual obstructions.	This is a local matter. Deal with it locally.
Institute school safety education and school safety patrol.	To be undertaken by the school district in Hebron; not effective in Beach because many children are taken by car.
Install fencing.	This would block access; citizens and train crews object.

Action	Reason(s) for Elimination
Change school lunch program.	School district policies interfere with this solution.
Provide transit service.	The expense of providing service to low and essentially random demand would not be balanced by benefits.

APPENDIX C

FUNDING SOURCES FOR LOW-COST ACTIONS

Please note that the information contained in this appendix was developed in 1980 and may have changed since then.

To assist the Management Board in its search for funding, existing funding sources were identified and evaluated as to their potential uses for the demonstration projects. Those that appeared most likely to provide funding within a period of time consistent with the study schedule were recommended to the Board as sources that should be investigated.

The results of this effort are presented in Exhibit C-1. The exhibit identifies the programs or agencies that fund the types of projects selected for demonstration. Comments about the chances of obtaining funding from these programs and agencies also are presented. 1/ Essentially, it was found that the federal-aid highway programs offer the best public source of demonstration project funding. Many of the projects are eligible for funding under these programs, including grade crossing improvements, highway/street improvements, fencing, and emergency medical service improvements. 2/ There is sufficient discretion at the state level to allocate funding to projects in a short time period if unobligated funds are available.

Other public programs that warrant investigation as sources of demonstration project funding are (1) the federal regional commissions, (2) city and county governments, and (3) discretionary funds that may be available to federal agencies. The regional commissions in which Minnesota and North Dakota participate have programs under which all of the

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1/ Although certain of the funding sources presented in Exhibit C-1 were not pursued for demonstration project funding, they may provide funding for actions designed to resolve rail/community conflicts in other contexts.

2/ The highway funds are not available for improvements or actions that are solely rail-oriented, such as siding relocations or changes to allow increased train speeds.

EXHIBIT C-1

PROGRAMS AND AGENCIES CONSIDERED AS POSSIBLE SOURCES OF DEMONSTRATION PROJECT FUNDING

AGENCY	PROGRAM	ELIGIBLE PROJECTS	EVALUATION
DOE	Environmental Research and Impact Assessments	Assessment of impacts of energy development and use through applied research and demonstrations	It is a possibility, although project approval requires 3 to 6 months
FRA	Railroad Rehabilitation Improvement-Guarantee of Obligations (20.309)	Acquisition, rehabilitation and improvement of railroad facilities and equipment	Do not pursue; projects not eligible.
MnDOT or NDSHD	Primary, Secondary and Urban Systems	Construction, improvements and 3R work on the federal aid highway systems	Worth pursuing
	Safer-Off System Roads	Improvement of roads not on the federal aid highway system; includes removal on safety hazards, traffic control devices, pavement construction and reconstruction	Worth pursuing
	Hazard Elimination Program	Projects to eliminate hazards to motorists and pedestrians on public roads	Worth pursuing
	Rail/Highway Crossing Improvements	Protective devices, grade separations, highway relocation and rail relocation	Worth pursuing
	Highway Safety Grants	Implement highway safety standards and conduct safety research	Worth pursuing
OW&UGL	Old West and Upper Great Lakes Technical Assistance Programs (75.002 & 63.002)	Planning, studies, demonstration projects to evaluate needs and develop potentialities of economic growth	Worth pursuing
	Old West and Upper Great Lakes Supplements to Federal Grant-In-Aid (75.003 & 63.003)	Local share of federal aid grant program for construction or equipping of facilities	Worth pursuing depending on other funding obtained.
	Upper Great Lakes Regional Transportation (63.004)	Planning, purchase of equipment, construction and operation of demonstration projects	Worth pursuing
	Upper Great Lakes Energy Demonstration Projects and Programs (63.005)	Demonstration projects concerning energy resource development and impacts	Worth pursuing

1/ The acronyms represent the following agencies: DOE - U.S. Department of Energy; EDA - Economic Development Administration, U.S. Department of Commerce; FmHA - Farmers Home Administration, U.S. Department of Agriculture; FRA - Federal Railroad Administration, U.S. Department of Transportation; HUD - U.S. Department of Housing and Urban Development; MnDOT - Minnesota Department of Transportation; NDSHD - North Dakota State Highway Department; OW - Old West Regional Commission; PHS - Public Health Service, U.S. Department of Health; UGL - Upper Great Lakes Regional Commission.

2/ Numbers in parentheses are the Catalogue of Federal Domestic Assistance Program identification numbers. The Catalogue provides a detailed description of each program.

EXHIBIT C-1 (Continued)

PROGRAMS AND AGENCIES CONSIDERED AS POSSIBLE SOURCES OF DEMONSTRATION PROJECT FUNDING

AGENCY[1/]	PROGRAM[2/]	ELIGIBLE PROJECTS	EVALUATION
FmHA	Community Facilities Loans (10.423)	Construction of community facilities that support overall community development such as fire and rescue services, transportation, traffic control, social, health, cultural and recreational benefits.	Do not pursue because the program provides only loans and loan guarantees, not grants.
	Industrial Development Grants (10.424)	Industrial site development in rural areas	Do not pursue since none of the demonstration projects are eligible for assistance under this program.
EDA	Economic Development Grants and Loans for Public Works and Development Facilities (11.300)	Public facilities construction needed to initiate/encourage long-term economic growth	Do not pursue due to questionable project eligibility in qualified communities (Hebron and Sauk Rapids).
	Economic Development-Business Development Loans (11.301)	Long-term business development loans for fixed assets aquisition.	Do not pursue because projects are not eligible.
	Economic Development Technical Assistance (11.303)	Demonstration projects grants, feasibility studies, managerial and operational assistance to solve economic development projects.	Do not pursue due to questionable project eligibility in qualified communities (Hebron and Sauk Rapids)
PHS	Community Health Centers (13.224)	Actions designed to improve availability, accessablity and organization of health care within undeserved areas.	Do not pursue due to questionable project eligibility.
	Health Services Research and Development Grants and Contracts (13.226).	Research, demonstration projects and evaluation activities designed to ensure development of new options for health care services.	Do not pursue due to unlikely project eligibilty.
	Emergency Medical Services (13.284)	Assistance to develop regional emergency medical services; feasibility studies, planning, establishing or improving operations.	Do not pursue because application deadlines and approval dates are inconsistent with the study schedule (next applications not accepted for another year).
	Grants for Training in Emergency Medical Services (13.287)	Costs of training personnel in emergency medical services.	Do not pursue; approval time (6 months) is inconsistent with the study schedule.
HUD	Community Development Block Grants/Entitlement Grants (14.218) Community Development Block Grants/Small Cities Program (14.221)	Wide range of activities directed toward economic development, neighborhood revitalization and improved community services and facilities.	Do not pursue because application deadlines are inconsistent with the study schedule (next applications are due in October).
	Urban Development Action Grants (14.221)	Economic development and neighborhood revitalization projects in severely distressed cities and counties.	Do not pursue; unlikely that projects are eligible.

demonstration projects are potentially eligible. County governments may be contacted for highway improvement funding; also the states pass money through to the counties to finance emergency medical services. It is recognized that local governments along the corridor have limited financial capabilities. About 80 percent of the communities have populations of under 5,000 people. For such communities, a $5,000 expenditure is a substantial budget item. Consequently, a financial contribution by the local government is not a condition for project implementation. On the other hand, the Board has stated that local government concurrence in closing selected crossings is a substantive contribution. Closing crossings will reduce grade crossing hazards and offset the increased costs that will result from installation of gates and grade crossing predictors at other crossings.

On the private sector side, the obvious funding source is Burlington Northern, Inc. Certain funding traditions and responsibilities suggest that the railroad is a likely source of funding in several project areas. These areas are grade crossing maintenance and changes in railroad facilities that benefit railroad operations. The railroad also has expressed its willingness to pay the local share of the cost to close crossings as part of the demonstration projects.

APPENDIX D

ACTIONS TAKEN BY BURLINGTON NORTHERN, INC. THAT WILL REDUCE RAIL/COMMUNITY CONFLICTS IN STUDY CORRIDOR

The information presented in the Appendix is taken from a letter from Russel Thompson, Burlington Northern, Inc., to Chip Taggart, Ernst & Whinney, dated September 12, 1979.

*Note: Those items listed below which are marked with an asterisk are items which were not implemented as a result of the corridor study, but were planned and/or budgeted by Burlington Northern prior to the study or are the result of established BN policy.

Anoka, Minnesota

1. Mayor and Chief of Police have been furnished the telephone numbers of the local agent and the chief dispatcher at Minneapolis, who will assist in clearing crossings for emergency vehicles.

2. Crossing maintenance work has been implemented.

Audubon, Minnesota

1. Investigation into visibility at crossings was carried out without finding any apparent problem. City officials have been contacted by the Trainmaster-Road Foreman to clarify the complaint.

Beach, North Dakota

*1. Funding for upgrading crossing signals through installation of gates and motion sensors at all three crossings in the Beach area has been recommended to the North Dakota State Highway Department, who will prioritize the funding for these crossings.

*2. Siding extensions are presently being constructed on each side of Beach at Yates, Montana, and Sentinel Butte, North Dakota, so as to hold a coal train. This will reduce the number of train meets at Beach and also reduce the duration that trains are held at Beach.

3. In addition, crews have again been instructed not to block crossings at Central and Second Avenues unless absolutely necessary. Officials are monitoring this situation on a continuing basis.

*4. Installation of CTC is scheduled for 1982, which will also improve train meets, reducing the time two trains will spend on the siding at Beach.

5. Names, addresses, and phone numbers of BN personnel have been furnished the city officials.

Big Lake, Minnesota

1. Eagle Lake Road crossing repaired and arrangements made with the City to ensure that crossing is kept in good condition.

2. Big Lake school officials have been contacted and arrangements made to conduct a school safety program and present a film on crossing safety at their schools.

*3. 1978 Work Program caused crossings to be blocked. Work now complete and crossing blockage has been minimized.

4. Operating practices have been changed in that crossover movements are now being made at Becker, Minnesota, rather than Big Lake whenever possible.

5. The chief dispatcher's telephone number in Minneapolis has been furnished the City officials to assist in clearing crossing for emergency vehicles.

6. Complaint was made that Highway 25 was closed for maintenance of crossing for four hours during the Fourth of July weekend in 1978 without notification to City officials. The County was notified by Burlington Northern in advance and they in turn notified the City in advance of the work.

   In the future, maintenance work will be planned to avoid conflicts with long weekends and Roadmaster will notify both the City and County relative to crossing work in the area.

Bismarck, North Dakota

*1. Twenty-fourth Street has had crossing signals, gates, predictors, and motion sensors installed. This work was previously authorized and installation completed on June 15, 1979.

Buffalo, North Dakota

1. In order to alleviate some of the visibility problems, the derail at Cargill was relocated so that loaded grain cars could be moved farther from the crossing to improve visibility.

2. Burlington Northern was not aware that the state highway was being blocked by trains other than those in the process of working through the dual control switch or lining up for reverse route movement. The situation has been monitored and crews advised of the need to leave crossing open.

Buffalo, North Dakota (Continued)

*3. Crossing signals at Highway 38 have been installed with gates, predictors, and motion sensors, with work completed August 15, 1979. This work had previously been authorized and it should relieve some of the complaints regarding traffic at this crossing.

4. Operating instructions have been issued which require that westward trains being held at Buffalo for opposing trains between the hours of 9:00 p.m. and 7:00 a.m. must stand not less than 300 feet east of the east switch of the elevator track. In addition, the following trains held by preceding trains on the westward track at Buffalo have instructions to stay clear of or cut all county road crossings. This should greatly reduce the complaints regarding noise and blockage of crossings.

5. Plans are being prepared and authority is to be requested for widening of the crossing at Wilcox Avenue. This work will probably be authorized and completed this fall. The area around Bush Avenue has been picked up by the Track Department.

Casselton, North Dakota

1. The main complaint has been of crossing signals being activated by standing trains. The solution to this is to install motion sensors and we have recommended to the State of North Dakota that they program the funding of upgrading the crossing signals at Casselton. Entering signal circuit signs will be established and bulletined for operation as a low-cost solution to the crossing signal problem pending installation of motion sensors.

2. Operating Department is working with Farmers Union Grain Terminal Association to limit height of material stockpiled along track near crossing and to reduce the number of empty cars on spot at the elevator. This can be done by placing the overflow of empty grain cars west of the crossing. While the grain elevator does obstruct the vision to some degree, it cannot be moved and is of a minor nature.

3. Maintenance of the crossings has been handled for correction.

Casselton, North Dakota (Continued)

4. Education of children concerning crossing the main line is a matter which can be handled by the parents, through our school education program, and to some degree with operation life-saver programs which efforts are being made to institute in North Dakota.

5. Pedestrian traffic crossing the main line was a minor complaint. Consideration will be given by Burlington Northern to constructing concrete walkways on our property once the City has established same to our right-of-way line.

6. Burlington Northern does not have any complaints on file of operating practices which falsely activate crossing signals nor poor maintenance of grade crossings. We have been extremely responsive where a solution exists.

Coon Rapids, Minnesota

1. City officials have been furnished with telephone numbers of the operator at Coon Rapids and chief dispatcher at Minneapolis to assist in case of crossing blockage during an emergency.

2. There was some fear in the neighborhood due to train speeds. Railway personnel recently presented our school safety program to Morris Bye Elementary School attended by 702 students. The school officials were very impressed and appreciative of the program.

3. The complaint that the crossing gates at Egret Avenue come down long before necessary has been investigated. The gates lower 25 seconds in advance of a train moving at 60 mph. Any trains moving slower than that time would result in gates being down for longer periods of time. The solution is for the City to request matching funds from the State so that motion predictors can be installed at the crossing.

4. Crossing maintenance is being monitored.

Detroit Lakes, Minnesota

1. The suggestion that noise barriers be installed at the Soo Line diamond is not a feasible solution. Maintenance of Way forces have checked the diamond to ensure it is in good condition to reduce noise and vibration.

Dickinson, North Dakota

*1. Crossing signals with gates and motion sensors are being installed at the Patterson Lake Road crossing and the Sixth Avenue crossing this year. These crossing signals were programmed earlier by the State. CTC installation in 1982 and 1983 will speed up inbound and outbound movement of trains, thereby reducing the congestion and delay at crossings.

Dilworth, Minnesota

1. The new residential development of 57 acres which is scheduled to be established south of the tracks will create additional crossing problems for the City.

2. It is recommended that a hot line be installed at Fargo control which the various emergency services would have access to which would enable Fargo control to take appropriate steps to provide for access at the various crossings for the emergency vehicles.

*3. It has also been recommended that a power switch be installed at 21st Street in Moorhead, so that traffic could maintain track speed through Fargo-Moorhead and into the yard at Dilworth. Funds have not been provided for this project to date.

Elk River, Minnesota

1. Blockage of crossings for 20 minutes would be very unusual unless an accident were involved. Trainmaster has provided the officials with telephone numbers of the agent at Elk River, operator at Coon Creek, and the chief dispatcher at Minneapolis, who will assist in case of blocked crossings during an emergency. Our tie program has been completed in this area so that blocked crossings due to maintenance work should not be a problem. The Maintenance Department will work closely with City officials in the future to hold this type of complaint to a minimum.

Frazee, Minnesota

*1. Train speed of 10 mph has been raised so that trains presently operate at 30 mph eastbound and 20 mph westbound over the bridge which is being rehabilitated.

Frazee, Minnesota (Continued)

2. Arrangements have been made to place red protective flags 500 feet west of the bridge so that trains would stop short of the crossing during the maintenance work.

Gladstone, North Dakota

*1. The crossing in Gladstone is only 2,941 feet long and is only used by the local when spotting or pulling cars at the elevator or if a work train is in the area. Operating crews will be alerted to the fact that if train is to be left on the short siding, that crossings be cut.

*2. Recommendation has been made to the North Dakota State Highway Department that the older flasher type crossing signals be upgraded and motion sensors with signals and gates be placed.

Glen Ullin, North Dakota

1. The Mayor was contacted and names, addresses, and phone numbers given to him to use when corresponding or calling the Burlington Northern under emergency situations.

*2. Extension of the siding at Glen Ullin is scheduled for 1981 and CTC installation will be in 1983. With the extended siding it will be possible to leave the main crossings in town open while the train is standing on the siding.

*3. Recommendation has been made to the North Dakota State Highway Department that the crossing signals be upgraded with gates and motion sensors.

Hawley, Minnesota

1. The Mayor indicated that our agent left the depot building when trains pass because of the hazard. This is not the case, as the agent leaves the depot to inspect the passing trains. The track through Hawley is in excellent condition and there is not much that can be done about the vibration problem.

Hebron, North Dakota

1. The Mayor has been advised the names, addresses, and telephone numbers in connection with correspondence and any emergency calls.

Hebron, North Dakota (Continued)

*2. The crossing signals at West Street are programmed for installation in 1979. The crossings at Elk Street and Elm Street have both been recommended for upgrading to the North Dakota State Highway Department.

*3. The siding will be extended in 1980 and CTC installed in 1983. The proposed extension will eliminate blocking of West Street by trains in the siding and eliminate the restricted visibility at Elk Street.

Little Falls, Minnesota

1. Telephone numbers have been given to the Chief of Police and the Mayor for emergency situations. The trainmaster has worked closely with the City officials in handling trains and stopping them at other points when emergency conditions necessitate such action.

*2. Rerouting of Trains 360 and 361 via Staples has eliminated a major source of crossing blockage. A contract has been let for grading to reduce the curvature on the Mississippi River bridge approach which will allow for increasing speeds to 30 mph.

Medora, North Dakota

*1. The main complaint at Medora has been the blocked crossing which is located near the west end of the siding. Trainmen have been instructed to cut this crossing to avoid excessive delays. The siding itself will be removed during 1980 and CTC is scheduled to go through the area in 1982.

2. When the siding is removed, it has been recommended that the motion sensors which are operating only on the siding be connected to the main line; this will be done.

Moorhead, Minnesota

*1. The recommendations for a power switch at 21st Street was covered under the Dilworth discussion.

New Salem, North Dakota

*1. Extension of the siding to the west is scheduled for 1981. This will allow a coal train to clear the Fifth Street crossing without blocking it. The importance of cutting the crossing at Fifth Street has been impressed on the crews to ensure that unnecessary blockage does not occur. Comment was made that the swirling snow turned up by passing trains made it difficult to see the warning signals. The signals are placed at standard distance from tracks per State requirements. The State Highway crossings have advance warning signs while the City crossing does not. It is recommended that if the City feels that additional safety beyond the automatic crossing signals is necessary, that the advance warning signs be placed by the City.

*2. Point was made that the vibration of passing trains created disturbances. The 1981 program provides for placement of welded rail through this territory which will greatly reduce the noise and vibrations.

Perham, Minnesota

*1. During switching operations, the brakemen protect the crossing and raise the gates to allow cars to pass if no movement is to be made. Trainmaster-Road Foreman will continue to monitor to make certain that this is being done.

*2. Improved crossing signal devices will be placed on the Sixth Avenue Northwest crossing, with work scheduled for completion in October.

3. City officials have been furnished the telephone numbers for the Staples operator and the chief dispatcher to assist them in case of blocked crossings during an emergency.

Richardton, North Dakota

*1. Extension of the siding is scheduled for 1981. When this work is completed, crossings can be cleared by standing trains in the siding.

*2. Highway No. 8 and "B" Street have been recommended for upgrading to the State Highway Department.

Sartell, Minnesota

1. City officials have been furnished telephone numbers of the chief dispatcher who will assist them in cases of blocked crossings during an emergency.

2. Maintenance of the Sartell crossing which was complained of has been shifted to the St. Cloud Signal Maintainer, rather than using the Little Falls Maintainer for this purpose. This will reduce the time it takes to repair signals in case they become inoperative.

Sauk Rapids, Minnesota

*1. The City has been advised that coal train traffic would only increase to about six to eight trains per day, not the 20 which they indicated.

2. The City should request the State Highway Department to program crossings for installation of gates and predictors.

*3. Crews are required by law to whistle for all public railroad crossings.

Sentinel Butte, North Dakota

1. The Mayor has been furnished the names, addresses, and phone numbers of offices and people on the Burlington Northern to contact in connection with the various matters.

*2. The siding at Sentinel Butte is being extended westward this year and will be shortened on the east end which will remove the siding from both crossings in the Town of Sentinel Butte. CTC is scheduled in 1982 through this territory.

*3. Recommendation has been made to the State that the flashing light signals be upgraded by placement of gates and motion sensors.

South Heart, North Dakota

1. The Mayor has been furnished the names, addresses, and phone numbers of Burlington Northern personnel to be contacted in emergencies or for other matters.

South Heart, North Dakota (Continued)

*2. The siding at South Heart is being extended eastward which will allow room for a train to occupy the siding without blocking the crossing.

*3. We have recommended to the State Highway Department that the Fourth Street crossing in South Heart be considered for upgrading with gates and predictors.

4. The elevator track has been raised to reduce the difference in elevation between the main line and the siding. Any further raising of the elevator track will create problems for the operator of the elevator.

5. The drainage problem near the west switch of our siding has been corrected. The drainage problem near the depot is being investigated and recommendations made for correction.

Staples, Minnesota

1. Telephone numbers of the operator and trainmaster have been furnished to City officials to assist them in case of blocked crossings during an emergency.

*2. Eastward trains change crews west of the crossing to avoid blocking the two crossings.

Steele, North Dakota

*1. The Third Avenue East and Fourth Avenue West crossings have had gates, flashing lights, and motion sensors installed in June, 1979. Have recommended to the State Highway Department that Mitchell Avenue be upgraded with gates and motion sensors.

Tappen, North Dakota

*1. Crossing signals will be installed at Second and Fourth Street in 1979 and 1980.

2. Some track changes are planned at Tappen which will improve the condition at the crossing. Most train traffic is through and very little emergency vehicle delay can be expected.

Wadena, Minnesota

*1. Recent signal circuit changes have been made wherein motion sensors were installed to relieve the down time of gates during switching operations. This has resulted in great improvement to this problem.

2. The City officials have been furnished with telephone numbers of the chief dispatcher, who will assist them in cases of blocked crossings during an emergency.

Office of Director, Public Works
St. Paul, Minnesota
September 11, 1979