EFFECTIVE PROMOTION OF TRAFFIC SAFETY PROGRAMS

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1

INTRODUCTION

Traffic Engineers have long recognized that traffic safety results from good traffic operations. Increased concern over traffic safety has led to improved techniques and procedures to enhance the planning, design, and operations of streets and highways over the past two decades.

The National Highways Safety Act of 1966 (Public Law 89-564) resulted from national concern about reducing traffic accidents and fatalities. It is based on the concept that a coordinated approach by all levels of government is the best way to solve highway safety problems. The act contains three major provisions:

- Accelerating highway safety programs in each state
- Increasing highway safety research and development
- Establishing the "National Highway Safety Advisory Committee"

The Act requires each state to have an approved program to reduce traffic accidents and the resulting deaths, injuries, and property damage. Each state must meet the following conditions to obtain approval of their safety plan:

1. The governor of the state shall be responsible for administering the program.
2. Political subdivisions of the state shall be authorized to carry out local highway safety programs within their jurisdictions, provided that their programs are approved by the governor and in accordance with uniform standards and the state comprehensive plan.
3. At least forty percent of federal funds under this section shall be expended by political subdivisions in carrying out local programs.
4. The state and its political subdivisions shall maintain their level of expenditures for highway safety programs.
5. Development and operations of comprehensive driver training programs shall be required by the state.

A Highway Safety Program Manual (HSPM) was developed by the U.S. Department of Transpartation to provide guidance to state and local agencies in conforming with highway safety programs. Volumes comprising the manual correspond to the Safety Standards and consist of the following:

- 0 - Planning and Administration
- 1 - Periodic Motor Vehicle Inspection
- 2 - Motor Vehicle Registration
- 3 - Motorcycle Safety
- 4 - Driver Education
- 5 - Driver Licensing
- 6 - Codes and Laws
- 7 - Traffic Courts
- 8 - Alcohol in Relation to Highway Safety
- 9 - Identification and Surveillance of Accident Locations
- 10 - Traffic Records
- 11 - Emergency Medical Records
- 12 - Highway Design, Construction, and Maintenance
- 13 - Traffic Engineering Services (Traffic Control Devices)
- 14 - Pedestrian Safety
- 15 - Police Traffic Services
- 16 - Debris Hazard Control and Cleanup
- 17 - Pupil Transportation Safety
- 18 - Accident Reporting and Investigation

The Office of Highway Safety in the Federal Highway Administration currently administers highway-related safety standards which include:

- Identification and surveillance of accident locations;
- Highway design, construction, and maintenance; and,
- Traffic engineering services.

Responsibility for the standard on pedestrian safety is shared between the FHWA and the National Highway Traffic Safety Administration (NHTSA). FWHA is responsible for highway-related aspects while NHTSA administers safety standards pertaining to the automobile and driver.

In Texas, all 18 standards are administered by the Texas Department of Highways and Public Transportation.

2
PROGRAM STRUCTURE AND ADMINISTRATION

Implementation and continued effectiveness of a traffic safety program at the local level requires clearly defined goals, objectives, and policies relating to traffic safety. These must be integrated into day-to-day planning, design, construction, maintenance, and traffic operations of the local street and highway system. In addition, some system is needed for processing safety-related information in order to achieve the desired results - especially under conditions of intense competition for scarce financial resources.

A structure for organizing an effective safety program is shown in Figure 2-1. The rectangles outlined in heavy broken lines are the three principal elements of a traffic safety improvement system. Evaluation of safety improvements provides feedback to enhance the planning and analysis and the implementation components. Continued evaluation is also essential for:

1. Reviewing goals, objectives, and policies.
2. Determining whether stated objectives have been achieved.
3. Ascertaining the validity of previous decisions.
4. Developing the support of public and local officials for implementation of traffic safety improvements.
5. Demonstrating a need for funding and indicating where limited funds should be spent.

Figure 2-2 identifies major steps that should be followed in the implementation of traffic safety improvements and evaluation.

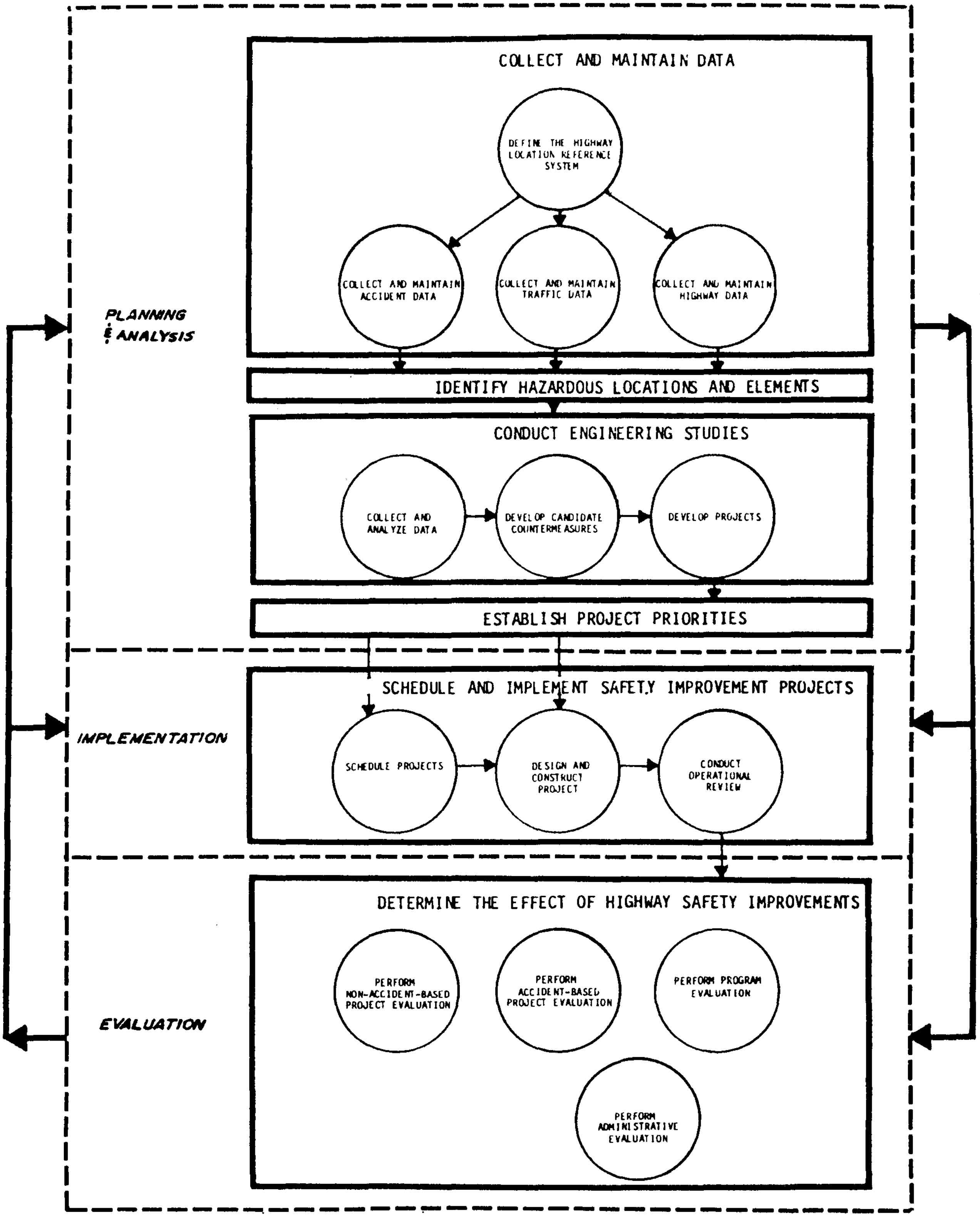


Figure 2-1 Elements of A Traffic Safety Program

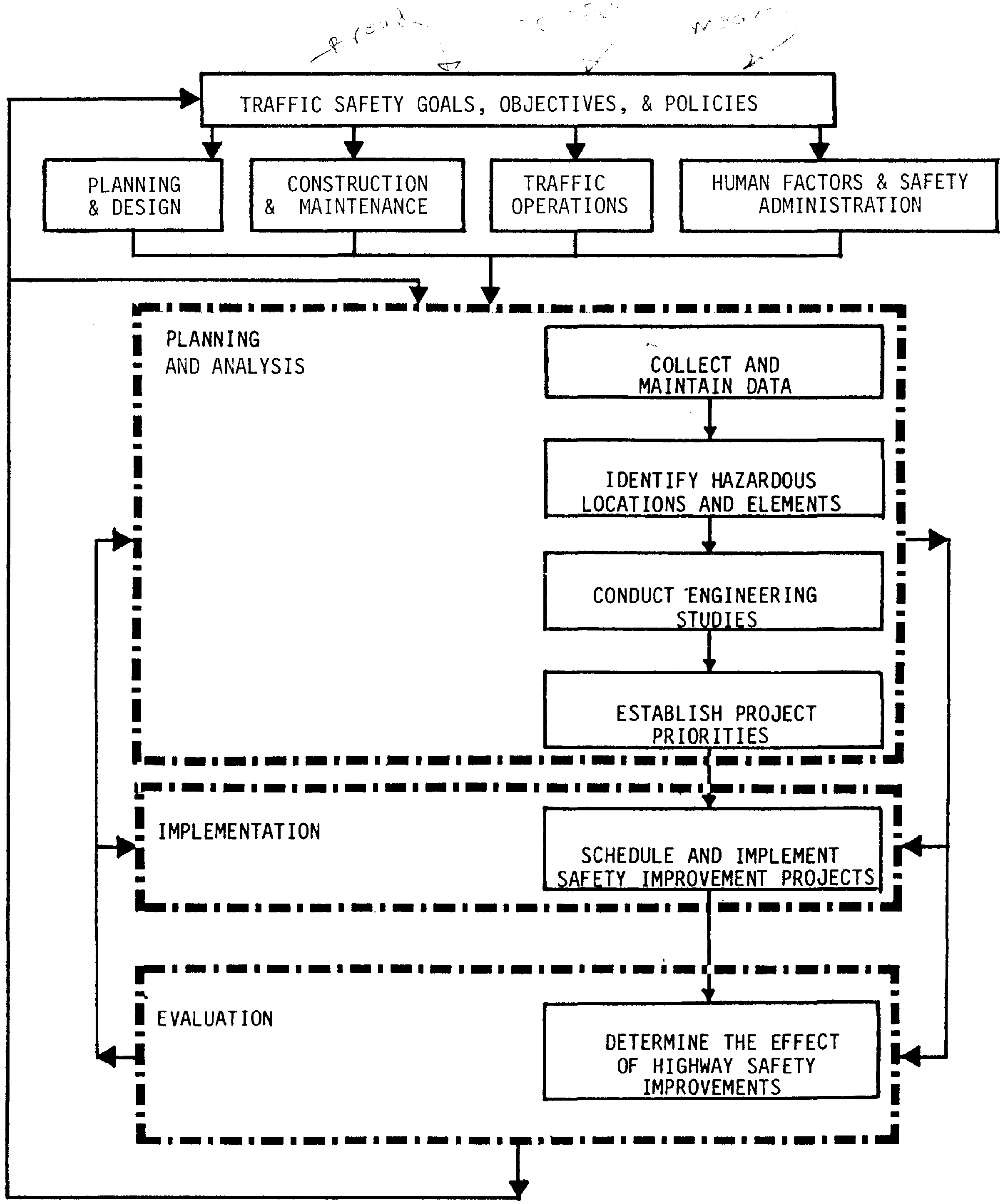


Figure 2-2 Major Activities Required In An Effective Traffic Safety Program

3
RESOURCE MANAGEMENT

Financial
Personnel
Information

INTRODUCTION

Resource management should be aimed toward achieving local transportation goals and objectives systematically within the prevailing constraints on available resources. Disparities between transporation needs and resources make improved resource management essential. To be successful, resource management must involve all phases of the transportation development and improvement process which affect traffic safety, including planning, programming, implementation, and evaluation.

If resource management efforts are to realize results which approach their full potential, they must begin with planning. While the initial inventory of resources is a rather obvious starting point for a resource management effort, it is a step not often taken. This phenomenon is the result of approaches which might be called "belt-tightening," or "cost-consciousness" instead of resource management. Reaction to dwindling funds, shrinking staff capabilities, and aging equipment is often one of "making do" or cutting costs. Instead, resource management should concentrate on attaining goals through effective management of information, funds, and personnel:

1. Information Resources: Information is essential to an effective traffic safety program. It provides the basis for selection and implementation of safety improvements. The objective use of information will either make or break the safety program.

2. Financial Resources: Any discussion of resource management must include financial resources. The objective of financial management is one of achieveing the highest level of safety improvement for the lowest possible cost.

3. Personnel Resources: The objectives of personnel management are related to enhancement and allocation - how to obtain, maintain, and assign personnel transportation functions and jobs.

This short course deals with information resources.

INFORMATION RESOURCES

A data base is absolutely essential for objectively identifying locations in need of traffic safety improvements, analyzing the nature of problems, selecting appropriate safety improvements, and prioritizing locations for the allocation of funds.

DATA COLLECTION AND MAINTENANCE

There are four tasks that must be accomplished to establish and maintain the data base needed to locate and analyze hazardous locations:

- Establish a location reference system
- Collect and maintain accident data
- Collect and maintain traffic data —
- Collect and maintain data on the physical characteristics of the street and highway system

ESTABLISH A LOCATION REFERENCE SYSTEM

In order to conveniently file and retrieve information, a system must be established for coding the location of traffic accidents and other information. Some systems in use are:

Milepost: Roadside workers are used to indicate the distance from a selected zero point. This method is most apparent on the interstate system; however, it has been used on state-maintained highways in Texas for several decades. It has not been implemented in urban areas, although a milepost system could be adapted for use in build-up areas.

Street and Block Reference: Due to the presence of street signing and numbering within municipalities, this has been and continues to be the prevalent method of reference within urban areas.

Reference Point: Some point of reference is established from which the distance to the location in question is given. Reference points which have been used include: road intersections, rivers and creeks, rural mailboxes, prominent physical or man-made features, and telephone and power poles. Reference points of this nature result in considerable question as to where an accident actually occurred and make the efficient retrieval of information difficult to impossible.

ACCIDENT DATA

Traffic accident records are a basic data in any traffic stafety record system. While traffic accident reports completed by police are the primary source of data, reports submitted by drivers often add valuable information.

Accident investigations by police vary from city to city. In small cities, a police report is available on all or nearly all accidents. In larger cities, it is increasingly common for police to investigate major accidents involving substantial traffic problems, injury or a fatality. While there may be an interest in acquiring extensive data on an accident report form (such as those listed in Table 3-1) the critical components for accident analysis, in order of importance are:

1. Accident location.
2. Collision diagram.
3. Accident description.
4. Accident conditions.
5. Date and time.

The standard accident report of the Department of Public Safety should be uniformly utilized. Police officers on traffic detail should be informed about how accident reports are used to identify hazardous locations and evaluate possible traffic safety and traffic engineering improvements. Close, continuing cooperation between traffic engineering/safety personnel and the police department will improve the quality

Data Element Name

ACCIDENT CASE NUMBER*
ACCIDENT COUNTY*
ACCIDENT DATE AND TIME*
ACCIDENT DAY OF WEEK
ACCIDENT LOCATION INVESTIGATION
ACCIDENT MUNICIPALITY*
ACCIDENT RECORD SOURCE
ACCIDENT SEVERITY*
ACCIDENT VEHICLES
BLOOD ALCOHOL CONCENTRATION TEST DATE AND TIME
BLOOD ALCOHOL CONCENTRATION TEST RESULTS
BLOOD ALCOHOL CONCENTRATION TEST TYPE
CAUSE FOR DRIVER/OPERATOR MANEUVER
CONTRIBUTING CIRCUMSTANCES, DRIVER
CONTRIBUTING CIRCUMSTANCES, ENVIRONMENT
CONTRIBUTING CIRCUMSTANCES, OTHER
CONTRIBUTING CIRCUMSTANCES, PASSENGER
CONTRIBUTING CIRCUMSTANCES, ROAD
CONTRIBUTING CIRCUMSTANCES, VEHICLE
DIRECTION OF EXTERNAL FORCE
DIRECTION OF TRAVEL BEFORE ACCIDENT
DRIVER DATE OF BIRTH*
DRIVER LICENSE JURISDICTION
DRIVER LICENSE RESTRICTION COMPLIANCE
DRIVER LICENSE NUMBER*
DRIVER LICENSE TYPE COMPLIANCE
DRIVER NAME*
DRIVER SOCIAL SECURITY NUMBER*
EMERGENCY NOTIFICATION*
EMERGENCY RESPONSE ARRIVAL TIME*
ESTIMATED COLLISION SPEED
ESTIMATED TRAVEL SPEED
FIRST HARMFUL EVENT
INJURED TRANSPORTATION
INJURY CLASSIFICATION
INJURY DESCRIPTION
INSPECTION STICKER NUMBER, CURRENT*
INVESTIGATING AGENCY TYPE
LIGHTING SYSTEM CONDITION
LOCATION OF FIRST HARMFUL EVENT OR OBJECT
LOCATION OF SUBSEQUENT HARMFUL EVENT(S) OR OBJECT(S)
MILEPOINT*
OCCUPANT IDENTIFICATION NUMBER
OCCUPANT LOCATION AFTER IMPACT
OCCUPANT LOCATION PRIOR TO IMPACT*
OCCUPANTS INJURED
OCCUPANTS PER VEHICLE
ODOMETER READING AT ACCIDENT*
PASSENGER AGE
PASSENGER RACE AND ETHNICITY
PASSENGER SEX
PEDALCYCLE ACTION
PEDALCYCLE LOCATION PRIOR TO IMPACT
PEDALCYCLE VISIBILITY
PEDESTRIAN ACTION
PEDESTRIAN AGE
PEDESTRIAN FATALITIES
PEDESTRIAN IDENTIFICATION NUMBER
PEDESTRIAN LOCATION PRIOR TO IMPACT
PEDESTRIAN RACE AND ETHNICITY
PEDESTRIAN SEX
PEDESTRIAN VISIBILITY
PEDESTRIANS
POINT OF IMPACT
POLICE ARRIVAL DATE AND TIME
POLICE CLEARANCE DATE AND TIME
POLICE NOTIFICATION DATE AND TIME
PORTION OF VEHICLE CAUSING INJURY
PRIMARY CAUSE FACTOR/DRIVER OPINION
PRIMARY CAUSE FACTOR/POLICE OPINION
PROPERTY DAMAGE AMOUNT
PROTECTIVE/RESTRAINT EQUIPMENT USE
REGISTRATION PLATE JURISDICTION
REGISTRATION PLATE NUMBER*
REGISTRATION PLATE YEAR
ROAD SURFACE CONDITION
ROAD SURFACE DEFECTS
ROAD VEHICLE/PEDESTRIAN TYPE*
ROADWAYS
SUBSEQUENT HARMFUL EVENT(S)
TRAFFIC CONTROL DEVICE CONDITION
TRAFFIC CONTROL DEVICE TYPE
TRAFFICWAY IDENTIFICATION NUMBER
TRAFFICWAY IDENTIFIER*
VEHICLE DAMAGE AREA/DEFORMITY
VEHICLE DAMAGE SEVERITY
VEHICLE DEFECTS OBSERVED
VEHICLE IDENTIFICATION NUMBER
VEHICLE MAKE*
VEHICLE MANEUVER
VEHICLE MODEL*
VEHICLE MODEL YEAR*
VEHICLE REMOVAL
VEHICLE TRAFFIC UNIT NUMBER
VEHICLE USAGE
VISIBILITY OBSTRUCTION
WEATHER CONDITION

Source: "Data Element Dictionary - State Model Motorist Data Base", American Association of Motor Vehicle Administrators, 1978.

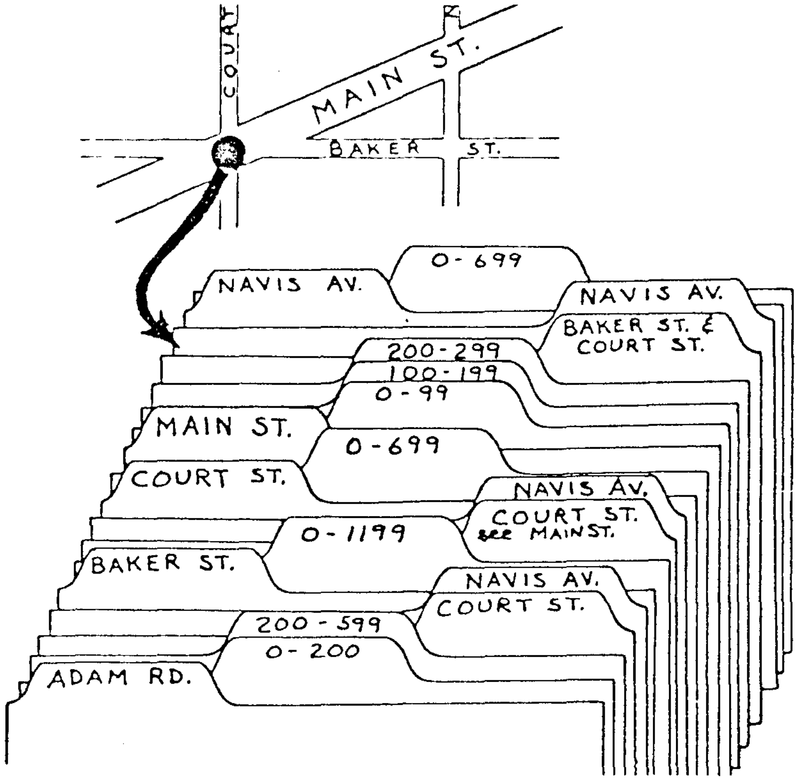
Figure 3-1 Data Items For Inclusion On An Accident Report Form

and accuracy of the data on the accident report form. Such a working relationship will also encourage police officers to offer information relative to hazardous locations through analysis of the accident reports before an accident pattern becomes established.

ACCIDENT REPORT FILE

Manual storage and maintenance of accident report files is the most basic method maintained by local police and traffic engineering departments. This system is normally found in jurisdictions with relatively small numbers of accidents per year. Accident reports should be filed on a daily basis to keep the system up-to-date.

There are various ways by which traffic accident reports might be filed. For traffic engineering and traffic safety purposes, location is the essential manner in which the accident reports must be available.



Typical traffic accident location file.

MAIN STREET (primary street) ☒ at Intersection with FIRST STREET (secondary street)

☐ from ____________ to ____________

Report No.	Date Mo.	Date Day	Date Yr.	Pers. K	Pers. I	Ill. D	Ill. N	Acc. Type	Remarks
A7692	2	13	69	0	1	✓		REAR END	W.B. ON 1ST ST. PAVMENT ICY
A7748	4	6	69	0	1		✓	PED.	
A7961	7	30	69	0	0	✓		FIXED OBJ.	HIT SIGNAL POLE

Accident location index card.

Source: "Program Management Guide - FHWA Highway Safety Program Standards" February 1976

Figure 3-2 Accident Location File and Index Card

Therefore, the reports themselves must be filed by location or, if filed in some other manner such as by accident report number, a traffic accident location file must be established. As indicated in Figure 3-2, an index file is maintained by location. For each accident the index card should show:

- Report number
- Date
- Severity (number of killed and injured)
- Type of accident (rear-end, right-angle, pedestrian, etc.)
- Lighting condition (day or night)
- Other information desired by the local agency

The availability of microcomputers offers a means for even small municipalities to automate a location file system.

ACCIDENT SPOT MAPS

Spot maps are used to provide a quick visual perspective of where accidents are occurring and their concentrations. Simple manual plotting of accidents may be desirable for small cities with few high-accident locations. Accidents can usually be placed fairly accurately. A colored pin is commonly used to show the location of each accident on a street map of the municipality or county. Different colors may be used to denote accident severity (black - property damage, yellow - injury, red - fatality). The spot map should be updated on a regular basis (daily or weekly).

Spot maps are generally kept for one calendar year. At the end of the year the map is photographed and a new map is started. Special spot maps can also be kept for specific accident classes, such as pedestrian accidents.

Computerized spot maps have been successfully used by some municipalities to permit quicker, more efficient output with added flexibility. One such computerized method was developed to plot accidents on an entire street network for any size city. The scale of computerized spot maps is user specified and may be generated in a wide range of sizes. The entire city may be plotted or specific areas or corridors may be "windowed" for plotting. For more detail, wall-sized enlargements of the plots can be easily obtained. Color coding by accident severity or other characteristics is also possible. Computerized spot maps rely on the initial coding of intersection nodes by coordinate, which allows for plotting of the street network.

TRAFFIC DATA

The routine collection and maintenance of traffic volume data for major streets is necessary to chart trends in traffic volumes over time, calculate accident rates, and apply accident rate methods in the identification of hazardous locations. Once a location has been identified as hazardous, it may be necessary to collect manual counts of vehicle type and traffic volume by individual maneuvers and lanes, speed studies, traffic conflicts, and erratic maneuvers.

Manual counting of traffic volumes on a system-wide basis is very expensive. Mechanical counters have the advantage of obtaining data over long periods of time at relatively low cost. Battery-powered units with rubber tube detectors provide flexibility in collecting data at different locations. They provide accurate count data when properly maintained and located.

TEXAS STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION ACCIDENT DATA BASE

The most fundamental output from the State Department of Highways and Public Transportation (SDHPT) accident data base is the Master Accident Listing (MAL). It contains detailed information on all accidents occurring on the state system. The MAL is generally not available outside the SDHPT. Four other computer programs have been developed cooperatively by the Texas Transportation Institute and the SDHPT. All four of the programs are written in SAS (Statistical

Analysis System) and designed to run against SAS data sets containing detailed information on over three million Texas traffic accidents. These SAS data sets go back to January 1, 1975.

The four programs to be discussed are:

- Save City/Save County
- TAP
- Window
- Casestudy

In addition, the Department of Public Safety (DPS) has developed the Urban Accident Location Coding Project.

Save City/Save County Program

The Save City/Save County Program has been designed to assist in the allocation of available safety funds to Texas cities and counties. It is a gross evaluation tool which identifies local governmental units which have an accident experience above the average of all similar units of government. The program is used by the Traffic Safety Section to determine where the available funding can be used effectively and is used in preparing the State's annual Highway Safety Plan. The program operates as follows:

- A given type of accident is defined. For example, serious and fatal accidents involving a hazardous moving violation.
- The frequency of this type of event is then determined for each city and county in Texas. The frequency is normalized by dividing by the population of cities (Acc/1000 population) and by vehicle-miles of travel in counties (Acc/million vehicle-miles of travel). The average rate for all cities and counties is then calculated.
- The average accident rate is multiplied by city population and county mileage figures to estimate the expected number of accidents for each city and county. Comparison of the expected and actual accident rates permits those units of government which have unusually high rates to be determined.

- All units of government are then ranked ordered in terms of the difference between the expected and actual accident rates.

- These rank-orderings are provided to D18TS of the SDHPT and each SDHPT District office receives a copy of the data for cities and counties within their district. An example of the output is shown in Figure 3-3.

Information concerning the Save City and Save County Program can be obtained from the Traffic Safety Specialist of the District Office, State Department of Highways and Public Transportation.

Traffic Accident Profiles (TAP)

To better assist cities in the 25,000 to 500,000 population range in allocating limited safety funds, the Traffic Accident Profile Program was developed. This program includes:

- Obtaining accident data for a selected city from the DPS master accident faile. The accidents are listed by:

    1. Street and Intersection
    2. Hour of the Day
    3. Alcohol Involvement
    4. Motorcycle Accidents, etc.

- From these preliminary findings, up to ten target areas (streets) within the city are targeted as high accident locations. Accidents within targeting areas are summarized by time of day, day of week, month of the year, etc.

- Tables summarizing the findings in each target area are sent to the city for analysis and interpretation.

The TAP program has been particularly useful in planning selective traffic enforcement programs. TAP does not replace information available locally, but rather organizes and quantifies what is already known or at least partially known within the community.

The major problem with TAP has been the lack of feedback on further analysis that may be desirable in providing direction to local safety programs. When questions are generated by TAP's report, the project staff is available to conduct further analysis to aid the city in best allocating its traffic safety resources.

1981 INJURY AND FATAL (A,B&K) HAZARDOUS MOVING VIOLATIONS
SAVECNTY = POTENTIAL ACCIDENT SAVINGS PER COUNTY

COUNTY	RANK	SAVECNTY
HARRIS	1	9725.88
DALLAS	2	3994.57
BEXAR	3	2187.06
TARRANT	4	2059.13
TRAVIS	5	1986.72
EL PASO	6	1594.07
NUECES	7	661.05
JEFFERSON	8	660.20
GALVESTON	9	654.97
ECTOR	10	610.96
TAYLOR	11	442.29
POTTER	12	440.26
CAMERON	13	434.00
BRAZORIA	14	427.65
HIDALGO	15	419.10
LUBBOCK	16	411.92
GREGG	17	411.86
BRAZOS	18	370.75
TOM GREEN	19	360.07
VICTORIA	20	325.42
MIDLAND	21	306.33
MCLENNAN	22	301.48
SMITH	23	273.51
BELL	24	265.71
DENTON	25	249.43
COLLIN	26	218.04
MONTGOMERY	27	205.85
WEBB	28	195.77
FORT BEND	29	184.26
WICHITA	30	174.61
ORANGE	31	166.57
GRAYSON	32	153.06
BURLESON	33	114.00
COMAL	34	101.09
JOHNSON	35	92.98
KERR	36	87.92
VAL VERDE	37	83.04
PALO PINTO	38	81.89
RANDALL	39	80.06
HAYS	40	75.72
ANDERSON	41	64.07
LIBERTY	42	62.65
LEE	43	57.43
BROWN	44	54.29
ARANSAS	45	54.27
BASTROP	46	52.49
HALE	47	49.77
WILLIAMSON	48	49.45
HUTCHINSON	49	49.15
MATAGORDA	50	46.47
PARKER	51	46.30
WASHINGTON	52	46.24
KLEBERG	53	43.67
HOCKLEY	54	43.44
CALHOUN	55	43.41
NACOGDOCHES	56	41.82
HOWARD	57	41.54
WALKER	58	40.80
STEPHENS	59	39.87
HARRISON	60	39.50
LAMAR	61	36.46
CHEROKEE	62	33.42
FAYETTE	63	33.19
TITUS	64	32.97
ANGELINA	65	31.81
HENDERSON	66	28.72
CORYELL	67	23.60
GRAY	68	22.23

Figure 3-3

The city must initiate a TAP analysis by contacting the Traffic Safety Specialist in the District Office of the State Department of Highways and Public Transportation. The information provided is shown in Figure 3-4.

High-Hazard Location (Window)

In the state of Texas there are almost 75,000 miles of highway on the state-maintained highway system. Some 46 percent of all accidents in the state occur on these state-maintained highways. If ways could be determined to define where accidents are occurring throughout this expanse of concrete and asphalt, procedures for allocating engineering and enforcement resources could be enhanced.

In order to locate and define accidents throughout this 75,000 miles of highway, the Window program has been developed. The program works as follows:

- The state-maintained highway system is subdivided into a series of segments referred to as control-sections. The control-sections vary in length from a few tenths of a mile up to 30 or 40 miles. Each control-section is further subdivided into mile points calibrated in one-tenth mile increments. Since there are approximately 75,000 miles of highway on the Texas-maintained system and since each of those miles is divided into ten points, there are approximately 750,000 discrete points on this system.

- The Window program which has been developed to view this state-maintained system relies on the fact that each on-system accident is associated with a unique control-section and milepoint.

- The Window program allows the user to specify a length which will represent the size of the Window.

- The program will move the Window along selected routes in one-tenth mile increments.

- The objective is the identification of a segment which includes the highest frequency of accidents. Work is now under way which will enable Window to include accident rate data.

- Window can be operated for total accidents, for individual severity class, or accident type. Selection of accident types is possible for all accident variables in the "Accident Detail Decoding Manual" (SDHPT, 1979).

AUSTIN 1981
ACCIDENT INFORMATION

TIME

TIME	FREQUENCY	CUM FREQ	PERCENT	CUM PERCENT
MIDNITE-12:59 AM	494	494	3.196	3.196
1-1:59 AM	496	990	3.209	6.405
2-2:59 AM	623	1613	4.031	10.436
3-3:59 AM	177	1790	1.145	11.581
4-4:59 AM	78	1868	0.505	12.086
5-5:59 AM	82	1950	0.531	12.616
6-6:59 AM	147	2097	0.951	13.568
7-7:59 AM	689	2786	4.458	18.025
8-8:59 AM	689	3475	4.458	22.483
9-9:59 AM	508	3983	3.287	25.770
10-10:59 AM	580	4563	3.753	29.523
11-11:59 AM	756	5319	4.891	34.414
NOON-12:59 PM	934	6253	6.043	40.457
1-1:59 PM	905	7158	5.855	46.312
2-2:59 PM	875	8033	5.661	51.973
3-3:59 PM	942	8975	6.095	58.068
4-4:59 PM	1275	10250	8.249	66.317
5-5:59 PM	1388	11638	8.980	75.298
6-6:59 PM	880	12518	5.694	80.991
7-7:59 PM	694	13212	4.490	85.481
8-8:59 PM	597	13809	3.863	89.344
9-9:59 PM	588	14397	3.804	93.148
10-10:59 PM	513	14910	3.319	96.467
11-11:59 PM	546	15456	3.533	100.000

LIGHT CONDITION

LIGHT	FREQUENCY	CUM FREQ	PERCENT	CUM PERCENT
DAYLIGHT	10205	10205	66.026	66.026
DAWN	78	10283	0.505	66.531
DARK-NO LIGHTS	3808	14091	24.638	91.168
DARK-STREET LITE	1051	15142	6.800	97.968
DUSK	314	15456	2.032	100.000

FIRST HARMFUL EVENT

_1STHARM	FREQUENCY	CUM FREQ	PERCENT	CUM PERCENT
OTHER NON-COL	56	56	0.362	0.362
OVERTURNED	216	272	1.398	1.760
PEDESTRIAN	145	417	0.938	2.698
OTHER MV IN TRAN	11961	12378	77.387	80.085
RR TRAIN	13	12391	0.084	80.170
PARKED CAR	1287	13678	8.327	88.496
PEDALCYCLIST	151	13829	0.977	89.473
ANIMAL	34	13863	0.220	89.693
FIXED OBJECT	1554	15417	10.054	99.748
OTHER OBJECT	39	15456	0.252	100.000

SEVERITY

TSEV	FREQUENCY	CUM FREQ	PERCENT	CUM PERCENT
NON-INJURY	10088	10088	65.269	65.269
POSSIBLE INJURY	2294	12382	14.842	80.111
NONINCAPACIT	2624	15006	16.977	97.089
INCAPACITATING	402	15408	2.601	99.689
FATAL	48	15456	0.311	100.000

Figure 3-4

AUSTIN 1981
ACCIDENT INFORMATION

DPS COUNTY

COUNTY	FREQUENCY	CUM FREQ	PERCENT	CUM PERCENT
TRAVIS	15328	15328	99.172	99.172
WILLIAMSON	128	15456	0.828	100.000

ROAD CLASS

ROAD	FREQUENCY	CUM FREQ	PERCENT	CUM PERCENT
INTERSTATE	1861	1861	12.041	12.041
US & STATE HW	4502	6363	29.128	41.168
FARM TO MARKET	496	6859	3.209	44.378
CITY STREET	8568	15427	55.435	99.812
OTHER (ALLEY)	29	15456	0.188	100.000

MONTH

MONTH	FREQUENCY	CUM FREQ	PERCENT	CUM PERCENT
JANUARY.	1132	1132	7.324	7.324
FEBRUARY	1214	2346	7.855	15.179
MARCH	1230	3576	7.958	23.137
APRIL	1197	4773	7.745	30.881
MAY	1347	6120	8.715	39.596
JUNE	1261	7381	8.159	47.755
JULY	1243	8624	8.042	55.797
AUGUST	1399	10023	9.052	64.849
SEPTEMBER	1279	11302	8.275	73.124
OCTOBER	1553	12855	10.048	83.172
NOVEMBER	1268	14123	8.204	91.376
DECEMBER	1333	15456	8.624	100.000

DAY OF WEEK

DAY	FREQUENCY	CUM FREQ	PERCENT	CUM PERCENT
SUNDAY	1593	1593	10.307	10.307
MONDAY	2109	3702	13.645	23.952
TUESDAY	2113	5815	13.671	37.623
WEDNESDAY	2206	8021	14.273	51.896
THURSDAY	2154	10175	13.936	65.832
FRIDAY	2776	12951	17.961	83.793
SATURDAY	2505	15456	16.207	100.000

Figure 3-4 Cont'd

AUSTIN 1981

PRIMARY STREET	INTERSECTING STREET	ACCIDENTS	INJURIES	FATALITIES	SINGLE VEHICLE ACCIDENTS	MULTI-VEH ANGLE APPROACH ACCIDENTS	MULTI-VEH SAME DIRECTION ACCIDENTS	MULTI-VEH OPPOSITE DIRECTION ACCIDENTS
	ACCIDENTS FOR 1ST ST S							
1ST ST S		156	46	2	36	28	77	15
1ST ST S	BEN WHITE BLVD W	8	2	1		4	4	
1ST ST S	ALPINE RD W	1				1		
1ST ST S	ANNIE ST W	5				4		1
1ST ST S	BANISTER LN	11	3			8	2	1
1ST ST S	BARTON SPR RD	5	1			2	2	1
1ST ST S	CANADIAN ST	1					1	
1ST ST S	CARDINAL LN	2				2		
1ST ST S	CENTER ST	1				1		
1ST ST S	COPELAND ST	2					2	
1ST ST S	CUMBERLAND RD	9	4			2		7
1ST ST S	ELIZABETH ST W	5				2	3	
1ST ST S	LIGHTSEY RD	2				2		
1ST ST S	LIVE OAK ST W	13	7			8	2	3
1ST ST S	MARY ST W	8	4			2	2	4
1ST ST S	MONROE ST W	2				1	1	
1ST ST S	OLTORF ST W	18	1			8	2	8
1ST ST S	PHILCO DR	3	4		1	1	1	
1ST ST S	RADAM LN	3	1		1		1	1
1ST ST S	RIVERSIDE DR W	16	5			7	4	5
1ST ST S	ST ELMO RD W	2				1		1
1ST ST S	CLARKE ST	1						1
1ST ST S	SOUTH PARK DR	1				1		
1ST ST S	STASSNEY LN W	21	5			18		3
1ST ST S	CAMELIA LN	1				1		
1ST ST S	RAMBLE LN	1	3			1		
1ST ST S	BRAMBLE DR	1						1
1ST ST S	FLOURNOY DR	1	3			1		
1ST ST S	TURTLE CRK BLVD	1				1		
1ST ST S	EBERHART LN	1				1		
1ST ST S	BUCKINGHAM PL	1				1		
1ST ST S	WIL CANNON DR W	2				1		1
1ST ST S	DITTMAR RD W	1				1		
1ST ST S	GT BRITAIN BLVD	1				1		
1ST ST S	SOUTH CENTER ST	3	1			1	2	
1ST ST S	09574	1	3					1
TOTALS FOR 1ST ST S		311	93	3	38	113	106	54
	ACCIDENTS FOR 1ST ST W							
1ST ST W		79	31	1	14	8	45	11
1ST ST W	BEN WHITE BLVD W	1	1					1
1ST ST W	GUADALUPE ST	10				6	4	
1ST ST W	LAMAR BLVD N	2					2	
1ST ST W	LAVACA ST	1				1		
1ST ST W	SAN ANTONIO ST	1	1			1		
1ST ST W	01688	1	1			1		
1ST ST W	LILAC LN	1					1	
1ST ST W	B R REYNOLDS DR	6	2		1		3	2
TOTALS FOR 1ST ST W		102	36	1	16	17	55	14
	ACCIDENTS FOR 29TH ST W							
29TH ST W		12	2		4	2	5	1
29TH ST W	GUADALUPE ST	10	3		3		5	2
29TH ST W	JEFFERSON ST	6	2			5		1
29TH ST W	LAMAR BLVD N	4	1			2		2
29TH ST W	RIO GRANDE AV	2				2		
29TH ST W	WEST AV	1				1		
TOTALS FOR 29TH ST W		35	8		7	12	10	6

Figure 3-4 Cont'd

AUSTIN 1981

RANKING OF LOCATIONS BY NUMBER OF ACCIDENTS

STREET OR CONTROL AND SECTION	INTERSECTING STREET OR MILEPOINT	NUMBER OF ACCIDENTS	RANK
US HWY 290 NSR E	I 35 SER RD NB N	32	1
24TH ST W	SAN GABRIEL ST	29	2
BURNET RD	RESEARCH BLVD	28	3
CAMERON RD	US HWY 290 SSR E	28	3
LAMAR BLVD N	MORROW ST	27	5
NORTHEAST DR	US HWY 290 SSR E	25	6
38TH ST W	LAMAR BLVD N	24	7
CONGRESS AV S	BEN WHITE BLVD E	23	8
7TH ST E	I 35 SER RD NB N	22	9
1ST ST S	STASSNEY LN W	21	10
6TH ST W	LAMAR BLVD N	21	10
FAR WEST BLVD	WOOD HOLLOW DR	21	10
AIRPORT BLVD	KOENIG LN E	20	13
GROVER AV	KOENIG LN W	20	13
US HWY 290 SSR E	I 35 SER RD SB N	20	13
24TH ST W	LAMAR BLVD N	19	16
AIRPORT BLVD	OAK SPRINGS DR	19	16
RIVERSIDE DR E	I 35 SER RD SB S	19	16
BEN WHITE BLVD E	I 35 SER RD NB S	19	16
1ST ST S	OLTORF ST W	18	20
BARTON SKWY	LAMAR BLVD S	18	20
CAMERON RD	ANDERSON LN E	18	20
MONTOPOLIS DR	RIVERSIDE DR E	18	20
RESEARCH BLVD	THUNDER CREEK RD	18	20
BEN WHITE BLVD W	CONGRESS AV S	17	25
BEN WHITE BLVD W	FRONTIER TRL	17	25
BALCONES DR.	NORTHLAND DR	17	25
RESEARCH BLVD	ANDERSON SQ	17	25
1ST ST S	RIVERSIDE DR W	16	29
12TH ST E	AIRPORT BLVD	16	29
15TH ST E	I 35 SER RD SB N	16	29
45TH ST W	GUADALUPE ST	16	29
ATLANTA ST	LAKE AUSTIN BLVD	16	29
BARTON SPR RD	RIVERSIDE DR W	16	29
LAMAR BLVD N	07900	16	29
OHLEN RD	RESEARCH BLVD	16	29
RESEARCH BLVD	CAP TEX HWY N	16	29
2ND ST E	CONGRESS AV	15	38
38TH ST W	GUADALUPE ST	15	38
AIRPORT BLVD	MANOR RD	15	38
BURLESON RD	BEN WHITE BLVD E	15	38
CAMERON RD	US HWY 290 NSR E	15	38
7TH ST E	PEDERNALES ST	14	43
7TH ST E	SPRINGDALE RD	14	43
AIRPORT BLVD	BOLM RD	14	43
AIRPORT BLVD	SPRINGDALE RD	14	43
LAVACA ST	2ND ST W	14	43
WOODROW AV	KOENIG LN W	14	43
1ST ST S	LIVE OAK ST W	13	49
6TH ST W	GUADALUPE ST	13	49
11TH ST E	I 35 SER RD NB N	13	49
M L KING BLVD E	I 35 SER RD NB N	13	49
M L KING BLVD E	I 35 SER RD SB N	13	49
CONGRESS AV S	RIVERSIDE DR E	13	49
LAMAR BLVD S	RIVERSIDE DR W	13	49
RESEARCH BLVD	BALCONES WDS DR	13	49
RIVERSIDE DR E	PLEAS VAL RD S	13	49
WOODWARD ST	BEN WHITE BLVD E	13	49
1ST ST E	I 35 SER RD SB N	12	59
5TH ST E	SAN JACINTO BLVD	12	59
6TH ST W	LAVACA ST	12	59

Figure 3-4 Cont'd

AUSTIN 1981

ALL ACCIDENTS--ACCIDENT INFORMATION

TABLE OF TIME BY DAY
CONTROLLING FOR TARGET=LAMAR BLVD N

TIME TIME DAY DAY OF WEEK

FREQUENCY	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	TOTAL
MIDNITE-12:59 AM	5	1	2	4	4	3	11	30
1-1:59 AM	12	0	3	2	2	6	12	37
2-2:59 AM	10	4	5	3	4	0	19	45
3-3:59 AM	2	1	0	0	0	3	2	8
4-4:59 AM	1	0	0	0	0	0	0	1
5-5:59 AM	2	1	0	0	2	0	1	6
6-6:59 AM	0	2	2	0	2	0	0	6
7-7:59 AM	0	7	7	4	3	2	0	23
8-8:59 AM	3	8	8	1	4	1	0	25
9-9:59 AM	2	3	7	7	1	2	4	26
10-10:59 AM	0	7	9	4	3	4	3	30
11-11:59 AM	7	8	8	9	9	5	6	52
NOON-12:59 PM	5	10	6	8	10	5	6	50
1-1:59 PM	2	13	5	14	17	10	8	69
2-2:59 PM	8	13	6	8	7	11	14	67
3-3:59 PM	4	3	8	6	3	13	10	47
4-4:59 PM	3	10	14	10	14	10	7	68
5-5:59 PM	4	9	14	8	14	15	4	68
6-6:59 PM	0	8	7	4	7	6	7	39
7-7:59 PM	7	3	9	6	6	5	2	38
8-8:59 PM	3	7	5	3	4	6	4	32
9-9:59 PM	3	7	5	1	5	5	6	32
10-10:59 PM	2	1	1	2	1	6	4	17
11-11:59 PM	3	6	2	1	2	6	7	27
TOTAL	88	132	133	105	124	124	137	843

Figure 3-4 Cont'd

AUSTIN 1981

ALL ACCIDENTS--ACCIDENT INFORMATION

TABLE OF MONTH BY DAY
CONTROLLING FOR TARGET=AIRPORT BLVD

MONTH MONTH DAY DAY OF WEEK

FREQUENCY	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	TOTAL
JANUARY	6	3	9	2	7	1	7	35
FEBRUARY	3	3	5	3	3	3	4	24
MARCH	1	7	10	6	3	9	2	38
APRIL	4	4	1	1	7	5	5	27
MAY	3	7	4	3	1	7	4	29
JUNE	4	10	2	5	2	3	7	33
JULY	7	3	4	5	5	6	6	36
AUGUST	1	3	4	3	4	6	7	28
SEPTEMBER	3	0	3	3	6	0	4	19
OCTOBER	3	0	4	6	7	8	10	38
NOVEMBER	3	6	2	4	1	6	8	30
DECEMBER	5	5	4	3	4	7	4	32
TOTAL	43	51	52	44	50	61	68	369

Figure 3-4 Cont'd

AUSTIN 1981

ALL ACCIDENTS--ACCIDENT INFORMATION

TABLE OF _1STHARM BY TARGET

_1STHARM FIRST HARMFUL EVENT TARGET

FREQUENCY COL PCT	LAMAR BLVD N	GUADALUPE ST	RESEARCH BLVD	I 35 N	BURNET RD	CONGRESS AV S	AIRPORT BLVD	LAMAR BLVD S	RIVERSIDE DR E	I 35 SERRD SB N	TOTAL
OTHER NON-COL	3 0.36	2 0.36	1 0.19	5 1.07	1 0.23	1 0.25	0 0.00	3 0.85	2 0.57	1 0.29	19
OVERTURNED	8 0.95	4 0.72	7 1.34	12 2.57	5 1.14	1 0.25	3 0.81	4 1.13	2 0.57	6 1.77	52
PEDESTRIAN	6 0.71	6 1.08	3 0.58	2 0.43	3 0.68	10 2.46	5 1.36	1 0.28	2 0.57	2 0.59	40
OTHER MV IN TRAN	757 89.80	483 87.34	462 88.68	353 75.59	398 90.66	356 87.68	341 92.41	313 88.17	300 84.99	301 88.79	4064
RR TRAIN	0 0.00	1 0.18	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1
PARKED CAR	9 1.07	24 4.34	7 1.34	4 0.86	5 1.14	13 3.20	0 0.00	2 0.56	1 0.28	3 0.88	68
PEDALCYCLIST	4 0.47	8 1.45	1 0.19	0 0.00	0 0.00	3 0.74	0 0.00	3 0.85	2 0.57	1 0.29	22
ANIMAL	0 0.00	0 0.00	2 0.38	2 0.43	3 0.68	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	7
FIXED OBJECT	56 6.64	25 4.52	37 7.10	88 18.84	24 5.47	20 4.93	19 5.15	29 8.17	44 12.46	24 7.08	366
OTHER OBJECT	0 0.00	0 0.00	1 0.19	1 0.21	0 0.00	2 0.49	1 0.27	0 0.00	0 0.00	1 0.29	6
TOTAL	843	553	521	467	439	406	369	355	353	339	4645

Figure 3-4 Cont'd

The Window program provides information to assist local district and city personnel in locating sites on the highway system which are experiencing a high frequency of a particular type of accident and which need to be investigated for potential remedial safety treatments. Example of output is shown in Figure 3-5.

The Window program is still under development and is available on a limited basis. Questions from cities and counties concerning Window data should be directed to:

Traffic Safety Section, D18TS
State Department of Highways and Public Transportation
11th and Brazos
Austin, TX 78701

Casestudy

In 1980, there were 432,940 accidents on the TTI master accident listing. These accidents occurred in rural and urban areas, on and off the state-maintained systems, on interstate highways and city streets. In order to access a subset of this data set, it is quite feasible to use canned statistical programs to cross one variable by another while, perhaps, selecting on a third, and to display that information in a cross-tabular format which may be meaningful for a particular analytical question. On the other hand, analysts are frequently faced with answering poorly defined questions concerning a given subset of accidents. Under circumstances such as these, one method of proceeding is to go to actual "hard copy" police accident reports for the subset of accidents which is of concern.

Unfortunately, it is a difficult, often costly procedure to sort through hard copies of police accident reports, particularly when that data set is large. In order to overcome the difficulty of retrieving individual copies of police officers' reports, a program entitled Casestudy was developed. The program works as follows:

- An analyst defines a given subset which is of interest. For example, the analyst may be interested in those accidents which occur on a particular control-section on the state-maintained highway system, or he might be interested in accidents involving working pedestrians in construction zones.

INTERSTATE ONSYSTEM SEGMENTS -- DISTRICT 24 1980
SUBSET = OVERTURNS / RANKING 200 1-MILE SEGMENTS
SEGMENTS SORTED WITHIN HIGHWAY

RANK	HWY DIST	HIGHWAY	BEGINNING MILEPOINT COUNTY	CONTROL-SECTION	MPT	ENDING MILEPOINT COUNTY	CONTROL-SECTION	MPT	ACCS	FATAL ACCS	FATALITIES	INJURY ACCS	INJURIES	PDO ACCS
1	24	IH 0010	EL PASO	2121- 1	4.5	EL PASO	2121- 1	5.5	5	0	0	3	3	2
2	24	IH 0010	EL PASO	2121- 2	19.1	EL PASO	2121- 2	20.1	5	0	0	2	3	3
3	24	IH 0010	EL PASO	2121- 3	28.9	EL PASO	2121- 3	29.9	5	0	0	3	3	2
4	24	IH 0010	EL PASO	2121- 3	30.6	EL PASO	2121- 3	31.6	5	0	0	4	4	1

INTERSTATE ONSYSTEM SEGMENTS -- DISTRICT 24 1980
SUBSET = OVERTURNS / RANKING 200 1-MILE SEGMENTS
TOTALS BY MILEPOINT WITHIN SELECTED SEGMENTS

RANK	HWY	HIGHWAY	BEGINNING MILEPOINT			ENDING MILEPOINT			ACCS	FATAL ACCS	FATALITIES	INJURY ACCS	INJURIES	PDO ACCS
1	24	IH 0010	EL PASO	2121- 1	4.5	EL PASO	2121- 1	5.5	5	0	0	3	3	2

COUNTY	CONTROL-SECTION	MPT	ACCS	FAT ACCS	FATS	INJ ACCS	INJS	PDO ACCS
EL PASO	2121- 1	4.5						
EL PASO	2121- 1	4.6						
EL PASO	2121- 1	4.7	1			1	1	
EL PASO	2121- 1	4.8	1					1
EL PASO	2121- 1	4.9	1					1
EL PASO	2121- 1	5.0	1			1	1	
EL PASO	2121- 1	5.1						
EL PASO	2121- 1	5.2						
EL PASO	2121- 1	5.3						
EL PASO	2121- 1	5.4						
EL PASO	2121- 1	5.5	1			1	1	

Figure 3-5

- Once this subset of the Texas accident data base has been defined and coded into the program, the program can then be executed to output a "proxy" police officer's report for all accidents in the subset. This proxy report is basically a facsimile of the report prepared by the investigating officer. Information contained on ths proxy report would include variables such as time of day; day of week; type of vehicles involved; ages, race, and sex of drivers involved, etc. In addition to all of these variables, the program also prints out the accident case number for the accident report. If the analyst desires further information from the police officer's report, information which is not on the facsimile (e.g., the police officer's narrative and/or a scene diagram), the analyst can go to the Texas Department of Public Safety and get a photocopy of the report itself.

When the data set being considered is small (less than 400 or 500 cases), this program has proven to be quite useful. It should be understood that this program is used primarily in a searching context. When the analyst has reason to believe that a certain subset of accidents may be of interest, but he is not sure of the relevant dimensions of the problem, Casestudy has proven to be useful.

The Casestudy program is still under development and is run on a limited basis. Example output is shown in Figure 3-6. Information about the Casestudy program can be obtained from the Traffic Safety Specialist of the District Office of State Department of Highways and Public Transportation.

TEXAS URBAN ACCIDENT LOCATION CODING PROJECT

In order to assist the cities of Texas in identifying high accident locations, the State Department of Highways and Public Transportation, in cooperation with the Department of Public Safety, has established the Texas Urban Accident Location Coding Project. Cities of over 25,000 population are invited to participate. Interested cities should contact:

Statistical Services Section
Department of Public Safety
5805 North Lamar Boulevard
Austin, TX 78752

CASESTUDY FOR TRAFFIC CIRCLE IN BROWNWOOD

1981 ACCIDENT NO. 1389752 PROXY REPORT

ACCIDENT DATA

MONDAY ,9 NOVEMBER ,11-11:59 AM		LIGHT CONDITION	DAYLIGHT	VEH 2 DIR. OF TRAVEL	NORTHEAST
BROWN COUNTY DISTRICT 23		WEATHER	CLEAR (CLOUDY)	PRIOR LOC. OF VEH. 2	HWY NO. 1
ON-SYSTEM ,PARTICIPATING CITY		SURFACE CONDITION	DRY	PRIOR POS. OF VEH. 2	12
ROAD CLASS	US & STATE HW	ROAD CONDITION	NO DEFECTS	LOCATION OF IMPACT ...	HWY NO. 1
CITY	BROWNWOOD	TRAFFIC CONTROL	YIELD SIGN	POINT OF IMPACT	12
POPULATION............	10,000-25,000	ALIGNMENT	CURVE, LEVEL	RAILROAD CROSSING NO.	
CITY ACCIDENT NO.	++++++	DEGREE OF CURVE	NO CURVE	INVESTIGATION	CITY PD ARREST
BLOCK NUMBER	00100	RELATION TO ROADWAY ..	ON ROADWAY	TOTAL VEH. REPORTED ..	2
PRIMARY STREET CODE ..	+++++	ROAD CONFIGURATION ...	INTERSECTION	NUM. OF VEH. IN DATA	2
CONTRL/SECT/MP	0054 /06 /1	INTERSECTION PATTERN	TRAFFIC CIRCLE	WORST INJURY	NON-INJURY
MILEPOST NUMBERING ...	N 46 W TO S 46 W	INTER. ROAD DESCRIP.	@ GRD MN LN HW	NUMBER OF INJURIES ...	0
SECONDARY STREET CODE	+++++	MANNER OF COLLISION ..	ANG 1 STR 2 L	FATALITIES	0
CONTRL/SECT/MP	0128 /01 /0.1	1ST HARMFUL EVENT	OTHER MV IN TRAN	INCAPAC. INJURIES	0
TURNPIKE STATION NO.		OBJECT STRUCK	NO CODE APPLIC	NON-INCAPAC. INJURIES	0
BRIDGE NUMBER		OTHER FACTOR	NO CODE APPLIC	NON-INJURED PERSONS ..	2
BRIDGE DETAIL		VEH 1 DIR. OF TRAVEL	NORTH	POSSIBLE INJURIES	0
PHYSICAL FEATURE A ...		PRIOR LOC. OF VEH. 1	HWY NO. 2	NUM. OF CAS. IN DATA	0
PHYSICAL FEATURE B ...		PRIOR POS. OF VEH. 1	12	NUM. OF PED. IN DATA	0

VEHICLE DATA

VEHICLE DATA	VEHICLE 1	VEHICLE 2
VEHICLE TYPE	PASSENGER CAR	PASSENGER CAR
VEHICLE YEAR	80	81
VEHICLE MAKE	CHEV IMPALA	OLDS 98
VEHICLE STYLE	4 DR SEDAN	4 DR SEDAN
CURB WEIGHT	3400-3499 LB	3800-3899 LB
DAMAGE	LD2	RF1
VEHICLE DEFECT	NO DEFECTS	NO DEFECTS
DRIVER AGE	29	68
DRIVER RACE AND SEX	WHITE F	WHITE M
DRIVERS LICENSE	TEXAS	TEXAS
DRIVER STATUS	CIVILIAN DRIVER	CIVILIAN DRIVER
LIABILITY INSURANCE		
DRIVER DEFECT	NONE	NONE
CONTRIBUTING FACTOR 1	NONE APPLIES	FAIL TO YLD ROW
CONTRIBUTING FACTOR 2	NONE APPLIES	NONE APPLIES
SEVERITY OF DRIVER INJURY	NON-INJURY	NON-INJURY
RESTRAINING DEVICE	UNKNOWN	UNKNOWN
DRIVER EJECTED		
VEH. PART CAUSING INJ.		
PART OF BODY INJURED		
EMERG. MEDICAL SERVICE		
HELMET INFORMATION		
DRIVER EYE PROTECTION		
COLOR OF DRIVERS LENS		
PROTECTIVE EQUIPMENT		
COLOR OF LOWER GARMENT		
COLOR OF UPPER GARMENT		
TOTAL OCC/CAS REPORTED	0	0
TOTAL OCC/CAS IN DATA	0	0
TOTAL INJURED IN VEHICLE	0	0

CASUALTY/OCC DATA

CASUALTY/OCC DATA	
TYPE OF CASUALTY/OCC	
VEHICLE NUMBER	
AGE OF CAS/OCC	
SEX OF CAS/OCC	
SEVERITY OF INJURY	
PART OF BODY INJURED	
EJECTED FROM VEHICLE	
MEDICAL SERVICE	
RESTRAINING DEVICE	
VEH. PART CAUSING INJ.	
HELMET	
EYE PROTECTION	
COLOR OF EYEWEAR	
MOTORCYCLE EQUIPMENT	
COLOR OF LOWER GARMENT	
COLOR OF UPPER GARMENT	
PEDESTRIAN ACTION	
PEDEST./PEDCYCLE FAULT	
PEDEST./PEDCYCLE DRINKING	

Figure 3-6

The purposes of the project are to 1) provide a precise method of locating both on- and off-systems accidents within cities, and 2) provide useable information to cities concerning their accident experience.

The Texas Urban Accident Location Coding Project requires that a participating city establish a five character code for each street in the city. The code number of the street and, for intersection accidents, of both streets must be entered on police officers' accident report forms prior to being submitted to the Department of Public Safety. There are no other personnel costs or monetary costs to the city.

Benefits include the following reports:

- Quarterly report on all accidents within the city (eight cities get monthly computer tapes)
- Annual report summarizing all accidents

These reports list all accidents by location within the corporate limits. These data are the beginning of any countermeasures to reduce safety problems within the city.

4

METHODS OF IMPROVING TRAFFIC SAFETY

dealing with the [illegible] and
the driver's [illegible]

TYPICAL PROBLEMS, TYPICAL COUNTERMEASURES

Having identified a location as hazardous, the problem is to determine what countermeasures might be effective. There are several sources of information that will assist in the selection of improvement alternatives. NCHRP Report No. 162, "Methods for Evaluating Highway Safety Improvements," provides accident reduction forecasts for various types of improvements. Table 4-1 presents an example checklist of potential improvements. A list of general countermeasures commonly associated with different accident patterns is given in Table 4-2.

Several important items should be kept in mind during the process of selecting appropriate improvements.

1. Identify all practical improvements--everything from a do-nothing alternative to an ultimate alternative such as complete reconstruction. We are not making a final decision. The principal objective is to make certain we do not overlook an alternative that may be the most practical and economically-advisable solution.

2. Identify all practical combinations of improvements.

3. For each alternative, identify the potential effect of the improvement--the number of accidents, the types of accidents, and the severity of the accidents.

There needs to be a complete documentation of data and logic leading to prescription of applicable improvements. When the time comes to evaluate the results of implemented improvements, the analyst will need to know the background and considerations that led to the recommendations--questions related to:

- Problem Identification. What method was used to identify the problem at the hazardous location, and how was the problem defined?

- Accident Characteristics. What accident data were available and how were they utilized?

- Selection of Applicable Improvements. Which improvements or combinations of improvements were considered applicable and why?

- Location of Peculiarities. Are there any peculiarities about the hazardous location that may cause the improvements to produce non-typical results?

TABLE 4-1
EXAMPLE CHECKLIST OF POTENTIAL IMPROVEMENTS

SECTIONS

- Eliminate parking
- Install delineators
- Add guardrail-embankments
- Add guardrail-fixed objects
- Remove fixed objects
- Flatten fill slopes
- Add painted or raised median
- Deslicking
- Resurfacing
- Widen traveled way
- Reconstruction
- Install or improve edge marking
- Install or improve warning and/or directional signs
- Install median barrier
- Breakaway sign and light standards
- Install lighting
- Shoulder stabiliation
- Widen shoulders
- Eliminate median crossovers
- Add climbing lanes

CURVES

- Install delineators
- Add guardrail
- Resurfacing
- Install warning signs
- Reconstruct curve

BRIDGE/UNDERPASS

- Install delineators
- Install lighting
- Energy absorption devices
- Add guardrails
- Bridge widening

INTERSECTIONS

- Install or improve warning and/or directional signs
- Install minor leg stop control
- Install lighting
- Install pedestrian signals
- Improve signals
- Install new signals
- Install warning signals
- Install stop ahead signs
- Install yield sign
- Install all-way stop signs
- Install warning signals
- Curtail left-turn movements
- Provide for left-turn movements
- Deslicking
- Install rumble strips

TABLE 4-2

GENERAL COUNTERMEASURES FOR ACCIDENT PATTERNS AND THEIR PROBABLE CAUSES

ACCIDENT PATTERN	PROBABLE CAUSE	GENERAL COUNTERMEASURE
Right-angle collisions at unsignalized intersections	Restricted sight distance	Remove sight obstructions Restrict parking near corners Install stop signs (see MUTCD) Install warning signs (see MUTCD) Install/improve street lighting Reduce speed limit on approaches* Install signals (see MUTCD) Install yield signs (see MUTCD) Channelize intersection
	Large total intersection volume	Install signals (see MUTCD) Reroute through traffic
	High approach speed	Reduce speed limit on approaches* Install rumble strips
Right-angle collisions at signalized intersections	Poor visibility of signals	Install advanced warning devices (see MUTCD) Install 12-in. signal lenses (see MUTCD) Install overhead signals Install visors Install back plates Improve location of signal heads Add additional signal heads Reduce speed limit on approaches*

* Spot speed study should be conducted to justify speed limit reduction.

TABLE 4-2 (Cont'd.)

ACCIDENT PATTERN	PROBABLE CAUSE	GENERAL COUNTERMEASURE
Right-angle collisions at signalized intersections (continued)	Inadequate signal timing	Adjust amber phase Provide all-red clearance phases Add multi-dial controller Install signal actuation Retime signals Provide progression through a set of signalized intersections
Rear-end collisions at unsignalized intersections	Pedestrian crossing	Install/improve signing or marking of pedestrian crosswalks Relocate crosswalk
	Driver not aware of intersection	Install/improve warning signs
	Slippery surface	Overlay pavement Provide adequate drainage Groove pavement Reduce speed limit on approaches* Provide "SLIPPERY WHEN WET" signs
	Large numbers of turning vehicles	Create left- or right-turn lanes Prohibit turns Increase curb radii
Rear-end collisions at signalized intersections	Poor visibility of signals	Install/improve advance warning devices Install overhead signals Install 12-in. signal lenses (see MUTCD) Install visors Install back plates Relocate signals Add additional signal heads Remove obstacles Reduce speed limits on approaches*

* Spot speed study should be conducted to justify speed limit reduction.

TABLE 4-2 (Cont'd.)

ACCIDENT PATTERN	PROBABLE CAUSE	GENERAL COUNTERMEASURE
Rear-end collisions at signalized intersections (continued)	Inadequate signal timing	Adjust amber phase Provide progression through a set of signalized intersections
	Pedestrian crossings	Install/improve signing or marking of pedestrian crosswalks Provide pedestrian "WALK" phase
	Slippery surface	Overlay pavement Provide adequate drainage Groove pavement Reduce speed limit on approaches* Provide "SLIPPERY WHEN WET" signs
	Unwarranted signals	Remove signals (see MUTCD)
Pedestrian accidents at intersections	Large turning volumes	Create left- or right-turn lanes Prohibit turns Increase curb radii
	Restricted sight distance	Remove sight obstructions Install pedestrian crossings Improve/install pedestrian crossing signs Reroute pedestrian paths
	Inadequate protection for pedestrians	Add pedestrian refuge islands
	Inadequate signals	Install pedestrian signals (see MUTCD)
	Inadequate signals	Add pedestrian "WALK" phase Change timing of pedestrian phase

* Spot speed study should be conducted to justify speed limit reduction.

TABLE 4-2 (Cont'd.)

ACCIDENT PATTERN	PROBABLE CAUSE	GENERAL COUNTERMEASURE
Pedestrian accidents at intersections (continued)	School crossing area	Use school crossing guards
Pedestrian accidents between intersections	Driver has inadequate warning of frequent mid-block crossings	Prohibit parking Install warning signs Lower speed limit* Install pedestrian barriers
	Pedestrians walking on roadway	Install sidewalks
	Long distance to nearest crosswalk	Install pedestrian crosswalk Install pedestrian actuated signals (see MUTCD)
Pedestrian accidents at driveway crossings	Sidewalk too close to traveled way	Move sidewalk laterally away from highway
Left-turn collisions at intersections	Large volume of left turns	Provide left-turn signal phases Prohibit left turns Reroute left-turn traffic Channelize intersection Install "STOP" signs (see MUTCD) Create one-way streets Provide turning guidelines (if there is a dual left-turn lane)
	Restricted sight distance	Remove obstacles Install warning signs Reduce speed limit on approaches*
Right-turn collisions at intersections	Short turning radii	Increase curb radii

* Spot speed study should be conducted to justify speed limit reduction.

TABLE 4-2 (Cont'd.)

ACCIDENT PATTERN	PROBABLE CAUSE	GENERAL COUNTERMEASURE
Fixed-object collsions	Objects near traveled way	Remove obstacles near roadway Install barrier curbing Install breakaway feature to light poles, signposts, etc. Protect objects with guard-rail
Fixed-object collisions and/or vehicles running off road-way	Slippery pavement	Overlay existing pavement Provide adequate drainage Groove existing pavement Reduce speed limit* Provide "SLIPPERY WHEN WET" signs
	Roadway design inadequate for traffic conditions	Widen lanes Relocate islands Close curb lane
	Poor delineation	Improve/install pavement markings Install roadside delineators Install advance warning signs (e.g., curves)
Sideswipe collisions between vehicles traveling in oppo-site directions or head-on collisions	Road design in-adequate for traffic conditions	Install/improve pavement markings Channelize intersections Create one-way streets Remove constrictions such as parked vehicles Install median divider Widen lanes
Collisions between vehicles traveling in same direction such as sideswipe, turning, or lane changing	Roadway design in-adequate for traffic conditions	Widen lanes Channelize intersections Provide turning bays Install advance route or street signs Install/improve pavement lane lines Remove parking Reduce speed limit*

* Spot speed study should be conducted to justify speed limit reduction.

TABLE 4-2 (Cont'd.)

ACCIDENT PATTERN	PROBABLE CAUSE	GENERAL COUNTERMEASURE
Collisions at driveways	Left-turning vehicles	Install median dividers Install two-way left-turn lanes
	Improperly located driveway	Regulate minimum spacing of driveways Regulate minimum corner clearance Move driveway to side street Install curbing to define driveway location Consolidate adjacent driveways
	Right-turning vehicles	Provide right-turn lanes Restrict parking near driveways Increase the width of the driveway Widen through lanes Increase curb radii
	Large volume of through traffic	Move driveway to side street Construct a local service road Reroute through traffic
	Large volume of driveway traffic	Signalize driveway Provide acceleration and deceleration lanes Channelize driveway
	Restricted sight distance	Remove sight obstructions Restrict parking near driveway Install/improve street lighting Reduce speed limit*

* Spot speed study should be conducted to justify speed limit reduction.

TABLE 4-2 (Cont'd.)

ACCIDENT PATTERN	PROBABLE CAUSE	GENERAL COUNTERMEASURE
Night accidents	Poor visibility	Install/improve street lighting Install/improve delineation markings Install improve warning signs.
Wet pavement accidents	Slippery pavement	Overlay with skid resistant surface Provide adequate drainage Groove existing pavement Reduce speed limit* Provide "SLIPPERY WHEN WET" signs

* Spot speed study should be conducted to justify speed limit reduction.

The recently completed Technology Sharing Reports FHWA-TS-232 and 233 "Synthesis of Safety Research Related to Traffic Control and Roadway Elements," is an extensive compilation of significant research in 17 different categories. This two-volume report contains invaluable information for all professionals concerned with highway and street design, traffic operations, and traffic safety.

OPERATIONAL AND MAINTENANCE PRACTICES

Parking Controls

Research results give widely different figures for accident reduction as a result of parking changes. However, the evidence clearly shows that 1) prohibition of parking reduces intersection accidents and midblock accidents, and 2) parallel parking is safer than angle parking.

The reduction in the number of accidents as a result of change from angle to parallel parking are reported to be in the range of 50 to 70 percent. Accidents per million vehicle-miles for angle parking are reported to be three to eight times that for parallel parking.

Total accident reduction of 10 to 90 percent as a result of prohibition of parking on major streets is reported in the literature. Figures in the 30 to 40 percent range are prevalent. Marconi reported a 32 percent reduction in the number of intersection accidents and a 42 percent reduction in mid-block accidents in San Francisco when parking was prohibited. Accident rates at intersections dropped from 0.63 per million vehicles entering the intersection to 0.43. Mid-block accidents per million vehicle-miles decreased from 3.6 to 2.1.

Speed Control

Accident rates have been found to be more related to variation of speeds in the traffic stream than to speed per se. When speed limits are set at the speed of the 85th percentile speed (85 percent of the drivers are traveling at this speed or slower while 15 percent are driving faster) the standard deviation and the skewness of the speed distribution are decreased. Accident involvement has been found to decrease with a decrease in these speed parameters.

Numerous studies have shown that compliance with arbitrarily set speed is extremely poor and may be counter-productive. The weight of evidence leads to the conclusion that speed variance and accident rates are directly related. Speed zoning concepts which result in the least variation in speeds within the traffic stream will provide the safest conditions.

Stop Signs

The stop sign is not a speed control device. Its use for this purpose is not permitted by the Manual on Uniform Traffic Control Devices. Consequently, erection of a stop sign for speed control will expose the city or county erecting the device to tort claims action. Furthermore, mid-block speeds may actually increase and create a more hazardous situation.

School Zones

Speed limits are commonly lowered near schools because of the perceived danger to children; speed limits of 20 or 25 mph are generally used. However, a study in Nebraska found no significant difference in pedestrian accident experience in cities that reduced speed limits in school zones and those which did not.

Various studies across the United States have found that compliance with school speed limits is poor. Compliance with a 25 mph limit at 51 locations in four states found compliance ranging from zero to 18 percent (Table 4-3). Studies have shown that the addition of flashing beacons generally results in a reduction in average speed of less than four mph with a reduction of ten mph reported at some sites.

TABLE 4-3

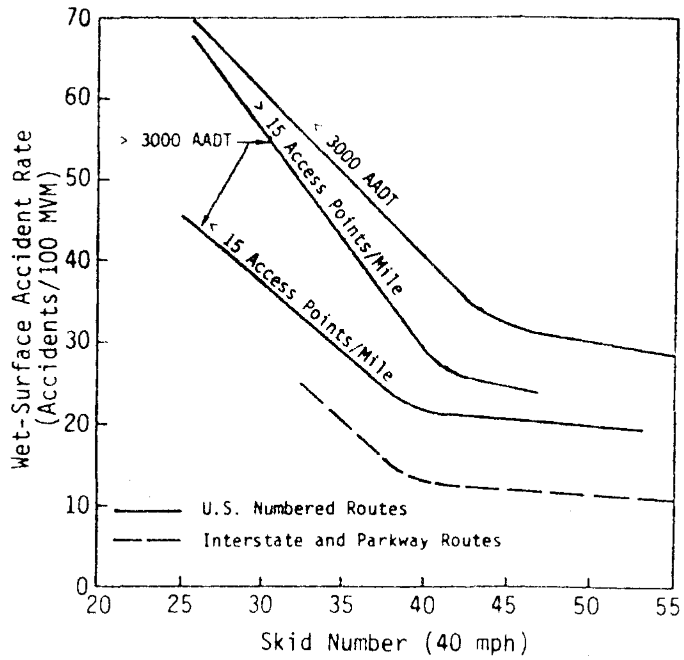
Compliance With Speed Limits at School Zones

Location	School Zone (mph)	Compliance (Percent)	85th Percentile Speed (mph)	No. Locations
W. Va.	15	5	-	114
Seattle	20	18	31	5
Ore.	20	10	44	3
Ky.	25	18	36-54	48
Calif.	25	2	54	1
Miss.	25	2	54	1
Lincoln, NE	25	21	32	1
Miss.	45	16	61	1

TABLE 4-4

Influence of Speed Humps on Vehicle Speeds

	Average Speed		85th Percentile Speed		
Location	Before (mph)	After (mph)	Before (mph)	After (mph)	Number of Streets
Brea, CA	32	22	38	25	1
Boston, MA	30	20	35	25	2
Sacramento, CA	-	-	37	27	1
Washington, DC	30	23	34	28	1
Great Britain	23-30	14-17	30-40	22-27	9
Australia	29	22	33	26	2



AADT - Average Annual Daily Traffic
MVM - Million Vehicle Miles

Source: Research Report 399, Kentucky Department of Transportation

Figure 4-1 Relationship Between Wet Surface Accidents And Pavement Skid Resistance

Speed Bumps and Speed Humps

Studies in the United States and Great Britain have shown that speed bumps increase the likelihood of loss of control by the driver and vehicle damage even at low speed. They are a physical obstruction and should never be used on a public street. Property damage or injury resulting from use of a speed bump on a public street exposes the municipality or county to the likelihood of a successful tort claims suit on the part of the injured party or parties.

Speed humps, on the other hand, are 12 feet long and three or four inches high. Experiments on residential streets in the United States, Australia, and Great Britain found them to be effective in reducing speeds (see Table 4-4) and can be safely crossed at 30 mph. Studies in Great Britain found that injury accidents were reduced by 60 percent. In Washington D.C., two accidents were report in a six-month period after installation of speed humps compared to nine accidents in the same six-month period the previous year.

Pavement Condition

The skid number at 40 mph* is the predominant measure of resistance to skidding used in the United States. As indicated in Figure 4-1, wet-surface accident rates have been found to increase rapidly for skid number less than 40. This is especially true at higher traffic volumes and with more frequent direct access points. This suggests that resurfacing or possible grooving would be an effective countermeasure where an unusually high percentage of accidents occurred on wet pavement.

Railroad Grade Crossings

A fundamental question in crossing safety is whether active or passive warning devices should be installed. Often this becomes an emotionally charged issue following a multiple fatality accident.

Passive Devices and Rumble Strips

A number of studies have been conducted to devlop new and/or improved passive signing systems for railroad grade crossings. The overall goal is to increase driver awareness of the need to look for trains. It is assumed that increased levels of looking behavior will result in accident reduction.

The adaptability of rumble strips on approaches to crossings was investigated in 1971 by the American Railway Engineering Association (AREA) technical sub-committee. Accident frequency had declined following the installation of rumble strips at several locations in Kentucky. Rumble strips were also judged to be effective at selected sites in Louisiana based on observed increases in looking behavior,

*(skid resistance of 40 mph/wheel load)100 = SN40

speed reductions, and complete stops. However, these studies are not conclusive. Problems of "driver surprise" and "potential loss of control" may create accident potential. Also, drivers have been observed to cross into the opposite traffic lane to avoid traversing the rumble strips. Drivers can also become accustomed to the rumble strips.

Active Devices

The use of active devices at grade crossings in California resulted in reductions of 69 percent in vehicle-train accidents, 86 percent in death and 83 percent in injuries. Accident rates were lower at rural crossings as compared to urban crossings. Double track main- or branch-line crossings have an 80 percent greater chance of accidents than single-track crossings.

A nation-wide study of accident rates at 2,994 rail-highway grade crossings before and after installation of active warning devices indicated significant improvement in safety (Table 4-5).

Flashing lights must have a high degree of alerting effectiveness and must be distinctive and readily recognized. The placement and alignment of standard flashing light signals have been found to have a very significant impact on conspicuity.

A driver approaching a crossing will not always see an adequately intense light from the signal because the narrow beam pattern of a standard 30-15 roundel. Very little deviation in the alignment of the device can seriously reduce the effectiveness.

TABLE 4-5

Effectiveness of Rail-Highway Grade Crossing Improvements

Warning Device		Number of Crossings	Percent Reduction in Expected Accidents
Before Improvement	After Improvement		
passive	flashing lights	1165	65
passive	flashing lights with gates	985	84
flashing lights	flashing lights with gates	844	64

Street Lighting

The following quote from Technology Sharing Report FHWA-TS-82-233, page 12-14, effectively state the state-of-the-art in relating traffic accidents and street lighting.

> With all of the sources of variation found in accident data, it is unlikely an unequivocal relationship can be developed between road lighting design and accidents alone. What is available demonstrates good quality lighting does not reduce accidents. The law of diminishing returns applies and there appears to be little return beyond fairly modest levels of lighting in the ranges given by current AASHTO and ANSI/IES practices.

The various studies seem to lead to the general conclusion that there is, at first, a sharp decline in night-time accidents as lighting levels increase and the decline in accidents levels off with further increases of lighting.

MAINTENANCE OF TRAFFIC CONTROL DEVICES

There is no reported research which establishes a direct relationship between maintenance of traffic control devices and traffic accidents. However, logic would suggest that a device which does not function as intended due to damage, vandalism, deterioration, or failure diminishes traffic safety. Maintenance is thus necessary to preserve or restore the device to its intended functional condition. Principal elements of effective maintenance are to have: 1)an up-to-date inventory of all control devices, and 2) a program to maintain their effectiveness.

Inventory

An inventory is one of the most important items in any traffic department. Many tort liability cases hinge on the adequacy of the signing at the location. Such items as sign condition, size, height between the pavement and the bottom of the sign, location relative to the roadway edge, type and size of support post and location relative to the intersection or mile point system are vital. The resulting inventory data can be used in the budgetary process as well as for legal situations. Inventory records also provide validation for product deficiency claims.

The tendency to treat the inventories as one-time survey records is an error. The inventory must be a continuous survey and a basic part of the on-going duties of the agency. The following steps are recommended:

1. Subdivide the city, county, or district into a workable number of areas. Six, twelve, and twenty-four are exceptionally good numbers of areas to have due to their relationship to the calendar year. If twelve areas are used, one area can be surveyed each month of the year.

2. Provide a map of each area to the field sign maintenance crew. This map should show the signs presently in place.

3. Provide sign crew with a supply of inventory sheets.

4. Instruct sign crew to conduct assigned sign maintenance each day and, when that is completed, to automatically return to

the area assigned for that month and continue the inventory process. They should report damaged or non-functioning devices on a work request sheet.

Maintenance Program

The two basic approaches to maintenance are:

1. Maintenance by exception - This concept operates under the old adage "if it ain't broken, don't fix it." Its primary disadvantage is that breakdowns rarely occur during working hours, requiring emergency repairs which substantially increase the maintenance costs and the hazard to maintenance personnel.

2. Preventive maintenance - This system attempts to identify the nature and frequency of malfunctions and to conduct preventive maintenance on the devices to minimize the probability of emergency maintenance.

Experience indicates that for complicated systems, such as traffic signal controlles, up to 90 percent of the emergency maintenance calls can be eliminated through a good preventive maintenance program.

A preventive maintenance program will not necessarily reduce the total maintenance cost, although it frequently has that result. Some of hte important benefits of preventive maintenance are:

1. It is less costly per call than emergency maintenance.

2. The best qualified personnel can be used rather than just the person on call.

3. With fewer emergencies, tort liability can be reduced.

4. The work will be much safe for maintenance personnel because time of repair can be scheduled to meet traffic demand.

5. It reduces the frequency and magnitude of damage thus allowing the equipment to function effectively for a longer period of time.

6. It reduces the likelihood that a tort liability case will occur and improves the city's defense when such a case is filed.

Routine inspection of all traffic control devices, by day and at night, on a regular basis, is a fundamental step in loss prevention. The period between inspections will vary, but a suggested guideline is a six-month review. Traffic control in construction and maintenance areas should be reviewed at the close of each work day. Additionally, all agency employees should be trained to look for and report any defective devices. This is particularly important for police, solid waste collection personnel, utility workers, and other agency personnel who routinely work on the street system. Emphasis should be placed on identification and reporting of defective or damaged devices. Each agency vehicle should contain a reminder card or display of the appropriate telephone number or office to notify when a defective device is identified.

Notice of a defect is important; timely notice is even more important. A program must be set up to ensure that your maintenance staff receives the defect report promptly from police sources, information sources, or anyone that the court could construe as being your agent. If the court feels that an agent of the city has known about a defect for an unreasonable period of time, the court will consider it constructive notice and assume that proper notice had been available and assign liability for any injury the defect may have caused. Also, if a defect is allowed to remain for an unreasonable period of time, even if the responsible city officials were not notified, the court can again consider it as constructive notice and assign liability. Thus, a program to ensure prompt notification should be developed.

If the city does not have around-the-clock maintenance, provisions should be made for a stand-by crew. Spare parts should be available to that crew no matter what their working hours. If a problem cannot be remedied promptly, adequate means must be taken to warn the public of the existing defect.

You should provide your maintenance crew with up-to-date equipment and ensure that the equipment is being used. Above all, mere visual inspections should be avoided. Make sure that your maintenance personnel avoid tunnel vision and repair only what they were sent to do. They should seek other problems that may exist and repair them.

DESIGN AND CONSTRUCTION

Access Management and Design

Various studies have shown that there is a direct relationship between accidents and the frequency of access drives and arterial traffic volume. Table 4-6 presents average driveway accident experience. Recent research has shown that the influence of the driveway manuever extends several hundred feet upstream of the location of the driveway which the vehicle driver intends to enter. Consequently, it is likely that the number of driveway accidents is under-reported on the police accident reports and that the problem is worse that the data in Table 4-6 indicates.

The increased number of accidents can be attributed to the frequent exposure to a large speed difference between the turning vehicle and other traffic. As shown in Figure 4-2, likelihood of a vehicle being involved in an accident increases dramatically as the speed at which the vehicle is traveling departs from the average speed of traffic. The rates, as interpreted from the figure, are given in Table 4-7. Also shown are the relative accident ratios for zero and 10 mph speed differentials. These data indicate that a vehicle on a main rural highway in the daytime is 180 times as likely to be involved in an accident when traveling at 35 mph below the average speed of the traffic stream. A vehicle 35 mph below the average speed has 90 times the likelihood of an accident as when traveling 10 mph slower that the average speed. The ratios for arterial streets are expected to be considerably larger because of the much more frequent exposure due to the higher volumes on urban arterials. A speed differential of 10 or 15 mph on urban arterials can be achieved only by providing left- and right-turn bays, or under certain conditions, continuous turn lanes.

TABLE 4-6

Average Number of Driveway Related Accidents Per Mile Per Year

Level of Development, Driveways per Mile		Highway ADT (Vehicles per Day) Low 5,000	Medium 5-15,000	High 15,000
Low	30	12.6	25.1	37.9
Medium	30-60	20.2	39.7	59.8
High	60	27.7	54.4	81.7

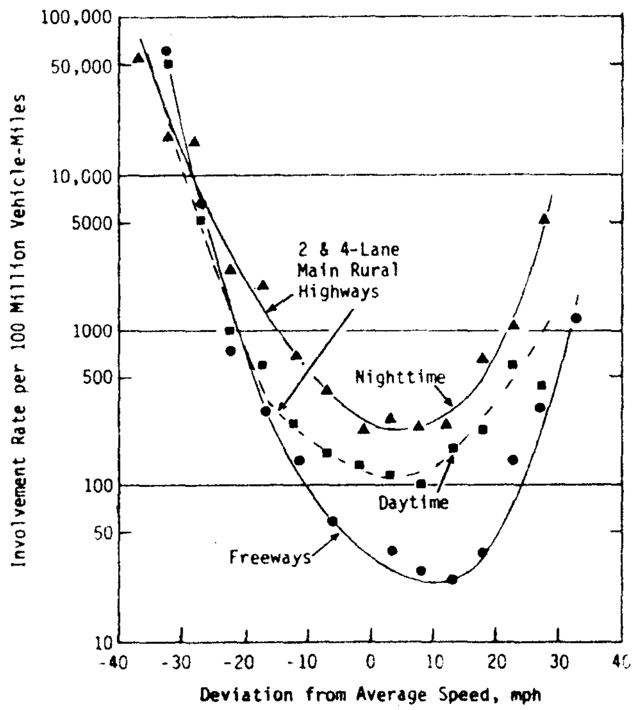


Figure 4-2 Accident Rate As A Function Of Deviation From The Average Speed Of The Traffic Stream

TABLE 4-7

Relative Accident Involvement Rates

	Speed Differential, mph				
	0	-10	-20	-30	-35
At grade highway, daytime					
rate	110	200	720	5000	20000
ratio of 0 mph	1	2	6.5	95	180
ratio to -10 mph		1	3.3	23	90
Freeway					
rate	30	100	600	2000	
ratio to 0 mph	1	3.3	20	670	
ratio to -10 mph		1	6	200	

Much longer spacing between access points than commonly found in urban areas is also needed. Analysis has shown that with driveway spacings of 200 feet, a speed differential of at least 24 mph will be generated by a vehicle making a right turn from a driveway into a 40 mph arterial street.

The Texas Engineering Extension Service offers a two-day short course which deals with specific problems of access management and driveway design.

Residential Subdivisions

Residential developments comprise the majority of the urban land uses. Low vehicular volumes and speeds are essential to preserve areas as attractive and safe places to live. The development of a functional street classification system and its implementation in street system design is essential in achieving traffic safety in residential areas.

Limited Access Subdivisions

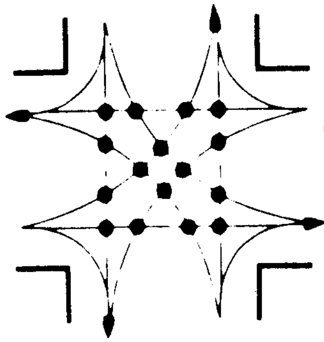
The limited access subdivision is characterized by:

1. Individual lots (houses) have access to a local street or minor collector street only. Major collectors connect with the arterial streets bordering the residential area at signalized intersections.

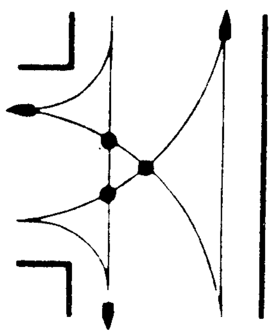
2. The street system within the residential subdivision is discontinuous. While travel through the subdivision is possible, the circuitous routing discourages traffic which does not have an origin or destination within the subdivision.

Research has shown that limited access subdivisions are superior to gridiron subdivisions in traffic safety. Market responses also show they are preferred by home buyers. Maks found that, within a five-year period, about 50 percent of the intersections within gridiron subdivisions studied had one or more accidents while fewer than ten percent of the intersections within limited access subdivisions had one or more accidents. This lower accident experience is due to the lower volumes and speeds within limited access subdivisions and the fact that these subdivisions have a larger proportion of three-way intersections.

As indicated in Figure 4-3, three-way intersections have fewer conflicts than four-way intersections. Furthermore, traffic approaching the intersection on the "stem" must slow in order to make a right or left turn maneuver and has a natural tendency to yield to other traffic. It is interesting to note that the likelihood of an accident at a three-way intersection is the same in limited-access and gridiron subdivisions. The probability of an accident in any year at a three-way intersection is 0.006 (0.6 percent). However, the probability of an accident in any year at a four-way intersection in a limited-access subdivision is nearly 10 percent (0.085) (Figure 4-4). In a gridiron subdivision, the probability increases to nearly 25 percent. This clearly suggests that four-way intersections should be avoided even in limited-access subdivisions and that the traffic safety of existing subdivisions with a gridiron street pattern can be significantly improved by modifying the street system.



16
CONFLICT
POINTS



3
CONFLICT
POINTS

Figure 4-3 Number of Conflict Points
For Three-Way And Four-Way Intersections

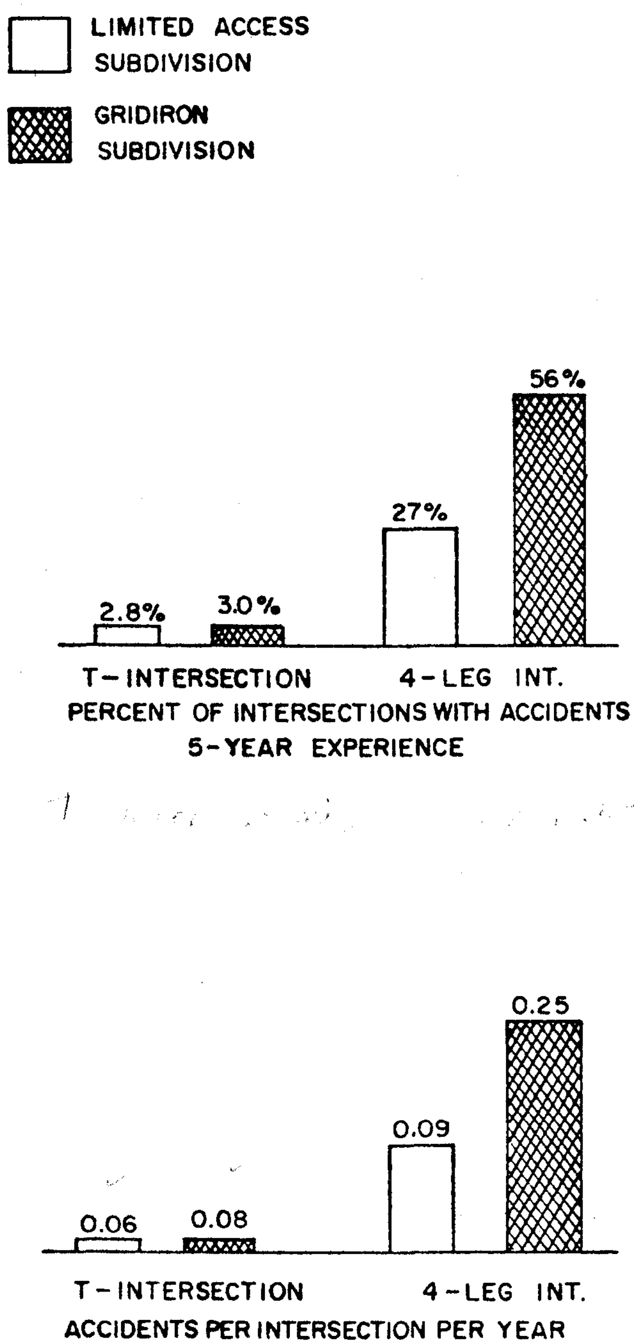


Figure 4-4 Accident Likelihood

Cul-de-sac and back-up (also called reverse frontage) lot arrangements are the preferable designs for the subdivision of land for residential lots adjacent to an arterial (Figure 4-5). The arrangements illustrated in Figure 4-6 should be avoided in new residential development. However, the side-on lot arrangement is particularly applicable in the improvement of traffic safety in an existing gridiron street pattern.

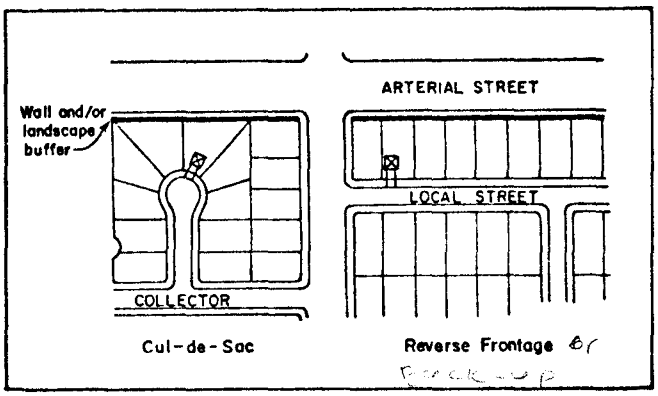


Figure 4-5 Preferred Lot And Local Street Designs For Residential Development Adjacent To Arterial Streets

GRIDIRON SYSTEM

MUST HAVE

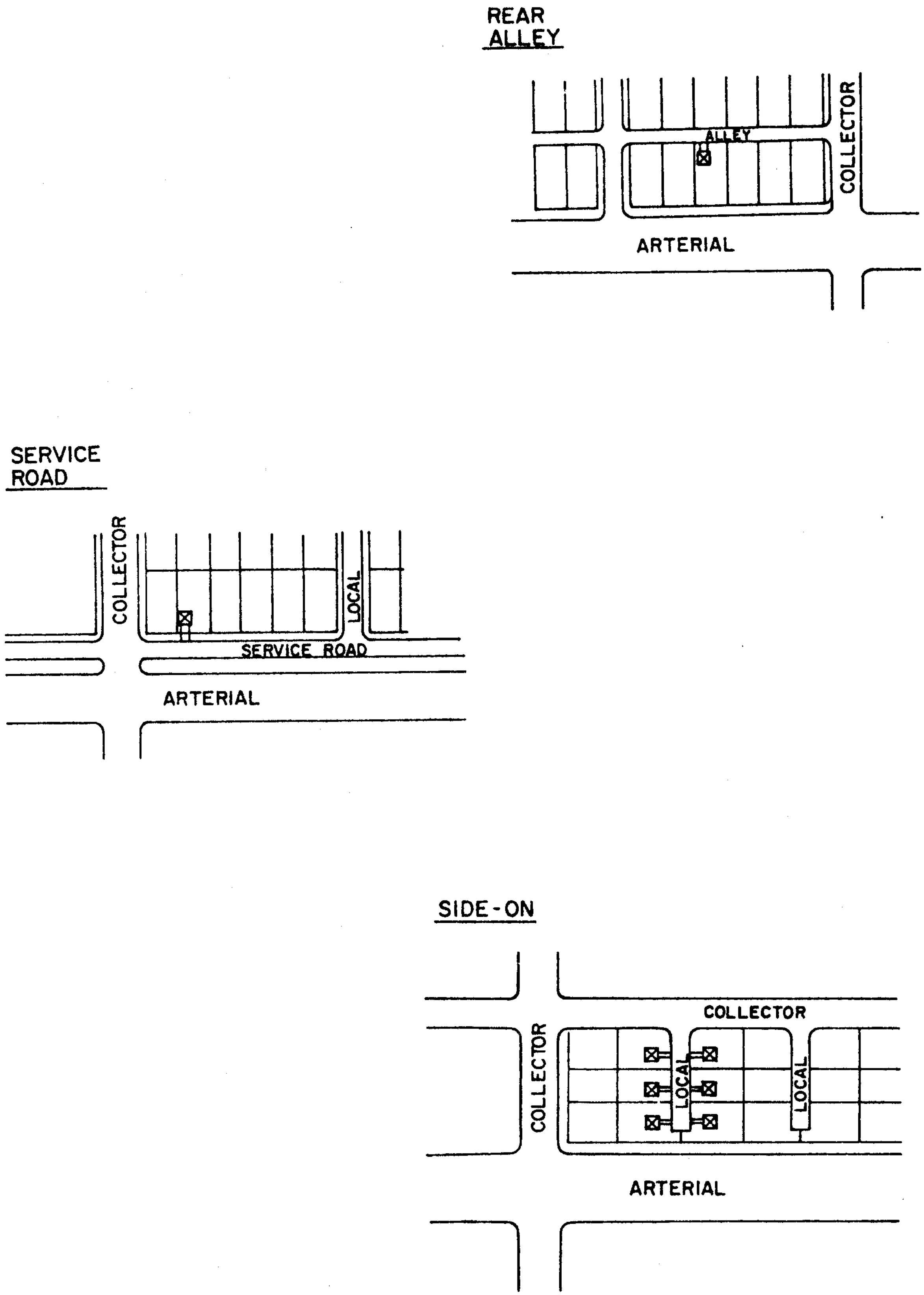


Figure 4-6 Poor Lot Arrangements Along Arterial Streets

MODIFICATION OF EXISTING GRIDIRON SUBDIVISIONS

Existing gridiron subdivisions can achieve traffic safety advantages of limited-access subdivisions by installing or redesigning of barrier medians in the arterial streets bordering the subdivisions and modifying the internal gridiron pattern. Overwhelming support of local residents is essential for satisfactory implementation of necessary modifications to the street system.

Based on the experience of Ottawa, Ontario, at least a year is required to prepare and evaluate the alternative plan and to review it with area residents. A total of 10-20 meetings with the citizen committee plus at least three public meetings are involved. Newsletters are used to inform the public and solicit opinions; however, experience has shown that many citizens are not interested in the process until a trial plan is actually implemented. The procedure followed by Ottawa is shown in Figure 4-7. The following factors are reported as having contributed to those traffic plans which were greatly acceptable to the neighborhood:

- The planning study had been assisted by a citizens' committee with wide representation from neighborhood residents and businessmen;
- The planning study concentrated on immediate traffic matters and did not deal with long-range transportation planning or other planning issues such as zoning, recreation or social planning;
- A clear set of goals and objectives were developed;
- The existing and desired functional classification of neighborhood streets was set forth;
- A trial plan was carefully prepared considering input from various technical agencies and the potential impact on peripheral arterials;
- The trial plan was presented to and implementation approved by neighborhood residents (through surveys and public meetings - sometimes at the block level);

- The plan was implemented as a package and not in stages;
- Implementation occurred as soon as possible after approval by the council; and,
- The trial plan was subjected to an adequate trial period before being approved for permanent implementation.

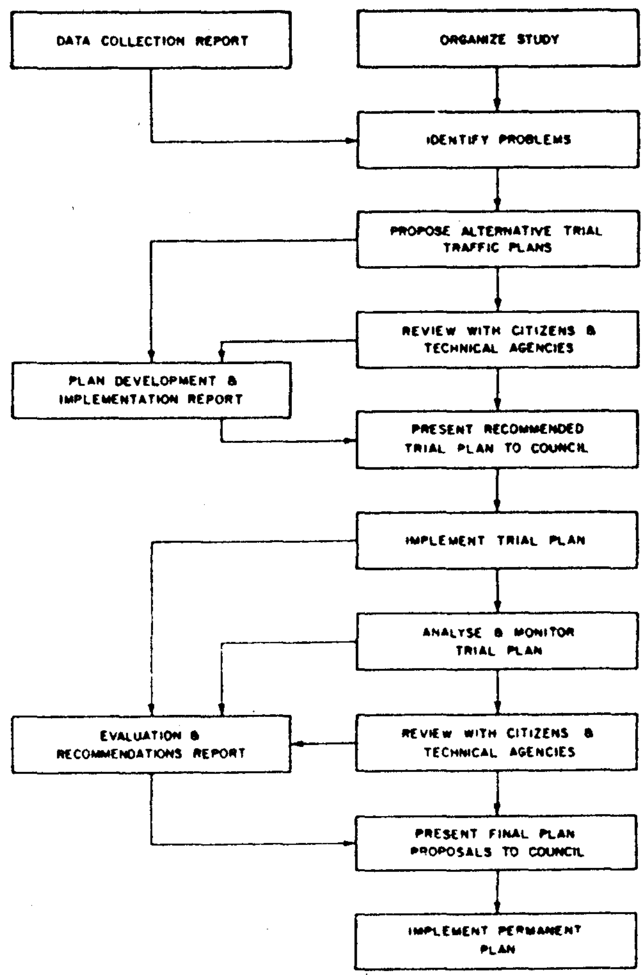


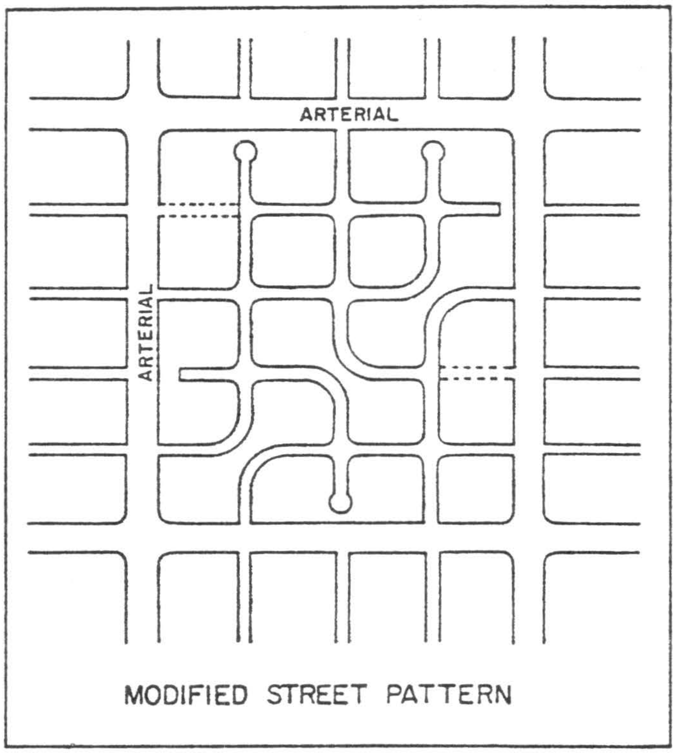
Figure 4-7 Major Steps Followed In Modifying Streets To Protect Existing Neighborhood From Through Traffic In Ottawa, Ontario

In September 1971, the City of Seattle implemented a trial demonstration traffic diversion plan for the Stevens Neighborhood. In January 1973, an ordinance was passed authorizing the Engineering Department to prepare plans, specifications, and cost estimates for the construction of permanent improvements.

The demonstration resulted in a rearrangement of the control devices. A primary reason for changing the design of the diversions was to maintain accessible travel paths in the winter during periods of inclement weather.

The neighborhood agrees that the plan is a success. The north-south traffic was reduced to approximately one-half of the predemonstration amount. East-west traffic volumes were reduced by approximately one fourth of the prediversion number. One accident has been reported in the two years following the installation, compared to 12 per year during the prior five-year period. The accident reduction is roughly equivalent to $20,000 savings per year. No discernable change in traffic volume or accidents has been experienced on adjacent arterial streets, nor did emergency vehicles enounter major inconveniences. Service vehicles found that, after the pattern became familiar, it was acceptable. The residents have developed stronger neighborhood identity, and environmental values have been enhanced in the areas of concern for safety, primarily for children, and the general feeling of relative serenity due to less noise. The few detrimental effects include some confusion to visitors, longer driving routes for some residents and for service and emergency vehicles, and increased street playing for children.

Figure 4-8 illustrates techniques that can be used to reduce the impact of through traffic on an existing residential neighborhood and improve traffic safety. The city of Boulder, Colorado, made extensive use of traffic directors to eliminate seven four-way intersections in a neighborhood gridiron street pattern (Figure 4-9). In Edinburg, Texas, selected streets were closed (Figure 4-10), the pavement was removed and the right-of-way deeded to the adjacent property owners. In other street segments the pavement was removed and replaced with pedestrian bicycle facilities.



REDUCTION IN THROUGH TRAFFIC.

Figure 4-8 Illustration Of Modifications In A Gridiron Street Pattern To Improve Neighborhood Safety

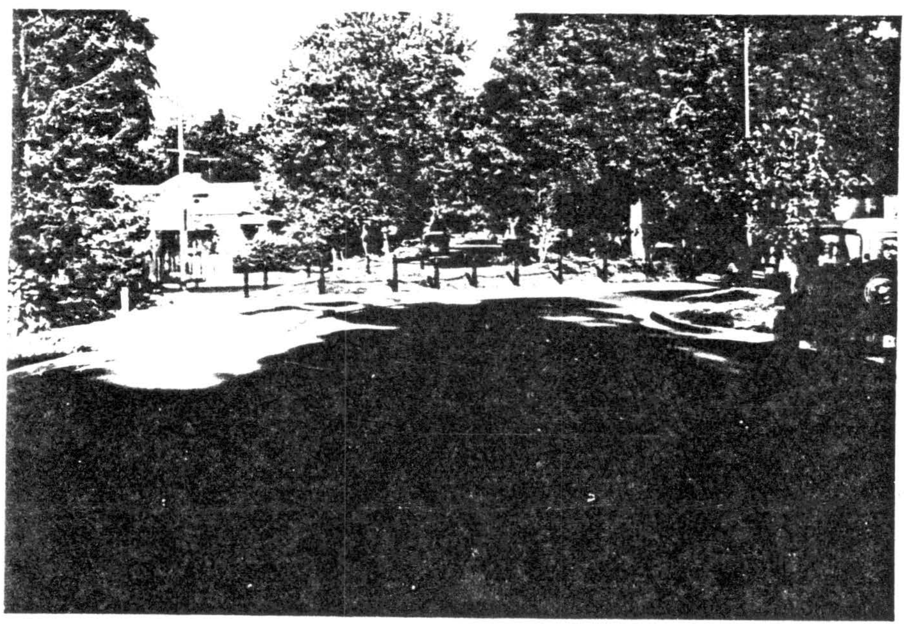


Figure 4-9 Traffic Diverter In Boulder, Colorado

Figure 4-10 Elimination Of Intersection Of Local Street With A Major Street Bordering A Neighborhood In Edinburg, Texas

COMMERCIAL DEVELOPMENT

Traffic safety problems associated with commercial office and retail development fronting on urban arterials result from the following:

1. Access designs which cause high speed differentials between turning vehicles and other traffic.

2. Inadequate driveway throat length which results in overlapping conflict points and low capacity. This problem is especially acute with shopping centers.

3. Poor site design which results in on-site parking and circulation problems. In many cases the inadequate site design causes traffic interference with traffic on arterial streets.

4. Poor parking lot design which results in damage to parked cars, high speed and/or random vehicular movements.

The first three problems result, or are aggravated, when residential structures along arterial streets are connected to commercial office and retail uses. Abandoning short sections of some local streets at the intersection with their arterial will increase intersection spacing. Improving the design of the remaining intersections will improve traffic flow and traffic safety.

Elimination of the intersection of a local street with an arterial generally means that existing local street right-of-way may be advantageously used to increase or improve the parking area or other expansion of the business.

Parking Lots

Experience has shown that shoppers tend to walk directly to the building entrance after parking their car. Parking could be arranged so that pedestrians do not have to walk from between parked cars. The design should afford drivers of the best possible view of pedestrians - including small children - and limit volume and speed where pedestrians may be present.

Parking stalls in retail areas should be ten feet in order to allow the door to be opened to at least the first stop without touching the side of a parked car in an adjacent space. This will largely eliminate the property damage caused by "dings" in the side of cars.

If angle parking is used, the "herringbone" pattern should be avoided because it exposes the side of a parked vehicle to the fron bumper of a vehicle parked at 90° to it. Parking spaces should be configured so that cars will be positioned front bumper to front bumper. Customers commonly traverse one-way parking isles in the wrong direction. This effectively negates the following arrangements in favor of one-way angle parking design: 1) elimination of head-on conflicts, and 2) safer pedestrian movement to and from stores. Safety of pedestrians within parking lots will be enhanced by:

- Avoiding or eliminating long, open circulation for autos adjacent to fronts of buildings and other areas where pedestrian-auto conflicts occur frequently.
- Orienting parking so that the circulation aisle between parked cars will be perpendicular to the building face.
- Prohibiting all parking at the curb adjacent to buildings.

Property damage events will be minimized by:

- Providing a landscaped buffer at the perimeter of the parking lot to provide drivers with a substantial visual perspective of the edge of the lot.
- Providing ingress/egress which will clearly identify the location of the driveway to drivers approaching the site on the arterial street and aid traffic leaving the site to locate the exit.
- Providing adequate driveway throat length so that complex maneuver areas and numerous conflict points are avoided.
- Providing landscaped barriers having substantial visual value to prevent random, diagonal maneuvers within larger lots.
- Dividing very large parking areas into individual lots connected by an on-site circulation road.
- Using ten-foot wide spaces in lots serving retail stores with "hair-pin" striping to guide drivers in the parking maneuver.
- Using end-islands with six-inch raised curbs at the end of all parking rows.

5

COST EFFECTIVE PROGRAMMING OF TRAFFIC SAFETY IMPROVEMENTS

INTRODUCTION

Effective programming of traffic safety improvements must begin with some quantatative means of identifying hazardous locations and conclude with a method of objectively setting priorities for improvement. The steps involved are:

1. Identifying hazardous locations.
2. Conducting engineering studies.
3. Evaluating corrective measures for each hazardous location.
4. Establishing priority for improvement.
5. Developing the improvement program.

A period of time must be established for accident analysis. The following should be considered when selecting the appropriate time period.

- The time period should be as short as possible to identify locations where sudden changes in accident patterns have occurred.
- The time period should be long enough to assure reliability in identifying hazardous locations. It has been shown that reliability increases with longer time periods, up to three or four years.
- Multiples of one year are preferred to avoid seasonal influences on accident patterns.

The first two are contradictory and care should be taken to try to account for both. Dual analysis using different time intervals may be used, with one shorter period to ensure responsiveness to sudden changes in accident patterns and one longer period to ensure maximum reliability.

IDENTIFICATION OF HAZARDOUS LOCATIONS

Hazardous locations may or may not be high accident locations. Where the hazard is obvious, drivers apparently exercise extreme caution with the result that accident frequency is unexpectedly low. Many locations have a high accident potential but have not established a high accident occurrence because traffic volumes are as yet low.

Current federal policy requires that identification of hazardous locations be based on analysis of accident experience. Four different analysis techniques are commonly used:

- Number of accidents (frequency) method.
- Rate of accidents method.
- Number-rate method.
- Rate-quality control method.

The first two methods are quite simple and readily adaptable to the smaller highway and street systems. The latter two listed above are recommended for larger systems with higher traffic volumes and wider variations of traffic.

Table 5-1 shows the basic data requirements for each of the four methods of analysis.

Table 5-2 shows which of the criteria measurement units are applicable to each of the alternative methods of analysis.

Other methods for identifying high accident/hazardous locations include:

- Poission probability
- Accident severity

The data identified in Table 5-1 are sufficient for the purpose of identifying hazardous locations. However, additional information will be needed later for evaluating alternative safety improvements and preparing program information.

TABLE 5-1

Accident Data Requirements

Basic Data Requirements	Number of Accidents Method	Accident Rate Method	Number-Rate Method	Rate-Quality Control Method
Time period	x	x	x	x
Accident locations	x	x	x	x
Section lengths		x	x	x
Traffic volumes		x	x	x
Average accident rates		x	x	x
Categories of highways			x	x

TABLE 5-2

Accident Criteria Measurement Units

Criteria	Number of Accidents Method	Accident Rate Method	Number-Rate Method	Rate-Quality Control Method
Sections:				
Accidents per mile			x	
Accidents per MVM		x	x	x
Intersections and Spots:				
Number of accidents	x		x	
Accidents per MV		x	x	x

Number of Accidents

The number of accidents at a location (intersection or segment of street) is the simplest and most commonly used procedure to identify and rank hazardous locations. The location with the highest number of accidents will rank first, the location with the second highest number of accidents, and so on. This method can be used effectively for small town street systems, local street systems in larger cities and low volume county roads. Consideration of the exposure factor is not as significant as on systems with higher traffic volumes or wider ranges of traffic volumes.

This is the simplest and most direct approach. All accidents are recorded by location and by the time period during which they occurred (usually months). Use of an accident spot map has proven to be one of the best ways to document the information.

The simplicity of this approach is justified because of low traffic volumes. There will not be many accidents, and few clusters of accidents will be found. Where clusters do appear, there will be an objective basis for investigation to determine if some element of roadway facility may be contributing to the accidents.

A variation of the procedure is to use the number of accidents to identify a group of high-accident locations for further analysis, then using some other method to rate them according to relative degree of hazard. A cirtical value should be established for location selection (such as five or more accidents per year). If the number of accidents at a location equals or exceeds the critical value, the location is designated as a high-accident site. The number of location studies that a city can complete in a year or less should be considered in selecting the critical number of accidents.

Accident Rate

Analysis by number of accidents alone can result in misleading conclusions when there is considerable variation in traffic volumes throughout the road or street system. Two locations having the same number of accidents should not reflect the same degree of hazard potential if one carries twice as much traffic as the other. The accident rate method considers this variable.

In addition to the basic information on accidents and their locations, we must also know the traffic volumes at all locations--and we must be able to compute system-wide accident rates for comparison with specific locations. With relatively small systems, the processes and calcuations can be performed manually. With larger systems a computer should be used for calculations and processing of data.

The accident-rate method involves the steps described below.

1. Locate all accidents in accordance with accepted coding practices.

2. Identify number of accidents in each established section and at individual intersections and spots.

3. Calculate the actual accident rate for each established section during the study period.

$$\text{Rate/MVM} = \frac{(\text{no. of accidents on section})\ (10^6)}{(\text{ADT})\ (\text{no. of days})\ (\text{section length})}$$

4. Calculate the actual accident rate for each intersection or spot during the study period.

$$\text{Rate/MV} = \frac{(\text{no. of accidents at intersection or spot})\ (10^6)}{(\text{ADT at location})\ (\text{no. of days})}$$

5. For the same period, calculate the system-wide average accident rates for sections, intersections, and spots -- using the formulas above and the summation of total accidents, total vehicle miles, and total vehicles, respectively, for each category of location.

6. Select accident rate cut-off values as criteria for identifying hazardous locations. A value about twice the system-wide rate usually is realistic and practical.

7. If actual rates exceed the minimum established criteria, the location is identified as hazardous and placed on the list for investigation and analysis.

Selection of the cut-off value (step 6) is not as critical as it might appear. The principal purpose is to control the size of the list of locations to be investigated -- a shorter list with high values, a longer list with low values. Experience will disclose the proper level for a particular agency.

The accident rate method is more complex than the accident numbers method -- and usually gives better results. But compromises are made in detail of specific and overall statistical reliability. Some of these limitations are overcome by the rate quality control method and the number-rate method. Most agencies with large complex systems should adopt one of these latter two methods.

Accident Number-Rate

The number-rate method is applicable to all highway or street systems--regardless of size of system or variations in traffic volumes.

A location with relatively high numbers of accidents per mile may appear to be quite hazardous. But if the traffic volume is exceptionally high at the location, the accident rate may not be abnormal--and the situation may not be as bad as it appears.

On the other hand, a location with relatively few accidents may show a very high accident rate because of extremely low traffic volumes. And again, the situation may not be as abnormal as it appears.

If both the number of accidents and accident rate at a location greatly exceed the average, we can be reasonably sure that the accident record is abnormal--and that conditions should be examined. The number-rate method is based on this concept. Additionally, this method considers variables related to categories of highways and types of intersections--categories differentiating between rural and urban locations, number of lanes, divided or undivided, and access control.

The number-rate method involves the following steps in addition to the basic recording of accidents and their locations:

1. For sections of highway, compute average accidents per mile for each category of highway--based on total data for all sections of each category.

   $$\text{Av. accidents per mile} = \frac{(\text{number of accidents})}{(\text{miles of category})}$$

   Av. accidents per MVM =

   $$\frac{(\text{number of accidents})\ (10^6)}{(\text{section ADT})\ (\text{no. of days})\ (\text{section length})}$$

2. Identify all clusters of accidents (two or more within 0.10 mile) at spots and intersections, and compute average accidents per location and per million vehicles for each category of highway.

$$\text{Av. accidents per location} = \frac{\text{total number of accidents}}{\text{total number of locations}}$$

$$\text{Av. accidents per MV} = \frac{(\text{total number of accidents})\ (10^6)}{(\text{location ADT})\ (\text{no. of days})}$$

3. Select cut-off values for each of the criteria above--start with values about twice the system-wide average for each highway category.

4. For each section, calculate both the actual number of accidents per mile and per vehicle mile.

5. For each cluster of accidents (spot or intersection) calculate both the number of accidents and the accidents per million vehicles passing the location.

6. All locations with number of accidents and accident rates both higher than the critical cut-off values should be placed on the hazardous location list. Comparisons must be made with criteria for the particular category of highway being analyzed.

Rate Quality Control

The rate quality control method is applicable to systems of all sizes and ranges of traffic volumes. As with the number-rate method, consideration is made of various categories of highway--rural, urban, two-lane, four-lane, etc. But the rate quality control method assures control of the quality of the analyses by applying a statistical test to determine whether a particular accident rate is unusual, as related to a predetermined average accident rate for locations having similar characteristics.

The tests applied are based on the commonly accepted assumptions that accidents fit the Poisson distribution.

The critical rate is determined statistically as a function of the system-wide average accident rate for the category of highway and the vehicle exposure (vehicles or vehicle miles) at the location being studied.

Critical rates are computed by the following formula:

$$Rc = Ra + K \frac{Ra}{m} - \frac{0.5}{m}$$

Where: Rc = Critical accident rate (For sections--accidents per MVM) (For intersections or spots--accidents per MV)

Ra = System-wide average accident rate by highway category (For sections--accidents per MVM) (For intersections or spots--accidents per MV)

m = Vehicle exposure during study period (MV or MVM)

K = Constant

The value of K determines the level of confidence that accident rates above the critical rate are significan and have not resulted by chance. A 95 percent level of confidence is desirable. Example values of K for various levels of confidence are shown below.

Level of Confidence	K
0.995	2.576
0.95	1.645
0.90	1.282

The rate quality control method involves the following steps in addition to the basic recording of accidents and their locations.

1. Compute system wide average number of accidents per MVM for each category of highway--based on total data for all sections of each category.

   Av. accidents per MVM =

   $$\frac{(\text{no. of accidents})\ (10^6)}{(\text{section ADT})\ (\text{no. of days})\ (\text{section length})}$$

2. Identify all clusters of accidents (two or more within 0.1 mile) at spots and intersections, and compute system-wide average accidents per MV at such locations by categories of highways.

Av. accidents per MV =

$$\frac{(\text{no. of cluster accidents})\ (10^6)}{(\text{ADT at clusters})\ (\text{no. of days})}$$

3. For each individual location, determine the vehicle exposure, m, during the study period.

   For sections:

$$m = \frac{(\text{section ADT})\ (\text{no. of days})\ (\text{section length})}{(10^6)} = \text{MVM}$$

   For intersections and spots:

$$m = \frac{(\text{location ADT})\ (\text{no. of days})}{(10^6)} = \text{MV}$$

4. For each location, compute the critical accident rate, Rc, by the formula:

$$Rc = Ra + K\sqrt{\frac{Ra}{m}} - \frac{0.5}{m}$$

   Where: Ra = Average accident rate for category of highway being studied (MVM for sections--MV for intersections and spots)

   m = Vehicle exposure at location (MVM for sections--MV for intersections and spots)

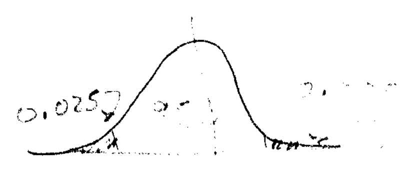
   K = Constant for probability level = t distribution = 1.645

   Start with a value of K = 1.5. A larger value of K will reduce the length of the hazardous location listing--but will increase the level of confidence that the locations truly are hazardous. A smaller value of K will produce a longer list with a lower level of confidence.

5. Compute the actual observed accident rate at each location for the same time period by:

   For sections:

$$\text{Accidents per MVM} = \frac{\text{no. of accidents}}{\text{millions of vehicle miles}}$$



   For intersections and spots:

$$\text{Accidents per MVM} = \frac{\text{no. of accidents}}{\text{millions of vehicles}}$$

Ra/Rc =< 1.0

6. Compare the actual accident rate with the critical rate at each location and prepare a list of all locations (sectors, intersections, and spots) with rates exceeding the critical value.

Poisson Probability

Accidents are generally considered to follow a Poisson Distribution, which is:

$$P(x) = \frac{e^{-m} m^{x}}{x!}$$

Where: $P(x)$ = Probability of exactly x events occurring in any selected interval

e = base of the natural log

m = the average number of events occurring in the selected interval

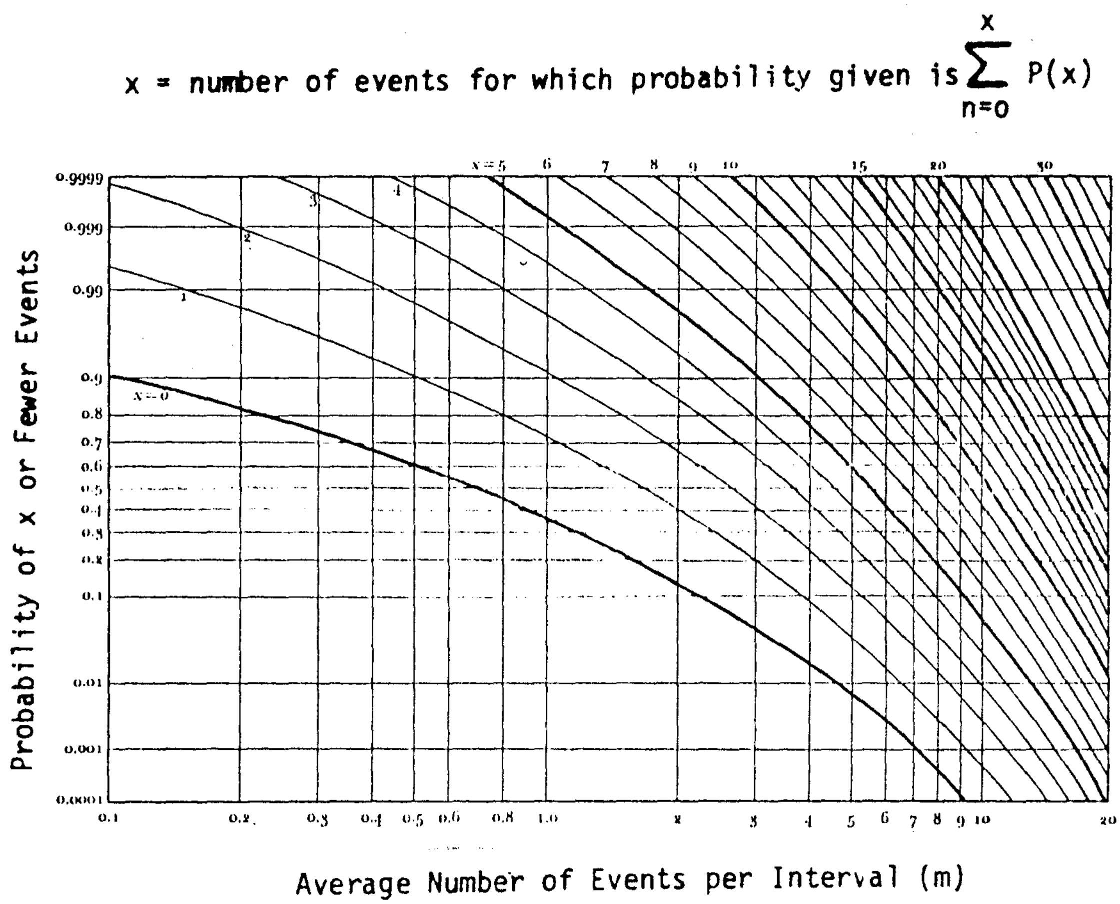
$x!$ = product of the x terms (e.g., $3! = 1 \cdot 2 \cdot 3 = 6$)

Table of the cumulative Poisson or graph given in Figure 5-1 eliminates the need for calculations. Application procedures are by the following steps:

1. Select the probability level that the accident frequency could not be due to chance; generally 0.05 (five percent) or 0.01 (one percent).
2. Calculate the average number of accidents (m) occurring in a selected time interval, say two years, for similar conditions (i.e., traffic volume, design of intersection, traffic control, or a combination of factors).
3. Determine the probability that, given an average number of accidents (m), the number of accidents of the subject location could exceed that which occurred.
4. When the probability of occurrence is less than the critical value, select these locations for further analysis.

Example: In a two year period, 21 accidents occurred at the intersection of a shopping center drive and an arterial street. The average number of accidents at locations having similar traffic volumes and

STUDY FOR PROBABILITY



Adapted from Poisson and other Distributions in Traffic, by Daniel. L. Gerlough and Frank C. Barnes, reproduced by permission of the Eno Foundation.

Figure 5-1 Graph of the Cumulative Probabilities of the Poisson Distribution speeds was 6.9 in a two-year period. Could the high accident experience be due to chance or is there statistical evidence that it is due to poor design?

The solution proceeds as follows:

1. Select a probability that the occurrence is not due to chance, say 0.01 and subtract from 1.0; 0.99 is the probability that x or fewer accidents are due to chance.

2. Locate 0.99 on the vertical axis and follow the line horizontally.

3. Locate m = 6.9 on the horizontal axis (note that the scale is logorythmic), read vertically to the 0.99 line.

4. The point at which steps 2 and 3 intersect is between x = 13 and x = 14. Thus, with an average 6.9 accidents in a two-year period, the probability of 14 or fewer accidents is over 99 percent; the probability of more than 14 accidents is less than one percent. Consequently, it may be concluded that the high accident rate is due to design and that redesign and reconstruction would be effective.

Accident Severity

Accident severities are often classified by the National Safety Council within the following five categories:

- Fatal Accident - One or more deaths.
- A-Type Injury Accident - Bleeding wound, distorted member, or person carried from scene (incapacitating).
- B-Type Injury Accident - Bruises, abrasions, swelling, limping (non-incapacitating).
- C-Type Injury Accident - Involving no visible injuries, but complaint of pain (probable injury).
- PDO Accident - Property damage only.

A weighting factor may be applied for each category (or simply Fatal, Injury, and PDO) to arrive at a severity index. Once the weighting factors have been decided, the procedure is applied in the following manner:

1. Classify each accident by the most severe injury (if any) which occurred.
2. Multiply the number of accidents in each category by the weighting factor for that category of accidents and sum.
3. Rank locations based on the total score.

Another severity method involves the determination of an average Relative Severity Index (RSI) for each location because various accident types are dependent on accident type, area type (urban, rural), and accident severity.

The following steps should be used to determine average RSI values for each individual location:

1. Classify each accident at the location under one of the appropriate categories.
2. Multiply the total accidents under each category (type of accident by its unit RSI value to determine the total RSI values for each accident type occurring at the location.
3. The total RSI value for the location is obtained by summing the total RSI values for each accident type at the location.
4. The average RSI value is determined by dividing the total RSI value for the location by the total number of accidents at the location.
5. Repeat steps 1 through 4 for each location.
6. Rank the hazardous locations by average RSI values.

Analysis of High Accident Locations

Once hazardous locations have been identified, it is necessary to perform various data collection tasks and analysis in order to develop corrective measures. These studies are technical in nature and will require some degree of proficiency in:

- Basic traffic engineering studies.
- Street and highway design.
- Warrants for traffic control devices.
- Design, traffic operations, and other safety practices which are effective in reducing accidents.
- Economic analysis of alternatives.

The types of investigations that may be necessary cover a wide range of topics including:

- Accident Report Related Studies.
- Engineering Studies:
  - Volume counts
  - Spot speed
  - Travel time and delay
  - Roadway and intersection capacity
  - Traffic conflict
  - Gap distribution and acceptance
  - Traffic lane occupancy
  - Queue length
  - Effectiveness of safety improvements
  - Traffic signal operations
  - School crossings
  - Condition/serviceability traffic control devices
  - Skid resistance
  - Roadway lighting
  - Railroad grade crossing

A principal source for a number of these studies is the Manual of Traffic Engineering Studies, 4th Edition, available from the Institute of Transportation Engineers.

Accident Report Summaries

Accident-based studies involve the development of statistical summaries of the accident data by various characteristics to detect abnormal accident trends. The accident data required for these summaries may be obtained manually from hard copy accident reports or by computer techniques from computerized accident files. Safety deficiencies are then identified based on a comparison of the frequency of occurrence of a specific characteristic to a "standard" frequency. Over-representations are identified by a disproportionately high percentage of certain accident characteristics when compared to similar locations. An adequate sample of data at comparable sites is necessary to identify an accurate over-representation of accident characteristics.

The statistical summaries of accident data may be developed either manually or by computer techniques. Several statistical packages are available for computer application, including the Statistical Package for the Social Sciences (SPSS), Data Analysis and Reporting Techniques (DART) and Michigan Dimensional Analysis System (MIDAS).

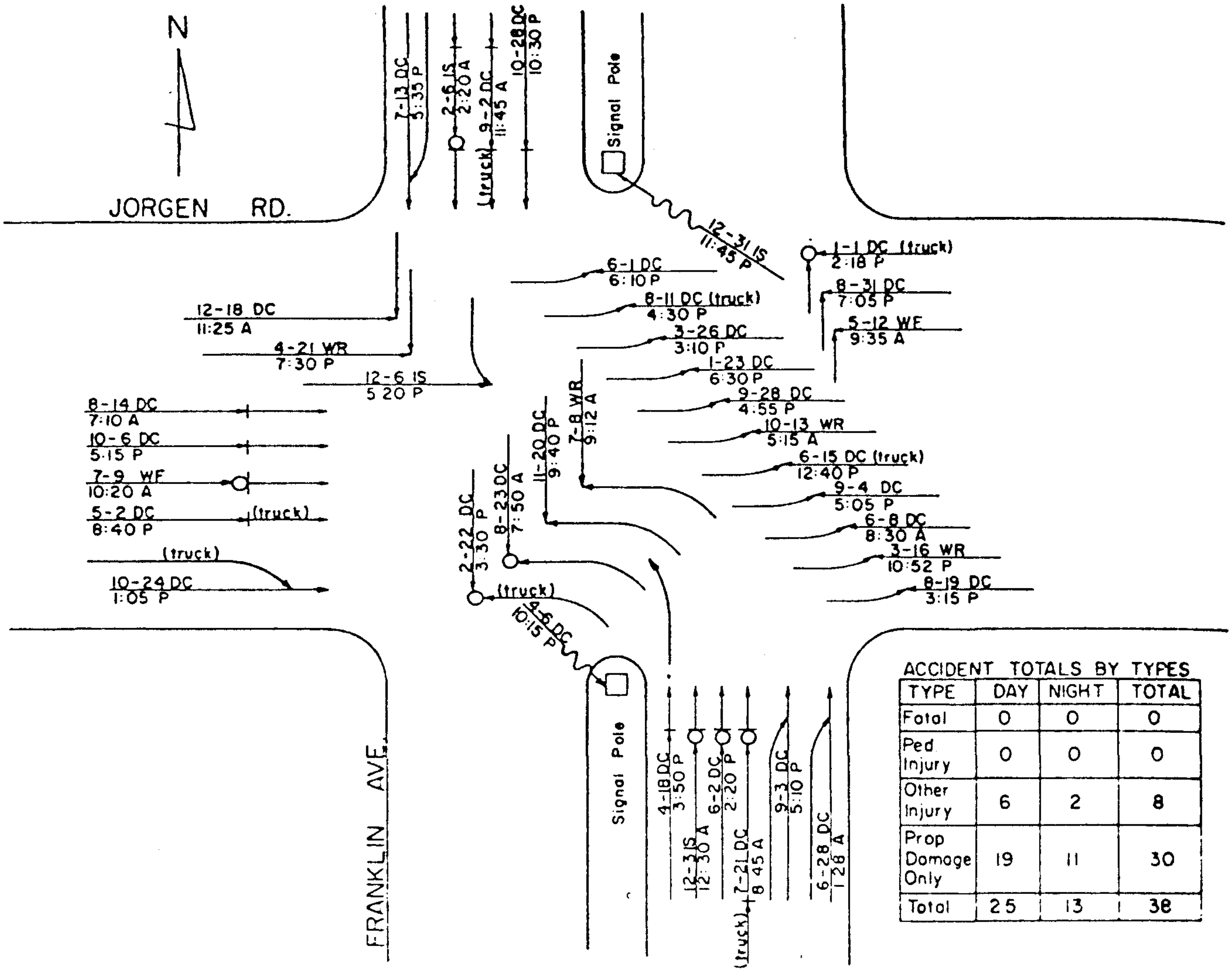
Collision Diagrams

The collision diagram is the best technique to summarize accident data for an individual high accident location. The graphical representation facilitates the identification of accident patterns (Figure 5-2). In combination with the condition diagram, it enables the Traffic Engineer to draw conclusions as to the characteristics causing the accidents and in turn make judgments as to effective corrective measures. Computerized collision diagrams have been developed in recent years for quick and easy production of such information. Accident types are plotted on the proper intersection legs and may be color coded by severity.

Physical Characteristics

Information as to the physical characteristics of a high accident location is necessary to prepare the condition diagram (Figure 5-3). Information needed includes such items as:

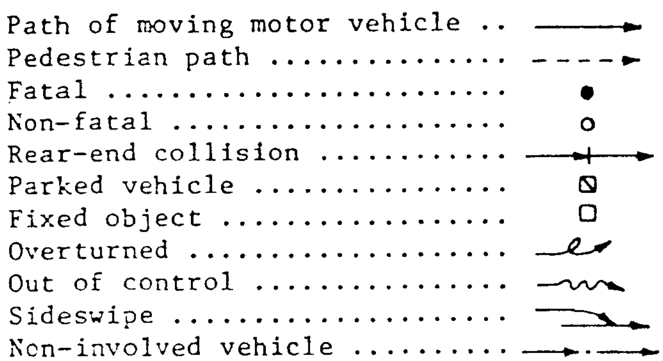
- Roadway characteristics
- Roadside characteristics
- Geometrics
- Street names
- Functional classification
- Corner radii
- Sidewalk locations
- Traffic regulations
- Traffic control devices
- Speed limits
- Visual obstructions
- Driveway locations
- All pavement markings



ACCIDENT TOTALS BY TYPES

TYPE	DAY	NIGHT	TOTAL
Fatal	0	0	0
Ped Injury	0	0	0
Other Injury	6	2	8
Prop Damage Only	19	11	30
Total	25	13	38

LEGEND



Time : A=AM P=PM
Pavement : D=Dry I=Icy W=Wet
Weather : C=Clear F=Fog R=Rain
SL=Sleet S=Snow

Figure 5-2 Typical Collision Diagram

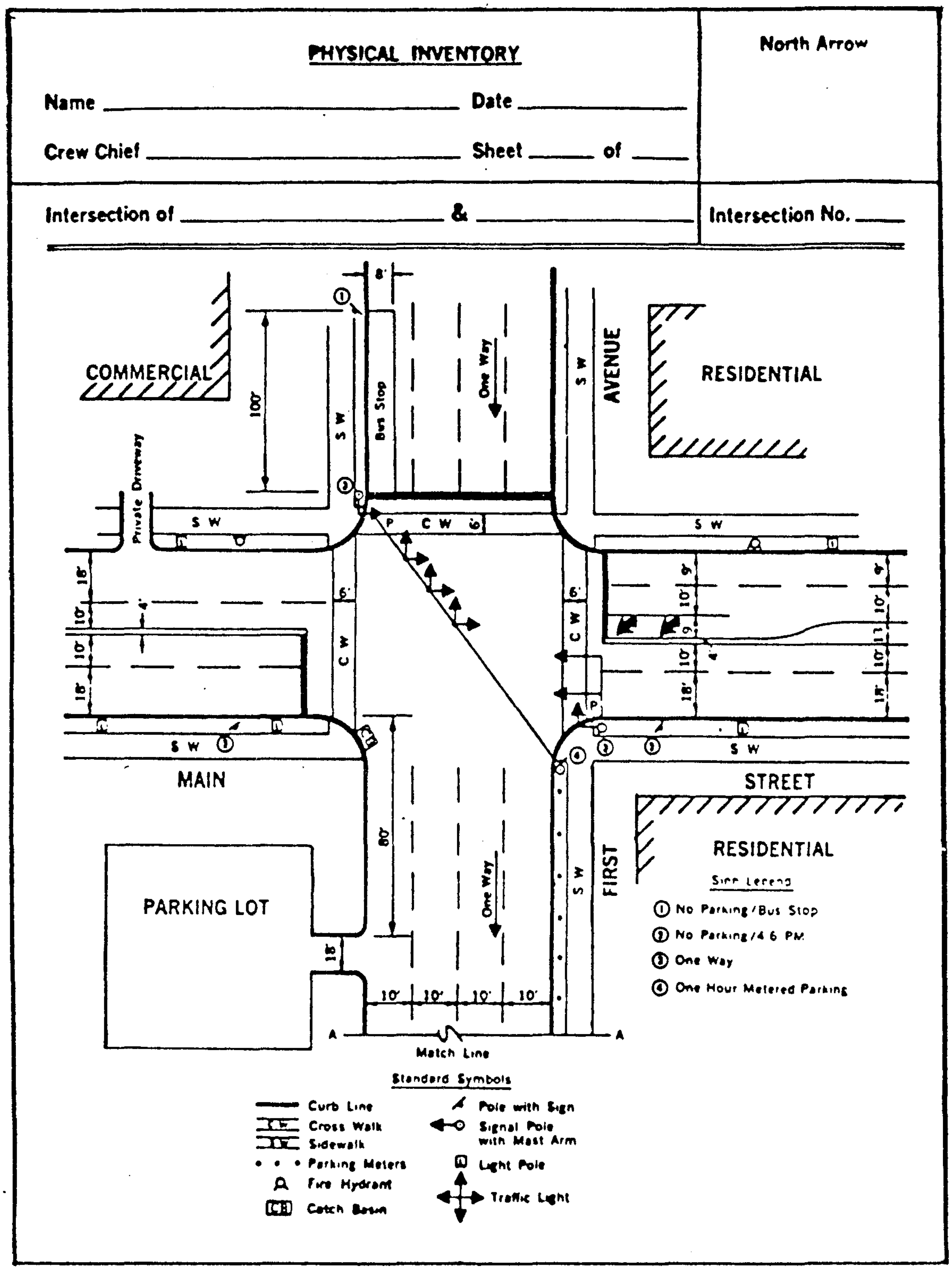


Figure 5-3 Typical Condition Diagram

Engineering Studies

Volume Studies

Traffic volume studies are conducted to determine the number and movement of vehicles and/or pedestrians within, through, or at selected points in an area. Volume data are used as basic input in all operations-based procedures. Its use is as a basic study procedure describing the exposure (vehicular or pedestrain) at each hazardous location.

Volume counts may include peak hour counts, 24-hour counts or short-term counts (5 minutes, 15 minutes, etc). Volume counts may include only total vehicle movements or may be individual turning movements (at intersections or driveways). Vehicle classification, pedestrian, and turn movement counts require manual counting procedures.

Spot Speed Studies

Spot speed studies are used to obtain an indication of the speed of traffic at one point on a roadway. They serve to estimate the speed distribution of the traffic stream during the observation period. Spot speed data are usually necessary when accident summary information indicates safety problems thaat may be caused by high speeds or unusual speed distributions. Spot speed studies may also be conducted upon completion of the safety performance studies if field observations indicate a possible vehicle speed problem.

Travel Time and Delay Studies

Travel time and delay studies are used to obtain data on the amount of time it takes to traverse a specified section of roadway and the amount, cause, location, duration, and frequency of delays. Travel time and delay characteristics are indicators of the level of service that is operating along a facility and can be used as relative measures of the efficiency of the traffic. Information from these studies can also be used to identify problem locations where safety improvements may be required to increase mobility and provide improved safety conditions.

Travel time and delay studies are useful for obtaining information on locations where accident patterns relating to congestion-type accidents exist; i.e, a significant number of rear-end, right-angle, or left-turn accidents. Intersection delays may be handled in a fashion similar to the travel time and delay studies.

Roadway and Intersection Capacity Studies

Highway capacity studies are conducted to measure the ability (supply) of a highway facility to accomodate or service the existing or projected traffic volumes (demand). Capacity is defined as the maximum number of vehicles that can pass over a section of a lane or roadway (or through an intersection) during a given time period (one hour unless otherwise specified) under prevailing highway and traffic conditions. The purpose of conducting a capacity study for traffic engineering safety projects is to provide a measure of the adequacy and quality of service being provided by the facility. Highway capacity studies are useful for obtaining information on locations where accident patterns relating to congestion-type accidents exist.

Traffic Conflict Studies

Traffic conflict studies can assist in the diagnosis of safety and operational problems at a highway location and in the evaluation of the effectiveness of improvement at a location. These studies are believed by many safety engineers to be useful in determining the accident potential at a site. Defined relationships between conflicts and accidents, however, have not yet been clearly established. Traffic conflict studies can be a supplement to routing field inspections of high-accident locations or they can be conducted at suspected hazardous sites.

A traffic conflict occurs when a driver takes evasive action, such as braking or weaving, to avoid a collision. Some conflict and event types include weave conflict, abrupt stops, slow for right-turn conflict, opposing left-turn conflict, pedestrian conflict, etc.

Conflicts may be counted based on type and severity. Erratic maneuvers, such as turns from the wrong lane, run-off-road, etc., may also be counted during the conflict study. The traffic conflict technique (TCT) was originally developed by the General Motors Laboratories in 1967 as a systematic method of observing and measuring accident potential at intersections. Since then, it has been modified and used by various U.S. highway agencies, particularly in the states of Ohio, Virginia, Kentucky, and Washington. A modified traffic-conflicts technique was recently developed in an NCHRP study by Midwest Research Institute.

Gap Distribution and Acceptance

Gap studies measure the time headway or gap between vehicles along a highway section (or at a point), and analyze the gap acceptance characteristics where a minor or alternate traffic stream intersects a major traffic stream. The need for gap analysis in highway safety studies is determined by the locational characteristics and the accident (or conflict) patterns occurring at the study location.

Traffic Lane Occupancy Studies

A traffic lane occupancy study can provide a measure of the traffic performance of a highway facility as a function of vehicle lengths, volumes and speeds. The occupancy factor is related to density and measures the percent of time a point on a roadway is occupied by a vehicle. Lane occupancy is defined as:

$$\text{Lane Occupancy} = \frac{\text{Time vehicles are present at a point on a roadway}}{\text{Total specified time period}}$$

Based on an established relationship between lane occupancy and traffic volume, the occupancy at various intervals can be determined. Lane occupancy studies are useful for obtaining information on locations where congestion-type accident patterns exist.

Queue Length Studies

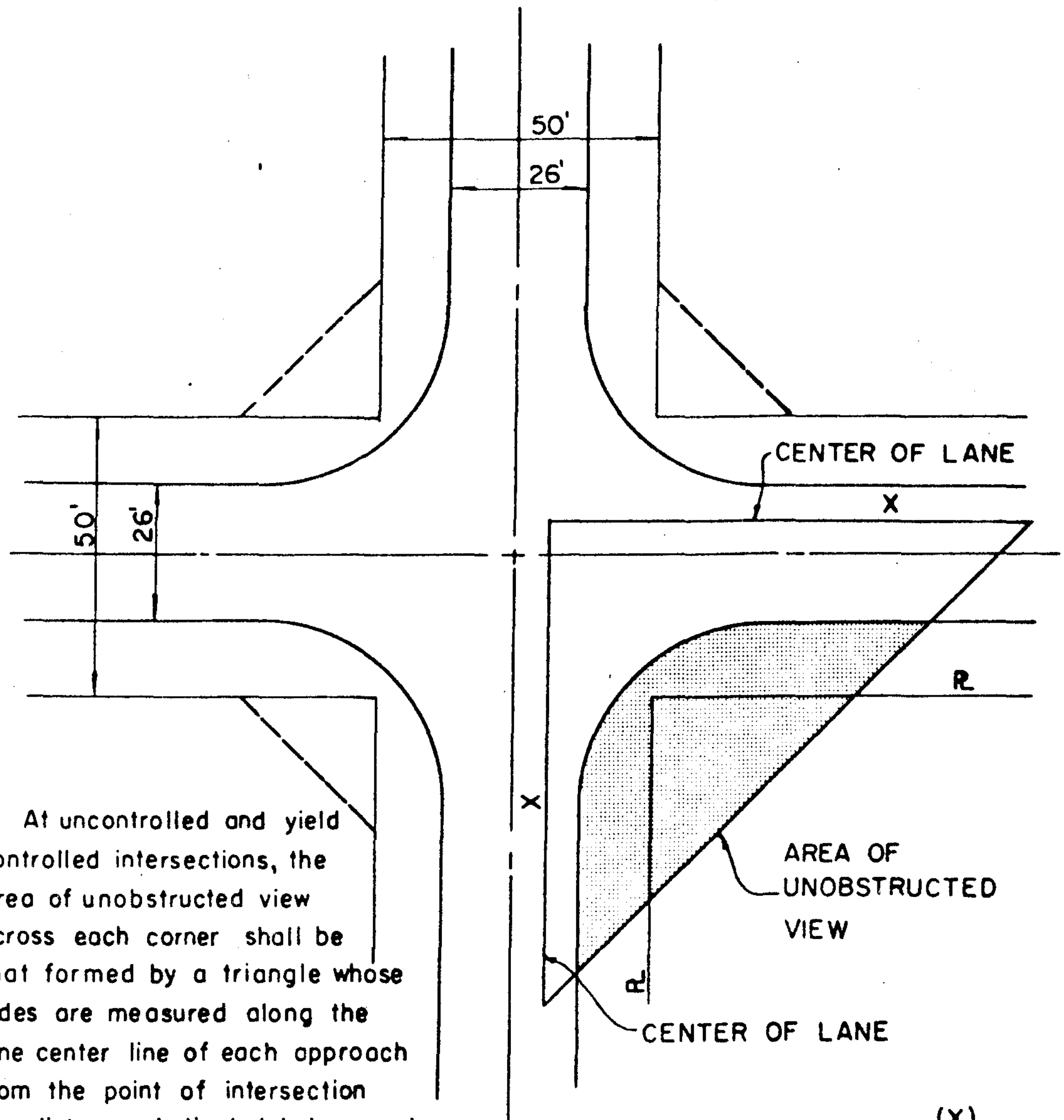
Queue length studies identify the number of vehicles that are stopped in a traffic lane behind the stop line at an intersection. They can also be used to determine the vehicular back-up at other locations, such as lane drop sections, railroad crossings, freeway incident locations, and other bottleneck situations. However, the primary purpose of queue length studies is to measure the performance of an intersection.

Queue lengths are usually observed at the beginning of the green phase and at the end of the amber phase for signalized intersections. A comparison of the queue lengths at these two distinct time points is used to assess the level of traffic flow as a measure of the "expected" delay to the vehicles. Queue length studies are useful in acquiring information for locations where congestion-related accidents (particularly rear-end accidents) occur frequently.

Benefit/cost = 1 or greater

cost/effectiveness = when can't quantify benefit.

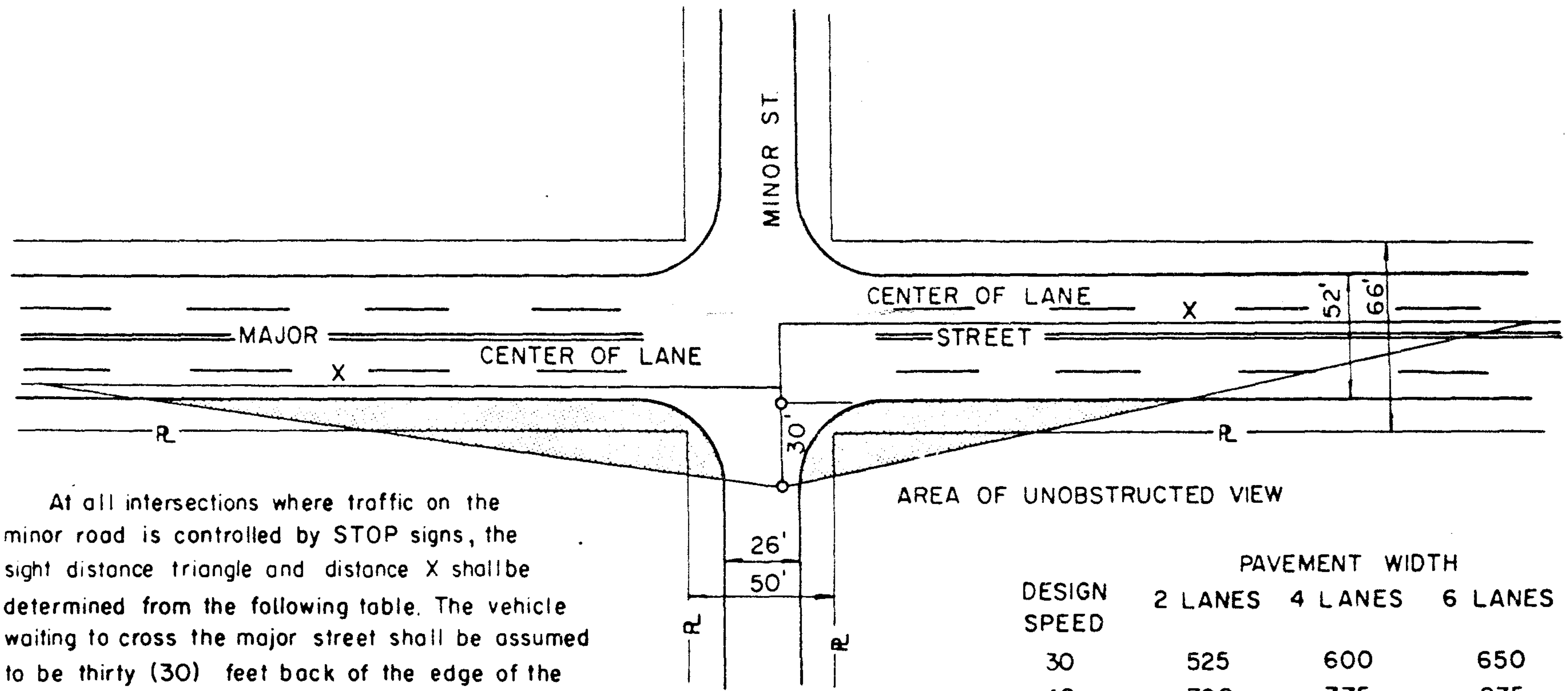
[illegible]



At uncontrolled and yield controlled intersections, the area of unobstructed view across each corner shall be that formed by a triangle whose sides are measured along the lane center line of each approach from the point of intersection the distance indicated below, <u>each leg determined by the speed limit on that approach to the intersection</u>.

APPROACH SPEED	(X) MINIMUM DISTANCE
25	150
30	200
35	235
40	275
45	310
50	350

Figure 5-4 Sight Triangle At An Uncontrolled Or Yield-Controlled Intersection



At all intersections where traffic on the minor road is controlled by STOP signs, the sight distance triangle and distance X shallbe determined from the following table. The vehicle waiting to cross the major street shall be assumed to be thirty (30) feet back of the edge of the major road.

DESIGN SPEED	PAVEMENT WIDTH 2 LANES	4 LANES	6 LANES
30	525	600	650
40	700	775	875
50	850	975	1075
60	1000	1175	1350

Figure 5-5 Sight Triangle For A Two-Way Stop-Controlled Intersection

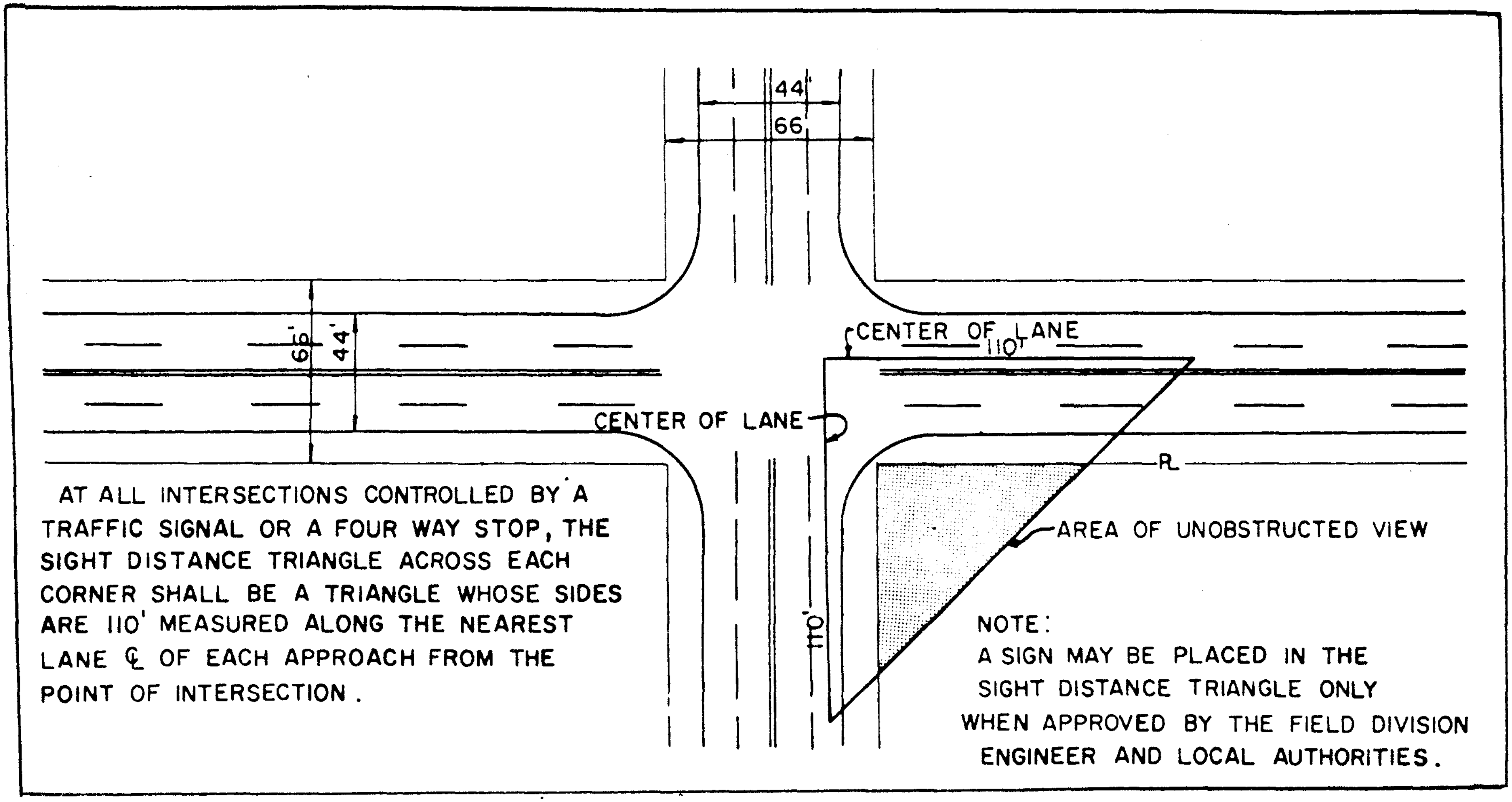


Figure 5-6 Sight Triangle For A Four-Way Stop Or Signal-Controlled Intersection

Traffic Control Device Studies

Traffic control device studies are used to determine the effectiveness of existing traffic control devices. Included under this classification of studies are inventories, signal warrant studies, stop-yield sign studies, and law observance studies. The inventories are conducted to review existing signs, signals, and pavement markings, and evaluate their quality, standardization, and application. The other three studies are conducted to evaluate the application of and/or compliance with the various traffic control devices.

Sight Distance and "Sight Triangle" Studies

Sight distance studies are made to determine if obstructions interfere with the driver's ability to see other traffic or traffice control devices. Common causes of obstruction include:

- vegetation
- buildings
- portable signs
- other vehicles parked near an intersection

School Crossing Studies

The purpose of these studies is to provide optimal safety conditions for school-age pedestrians within the roadway environment in and around school areas. These studies must not only evaluate the relative hazard at the site based on the physical and operational conditions, but must also account for the students' level of understanding of the situation. School crossing pedestrian accidents are relatively rare events. Available pedestrian accident data at such locations are usually non-existent or insufficient for most study purposes. Other forms of data need to be collected to facilitate the assessment of school crossing locations. This data may include pedestrian volumes, pedestrian delay, roadway width, types of traffic control devices, etc.

Bicycle and Pedestrian Studies

Bicycle and pedestrian studies are conducted to evaluate the safety and operational characteristics of bicycle- and pedestrian-related activities. Bicycle studies may include the following items:

- Capacity of bicycle facility
- Bicycle speeds
- Bicycle-related accidents
- Bicycle volumes
- Sight distances
- Use and compliance of traffic control devices

Pedestrian studies may include the following items:

- Pedestrian volumes
- Pedestrian delay times at crossings
- Pedestrian-related conflicts
- Pedestrian use and compliance of traffic control devices
- Behavioral information
- Pedestrian-related accidents

The decision to conduct these studies may develop from accident experience, citizen complaints, or field reviews.

Railroad Crossing Studies

Railroad crossing studies are used to determine the hazardousness of an at-grade crossing situation. This hazardousness can be determined through the collection and analysis of inventory and accident data at each crossing location. The Railroad Crossing Inventory Form, as recommended by the U.S. DOT is shown in Figure 5-7. All signs, pavement markings and signals must conform to the MUTCD. Hazard

OMB-004 R4009

U.S. DOT — AAR CROSSING INVENTORY FORM

A. INITIATING AGENCY
☐ RAILROAD ☐ STATE

B. CROSSING NUMBER

C. REASON FOR UPDATE:
☐ CHANGES IN EXISTING CROSSING DATA
☐ NEW CROSSING
☐ CLOSED CROSSING

D. EFFECTIVE DATE
M D Y

Part I Location and Classification of All Crossings (Must Be Completed)

1. Railroad Operating Company
2. Railroad Division or Region
3. Railroad Subdivision or District
4. State
5. County
6. County Map Ref. No.
7. City
8. Nearest City
9. Highway Type and No.
10. Street or Road Name
11. FR I. D. No.
12. Nearest RR Timetable Station
13. Branch or Line Name
14. Railroad Mile Post

DO NOT WRITE IN THIS SPACE
State County
City Nearest City
RR Code Timetable Station

15. Pedestrian Crossing
☐ 1. at grade
☐ 2. RR under
☐ 3. RR over

16. Private Vehicle Crossing
A. ☐ 1. Farm ☐ 2. Residential ☐ 3. Recreational ☐ 4. Industrial
B. ☐ 5. at grade C. ☐ 8. signs–specify
☐ 6. RR under ☐ 9. signals–specify
☐ 7. RR over ☐ 0. none

17. Public Vehicle Crossing
☐ 1. at grade
☐ 2. RR under
☐ 3 RR over

COMPLETE REMAINDER OF FORM ONLY FOR PUBLIC VEHICLE CROSSINGS AT GRADE

Part II Detailed Information for Public Vehicular at Grade Crossing

1A. Typical Number of Daily Train Movements

Daylight (6 AM to 6 PM)		Night (6 PM to 6 AM)	
thru trains	switching	thru trains	switching
1	2	3	4

1B Check if Less Than One Movement Per Day 5

2. Speed of Train at Crossing
A. Maximum time table speed 1
B Typical Speed Range Over Crossing from 2 to 3 mph

3. Type and Number of Tracks
main 1 other 2 If other specify 3

4. Does Another RR Operate a Separate Track at Crossing?
☐ Yes 1☐ No Specify RR 2

5. Does Another RR Operate Over Your Track at Crossing?
☐ Yes 1☐ No Specify RR 2

6. Type of Warning Device at Crossing
A. Signs

Crossbucks		Standard Highway Stop Sign	Other Stop Signs	Other Signs Specify
reflectorized	non-reflectorized			
01 Number	02 Number	03 Number	04 Number	05 Number 06; 07 Number 08

B. Train Activated Devices

Gates		Cantilevered Flashing Lights		Mast Mounted Flashing Lights	Other Flashing Lights Specify	Highway Traffic Signals	Wigwags	Bells
red & white reflectorized	other colored	over traffic lane	not over traffic lane					
09 Number	10 Number	11 Number	12 Number	13 Number	14 Number 15	16 Number	17 Number	18 Number

C. Specify Special Warning Device not Train Activated 19
D. No Signs or Signals ☐ 20

7. Is Commercial Power Available? ☐ Yes ☐ No
8. Does Crossing Signal Provide Speed Selection for Trains? ☐ Yes ☐ No ☐ N/A
9. Method of Signaling for Train Operation: Is Track Equipped with Signals? ☐ Yes ☐ No

Part III Physical Data

1. Type of Development ☐ 1. Open Sp. ☐ 2. Res ☐ 3. Comm. ☐ 4. Ind. ☐ 5. Inst.
2. Smallest Crossing Angle ☐ 0°-29° ☐ 30°-59° ☐ 60°-90°
3. Number of Traffic Lanes Crossing Railroad Number
4. Are Truck Pullout Lanes Present? ☐ Yes ☐ No
5. Is Highway Paved ☐ Yes ☐ No
6. Pavement Markings ☐ Stoplines ☐ RR Xing Sym. ☐ None
7. Are RR Advance Warning Signs Present? ☐ Yes ☐ No
8. Crossing Surface ☐ 1 Sec. Timber ☐ 2 Full Wd Plank ☐ 3 Asphalt ☐ 4 Concrete Slab ☐ 5 Concrete Pave ☐ 6 Rubber ☐ 7 Metal Sections ☐ 8 Other Metal ☐ 9 Unconsolidated ☐ 0 Other Specify
9. Does Track Run Down A Street? ☐ Yes ☐ No
10. Nearby Intersecting Highway? ☐ Yes ☐ No

Part IV Highway Department Information

1. Highway System
2. Is Crossing on State Highway System? ☐ Yes ☐ No
3. Functional Classification of Road over Crossing
4. Estimate AADT
5. Estimate Percent Trucks

I. D. Number

Figure 5-7 Grade Crossing Facilty Inventory indices are often determined, as part of the analysis, through numerical methods. Recently, several hazard indicies have been developed, tested, and evaluated in a study conducted by the Transportation Systems Center, U.S. DOT.

Railroad crossing studies may be necessitated through accident experience, the occurrence of a recent fatal accident, citizen complaints, or continous monitoring.

Roadway Lighting Studies

Roadway lighting studies are used to assess the adequacy of existing lighting facilities or the need for new, additional, or improved lighting facilities. These studies are necessary where a high nighttime accident rate (percentage) occurs or a possible nighttime accident problem is observed in the field review. Existing lighting conditions are compared to design standards to determine if lighting facilities should be installed or improved. Design standards are set forth in the Roadway Lighting Handbook (U.S. Department of Transportation, Federal Highway Administration, December 1979).

Skid Resistance Studies

Skid resistance studies are conducted to measure the traction properties between the vehicle tires and the pavement surface. These studies are useful in identifying any excessive "slipperiness" of the pavement surface at a site.

The need for performing skid resistance studies is dictated by the occurrence of a pattern of accidents under "wet-weather" or "wet pavement" conditions. Skid tests are conducted based on ASTM (American Society of Testing Materials) standards which develops skid numbers. These measured skid numbers are compared to area-wide averages or standards. Measured values lower than the standard indicate inadequate skid resistance.

General Safety Audit

A pattern of traffic accidents in which "vehicle out of control" or "poor pavement conditions" were noted as causes or contributing circumstances is an indication that a study of the pavement condition should be made.

In any event, a systematic inspection should be made of the street system (at least once a year for arterial streets) to detect existing or developing deficiencies in traffic operations, physical, and environmental conditions. Potential hazards that should be checked include:

- potholes, bumps, and highly irregular pavement surfaces.
- vegetation obstructing visability of traffic control devices.
- missing or damaged signs and markings.
- signs and vegetation within the sight triangle.
- bright or flashing lights which interfere with traffic signal visibility.
- time marks which indicate a repetitive pattern of drivers having difficulty.

Police officers and city maintenance and service crews also should be encouraged to submit a hazard report when they see a condition which they perceive as dangerous.

Evaluating Hazardous Locations

Once a location has been identified as potentially hazardous, the question is: are the larger numbers of accidents, higher rates, or larger severity index due to chance or due to real differences in conditions? The question can be approached by comparing the accident statistic for a given location with its critical value. The critical frequency for the number of accidents is:

$$\text{Critical Frequency} = F_c\ F_a + K\sqrt{\frac{F_a}{m}} - \frac{1}{2m}$$

where: F_c = Critical frequency

F_a = Average frequency for all roadways of same category for state or area

K = Constant whose magnitude determines the level of statistical significance (1.645 for 95 percent confidence)

m = Average exposure of traffic during study

The critical values for accident rate and severity are:

$$\text{Critical Rate} = R_c = R_a + K\sqrt{\frac{R_a}{m}} - \frac{1}{2m}$$

where: R_a = Average rate for all roadways of same category.

$$\text{Critical severity} = S_c = S_a + K\sqrt{\frac{S_a}{m}} - \frac{1}{2m}$$

where: S_z = Average severity for all roadways of same category.

<u>Safety Indices</u>. A comparison is then made of actual statistics with critical statistics to determine if the location is to go on the priority listing. This is accomplished by computing a Safety Index for each of the statistics.

Frequency Index: $FI = \frac{F}{F_c}$

Rate Index: $RI = \frac{R}{R_c}$

Severity Index: $SI = \frac{S}{S_c}$

If none of the three indices is greater than 1.0, this would indicate that the safety problem at the location is not critical and, therefore, it would be dropped from further consideration.

Priority ranking is established by the magnitude of the safety index with larger values having higher priority. It is possible, of course, that a given hazardous location will have a different priority ranking by the different indices.

Hazard Index

In research conducted by Taylor and Thompson*, a Hazardousness Rating formula was developed which incorporates both accident and non-accident measures or predictors. This formula is intended to be a supplement rather than an alternative to accident record systems in the identification and ranking of problem locations.

From an initial list of indicators those listed below were selected for inclusion inthe index. The weighting factors were determined through workshops attended by various highway officials around the country.

Indicator	Final Weight
Number of Accidents	14.5
Accident Rate	19.9
Accident Severity	16.9
Volume/Capacity Ratio	7.3
Sight Distance	6.6
Traffic Conflicts	5.3
Erratic Maneuvers	6.1
Driver Expectancy	13.2
Information System Deficiencies	10.2
	100.0

Using the weighting factors above and applying them to the scaling factors related to the raw data, the Hazardousness Index Formula is used in the following general form:

---

*J. I. Taylor and H. T. Thompson, "Identification of Hazardous Locations" Report No. FHW-RD-76-44.

$$H.I. = \frac{\sum \left[W_i \, (I.V.)_i \right]}{\sum W_i}$$

Where: H.I. is the Hazardous Index for the site under study

W_i is the weighting factor for indicator i.

$(I.V.)_i$ is the Indicator Value for indicator i.

$\sum W_i$ is the sum of the weighting factors for all the indicators used at the site under study.

It is not practical to collect all the indicator data for all spot locations within a particular jurisdiction. Some of the indicators require extensive data collection while others require at least a visit to the site. Therefore, it is not feasible to utilize the Hazardousness Index as a screening process. Rather, its value lies in comparing the relative hazardousness of various sites already under consideration.

EVALUATION OF ALTERNATIVE COUNTERMEASURES

The objective in this step is to determine which of the several alternatives will provide the greatest return for the resources expended. Generally, an evaluation pertains to the consideration of several alternatives at a single location. Care should be exercised, however, in evaluating the total effects of alternatives, particularly where an alternative will result in the re-routing of traffic or some other major change in the operational pattern. Where such major changes may be experienced, the evaluation should consider possible increase in accidents at other locations due to these changes.

Evaluations are based principally on economic analyses and will involve the following six steps:

1. Estimating accident reduction.
2. Assigning values to accident reduction.
3. Estimating secondary benefits.
4. Estimating improvement costs.
5. Analyzing improvment at each location.
6. Assigning program priorities.

It is generally agreed that an analysis identifying annual benefits and annual costs is acceptable for safety improvement evaluations.

The assumptions behind this approach are:

- The relative merit of an improvement is measured by its net annual benefit or benefit/cost ratio.
- All costs can be reduced to an equivalent uniform annual cost.
- All benefits can be reduced to an equivalant uniform annual benefit.
- An improvement will be needed for its entire service life.

Information needed for analyses includes:

- Initial costs
- Annual costs
- Terminal values
- Service life
- Benefits
- Interest rate

Estimating Accident Reduction

The premise for proposing an improvement at a hazardous location is that there will be benefits resulting from accident reduction. The justification for any improvement, and its priority, is based on the ratio of the benefits and the costs of implementing the improvement. Therefore, the prediction of accident reduction becomes very critical in the process of evaluating improvements.

Benefits eventually will be identified in dollar amounts related to reductions in fatalities, personal injuries, and property damage--but initially the yardstick will be reduction in accident rate with consideration of types of accidents and their severities. Required input data for each location will include:

- Historical accident experience--accident rate, types of accidents, and severity.
- Estimated future ADT--the growth or decline of traffic volumes.
- Expected reduction in accident rate--by type of accident or by severity.

Accident reduction forecast tables in NCHRP 162 provide reasonable indicators (based on limited experience data) of potential accident reduction following implementation of particular improvements. The organization of tables identifies several possible combinations of conditions:

- Type of location (sections, curves, intersections, etc.)
- Type of improvement
- Urban and rural
- Two lanes or more than two lanes

Expected accident reduction for any future year is calculated as:

$$\text{Accidents Saved} = N \left[P \, \frac{\text{ADT - future year}}{\text{ADT - record period}} \right]$$

Where: N = the number of accidents in the period before the improvement project.

P = the percent reduction selected from the table (expressed as a decimal).

Two methods commonly are used for assigning economic values to accident reductions are:

1. Cost by severity class, or

2. Cost by type of accident.

Motorists pay for accidents in one or more of the following ways:

- Direct settlement paid to other persons
- Payment as a result of judicial proceedings
- Medical and property damage repair costs
- Automobile insurance premiums

The most reliable data on accident costs would be those which have been collected locally. Information from the Motor Vehicle Administration, local insurance companies, fleet operators, and the Public Health Service, will be more suitable than nationwide statistics. Two of the more commonly used nationwide studies are summarized below:

Severity Class	Cost Per Accident	
	NHTSA	NSC
Fatal	$287,000	$150,000
Non-Fatal Injury (Average)	3,200	5,800
Property Damage Only	520	850

While NHTSA did not attempt to place a value on human life, it did include calculable costs associated with the loss of human life--wages lost, medical expenses, legal fees, insurance payments, home and family care, and property damage. About eight percent of total costs were assigned to "pain and suffering."

Accident cost data from the sources above reflect certain philosophies as to what cost elements are included. Basic cost data adopted by any agency must reflect concepts and judgments acceptable to that agency. Top management should be involved in these decisions.

Methods of assessing accident costs for cost-effective studies have been developed in a report (6) prepared by TTI for the FHWA. Recommendations of this report include:

1. Cost per fatality - $300,700 in 1978 dollars.
2. Average accident costs should be calculated for different situations, classified according to area (rural, urban), type of roadway, design feature, and accident location with respect to roadway.
3. Accident costs should be updated to include the effects of inflation.

Benefits Calculated From Reduced Accident Severity

When calculating accident reduction benefits on the basis of severity of accidents, the following steps are followed:

1. Select or develop average cost data for each of several classes of severity--i.e., fatalities, one or more classes of injuries, and property-damage-only accidents.
2. Compute the expected accident reduction (numbers of accidents) by each severity class, for each year of the service life of the improvement.
3. Multiply the average costs for each severity class by accident reduction numbers for each year.
4. Compute the total of all calsses for each year and calculate the total annual benefits.

Benefits Calculated Type of Accident

When benefits are computed on the basis of the types of accidents, the procedures are:

1. Select or develop average cost data by accident severity classes.
2. Establish categories of types of accidents (head-on, side swipe, left turn, etc.) and determine the frequency of each severity class for each accident type.

3. Compute the average cost for each accident type:

$$\text{Average accident cost} = \frac{(Ff)(Cf) + (Fi)(Ci) + (Fp)(Cp)}{Ff + Fi + Fp}$$

Where: Ff = Number of fatal accidents for this accident type

Fi = Number of injury accidents for this accident type

Fp = Number of property damage accidents for this accident type

Cf = Average cost per fatal accident

Ci = Average cost per injury accident

Cp = Average cost per property damage accident

4. Multiply the average accident cost for each accident type by the reduction of each accident type and sum all types to obtain a total dollar value for each year.

Either of the above techniques is acceptable. Cost by type of accident reduces the influence of the rare event, a fatal accident, yet reflects its importance through the types of collision. If it is difficult to obtain data relating accident severity to types of accidents, costing by severity class may be more practical.

Secondary Benefits

The primary benefit to be expected from the implementation of an accident reduction improvement is a decrease in accident rate or severity, and the benefit analysis should focus on these factors. However, the possibility should not be overlooked that a safety improvement also may affect other road user and non-road user benefits. For example, a signal installation may reduce certain types of accidents while simultaneously increasing motorist delay; signal progression may reduce rear end collisions and lower auto emission levels; and street lighting has been shown to have a beneficial effect on both nighttime accidents and street crime.

Examples of secondary benefits might include:

- Reduced traffic congestion--which will not only decrease idling time and cost for vehicles but also reduce motorist delay.
- Improved roadway and roadside geometrics--which can minimize wear to vehicle components and also reduce fuel consumption.
- Higher speed of operation from realignment of a series of sharp horizontal curves.
- Smoother operation from implementation of a one-way street system with signal progression.
- Reduction in the need for vehicular "slow-downs" by improving the sight distance on the approach to a yield-controlled intersection.
- Reduction of the time and mileage for lost motorists by improving guide signing at an interchange.
- Elimination of motorist delay by prohibiting left-turns at selected locations.
- Reduction in street crime brought about by improved roadway lighting.
- More effective use of enforcement and other protective service personnel brought about by fewer accident-related duties.

Often these benefits will be negligible compared to the accident reduction benefits. But under some circumstances, the secondary benefits will be significan and should be included in the analyses.

<u>Safety Improvement Costs</u>

There are three basic parts of improvement costs:

- Initial costs--the investment prior to and during construction.
- Annual costs--the annual expense required to keep the improvements operating.
- Terminal value--the amount recoverable at the end of the service life.

The manner of estimating initial costs will vary with the complexity of the improvement. Routine installation of signals, signs and similar standard installations can be based on average costs from experience. More extensive improvements will require preliminary design and estimating of quantities as bases for cost estimates.

Many improvements require an annual expenditure for maintenance and operation. For example, a traffic signal will have annual costs for electrical power and equipment maintenance. Annual cost figures can be obtained by analyzing operating cost data. For some improvements, the annual cost will be zero or so small that it can be ignored in the economic analysis.

The terminal value is the difference between the monetary value at the end of the period of service and the future cost of removal, repair, transfer, and/or sale. For a safety improvement, it may include signing that is useable at another location or salvageable guardrail. If a proposed improvement will have terminal value, it should be included in the analysis. However, most improvements have very little terminal value.

Estimated Service Life

The service life is the period of time that the improvement can reasonably be expected to affect accident rates. Twenty years usually is the maximum time for major geometric changes of roadways or bridges. Examples of estimated life used in California are:

Improvement	Service Life
Signals	15 years
Safety Lighting	15 years
Median Barriers	15 years
Flashing beacons	10 years
Guardrail	10 years
Pavement Grooving	10 years
Signing (major)	10 years
Signing (minor)	5 years
Raised Pavement Markers	5 years
Guide Markers	5 years
Painted Stripes	2 years

Both the costs and benefits of improvements should be calculated for the period of time designated as expected service life. The analysis period should not extend beyond the period of reliable forecast. Thus, the estimated service life should reflect the length of time that estimated accident reduction reasonably can be expected instead of the physical life of the improvement. For example, given a strong possibility of an intervening solution, such as improved vehicle design, traffic diversion or highway resconstruction, the service lives of the alternatives should be adjusted to reflect the shorter planning horizon.

EQUIVALENT UNIFORM ANNUAL BENEFITS AND COSTS

In order to conduct meaningful economic analyses, there is need to convert the computed benefits and costs to equivalent uniform annual values--with appropriate consideration of interest rates and the cost of capital investment.

Equivalent Uniform Annual Benefits From Improvements (EUAB)

When estimated benefits from accident reductions are expected to be reasonably uniform through each year of the lifespan of the improvement, the calculated annual benefit value may be used directly as the "equivalent uniform annual benefit."

Accident reduction usually will be related to projected traffic volumes--and if a significant increase in traffic is expected, the benefits will increase proportionally during the period. Simple averaging of the annual benefits will not give a proper basis for economic evaluation. It is necessary to establish an equivalent uniform annual benefit (EUAB) with consideration of the interest rate. The following formula should be used:

$$EUAB = CR_n^i \sum (\text{each year's benefit})(\text{each year's } PW_n^i)$$

Where: Cr_n^i = Capital Recovery Factor for n years (service life of improvement) at interest rate i

PW^i_n = Present Worth Factor for each year at interest rate i

$\sum$ = Summation of all years of service life

The factors for capital recovery and present worth may be found in conventional interest tables.

The interest rate (time-value-of-money) selected for use in an analysis of improvements should not be less than that at which money can be obtained on the municipal bond market. A logical upper limit is the cost of long-term borrowing in the private sector as evidenced by home mortgage rates.

Selecting Alternatives

When dealing with mutually exclusive alternatives--different countermeasures for an individual hazardous location--the various alternatives can be ranked in order of their cost/effectiveness or benefit/cost ratio. That countermeasure or group of countermeasures which has the lowest ratio of benefits to cost would be selected.

All alternatives having a benefit-to-cost ratio of less than 100 would be rejected. Even though a location had been identified as hazardous, all of the alternative countermeasures might turn out to be less than 1.0. In such a case, all the alternatives would be rejected and the funds would be used at other locations.

When using the cost/effectiveness ratio method, the alternative having the lowest cost to the safety benefits anticipated would be chosen. The implied condition is that the hazard is to be mitigated, the only question is how to achieve the greatest results for the fewest dollars.

The more complex problem is one of choosing between different location alternatives and establishing priorities for the list of alternatives. The list may be very long and require a number of years to accomplish with a limited amount of funds available in any one budget year. Some rational approach is required to determine a priority ranking.

Establishing Priorities

Various indices such as number of accidents, accident rate, or Hazard Index continue to be used to establish priorities. The logic of using such statistics is essentially: all hazardous situations will be corrected and the worst will be done first.

The percent reduction in the index can be used as a priority measure. This may, however, result in locations having, for example, a large number of accidents and a large potential for accident reduction--a lower priority than a location with considerably fewer accidents where a small decrease in number of accidents will be a very large percentage change. This characteristic is evident from the equations for:

Number of Accidents:

$$\% \text{ reduction} = \frac{\text{estimated reduction in \# of accidents}}{\text{\# accidents occurring}} \times 100$$

Accident Rate:

$$\% \text{ reduction} = \frac{\text{estimated reduction in accident rate}}{\text{present accident rate}} \times 100$$

Hazard Index (HI):

$$\% \text{ reduction} = \frac{\text{present HI - estimated HI}}{\text{present HI}} \times 100$$

The percentage does no consider the cost of the improvement. It may well be that the cost of a reduction of modest magnitude, but big percentage, may be as much or more than that of a much larger reduction, but smaller percentage, at some other locations. All in all, the percentage reduction is a poor method of establishing priority of safety improvements.

Cost/Effectiveness

The ratio of cost-to-effectiveness considers the cost of the safety improvement relative to the estimated safety benefits. Priority is established by comparing the ratios, using the same measure of effectiveness (i.e. number of accidents, accident rate, Hazard Index, etc.) for the several locations under consideration. The lower the cost per unit of effectiveness, the higher the priority. The problem is that different priority listings can benefit if two or more measures of effectiveness are used.

Because the cost/effectiveness ratio does not necessitate the conversion of all expected benefits to dollar values, it is less complex than methods which do. This also avoids the potential controversy of placing a dollar value on a life.

Engineering Economic Analysis

There are numerous textbooks which cover the various methods of engineering economic analysis and their application to selection of alternatives with and without budget constraints:

Net Uniform Annual Equivalent Amount

Net Present Worth

Net Future Worth

Rate-of-Return

Benefit/Cost Ratio = should be 1 or ...

Net present worth and net future worth require that the analysis period be the same for all alternatives under consideration. Consequently, these two methods are not convenient to most safety improvement alternatives. The rate-of-return method is often avoided because the calculations take considerably longer than other methods. However, computer program are available which eliminate computational drudgery.

Benefit/Cost Ratio

The benefit/cost ratio is frequently used in civil engineering practice - probably because federal legislation mandates that a specific formation of the benefit/cost ratio be used for U.S. Army Corps of Engineers projects. Application requires that all benefits and costs be in dollar amounts or converted to dollar amounts. The general practice is to use uniform annual equivalent amounts.

Priority is determined by the magnitude of the B/C ratio - the largest ratio is first priority, the second highest is second priority, and so on. However, with a budget constraint, selecting those with the highest B/C ratios will not necessarily maximize benefits.

Maximizing Net Benefits

A more economically sound procedure is to use the net worth as the measure of priority. The larger the net worth, the higher the priority. This will result in the same order of selection as if the rate-of-return method were used. An example of the difference in projects is shown in Table 5-3.

TABLE 5-3

Example of Selecting Priority

Projects Subject To A Budget Constraint

Project	Project Cost	Uniform Annual Equivalent Amounts		B/C Ratio	Priority by B/C	Net Annual Worth	Priority by NAW
		Benefits	Costs				
A	$ 30,000	$ 99,000	$ 9,000	11	1	90	2
B	20,000	48,000	6,000	8	2	42	3
C	100,000	140,000	20,000	7	3	120	1
D	20,000	48,000	8,000	6	4	40	4
E	50,000	40,000	10,000	4	5	30	5
F	40,000	20,000	10,000	2	6	10	6
G	30,000	10,000	10,000	1	7	0	7
H	70,000	20,000	20,000	1	8	0	8

Projects Selected With $200,000 Budget Constraint

Method	Projects	Total Project Costs	Total Annual Benefits
B/C Ratio	A,B,C,D,G	$200,000	$297,000
Net Annual Worth	A,B,C,E	$200,000	$327,000

The Texas Safety Improvement Index

The Texas Safety Improvement Index (SII) is a benefit-cost ratio calculated in a consistent manner for use in programming safety funds among candidate projects in the State of Texas. Familiarity with the SII is essential for personnel involved in planning and designing safety projects which may be proposed for state funding.

In order to calculate the SII the following variables need to be understood and used:

- R - Accident reduction factor for candidate project (see Table 5-4).
- F - Number of fatalities during the pre-project analysis period.
- I - Number of injuries during the pre-project analysis period.
- P - Number of PDO accidents during the pre-project analysis period.
- Y - Number of years in the pre-project analysis period.
- M - Additional maintenance costs associated with project.
- S - Annual savings associated with project.
- Q - Annual increase or decrease in savings.
- L - Service life of project.
- A_a - Average daily traffic after project is completed.
- A_b - Average daily traffic before traffic project is initiated.
- B - Total discounted benefits.
- i - Interest rate.
- C - Initial cost of project.

A discussion of some of these variables is warranted to explain how they should be used in calculating the SII. Accident reduction factors (R) are difficult to estimate and difficult to use properly. They represent average values measured as a part of evaluations of completed projects. There are a number of efforts underway to obtain better estimates at state and federal levels alike. Considerable judgment is necessary to apply accident reduction factors properly. For example, the accident reduction factor in Table 5-4 for constructing a pedestrian overpass is 95 percent. It should be apparent to all users that it is not expected that a pedestrian overpass will reduce total accidents by 95 percent. Rather, this is the reduction which could be expected in pedestrian accidents.

A project is likely to affect maintenance costs. Often a project will cause maintenance costs to increase; occasionally a project will result in a decrease in needed maintenance. It should be observed that if the change in maintenance costs (M) is positive and is more than the value of accident savings, the SII will be negative. While this may seem odd at first, it is quite consistent with the normal interpretation of benefit-cost ratios in general and the SII in particular, to wit: only positive values greater than one represent cost-effective projects.

The annual savings in accidents (S) is a base value representative of the first year after project completion. For each later year during the life of the project, S is modified to account for anticipated changes in exposure (traffic volume). This modification is accomplished through the use of the Q-value, the annual increase or decrease in savings. If current or projected traffic volumes are not known, and A_a and A_b are both evaluated as 1, Q will be zero. A zero value for Q will also result if projected traffic volumes do not change from current traffic volumes.

The calculation of the SII involves four equations described in the following paragraphs.

EQUATION 1 - Annual Savings

$$S = \frac{R(140{,}000\ F + 5{,}300\ I + 760\ P)}{Y} - M$$

Annual savings are calculated based on historical accident experience which is annualized by dividing by the number of years (Y) of data and multiplied by an accident reduction factor (R) to account for the influence of the project in the future. Before a value is given to annual savings, changes in annual maintenance costs (M) are deducted.

EQUATION 2 - Annual Increase or Decrease in Savings

$$Q = \left(\frac{A_a - A_b}{A_b} \div L \right) S$$

This equation evaluates the expected incremental annual change in savings by accounting for anticipated increases or decreases in traffic volume.

EQUATION 3 - Total Discounted Benefits

$$B = \frac{S + \frac{1}{2} Q}{(1 + i)} + \sum_{j=2}^{L} \frac{(S + \frac{1}{2} Q) + (j - 1) Q}{(1 + i)^j}$$

The first term of this equation evaluates benefits for the first year following project completion.

The second term repeats the same calculation for each succeeding year by increasing Q for each of the succeeding years and also accounting for the time-value of money. The solution of this equation is shown in the example included at the end of this section.

EQUATION 4 - SII

$$SII = \frac{B}{C}$$

The SII is shown here as a simple ratio of benefits to costs. As has already been discussed, the interpretation of the SII is based on the fundamental principle that only projects with SII values greater than one are considered cost-effective.

In actual practice the SDHPT produces a listing of projects ranked in descending order of SII in order to produce the annual Statewide Highway Safety Improvement Program. An exerpt from the 1983 program is included in Figure 5-8.

EXAMPLE PROBLEM

A location has the following accident history for a two-year period:

Fatalities	-	5
Injuries	-	20
PDO's	-	100

A countermeasure is proposed which is expected to reduce accidents by 25 percent (R = 0.20). Maintenance costs will increase because of the project by $500 per year.

(Equation 1) $$S = \frac{0.25\ [140{,}000(5) + 5{,}300(2) + 760(100)]}{2} - 500$$

$$S = \$109{,}750$$

The service life (L) of the proposed project is five years and during that time traffic volumes are expected to rise from 15,000 to 30,000 ADT.

(Equation 2) $$Q = (\frac{30{,}000 - 15{,}000}{15{,}000} \quad 5)\ 109{,}750$$

$$Q = \$21{,}950$$

Using an interest rate (i) of eight percent we can now calculate the total discounted benefits.

(Equation 3)

(first year) $$B_1 = \frac{109{,}750}{1.08} = 101{,}620$$

$$\text{(second year)} \quad B_2 = \frac{109{,}750 + 21{,}950(1)}{1.08^2} = 112{,}912$$

$$\text{(third year)} \quad B_3 = \frac{109{,}750 + 21{,}950(2)}{1.08^3} = 121{,}972$$

$$\text{(fourth year)} \quad B_4 = \frac{109{,}750 + 21{,}950(3)}{1.08^4} = 129{,}071$$

$$\text{(fifth year)} \quad B_5 = \frac{109{,}750 + 21{,}950(4)}{1.08^5} = 134{,}449$$

$$B = B_1 + B_2 + B_3 + B_4 + B_5 = \$600{,}024$$

The countermeasure will cost $400,000 to implement. The SII is a comparison of the present worth of the benefits (B) to the project cost.

$$\text{(Equation 4)} \quad SII = \frac{600{,}024}{400{,}000} = 1.5$$

WORK CODE	R.F.	TYPE OF WORK CODES
1	32%	Eliminate Parking
2	25%	Install/Imprv Edge Marking
3	20%	Install/Imprv Pavement Mark
11	25%	Reflectorized Traf Buttons
30	20%	Pavement Marking (School Zones)
90	65%	Centerline Striping
49	60%	Const. Pedestrian Walkway
16	42%	Grooving To Prev Hydroplaning
6	21%	Resurfacing (Wet Acc. 42%)
9	28%	Widen Travelway
13	40%	Construct New Frontage Roads
42	88%	Reconstruct Curve (for Super - 65%)
15	40%	Imprv Horizontal and/or Vertical Align
17	15%	Modern of Travelway to Des Std
21	21%	Asphalt Seal Coat (Wet Acc. 42%)
23	30%	Entrance Ramp Modification
24	20%	Exit Ramp Modification
69	25%	Add Turning Lane
80	40%	Reconstruct Intersection
81	40%	Construct Turn-Arounds
82		Increase Turning Radius
95	10%	Add Acceleration/Deceleration Lanes
96	20%	Emergency Truck Dec Beds (Truck Acc. 60%)
31	21%	ACP Overlay
40	25%	Install Delineators
41	35%	Install/Imprv Warning Signs
10	90%	Live Stock Fencing
29	27%	Surveillance and Control System
4	36%	Install Median Barrier
5	8%	Install Painted/Raised Median
7	28%	Shoulder Stabilization
8	15%	Widen Shoulder
12	46%	Flatten Side Slope
18	42%	Div Hwy - Imprv Med and/or Shlders

WORK CODE	R.F.	TYPE OF WORK CODES
50	50%	Br Underpass - Install Delin
51	50%	Safety Lighting - Bridge
52	10%	Safety Lighting - Bridge U/P
53	50%	Install Guardrail - Bridge End
54	44%	Widen Existing Bridge
55	62%	Replace Narrow Bridge
56	40%	Widen Small Structures
58	5%	Modernize Br Rail to Des Std
60	95%	Construct Pedestrian Cross-Over
78	55%	Grade Separation
79	55%	Construct Interchange
22	50%	Install Prot. at Twin Br Med Open
27	25%	Safety Treat Sign Supports
28	25%	Safety Treat Luminaire Supports
32	30%	Safety Treat Conc Headwalls
33	20%	Remove Curb and/or Riprap
34	25%	Safety Treat Sign Supports
35	85/99%	Remove/Relocate Fix Objects
44	30%	Install Protective Guardrail
57	80%	Install Impact Attenuation System
19	5%	Improve Guardrail to Des Stds
20	30%	Modernize Drainage to Des Stds
14	25%	Safety Lighting (Night Acc. Only)
75	75%	Safety Ltg at Intersect (New)
76	50%	Safety Ltg at Intersect (Imprv)
65	20%	Install/Imprv Warning Signal
66	13%	Add Pedestrian Signal
67	12%	Improve or Modernize Signals
70	21%	Add Turn Lane and Signal
71	15%	Add Turn Signal (No Lane)
72	18%	Install New Traffic Signal
64	20%	Install/Imprv Stop Signs
74	27%	Rumble Strips
77	30%	Channelization

STATEWIDE HIGHWAY SAFETY IMPROVEMENT PROGRAM

PRIORITY REPORT

PRIOR #	SAFETY INDEX	UNIQUE #	DIST COUNTY #	ROUTE (PRI) CTRL SECT	ROUTE (SEC) CTRL SECT	B MP	E MP	L(MI)	ROAD TP	SKID	LOCATION	RD CLASS	FUNC CLASS	FATL	INJ	PDO	YRS	PROPOSED IMPRVMNTS	ADT	EST IMPRVMNT COST
1	93.47	30346	16 LIVE OAK 149	U S HWY 0059 0000 00		0	0	43.5	2LN NDV		US 59 IN LIVE OAK CO (2 SECTIONS)	RURAL	PRIN ARTL	9	20	5	3	(1) REFLECTORIZED TRAFFIC BUTTONS (2) (3)	1,000	$11,500
2	70.52	30343	16 BEE 13	U S HWY 0059 0008-02		0	17.3	17.3	2LN NDV		US 59 W OF GOLIAD IN GOLIAD CO	RURAL	PRIN ARTL	3	8	10	3	(1) REFLECTORIZED TRAFFIC BUTTONS (2) (3)	2,000	$4,600
3	67.78	30373	9 MC LENNAN 161	STATE LP 0491 0014-09	0014-10	14.6	19.4	3.2	GLN DIV		ON LOOP 491 AND SH 6 FROM S CL OF BELLMEAD TO BRAZOS R IN WACO	URBAN	PRIN ARTL	3	22	30	3	(1) SAFETY TREAT LUMINAIRE SUPPORTS (2)SAFETY LIGHTING (NIGHT ACC ONLY) (3)	9,000	$19,000
4	64.30	30338	16 NUECES 178	FARM MKT 2444 2343-01	CTY STRT	24.1	24.1	0	2LN NDV		FM 2444 W YORKTOWN RD	RURAL	MIN ARTL	0	19	1	3	(1) INSTALL/IMPRV WARNING SIGNALS (2)SAFETY LTG AT INTERSECT (NEW) (3)	2,000	$6,000
5	59.46	30340	16 JIM WELLS 126	FARM MKT 0665 0086-19		0	9.6	9.6	2LN NDV		FM 665 IN JIM WELLS CO	RURAL	MIN ARTL	2	6	7	3	(1) REFLECTORIZED TRAFFIC BUTTONS (2) (3)	3,000	$2,500
6	50.69	30318	6 PECOS 186	U S HWY 0285 0139-07	FARM MKT 1776 2262-03	13.7	13.8	0.1	2LN NDV		ON US 285 AT FM 1776	RURAL	MIN ARTL	4	16	2	3	(1) INSTALL/IMPRV WARNING SIGNALS (2) (3)	1,000	$10,000

Figure 5-8

EVALUATION OF IMPLEMENTED IMPROVEMENTS

One of the principal weaknesses of past experience with traffic safety programs has been lack of adequate follow-up and evaluation of the actual results of implemented improvements.

The traffic safety engineer is constantly faced with crucial decisions involving selection and implementation of safety countermeasures. To facilitate decisions regarding the continuation, addition, or deletion of various types of highway safety programs, it is critical that valid evaluations of completed safety projects to conducted. Quantitative answers to whether or not the project is accomplishing its intended purpose, how efficiently the purposes are being accomplished and whether the project is producing unexpected or contrary results are all critical to the decision making process. Project evaluation may be warranted for other reasons. These include the evaluation policy of the implementing agency, requirements of federal or state funding agencies, or special requests from policy makers of a community. Without evaluation of individual projects, the effectiveness of safety programs cannot be determined. If this determination is not made, limited safety funds may not be allocated to those programs which are most effective in saving lives and reducing injuries and property damage.

For many agencies, it may not be feasible to evaluate all traffic safety projects due to manpower and fiscal constraints. In such instances, the selection of specific types of projects which warrant evaluation may prove to be an effective way of obtaining maximum evaluation results for the available dollars.

Basis For Comparison

The purpose for implementing a safety improvement is to effect a significant accident reduction. There are three possible results that may occur: an increase in accidents, a decrease, or no significant change. Four analytical frameworks or experimental plans are recommended in the FHWA Procedural Guide, "Evaluation of Highway Safety Projects" to measure the impact of a traffic safety project. The four experimental plans are:

- Before and after study with control sites.
- Before and after study.
- Comparative parallel study.
- Before, during, and after study.

Figure 5-9 illustrates the information required for each of the evaluation plans. The manner in which the data might be displayed for each is given in Figure 5-10.

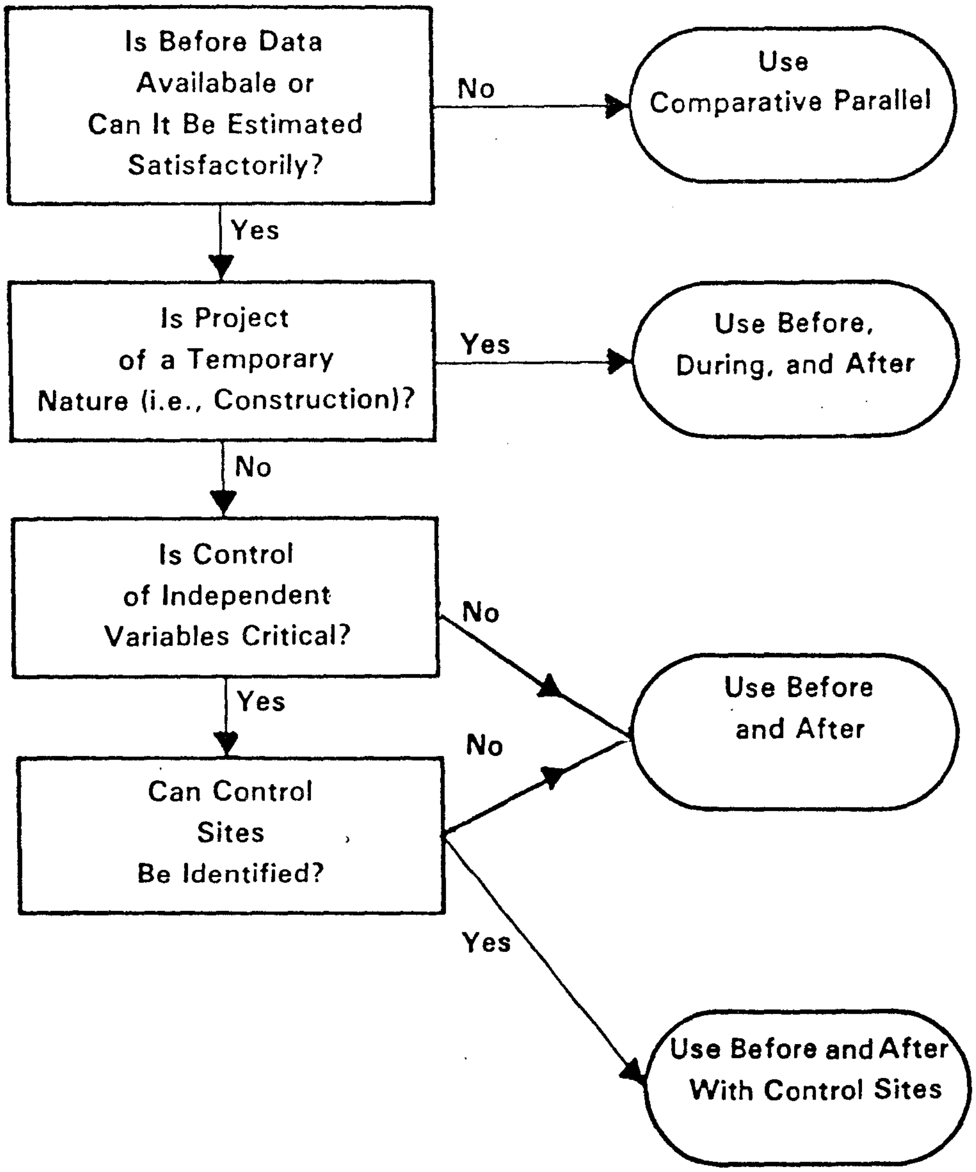
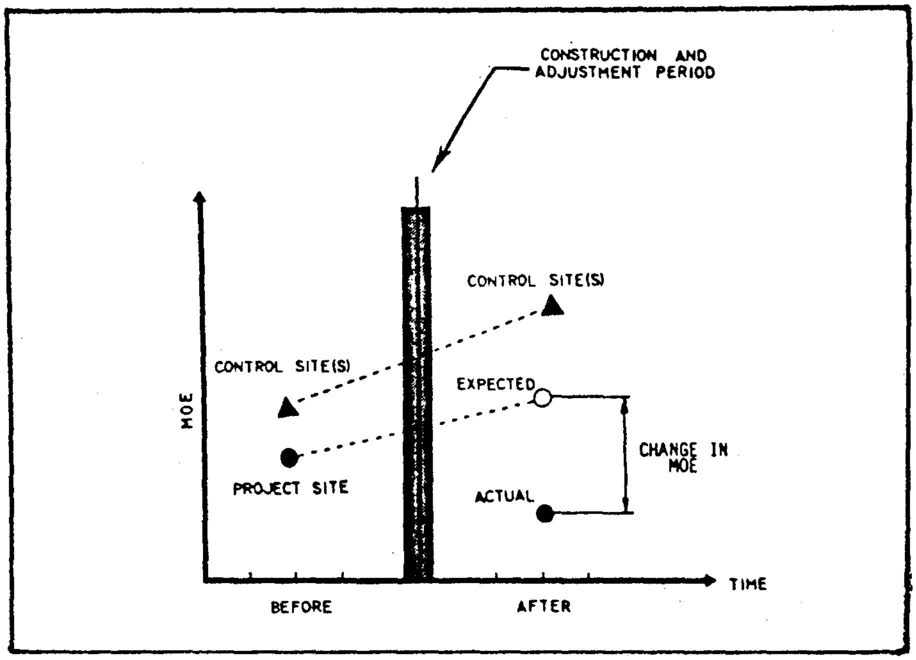
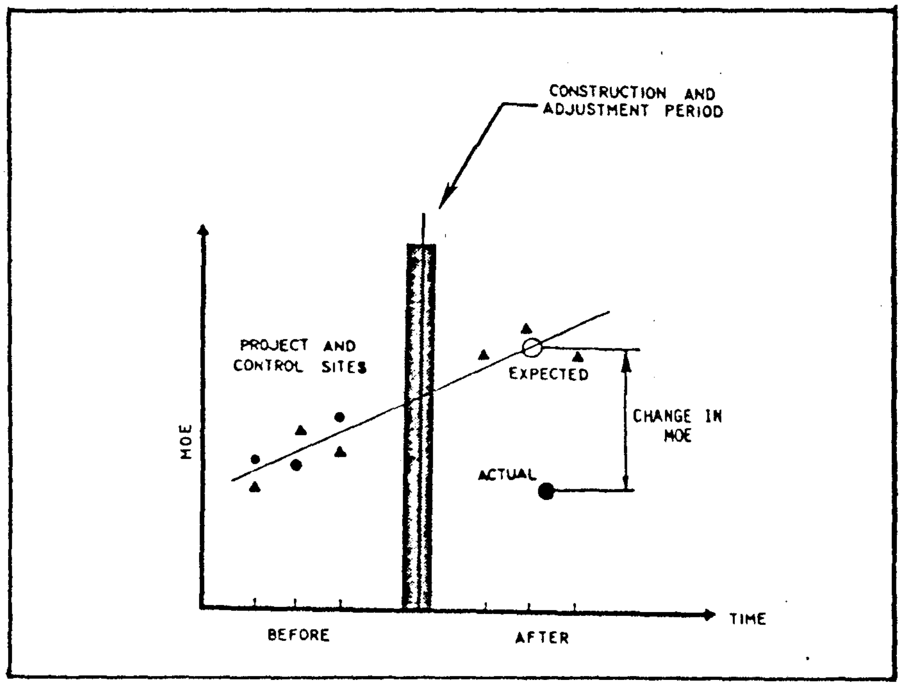


Figure 5-9 Selection of Evaluation Plan



Before and after study with control sites



Before and after study with control sites
(trend analysis)

Figure 5-10 Schematic Examples of Data Presentation for Safety Evaluation

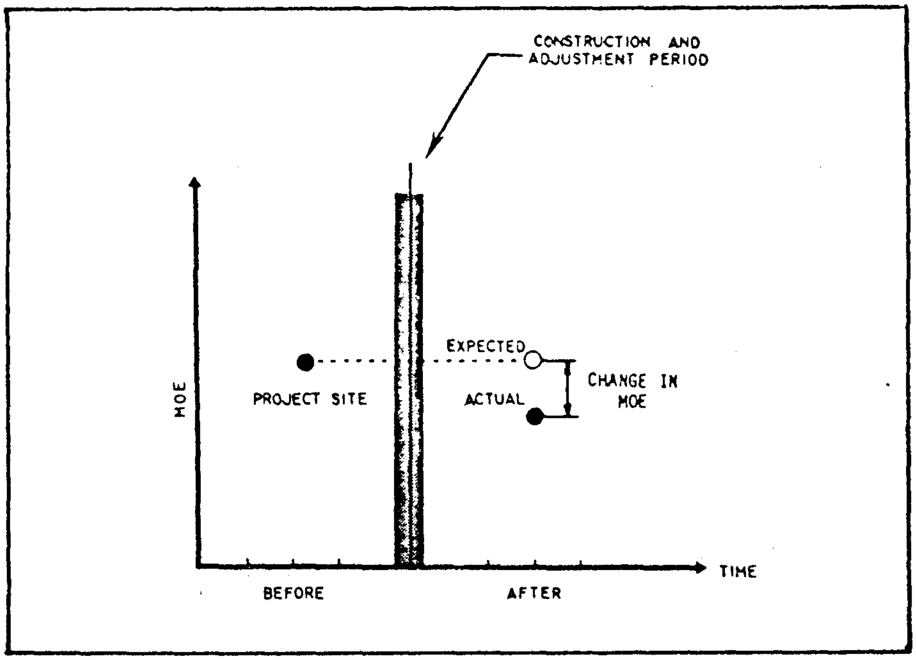
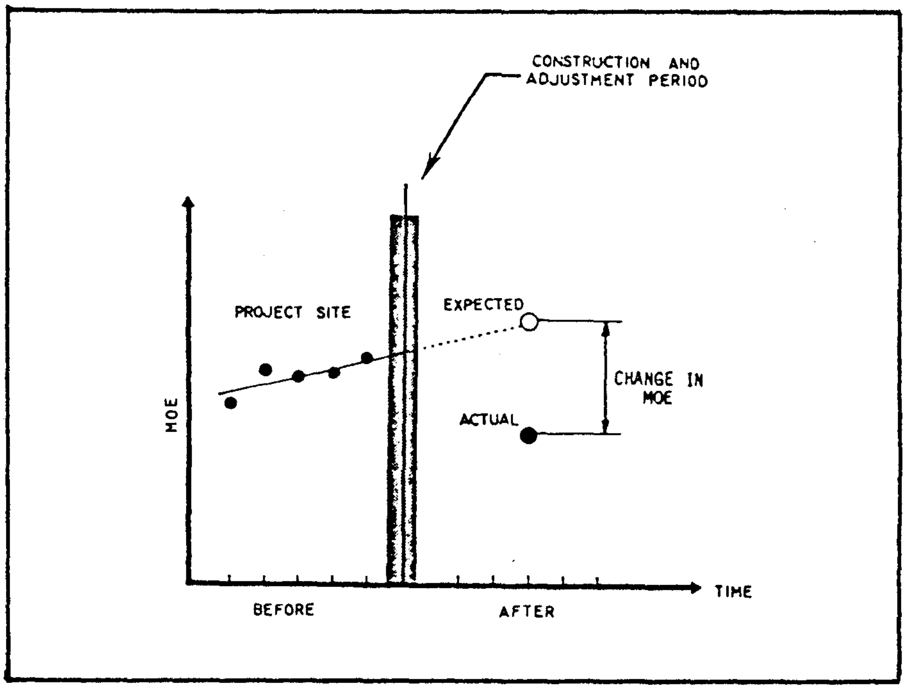
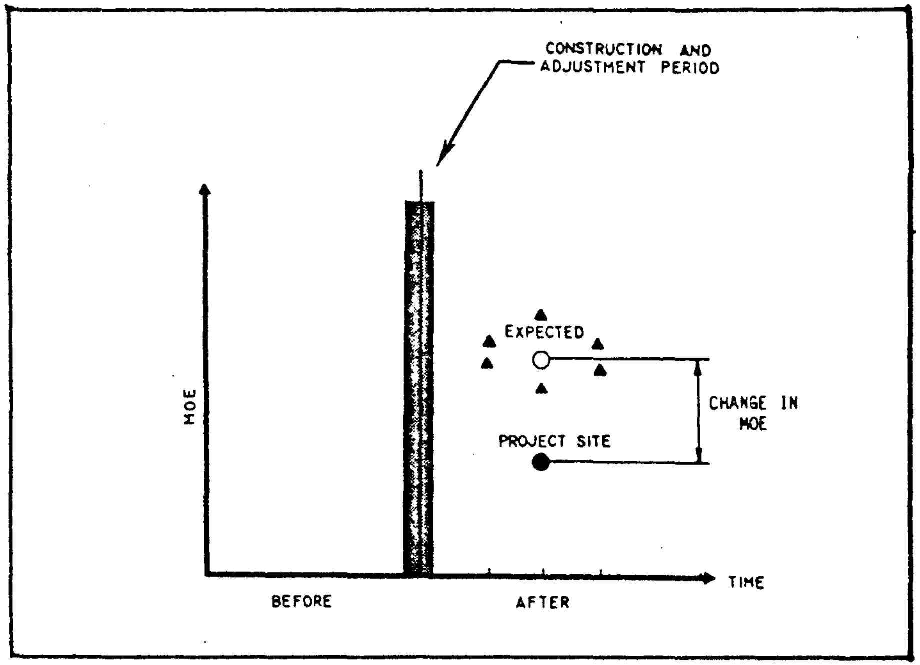


Figure 31. Before and after study

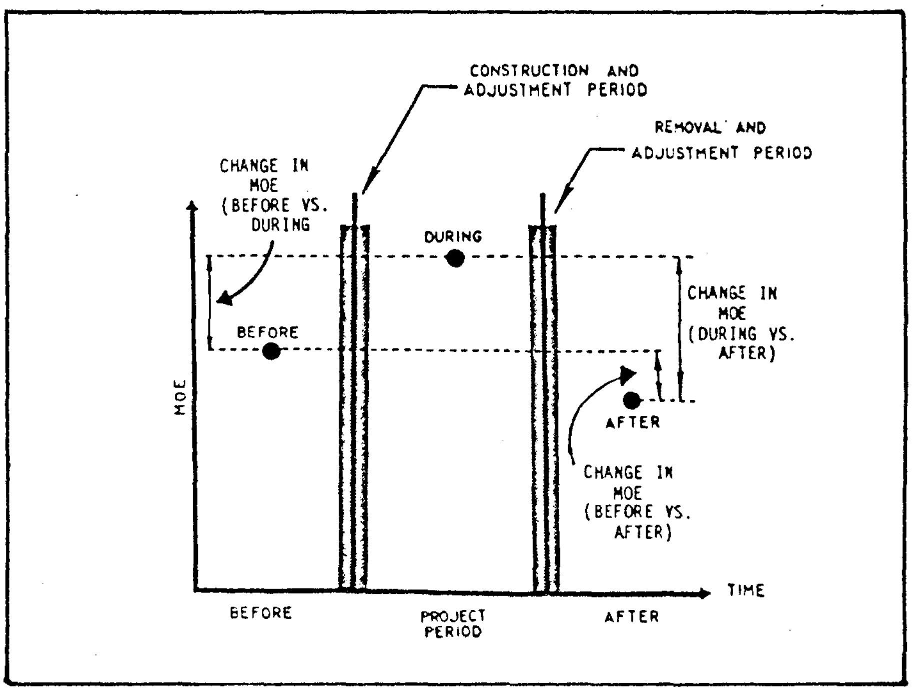


Before and after study (trend analysis)

Figure 5-10 Continued



Comparative parallel study



Before, during and after study

Figure 5-10 Continued

The Before and After Study With Control Sites. This plan is considered the most desirable for highway safety project evaluation. It compares the percent change in the selected Measures of Effectives (MOE) at the project site (test site) with the percent change in the MOE at similar site(s) without the improvement (control sites) for the same time period. An assumption is made that the test site, in the absence of the improvement, will exhibit behavior similar to the control sites. Any difference in the accident experience between the project and control sites is attributable to the highway improvement. The selection of control sites is the most difficult aspect of this plan.

The Before and After Study. This plan is commonly used in the evaluation of highway safety projects if control sites are not available or if the control of specific independent variables is not critical. This approach is based on data collected at two points in time; before and after project implementation. There are two basic assumptions involved in this plan: 1) without the introduction of the highway safety improvement, the MOE value will continue at the same level, and 2) the MOE value measured after project implementation is attributable to the improvement. If either or both assumptions are erroneous, the plan will lead to inaccurate conclusions.

Comparative Parallel Study. This plan is similar to the Before and After Study with control sites with the exception that no data is available prior to project implementation. The assumption made in this plan is that the test site and the control site (or average of the control sites) will exhibit similar behavior in the absence of the improvment. The control sites should exhibit similar deficiencies to those at the project site prior to improvement. The observed difference in the MOE at the project site when compared to the average MOE for the control sites is attributed to the improvement.

Before, During, and After Study. This is similar to the Before and After Study with the modification that measurements are taken at three points in time. This is most applicable for temporary projects (i.e., temporary signing for construction zone traffic control) which will be discontinued or removed after a period of time. Comparisons are made to determine the effectiveness of the temporary project and the residual effect of the project on the site after work is completed.

Evaluation Procedures

Evaluation of implemented highway safety improvements requires the application of a logical procedure to assess effectiveness. FHWA has developed a detailed procedure consisting of six functional tasks that allow the evaluator to conduct a proper evaluation. The six functional tasks which comprise the evaluation procedure are:

- Develop evaluation plan;
- Collect and reduce data;
- Compare measures of effectiveness (MOE's);
- Perform tests of significance;
- Perform economic analysis; and
- Prepare evaluation documentation.

Develop Evaluation Plan. The plan serves as the guide for accomplishment of the evaluation and analysis. Steps or subtasks involved include review of the implemented improvements, selection of projects or groups of projects to evaluate, selection of MOE and the experimental plan, determination of data needs, and collection requirements.

Collect and Reduce Data. This task provides the before, during, and after data necessary for the analysis. Basic data needed are traffic volumes, accident data, and changes in the physical environment that may affect accident experience and records - illumination, skid resistance, etc. Reduction is accomplished using the same techniques and methods that are utilized for identification of hazardous locations.

Compare Measures of Effectiveness. This evaluation task compares the changes in the before and after accident performance for each MOE selected in the Evaluation Plan. Changes are usually expressed in both percentages of actual change and expected change as a result of the improvement.

Before and after comparisons normally will be made in terms of accident rates-accidents per million vehicles or per million vehicle miles. The basis for measurement will be percent reduction of accident rate. Comparisons also may be made in terms of numbers of accidents, but adjustments must be made for both time periods and changes in traffic volumes for meaningful results.

Before and after data should reflect comparable time periods, preferably at least twelve months. When less than twelve months of data are available following implementation, the before data should be selected from the same months as the after data. For example, if after data are based on a period from October to March, the before data should be based on experience for the same months of the preceding year--or for the average of those months for several preceding years. For each location, or for each group of locations with similar characteristics and improvements, the change in accident experience is calculated and identified as:

Percent Accident Reduction =

$$\frac{\text{(Accident rate before)} - \text{(Accident rate after)}}{\text{(Accident rate before)}} \times 100$$

This procedure should then be repeated to identify changes in accident experience by types of accidents and severity of accidents. This will permit evaluation of the overall effect of the improvement. For example, the total accident rate may not have been materially reduced, but a significant decrease in severity of accidents will result in measurable overall benefits. On the other hand, a reduction in accident rate may produce little benefit if, for some unforeseen circumstance, the severity of accidents shows a marked increase.

Perform Tests of Significance. The statistical significance of the changes found in the MOE must be determined to find out whether the changes can be attributed to the safety improvement project or are due to other factors. The recommended statistical techniques are the Poisson test for accident frequency, the Chi Square test for count data, the t-test for continuous data and the F-distribution for variance.

Perform Economic Analysis. The original documentation to implement the safety improvement should have included an economic justification. Actual findings and updated costs will provide information concerning the validity of the original analysis.

The original premise was that each improvement was economically justified. Using the actual findings on reduction of accidents by types and severity along with updated data on accident costs and the costs of implementing improvements, it can be determined whether a wise decision was made. More importantly, the findings willhelp to make better decisions next year.

Two methods are recommended for conducting an economic analysis. These are the benefit/cost ratio and the cost/effectiveness methods.

Prepare Evaluation Documentation. This task provides for reporting of and review of the findings. It provides an overall evaluation of the effectiveness of the project and documents all the activites performed and results obtained during the evaluation.

Significance of Results

Before jumping to a conclusion about the merits of a particular improvement and its effectiveness in reducing accidents, it is necessary to take a second look at the data to determine how much confidence to place in the findings.

There is a certain degree of chance in all happenings. Just because a coin comes up heads seven times out of ten flips, we would not have much confidence in predicting 70 heads out of 100 flips. We are reasonably sure it is going to even out about 50-50 in the long run. But if it happened that heads came up 70 out of 100 times, the results would start to be significant--we would begin to believe the coin was unbalanced, or that something other than mere chance was controlling the happening.

The same thing applies to accident data. We would have little confidence in predicting great changes on the basis of one week's experience, or a month--or probably even three months. The more experience we observe the greater will be our confidence.

Suppose two locations had the accident experience shown below for period of one year before and one year after implementation of an improvement.

Location	Before Accidents	After Accidents	% Reduction
A	50	30	40
B	5	3	40

Even though both locations experienced the same percent reduction during the same period, we would have a great deal more confidence in the findings at location A than at location B.

Statistical tests can be employed to determine whether the results at a particular location or group of locations are truly statistically significant. Principal tests are the Poisson, t-test and F-test.

The Poisson distribution is recommended as the test to be used to determin whether the change in MOE can be attributed to the safety project. This statistical technique is an accepted method of testing the results of accident related projects. The test of proportions or t-test is recommended for testing whether the safety project has resulted in significant reduction in certain performance characteristics such as a reduction in speed. The F test is used to test for changes in the variance of before and after MOE distribution.

One of the key steps involved in performing statistical tests is determining the level of confidence by which statistical fluctuations will be measured -- in other words, determining the risk a decision maker is willing to accept. Results which are significant at the 95 percent level of confidence are more statistically reliable than those at 80 percent confidence levels. Results at both levels may offer valuable insights but the 95 percent confidence levels can be used with less risk and is generally considered an acceptable level of confidence.

The Poisson curves in Figure 5-11 are constructed to assure a 99, 95, 90 and 80 percent level of confidence that the indicated accident reduction was significant. This means that there is respectively only a 1, 5, 10, and 20 percent probability that the reduction occurred by chance.

Use of the Poisson Test. It can be observed from the Poisson curves in Figure 5-11 that the percent change required to achieve statistical significance increases with a decreasing number of accidents. This effectively limits the practical use of this technique to locations with high accident frequencies. Testing of results involves the following steps.

1. Obtain the value of the expected before accident frequency associated with each MOE and the percent change in the MOE.

2. Locate the point of intersection of the expected before frequency and the percent change on Figure 5-11. If the project is a high cost project (such as major reconstruction) compare this point to the curves for a level of confidence of 95 or 99 percent. If the project is a low cost project, compare the point of intersection to the curves for the 80 or 90 percent level of confidence.

3. If the point of intersection is below the curve, the change was not significant at the selected confidence level. For a high cost project, the evaluator should then compare the point with lower confidence limits and include these results in the evaluation report. Thus, the change in MOE may not be significant

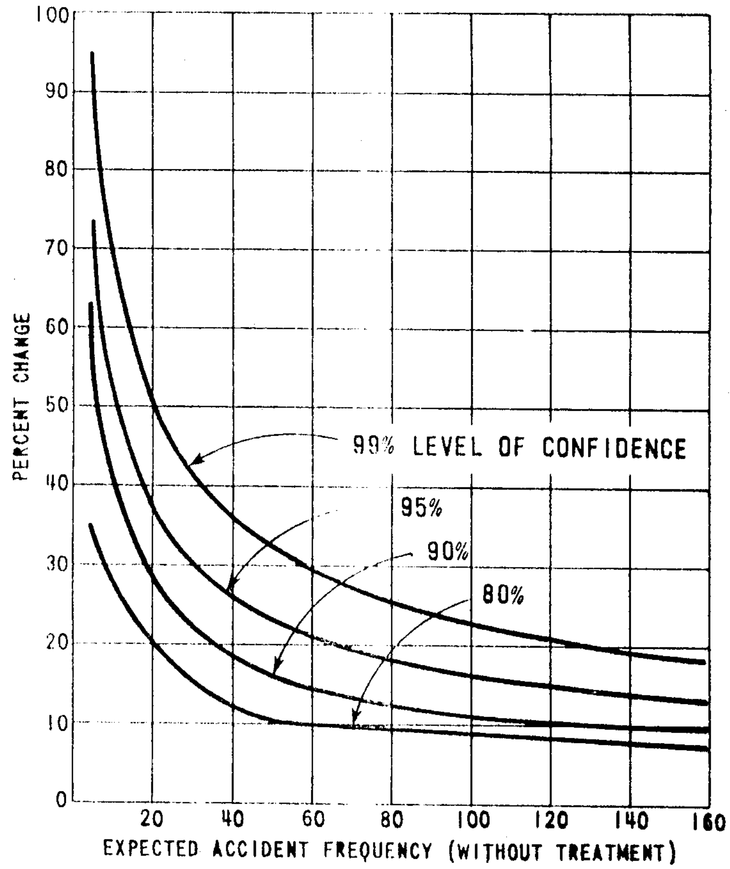


Figure 5-11 Curves for Poisson Test for Significance In Accident Reduction

at the 95 percent level, but significant at the 90 or 80 percent level.

4. If the point of intersection is above the curve, the change was significant at the selected confidence level and we conclude that the project was effective for the particular MOE being tested. The point of intersection should then be compared with the figures for higher confidence levels, and the results included in the evaluation report.

Evaluation of Your Traffic Safety Program

The entire traffic safety program should be evaluated periodically. It would be appropriate if such review were completed each year prior to preparation of the municipal or county budget. This evaluation should be in terms of:

Effectiveness. Are we getting results consistent with the defined objectives? Is there evidence of positive benefits? Are the expenditures economically justified?

Appropriateness of Objectives. Are current objectives appropriate? Have conditions changed or is there any indication of trends which would point to redirection of effort?

Criteria and Procedures. Based on experience, should changes be made in criteria and procedures for planning and implementing programs? Are the values used for forecasting still valid? Are the basic data on costs and benefits realistic? Is accident reporting of adequate quality and precision?

Legislators and top officials will have a principal interest in the first evaluation above--effectiveness. They have made a commitment to the program, established objectives and allocated resources for safety improvements. They should expect an accounting of the results--both costs and benefits. any they should know what to expect from future investments.

Those persons charged with responsibility for executing the safety program should have a keen interest in the third evaluation above--criteria and procedures. The effectiveness of future programs is dependent on reliable data, realistic criteria and sound decisions. There is a need continually to improve and refine the program management.

All levels of officials and management should have an awareness of changing conditions and of circumstances which might suggest changing the direction and scope of safety efforts.

Effectiveness

Resources have been invested in highway safety improvements. What did we get for our money?

Effectiveness is best measured in terms of:

- Increase or decrease in accident rates and accident severity at improved sites.
- Total reduction in cost of accident damage.
- Achievement of other project objectives.
- Economics - cost/benefits and cost/effectiveness.

This type of information should be summarized from actual experience data and present in graphical or tabular form.

- Are the cost estimates reliable for implementing improvements?
- Are the estimates of improved service life realistic?
- Is the interest rate appropriate for economic analysis?
- Are the analyses providing valid comparisons of costs and benefits?
- Are the priority indicators valid and realistic?

Implementation Effectiveness

- Are all available earmarked safety funds being utilized?
- Is the safety program adequately coordinated with other agency improvement programs?
- Is there any overlap of responsibility for planning and implementing safety improvements?
- Are various improvements being implemented in the most economical manner? By contractors? By agency work forces?
- Is the scheduling process effective? Are there problems with manpower utilization and meeting target dates?
- Should there be changes in the approach to funding safety improvements?

Evaluation Effectiveness

- Is all necessary information being documented accurately?
- Are the data on post-implementation accidents reported adequately?
- Are the tests adequate to assure that the results are significant?
- Are the tests adequate to assure that the results are significant?
- Do we have a reasonable level of confidence that the results were primarily attributable to the improvements?
- Are the actual benefits and costs or increases in effectiveness at each location reasonably close to our predictions? If not, why?
- Is there reasonable consistency in the results from one location to another?

Program Effectiveness

- Are the benefits identified with highway safety improvements sufficient to justify the investments in the program?
- Are there particular types of investments that are more productive than others?
- What is the total scope of the problem? Are we making progress?
- Is there need to adust the levels of funding or to change emphasis?
- Is top management getting the information they need for policy decisions?
- Based on experience, is there a need to update standards, guides, and criteria for planning safety improvements?
- Can improvements be made in the safety management system procedures?

6

SELLING YOUR TRAFFIC SAFETY PROGRAM

TORT LIABILITY

Law suits arising out of accidents which result from alleged defects in the street and highway system are a cost which should be seriously considered by local government. Even if the city or county is successful in defending itself, it will cost several thousand dollars. Avoiding the potential costs of tort claims actions may be helpful in successfully selling traffic safety improvements.

General guidelines which the courts have established in dealing with responsibility include:

1. The State is not an insurer of the roads or a guarantor of absolute safety.

2. The motorist has a right to presume and to act upon the presumption that a highway is safe for usual and ordinary traffic, either in the daytime or at night. He is not required to anticipate extraordinary dangers, impediments, or obstructions to which his attention has not been directed or of which he has not been warned.

3. Public highways must be maintained in a way that is reasonably safe for travel. What is reasonably? An acceptable definition is "that reasonable which is expected in a given circumstance." A road reasonably safe for travel is one which is maintained within accepted and understood criteria, under generally promulgated engineering standards, or subjected to generally promulgated engineering attitudes.

4. In maintaining the highways in a manner that is reasonably safe for travel, there is wide latitude in the exercise of administrative discretion, but continual supervision and inspection are axiomatic. It is in the area of this general principle that a noticeable connection exists between positive administrative attitudes and negligence cases.

5. The courts recognize modifying factors in establishing what is reasonably safe, among them the terrain encountered and traffic conditions.

6. Recovery is predicated upon more than the presence of hazardous conditions.

7. The authorities must provide proper safeguards or adequate warnings of such conditions--these warnings must be commensurate with danger. For example, an oil film on a highway

has been held to be more than a slippery condition and warning signs or speed advisory signs are necessary to alert motorists.

8. Negligence is predicated upon knowledge or information of the existence of a dangerous or defective condition and a subsequent failure to safeguard such condition.

General duties are the most important guidelines in protecting against liability suits. Basically, there is a duty to maintain the roadway in a reasonably safe condition. This would involve, in essence, inspection, anticipation of defects, and conformity with generally accepted standards and practices. There is no requirement for perfect condition or repair or for actions "beyond the limits of human ingenuity."

The key term is reasonability. There are many factors upon which a determination of what is reasonable may be based; among them, the character of the roadway in question, the width and construction of the road, the slope or descent of the banks when the road is elevated, the direction of the road, whether or not the condition is obvious or hidden, points of ingress and egress, especially where there is a grade change, and traffic conditions.

Notice of Defects and Complaints

The most basic feature of tort claims cases is negligence on the part of the agency employee. Characteristically, these actions claim failure to respond to complaints or failure to respond in a reasonable period of time. Thus, the approaches to minimizing claims involve rapid and orderly response to complaints along with maintenance of adequate records to document the actions taken. These records should include:

1. Who reported the defect or made the complaint.
2. Time it was received by the dispatcher.
3. Time it was given to the repair crew.
4. Time crew responded.

5. Time repair was completed.

6. What trouble was found, including that found by maintenance persons.

7. What repairs were made.

8. What materials were used.

Based on complaint history and/or high accident experience, sites should be selected periodically for critical review. Both basic design and traffic control elements should be reviewed in the field. If possible, interviews with persons who have field complaints should be conducted. Often, rather minor improvements can result in substantial improvement in the safety record of a location.

Also, remember that repeat accidents, particularly of a similar type, can be construed as notice of an existing hazard.

Remember that while design immunity may exist, a court may consider it waived when there is a notice of a design feature that has become obviously or manifestly dangerous following its adoption. Courts have repeatedly held that if the design is one so obvious that a reasonable man would not have approved its use, then the agency may be held liable.

Jurisdictions recognize an exception to design immunity where the hazard is permitted to remain after the public has given reasonable notice that the defect is a source of danger. Once the city has notice that a design, under changed conditions, has resulted in a dangerous condition of public property, it must act reasonably to correct or alleviate the hazard.

Work Zones

Work zones present special traffic safety problems. Construction, maintenance, or other work on or adjacent to traffic lanes present conditions which are outside of the drivers' normal expectations. The

Federal Highway Administration's Technology Sharing Report, "Traffic Control in Construction and Maintenance Work Areas," is a valuable source of information. The Texas Engineering Extension Service also conducts a short course on this topic. Information may be obtained by contacting the Public Works Training Division at (409) 845-2911.

Standard and Accepted Practice

Individuals concerned with traffic control must be familar with the Manual on Uniform Traffic Control Devices (MUTCD) and sound traffic engineering practices.

Making the System Work For You

Local traffic safety improvements must compete with a variety of other demands on the city or county budget. Success will depend on a number of factors including your skill in working within the political system and effectively making your case.

City councils and county commissioners courts are policy oriented. In most instances one is more effective when presenting such groups with a set of well-defined alternatives rather than a "this is what you must do". The latter approach essentially leaves them with the choice of doing as they are told, doing nothing, or perhaps formulating their own program without the benefit of technical advice. Very often it will be one of the latter two options.

A technique that has been found to be effective with elected and appointed officials is to arrange a tour of "good and bad" examples within your urban area. Careful explanation of the good and bad features of each location will provide a basis for better appreciation of the need for various safety improvement and, more importantly, the knowledge that funds will be most effectively invested. A futher benefit of such periodic tours is that it is often possible to avoid creating situations which will become traffic problems or hazards later on. The ability to relate the proposed situation to an existing one provides a basis for effective communication.

Working relationships with other city staff, especially engineering, planning, public works, and police, is essential. In most if not all cases, what is good from a traffic safety standpoint is also good engineering practice and vice versa.

Once policies and standards which foster traffic safety are included in the comprehensive plan and/or embodied in ordinance, it provides elected or appointed officials with a means of withstanding pressure from vested interests.

Continued public support from elected and appointed officials, as well as the public at large, is essential to an effective traffic safety program. Local governments are faced with demands for services increasing faster than revenues. In this fiscal environment the success of the traffic safety administrator is likely to be directly related to 1) the quality of the information provided, and 2) the effectiveness in communicating this information to the public and their government representatives.

CITIZEN PARTICIPATION

The public hearing is the common method of obtaining citizen involvement. For a variety of situations it is required by state law. However, is not an effective means of achieving general citizen participation or broad-based public support. Commonly, only those individuals which have a strong personal or vested interest attend public hearings. On occasion, a public hearing results in uninformed participation of persons who attended the meeting for some other agenda topic. The public hearing is therefore a poor method of obtaining citizen participation and of gauging broad based public opinion.

A brief description of various methods of citizen participation and public information follow. A summary identifying the application of each is given in Table 6-1.

TABLE 6-1 SUMMARY OF APPLICATION OF TECHNIQUES

Techniques	Representative of General Public		Audience				Utilization								
	Yes	NO	General Public	Selected Public	Public Officials	Professionals	Public Inforamtion	Citizen Groups to Influence Public Officials	Gather Information	Obtain feedback	Evaluate Problem	Select Alternative	Annual Program	Major Improvement Affecting General Public	Major Improvement Affecting Specific Area
Public Hearing		X	X				X								
Administrative Commission		X			X		X				X	X			
Advisory Committee		X			X			X	X	X	X				
Neighborhood Meetings		X		X			X	X	X	X	X				X
Sample Survey	X		X				X		X		X			X	X
Focus Group	X		X	X			X		X	X	X				X
Civic/Church and other Organizations		X		X			X		X	X					
News Media															
- news release			X				X						X	X	
- public service announcement			X				X	X						X	
- paid advertisement			X				X	X							
Newsletter			X	X	X	X	X	X					X	X	X

Administrative Commissions

All municipalities have a number of standing commissions which have direct or indirect relationships to traffic safety. Special efforts should be made to work closely with the following and to inform them on safety issues.

Planning and Zoning Commission (P&Z)

Planning and zoning actually involve two separate functions - an administrative function with respect to planning and an advisory one in regard to zoning. They are highly related and most municipalities combine these activities under a single appointed commission. Because of the work load, large cities often have a Planning Commission and a separate Zoning Board. Both have implication in regard to traffic safety.

A planning commission has the following responsibilities which will influence traffic safety:

- Development of the comprehensive plan-including a thoroughfare plan element and development policies.
- Recommendation of the comprehensive plan for council adoption -including policies for development and access management along arterial streets.
- Recommendation of changes in the subdivision ordinance - including such traffic safety considerations as minimum lot size for direct access to arterial streets, subdivision design requirements, separation to avoid "jog intersections," provision of bicycle and pedestrian facilities, etc.
- Approval of subdivision plots.
- Approval of conditional use request.
- Approval of site development plans, or consideration of appeals if site plan approved rest with the city staff.

Zoning is a legislative function. Therefore, the city council must act on all requests for changes in zoning, and pass an ordiance ammending the Official Zoning Map. These requests are first considered before the Zoning Board (or a joint Planning and Zoning Commission) which makes favorable or unfavorable recommendations to city council. This offers an opportunity to formally address problems relating to traffic safety such as:

- Will the zoning change result in a large volume of traffic?
- Is the site adequate in view of size, shape, and location to safely accommodate more traffic and parking, or will the change reduce an existing problem?

The Zoning Board also is the place to initiate proposed changes in the zoning ordinance which can improve traffic safety.

Zoning Board of Adjustment (ZBA)

The Zoning Board of Adjustments is a quasi-judicial body. Its decisions are not subject to review by the city council or administrative commission; appeals are made directly to a State District Court. Its functions are to: 1) interpret the zoning, subdivision, and related development control ordinances in event of a conflict or confusion as to meaning, and 2) grant exceptions to the application of these ordinances due to hardship to the land (not financial hardship to the owner or developer). In some cities, ordinances also specify the ZBA as the body to which all appeals for exception from various development ordinance requirements are addressed.

In many cases, a ZBA elects to make decisions which have traffic safety impacts whether they are within their jurisdiction or not. However, since a ZBA decision is appealable to a State District Court only, it behooves the traffic safety professional to make a special effort to be aware of matters being brought before the ZBA and to carefully explain any traffic safety matters.

Advisory Committees

Appointees to commissions, committees, and task forces are individuals known to elected officials who have an interest in and/or are knowledgeable about the problems being considered by the group to which they are appointed. Such groups may or may not represent broad-based citizen viewpoints.

Permanent Safety Committee

A safety committee is generally appointed by and serves in an advisory capacity to the city council. In medium-sized and smaller municipalities, the safety committee generally has broad-based jurisdicition related to police, fire, and other public safety concerns in addition to traffic safety. In large cities, a committee having specific responsibility for traffic safety is desirable because of more numerous and complex problems.

Because of the continuing nature of safety-related issues, a standing committee or commission responsible for traffic safety should be organized. At least some members of the committee should be selected for their technical expertise in Traffic Engineering. Appointment should be made by the city council. A formal swearing-in ceremony before the city council should be followed by seating members to promote the importance and visability of the committee and its relationship to the city council. The chairman will be the principal contact between the committee and the city council and city staff. He or she must have ready access to elected and appointed city officials if the group is to be effective. Therefore, the chairman should be appointed by the city council, rather than by the safety committee membership.

If a safety committee is to be successful, especially a standing committee, the following are essential:

1. A clear statement of role, responsibilities, and authority.

2. A specific relationship with all city staff -- especially such positions as traffic safety coordinator, city engineer, traffic engineer, public works direction, and planning direction.

3. Appointment of chairmen who have, or can establish, an effective working relationship with elected and administrative officials of local government.

4. Appointment of members who have the capability to dilligently study and understand traffic safety problems.

5. Adequate professional staff support to enable committee members to understand various technical matters, provide information, and prepare technical documentation on the committee's behalf.

6. The support of elected officials and influence upon their decisions in traffic safety-related matters. Ignoring the committee's authorities and repeatedly failing to endorse and implement its recommendations will quickly demoralize committee members.

7. Members should be appointed for a specific period with overlapping terms to provide continuity.

Ad Hoc Committee

An Ad Hoc Committe or task force on traffic safety (or other topic) is most appropriate in:

1. Dealing with specific technical or policy issues which are of transitory concern.

2. Assisting in identifying the best manner for addressing a long-term problem and in defining the scope, role, and authority of a permanet committee or commission to be appointed by elected officials.

Because such a committee, or task force, is specific-issue oriented and transient in nature, the appointment of individuals having specific knowledge and skills, rather than a broad-based representation of the population, is appropriate.

Neighborhood Meetings

Neighborhood meetings might be used effectively to explain situations of various complexities to residents of a defined area and to obtain discussion and feedback on potential solutions. Meeting topics should be of concern to specific neighborhoods (such as modifications of the street pattern to discourage through traffic) for which meetings are held. When an issue is of city-wide concern, a series of meetings might be held for different neighborhoods.

Problems with the use of neighborhood meetings include:

1. Establishing contact with all residents of the target area is difficult and time consuming, unless there is an up-to-date city directory or a strong, active neighborhood association.

2. Attendance at the meeting is likely to be low unless there is unusual interest and concern.

3. Persons from outside the neighborhood may attempt to "take over" the discussion.

Survey of Citizen Attitudes

Surveys of citizen attitudes and concerns are advantageous because statistical inferences can be made for the public at large. Such data are often very effective when dealing with issues on which some individuals have preconceived solutions, when participation at a public hearing becomes emotional, or where a measure of public awareness or preference is needed for policy decisions. The following is a sequence of steps which should be followed:

1. Identify the problem and define specific objectives.

2. Formulate survey questions and design the survey instrument.

3. Prepare instructions for interviews.

4. Perfect the survey instrument and revise as necessary (pretest again if substantial revisions are made).

5. Identify the population to be surveyed.

6. Select the sample.

7. Administer the survey.

8. Tabulate and analyze the results.

9. Draw inferences and prepare documentation.

Telephone surveys offer the advantage of being relatively inexpensive. Selection of the sample from the telephone book will result in statistical bias; however, since most dwellings in Texas have phones, the bais is not likely of practical significance. Another survey method is sending forms out with the monthly utility billing. In this case, care should be taken to determine whether reponses from different parts of the city are in proportion to the number of residents. Home interviews are the most expensive survey method; their cost is rarely justified by the improved quality of the data.

For the purpose of explaining the statistical analysis and inference, consider the following statement and the tabulation of responses received.

> The number of frequency of direct access driveways to Texas Avenue and other arterial streets should be severly limited.

Strongly Agree	Agree	Disagree	Strongly Disagree	No Opinion, No Response
29	38	17	9	11

The use of Binomial Proportions requires that the responses be divided into two, and only two groups. In this case it was decided to set confidence limits on the "agree catagory". Thus, the agree and strongly agree are added together, so:

n_p = 29 + 38 = 67

n_p = 17 + 9 + 11 = 37

n = total sample size = 104

Where n_p = number responding "yes"

n_g = number responding other than "yes"

The confidence limits on the proportions, p, are:

$$CL = p + t\sqrt{\frac{pq}{n}}$$

Where: CL = the confidence limits for a specific percent confidence

p = ng/n

q = ng/n = 1 - np/n

n = the total sample size

t = the statistic of the standard normal curve for the selected confidence statement is t = 1.645 for 90 percent confidence and to 1.96 for 95 percent confidence.

The 95 percent confidence limits are then computed as:

p = 67/104 = 0.644

g = 1 - p = 0.356

$$CL\ 95\% = 0.644 \pm 1.96\sqrt{\frac{(0.644)\ (0.356)}{104}}$$

$$= 0.644 \pm (1.96)\ (0.04695)$$

$$= 0.644 \pm 0.0.92$$

Upper 95% CL = 0.736 , say 0.55

Lower 95% CL = 0.552 , say 0.74

Thus, based on the sample survey it can be stated that there is a 95 percent chance that the actual percentage of the population in favor is between 55 and 74 percent; there is at least a 97 percent (97.5 percent) chance that at least 55 percent of the population favors limiting direct access to Texas Avenue and other arterials.

Focus Groups

The technique of using focus groups has been applied to a variety of policy issues such as transit fares and service structure. Its application in traffic safety might include: identification of the public's concerns regarding different traffic safety problems, preference as to mutually exclusive alternative traffic safety improvements, changes in local traffic ordinances, administration, and/or enforcement, and the potential acceptance of traffic safety measures.

A focus group should be a smaller number of individuals selected at random from the population of interest. For example, a focus group to deal with municipality-wide traffic safety issues would be selected to represent the total population. A focus group concerned with accident reduction might be drawn from individuals involved in a reported accident within the past year or two. The first step is to identify the appropriate population for the issue involved. Individuals are then chosen using a random selection procedure so that inferences can be made relative to the population based upon results obtained from the focus group. Materials including the topic or topics to be covered, nature of the involvement and the date, time and place of each meeting are mailed to each individual. Those invited to participate in the focus group are sometimes paid for their cooperation.

After introductions and explanations of how the session will be conducted, participants are presented with adequate background information to understand the problem or topic. The participants are then left to organize themselves, discuss the problem and arrive at conclusions and recommendations. Staff persons are available to answer questions and observe and record the deliberations of the group. However, the staff should not allow themselves to become involved in the group's discussion in order to avoid biasing or influencing their conclusions.

Sessions are relatively long (usually three or four hours); however, a particular group may meet more than one time. Focus groups dealing with transit fare and service issues usually involve only one session.

Focus groups have been successful in situations where concentrated, intense involvement is essential in obtaining constituent response to a specific issue. When statistically sound sampling procedures are followed in selecting individuals, statistical inferences can be made regarding the community from which focus group members are drawn.

Civic Groups, Churches, and Other Organizations

In all municipalities there are a variety of associations and organizations which might be helpful in developing awareness of traffic safety problems. These, and the nature of their potential involvement include:

Chamber of Commerce

Many business and financal leaders of a community belong to the chamber of commerce. Thus, their organization presents an excellent forum to:

- Help develop a general awareness of traffic safety and support for a traffic safety program.
- Explain the traffic safety problem and nature of countermeasures at specific hazardous locations, especially in or adjacent to commercial areas.
- Stimulate improved design for access and on-site parking and circulation of commercial development.
- Explain the nature of traffic problems on existing arterial streets and the types of improvements that can be made to improve traffic flow and traffic safety.

Homeowners Associations

Some established residential areas have active homeowners associations. These can be convenient focal points in dealing with traffic safety problems which affect the specific residential area.

Service Clubs

Various clubs, such as the Lions, Kiwanis, etc., provide a forum for explaining and discussing a wide range of traffic safety issues. Because they undertake a variety of civic service projects, they may also be a source of assistance when a number of people are needed to collect specific data such as turning movements, manual classification and/or pedestrian counts and funds are not available to employ others.

Scouts

Both the Boy Scouts and Girl Scouts engage in public service projects. A scout working on his Life Scout or Eagle Scout service project may help organize younger scouts to assist in a variety of data collection. On occasions, the entire Boy Scout Troop, Girl Scout Troop, or Explorer Scout Post undertake community service projects. Some units conduct a major service project each year; the majority welcome invitations to do service projects within their capability. Scout units are an effective organization and promote participation. Consequently, training and supervision for routine data collection is easy to accomplish.

Church Groups

Some churches have strong neighborhood identity. In these cases, the church leadership can be instrumental in developing support for countermeasures needed to mitigate a traffic safety problem in proximity to the church or in the neighborhood.

News Media

A good relationship to the local news media is essential to a traffic engineering and traffic safety program. A good personal contact and professional relationship should be established with each newspaper, radio station, and TV station providing local coverage. Public TV stations are often very interested in topics of public concern for inclusion in their local programming. This coverage presents a forum for much greater detail than inclusion in the local evening news.

Prior to any interview you should:

1. Find out the format of the interview, the amount of time for the interview, and whether the interview will be live or taped for broadcast at a later time.

2. Clearly define the specific objective that you wish to achieve through the interview.

3. Outline the information to be covered in detail; rehearse the material.

4. Arrange to discuss the problems and the technical content with the interviewer before the interview actually takes place. Suggest appropriate questions which will cover the material you need to present in order to meet your objectives. Know the questions beforehand; don't get caught off guard and embarrass yourself and the interviewer--especially on a live broadcast.

5. If on TV, have appropriate, yet simple and attractive visual aids. Make your interview look professional.

If the message is to be given by a member of the media, give them a typewritten text which contains the detailed information needed to effectively get your message across. For TV, provide them with attractive visual aids--it makes them look good and helps communicate your message.

To assist the printed media and help ensure that the correct information is reported, prepare a typewritten text and keep a copy for your files. Study the style of the newspaper in which the article will appear and write your text in the same style. You know the information better than anyone else; besides, the reporter may have other articles to prepare. Attach appropriate photographs, maps, or sketches which will attract the readers attention and help get your message across.

If the information needs to be on radio or TV or appear in the newspaper at a particular time, get with the media people well in advance. Prepare your material early whenever possible and make arrangements for them to schedule your message.

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REFERENCES

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